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(54) **Sealing device**

(57) A device (10) for sealing a leak in a vessel comprises a sealing member (12), means (16) for locating the sealing member adjacent a leak in a vessel wall and actuating means (14) for pressing the sealing member against the vessel wall to seal the leak.

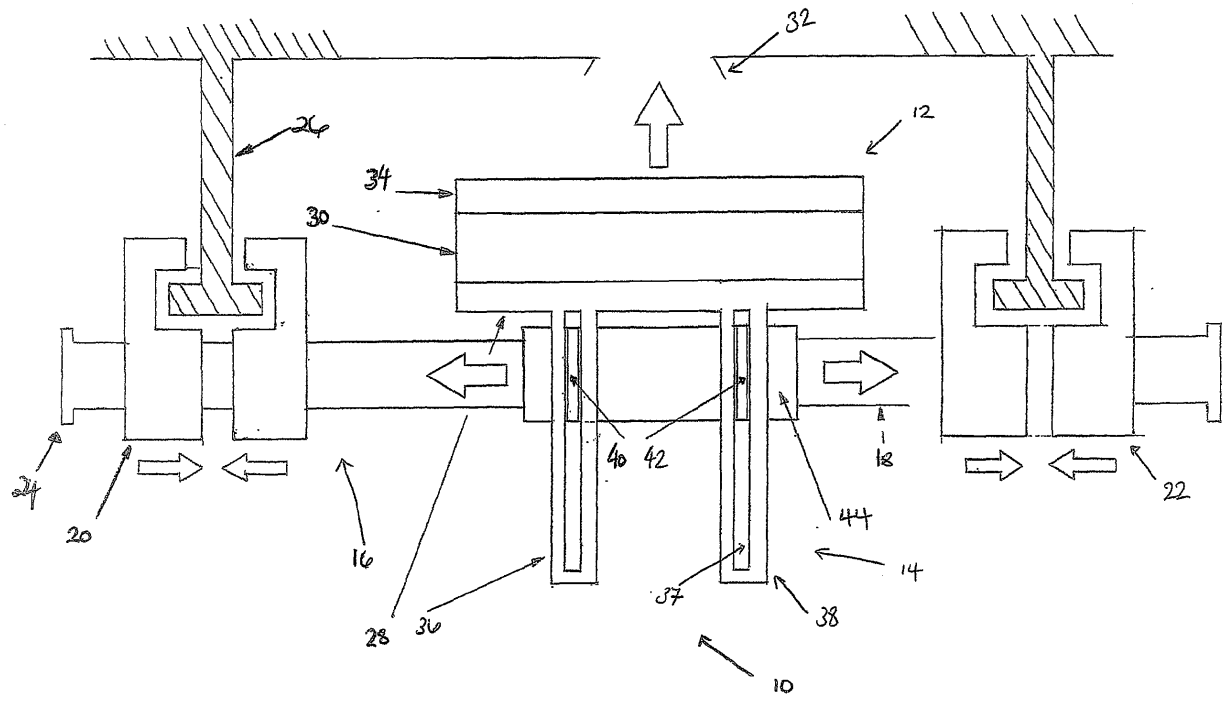

FIG 1

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Description

FIELD OF THE INVENTION

[0001] This invention relates to the field of stopping leaks in vessels. In particular the present invention relates to preventing and sealing leaks in ships and boats. The present invention also relates to methods of sealing leaks in vessels.

INTRODUCTION

[0002] Boats and ships include a hull portion, a section of which typically lies below the water line. Any breach of the hull portion can result in a leak which must be dealt with as quickly as possible to minimise water entering the ship. If a leak is not sealed quickly enough, sinking can become a possibility.

[0003] Numerous strategies are employed to reduce hull breaches and limit vessel losses due to sinking. For example, in some ships, the hull can be divided into a plurality of watertight sections which limit the spread of water throughout the hull.

[0004] In addition, or as an alternative for smaller ships or ships where sufficient compartmentalisation of the hull is not feasible (e.g. large sections are required to house machinery or cargo), temporary methods of sealing a hull breach or leak may be employed.

[0005] One such sealing method is the use of a plate lowered onto the outer face (i.e. waterside) of a ship's hull and held in place by a series of ropes and pulleys as disclosed in US 4,712,502. However, this and similar devices have the disadvantage that they require significant manpower during installation. Additionally, where the vessel is a ship, the personnel installing devices of the prior art are exposed to the elements and possibly considerable danger during installation.

[0006] A hull breach or leak may also be sealed from the inside of the vessel, however these methods require the actuation of force against the flow of incoming water, which can be considerable. Such methods also typically require a large amount of manpower and are prone to failure and/or crew injury caused by the constant pressure of incoming water.

[0007] There is therefore a need for improved means of sealing leaks in vessels which facilitate rapid and efficient sealing of a leak in the vessel wall.

SUMMARY OF THE INVENTION

[0008] In one aspect the present invention provides a device for sealing a leak in a vessel, the device comprising:

a sealing member;
means for locating the sealing member adjacent a leak in a vessel wall; and
actuating means for pressing the sealing member against the vessel wall to seal the leak.

[0009] In one embodiment the sealing member comprises a support plate. Optionally, the support plate is substantially planar but may be formed in any shape to complement the contours of the vessel wall. The support plate may comprise any suitably durable material such as metal, metal alloy, plastic or wood.

[0010] Optionally, the sealing member comprises a deformable portion which may be mounted on a surface of the support plate nearest to the vessel wall in use.

[0011] The deformable portion may be mechanically mounted in position on the support plate. The deformable portion may be realisably mounted on the support plate by securing means.

[0012] Conveniently, the deformable portion is mounted on the support plate using an adhesive. Other suitable means of mounting the deformable portion on the support plate include, but are not limited to, clips, bolts, pins, loops and Velcro ™

[0013] The at least one deformable portion is preferably a deformable layer. The deformable portion may be shaped to complement the shape of the support plate or may be longer, wider and/or deeper than the support plate. The deformable layer may comprise any suitable deformable or compressible material such as foam, rubber, polystyrene and the like.

[0014] Optionally, the sealing member also comprises at least one resilient portion which is mounted on the support plate. Alternatively, if a deformable portion is present, the at least one resilient portion is mounted on the deformable portion. Optionally, the resilient portion is mounted on the support plate or the deformable portion using adhesive. Other suitable means of mounting the resilient portion on the support plate or the deformable portion include, but are not limited to, clips, bolts, pins, loops and Velcro ™

[0015] Preferably the resilient portion is a layer and comprises any suitably resilient material such as rubber, extruded sheet plastics, silicon, silicon rubber, synthetic plastics and the like.

[0016] Optionally, the resilient portion is the same width and length as the deformable portion, if present, or the support plate. Conveniently, the resilient portion may be wider, longer, deeper and/or thinner than the deformable layer and/or the support plate.

[0017] Optionally, the sealing member comprises a laminate structure including a support plate, at least one deformable portion and at least one resilient portion.

[0018] Optionally, the sealing member may include more than one deformable layer and/or more than one resilient layer. Preferably the deformable layer and the resilient layers are alternated. Preferably, a resilient layer contacts the vessel wall to seal the leak in use.

[0019] Preferably, the sealing member is shaped to be complementary to the contours of the vessel wall interior. Preferably, the sealing member is substantially planar. In some embodiments, the sealing member is curved or

arcuate.

[0020] Conveniently, the resilient portion and/or the deformable portion may be the same shape as the support plate. Optionally, the deformable portion and/or resilient portion may be of variable thickness and selected to enable the sealing device to accommodate debris present on the inner hull surface at and/or near the breach site.

[0021] In one embodiment, the sealing member further comprises at least one guide member connected to a surface of the support plate opposite to the surface of the support plate on which the deformable portion and/or resilient portion are mounted.

[0022] Optionally, the support plate comprises a plurality of guide members.

[0023] Conveniently, the at least one guide member may be releasably connected to the support plate.

[0024] Each guide member may be engageable with a complementary receiving means provided on the actuating means.

[0025] Preferably, the actuating means comprises a receiving means which may be engageable with the guide member of the sealing member.

[0026] In one embodiment, the at least one guide member comprises an elongate member with a slot engageable with a complementary projection receiving means such that the guide means moves along the receiving means. In another embodiment the guide member comprises a tubular or elongate member which slides inside U-shaped, C-shaped or hollow receiving means provided on the actuating means.

[0027] Preferably, at least one guide member is connected to the support plate at a point above the level of the actuating means and at least one guide member is connected to the support plate at a point below the level of the actuating means.

[0028] Conveniently, the actuating means comprises a sleeve slideably mounted on the locating means. Optionally the sleeve is circular, rectangular, square or oval in cross section.

[0029] Preferably, each actuating means and sealing member includes equal numbers of guide members and receiving means.

[0030] In one embodiment, the actuating means further comprises at least one lever. Preferably, the at least one lever includes a handle and a connecting portion where the connecting portion is coupled to the sealing member, preferably the support plate. Preferably, the connecting portion of the at least one lever is pivotally connected to an outer surface of the support plate. Optionally the lever handle is pivotally coupled to the connecting portion. Optionally, the lever includes a cog and ratchet mechanism. Alternatively, the lever includes a screw threaded mechanism.

[0031] In another embodiment, closing guides are mounted on the sleeve. Closing guides may act to prevent any bending or contortion of the lever during movement and can act to direct movement of the lever. Preferably, the closing guides project from a surface of the sleeve to support the lever and/or are selectively engageable with portion of the lever during use. Preferably, the closing guides contact either the connecting portion or the handle portion. Optionally, more than one closing guide is present on a sealing device of the present invention.

[0032] Conveniently, operation of the actuating means by movement of the at least one lever moves the sealing member towards the leak site such that when sealing a leak, the sealing member is pressed against the leak site.

[0033] Optionally the lever is hydraulically operated, motor operated or spring loaded.

[0034] In a preferred embodiment, the actuating means includes a locking means to hold the sealing device in a sealing position against the leak site. Optionally, the locking means includes a locking pin provided on the sealing device and an aperture present within the lever. Preferably, the locking pin is received by the aperture present on the sealing device.

[0035] In one embodiment of the present invention, the locating means comprises a support member fixed at a chosen location within the vessel. Optionally, the locating means includes a support member which extends across the vessel interior and contacts the interior wall of the vessel at at least one location, preferably at two locations. Optionally, the support member is positioned within the vessel substantially parallel to the leak site and spaced away from the leak site.

[0036] Optionally, the support member is a longitudinal brace. The support member may be any shape in cross section, such as but not limited to, rectangular, T-shaped, H-shaped, square, U-shaped, C-shaped, circular, oval or other suitable shape. The support member may comprise any suitably durable material such as metal, plastic, wood or metal alloy.

[0037] In some embodiments, the locating means is adapted to accommodate interior projections extending from the vessel's interior surface. For example, where the vessel is a ship, the hull is typically fabricated in U-shaped sections which are welded or bolted together to form the hull. At the edges of the connected sections the hull projects inwardly. Thus, the interior hull surface is divided into a series of sections edged with inwardly facing projections or an internal framework. Typically, the projections are T-shaped or P-shaped in cross section.

[0038] In a preferred embodiment, the locating means further comprises at least one clamp adapted to engage sections of the vessel internal framework and the support member. The at least one clamp is adapted to receive the support member and to hold the support member at a spaced position relative to the vessel wall.

[0039] Preferably two or more clamps are used per support member.

[0040] Optionally, the clamp includes at least one clamping surface. Optionally, the at least one clamping surface includes serrations, teeth, indentations, projections or the like to increase gripping between the clamp

and the vessel interior.

[0041] In a second aspect of the present invention, there is provided a method of sealing a leak in a vessel comprising the steps of:

a) mounting a sealing member within the vessel
b) locating the sealing member adjacent the leak site; and
c) forcing the sealing member against the leak site to seal the leak.

[0042] Preferably, the sealing member is forced against the leak site by operation of an actuating means.

[0043] Embodiments of the present invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Fig. 1 is a diagrammatic representation of a sealing device according to one aspect of the present invention;
Fig. 2 is a side view of a sealing device of Fig. 1;
Fig. 3 is a rear view of an actuating means;
Fig. 4 is a top view of an actuating means of a sealing device in a closed position;
Fig. 5A is a bottom view of an actuating means;
Fig 5B is a cross section view of the actuating means of Fig. 5A;
Fig 6 is a diagrammatic representation of a lever for pressing a sealing member according to one embodiment of the present invention;
Fig 7A is a rear view of the lever of Fig 7B;
Fig. 7B is a diagrammatic representation of an alternative lever for pressing a sealing member according to one embodiment of the present invention;
Fig. 8 is a diagrammatic representation of an arrangement of a sealing device using two sealing device to seal a leak;
Fig. 9 is a diagrammatic representation of various support members;
Fig. 10 is a diagrammatic representation of a clamp;
Fig. 11 is a diagrammatic representation of a further clamp;
Fig. 12 is a diagrammatic representation of a clamp closing means;
Fig. 13 is a schematic plan view of a further alternative clamp;
Fig. 14 is a diagrammatic representation of an alternative connection mechanism between the actuating means and the sealing member of the apparatus;
Fig. 15 is a schematic plan view of a further alternative clamp;
Fig.16 is a schematic side view of the clamp of Fig. 15, and
Fig. 17 is a schematic front view of a rotation plate of the clamp of Fig. 15.

DETAILED DESCRIPTION OF THE INVENTION

[0044] Fig. 1 depicts a sealing device in accordance with one embodiment of the present invention where the device is positioned within the hull of a ship.

[0045] A sealing device 10, comprising a sealing member 12, an actuating means 14 and a locating means 16, is located within a vessel. Locating means 16 comprises an elongate support member 18 connected to interior projections from the vessel wall by clamps 20 and 22. The support member 18 may be any suitable shape in cross section, for example but not limited to H-shaped, circular, rectangular, square, oval and the like (Fig. 9). Support member 18 may be hollow to reduce the weight of the support member. Support member 18 may be made of any durable material such as metal, metal alloy, plastics or wood.

[0046] Clamps 20 and 22 mounted on support member 18 hold support member 18 in a designated location within the vessel interior. Clamps 20 and 22 may be adapted to clamp to T-shape projections 26 within the vessel interior. Support member 18 includes end terminal flanges 24 to prevent dissociation of the support member 18 from clamps 20 and 22.

[0047] As discussed below, clamps 20 and 22 may be adapted to accommodate different shaped projections extending from the vessel wall interior. As shown in Fig. 1, clamps 20 and 22 are adjustable to accommodate different sized projections and to ensure the clamps may be tightened against the projection.

[0048] The sealing device 10 comprises sealing member 12. In the embodiment of Fig. 1, sealing member 12 comprises an outer support plate 28. Support plate 28 is substantially planar and is formed of a durable material capable of withstanding force exerted upon it by the actuating means and the force of incoming fluids entering the vessel from the leak site. Preferably, support plate 28 comprises a layer of lightweight and durable metal, metal alloy or plastic.

[0049] A deformable layer 30 is mounted on one surface of support plate 28. The deformable layer 30 typically comprises a layer of foam or other mouldable material. The deformable layer 30 preferably covers the outer surface of support plate 28 and may extend beyond the outer edges of the support plate 28. For example, the deformable layer 30 may be wider and/or longer than the support plate 28. In the illustrated embodiment, deformable layer 30 is substantially thicker than support plate 28 and is of suitable thickness to accommodate debris 32 on the vessel wall interior. As would be appreciated by the person skilled in the art, the deformable layer 30 can be of any suitable thickness to accommodate the debris at any given leak site. In the illustrated embodiment, the deformable layer 30 is mounted on the support plate 28 using a water insoluble adhesive. Any other means of mounting the deformable layer 30 may be used such as bolts, pins, straps and the like.

[0050] A resilient layer 34 is mounted upon deformable

layer 30 such that the deformable layer 30 is sandwiched between the support plate 28 and resilient layer 34. Resilient layer 34 forms the innermost surface of the sealing member 12 and contacts the leak site to seal off the leak site when in use. Resilient layer 34 comprises a layer of rubber or other water resilient material. In the embodiment of Fig. 1, resilient layer 34 is thicker than support plate 28. However, as would be appreciated by the person skilled in the art, the depth of resilient layer 34 can be designed to accommodate different types of leak. For instance, where a leak is in a ship below the water line the resilient layer may be designed to be very thick to ensure a strong enough seal may be formed against the force of water entering the vessel at the leak site.

[0051] Resilient layer 34 may be of the same or different depth than the deformable layer 30 and/or support plate 28 i.e. the resilient layer 28 may be thicker or thinner than the deformable layer 30. Resilient layer 34 typically covers the whole of the outer surface of the deformable layer 30 and may extend beyond the outer edges of the deformable layer 30. Typically, the resilient layer 34 is the same width and length as deformable layer 30, although it may be longer, shorter, wider and/or narrower than the deformable layer 30.

[0052] Sealing member 12 further comprises guide members 36 and 38 connected to a surface of the support plate opposite to the surface of the support plate on which the deformable layer 30 is mounted. As shown in Fig. 2, guide members 36 and 38 may be detachable from support plate 28 or may be integral to the support plate 28 as shown in Fig. 1. Suitable means of detachably connecting the guide members 36 and 38 to support plate 28 include bolts and screws, pins and quick release mechanisms known to the person skilled in the art.

[0053] Guide members 36 and 38 comprise an elongate member with a central aperture 37 provided therein extending substantially along the length of the elongate member 36, 38. As would be appreciated by the person skilled in the art, the central aperture 37 may be replaced by a central slot or recess, or may be absent. The guide members 36 and 38 may be formed of any suitable material and are preferably formed from the same material as the support plate 28.

[0054] The sealing device 10 further comprises actuating means 14. In the embodiment shown, the actuating means comprises a rectangular sleeve 44. Circular, square, oval, hexagonal or other shaped sleeves may be used. Sleeve 44 includes a central opening (not shown) adapted to receive support member 18 such that sleeve 44 is slideably mounted on support member 18. Sleeve 44 may comprise any suitably durable material capable of withstanding forces exerted thereon during use and which permits smooth movement of the sleeve along support member 18. Suitable materials include metals, metal alloys, wood and plastics.

[0055] In the embodiment shown in Fig. 2, guide members 36 and 38 comprise elongate members with a longitudinal slot adapted to receive receiving means 40 and 42 such that the sealing member is moveable along the axis of the longitudinal guide members as shown by arrows A and A' in Fig. 2.

[0056] Fig. 3 is a side view of the actuating means 14 of one embodiment of the invention. Sleeve 44 is slideably mounted on support member 18. Levers 46 and 48 are pivotally mounted on a surface of sleeve 44. As shown in Fig. 4, levers 46 and 48 comprise handle portions 50 and 52 and corresponding connecting portions 54 and 56. Connecting portions 54 and 56 are pivotally coupled to handle portions 50 and 52. Connecting portions are further pivotally coupled to the same surface of support plate 28 upon which guide members 59 and 61 are mounted. In the embodiment shown in Fig. 4, guide members 59 and 61 comprise elongate members without any aperture, slot or recess and are adapted to be slideably mounted within receiving means 60 and 62. In the embodiment shown in Fig. 4, receiving means 60 and 62 comprise two substantially parallel and spaced elongate projections 66, 68 and 70, 72 mounted on and extending away from sleeve 44. Guide members 59 and 61 move within the channel 74, 76 formed between the spaced elongate projections. As would be understood by the person skilled in the art, projections 66, 68, 70 and 72 may be any shape and may be connected, e.g. the guide members may be, in cross section U shaped, n-shaped, rectangular, square circular or oval bodies mounted on sleeve 44.

[0057] Closing guides 78, 80, 82, 84, 86, 88, 90 and 92 are provided on the same surface of sleeve 44 as the receiving means 60 and 62. Closing guides 78, 80, 82, 84, 86, 88, 90 and 92 provide a pathway to guide and support for handle portions 50 and 52 and lever portions 54 and 56 during operation of the sealing device 10. Closing guides of the present invention act to counter any bending created by the potentially intense pressures needed to close the sealing device against the leak site to seal the leak. The closing guides 78, 80, 82, 84, 86, 88, 90 and 92 may comprise structures extending from an appropriate surface of the sleeve 44 which act to support and guide handles 46 and 48. Closing guides may be formed of any suitably durable material such as plastic, metal, metal alloy and/or wood. Optionally, the closing guides may comprise loop structures present on sleeve 44. Alternatively, closing guides can be any suitably shaped hollow body mounted on sleeve 44, for example, closing guides may be U shaped, n-shaped, rectangular, square, circular or oval bodies, which are adapted to receive and be engageable with handle portions 50, 52 and connecting portions 54 and 56. An example of rectangular shaped closing guides are shown in Fig. 5A.

[0058] As shown in Fig. 4, the pivot points about which handle portions 50, 52 pivot during operation are defined by apertures 55, 57. Apertures 55, 57 are adapted to receive locking pins are provided in the handle portions 50, 52.

[0059] Locking pins (not shown) extend into corresponding apertures 55, 57 on the sealing device 10 such

as locking pin holes 51, 53 provided on handle portions 56 and 58. Separate locking pins may be inserted into locking pin holes 51, 53. Insertion of locking pins into locking pin holes permit the levers 46, 48 to be locked at a given position. Optionally, locking pins may be connected to the sealing device 10 via chains or ropes to ensure locking pins are readily accessible when the sealing device is in use. As would be understood by the person skilled in the art, locking pins may be connected to any part of the sealing device 10 which allows convenient and rapid use of the locking pins.

[0060] Receiving means 40 and 42 are mounted on actuating means 14 and are adapted to receive guide members 36 and 38 and operatively couple sealing member 12 and locating means 16. As shown in Fig.1 receiving means 40 and 42 comprise projections extending from an upper surface of the actuating means 14. In the embodiment shown, receiving means 40 and 42 include projections with a cross section which is complementary to the width of central slot 37 so that guide members 36 and 38 may be moved along the receiving means 40, 42 to move the sealing member 12 towards or away from the leak site as required.

[0061] Receiving means 40 and 42 may comprise any suitable material of sufficient strength and smoothness to allow movement of the guide members 36, 38 coupled thereto.

[0062] In the embodiment shown in Fig. 1, receiving means 40 and 42 are mounted on the upper surface of the actuating means 14. Preferably, receiving means 40, 42 mounted on the upper and lower surface of the actuating means 14. In one embodiment, the receiving means mounted on the lower surface of the actuating means 14 engage with further guide members (not shown) extending from the support plate 28.

[0063] In one embodiment, as shown in Fig. 5A and Fig 5.B receiving means comprise rectangular projections with a central slot along which the guide means (not shown) are slideably mounted. Closing guides are provided as a rectangular projection 98, 100 within which the handle portion and connecting portion may move and the direction of their movement controlled by contact with a portion of the closing guides 98, 100.

[0064] As shown in Fig. 5B, sleeve 44 is extruded to provide flange portions 99, 101. Flange portions 99, 101 further comprise at least one aperture, optionally a series of apertures adapted to receive locking pins to secure the levers in a given position.

[0065] Fig. 6 shows an alternative lever. Handle portion 106 is pivotally connected to cog portion 108. Cog portion 108 is operatively coupled to complementary teeth 110 present in ratchet portion 112. Ratchet portion 112 is connected to the same surface of support plate 28 as guide members 114. Movement of handle portion 106 in the direction illustrated by arrow B moves the support plate 28 in the direction of the leak site as illustrated by arrow B'. Locking pin holes 116, 118 allow the handle to be locked at any given position by inserting a locking pin into locking pin holes 116 and 118. Continued movement of handle portion 106 moves cog portion 108 along teeth 110 to tighten the seal formed between sealing member 12 and the leak site.

[0066] Fig 7A and Fig 7B illustrate a further possible lever. Handle portion 124 includes a projection 126 extending from an outer portion of the handle portion 124. In the embodiment shown, handle portion 124 is substantially planar and is circular in cross section but as would be understood, handle portion 124 may be any suitable shape in cross section. Handle portion 124 is connected to a screw threaded bolt 125. Bolt 125 is connected to the same surface of support plate 28 as guide means 120. Bolt 125 is received by a bolt receiving means mounted within a body 128 provided on sleeve 44 and projecting there from. Body 128 may be any suitable shape and includes an inner screw threaded channel which is complementary to the screw thread of bolt 125. Turning projection 126 in the direction of arrow C moves the support plate 28 towards the leak site i.e. in the direction shown by arrow C'. Bolt 125 and body 128 are formed of any suitable material such as metal, wood, metal alloys or plastics. body 128 may be formed of one material and the internal screw threaded channel within body 128 may be formed of a second material more suited to forming a durable thread.

[0067] As would be understood by the person skilled in the art, other levers may be included in a sealing device 10 of the present invention. For example, hydraulic, motor driven or spring loaded levers may be used to assist pressing the sealing member against the leak site. Such levers may also be used to hold the sealing member against the leak site until permanent repair of the leak site may be achieved.

[0068] In some instances, the leak site may be an aperture or the like within the vessel wall where the aperture or the like has a larger surface area than the surface area provided by sealing member 12, i.e. the surface area provided by the resilient layer 34, or if no resilient layer 34 is present deformable layer 30, or of no resilient layer 34 or deformable layer 30 are present in the sealing member 12, then the surface area provided by the surface of the support plate 28 nearest to the leak site when the sealing device is assembled on the actuating means 14, is smaller than the area of the leak.

[0069] If the leak site is larger than the sealing member 12 as explained above, two or more sealing devices of the present invention may be used to seal the single leak.

[0070] One possible arrangement using one sealing member 12, two locating means and two actuating means to seal a single leak is shown in Fig. 8; however, the person skilled in the art would readily understand without the use of any inventive skill that any of the modifications disclosed herein could be used in place of the specific embodiment shown in Fig. 8. i.e. alternative sleeve, lever, guide means, receiving means and locking means other than those shown in Fig. 8 could be used on sealing devices where two or more sealing devices

are used to seal a single leak. Additionally, multiple devices may also be arranged to seal a series of leaks orientated within a single portion of the interior framework of a vessel or one large leak.

[0071] As shown in Fig. 8, one large sealing member 156 is supported by two actuating means and is located within the vessel via two locating means. Two support members 138 and 140 are connected to the internal framework of the vessel via clamps 142, 144, 146 and 148. In the embodiment shown, the internal framework includes T-shaped projections 150, 152 extending out of the vessel interior wall surface 154. Each support member is slideably mounted on a sleeve. Each sleeve is operatively coupled to the same support plate 28 156. In the illustrated embodiment, a pair of levers 158, 160 and 162, 164 are present. Operation of the levers moves support plate 28 154 towards the leak site to allow the leak to be sealed as explained below.

[0072] As would be understood by the person skilled in the art, more than two pressing and locating means could be used to support larger sealing members. Additionally, sealing devices in accordance with the present invention may be attached within a compartment of a vessel as defined by projections extending from the interior wall of the vessel.

[0073] To seal a leak in a vessel the sealing device may be assembled after the leak is caused or, the device may be in place within the vessel preassembled such that when a leak occurs it may be sealed instantly.

[0074] In use, a sealing device 10 in accordance with the present invention is assembled within a selected area of the vessel interior. On realisation that a leak has occurred, the sealing member is positioned adjacent the leak site by sliding the sealing member and lever along support member 18 until the sealing member is suitably positioned relative to the leak site. Ideally, and as illustrated in Fig. 1, sealing device 10 is suitably positioned along the support member 18 when the centre of the outermost surface of the sealing member 12, in the illustrated embodiment of Fig. 1 the centre of the resilient layer 34, is above the leak site.

[0075] To seal the leak, the levers provided on the actuating means, e.g. as shown in Fig. 3 and Fig. 4, are operated. Fig 4 illustrates handle portions 50, 52 in a closed position, i.e. the sealing device is in a leak sealing position. In an open position, handle portions 50, 52 are approximately parallel to the longitudinal axis of connecting portions 54, 56.

[0076] In the illustrated embodiment of Fig. 4, handle portions 50 and 52 are pulled in the direction shown by arrows D and D'. As handle portions 50 and 51 are connected to connecting portions 54 and 56, movement of the handle portions 50, 51 in the direction of arrows D and D' forces connecting portions 54, 56 towards the leak site. As support plate 28 is pivotally coupled to connecting portions 54 and 56, pulling handle portions 50 and 52 in the direction of arrows D and D' also pushes support plate 28 towards the leak site. Support plate 28 moves towards the leak site along the pathway provided by guide means and receiving means 60 and 62. As would be appreciated by the person skilled in the art, the relative dimensions of the components of the sealing member 12 and the actuating means 14 are designed such that at least when the levers are fully extended such that handle portions 50 and 52 are substantially perpendicular to connecting portions 54 and 56, the outermost surface of the sealing member 12 is firmly pressed against the vessel wall interior.

[0077] Closing guides 78, 80, 82, 84, 86, 88, 90 and 92 are positioned upon sleeve 44 at a suitable point whereby, in the embodiment shown in Fig. 4 excessive pivoting of handle portions 50, 52 and/or connecting portions 54,56 is limited. In this way, force exerted on handle portions 50, 52 is efficiently used to move support plate 28. Closing guides 78, 80, 82, 84, 86, 88, 90 and 92 further act to prevent or limit any bending or contortion of the levers during use which may occur in instances where a large amount of fluid enters the vessel at the leak site exerting substantial forces against support plate 28.

[0078] The levers 46, 48 are pulled in the direction of arrows D and D' until the resilient layer 34 (or if absent, the deformable layer 30, or if a deformable layer 30 is absent the support plate 28) is pushed against the vessel wall. Force exerted through levers 46 and 48 holds the resilient layer 34 against the leak site. Force may be maintained by locking the levers in position using locking pins as hereinbefore described. Continued force exerted on the resilient layer 34 causes a seal to be formed between resilient layer 34 and the vessel wall which prevents further entry or exit of fluids into or out of the vessel.

[0079] In some embodiments, levers used in the apparatus of the present invention may be spring loaded, hydraulically or motor driven. In such instances, force upon resilient member 34 may be maintained by the hydraulic, motor driven or spring loaded levers.

[0080] If a sealing member as shown in Fig. 1 is present in the sealing device 10, the layer of rubber or similar material forming the resilient layer permits a tight seal to be created between the vessel wall and the resilient layer. However, the person skilled in the art will appreciate that in the absence of the resilient layer, a tight seal may be formed between the vessel wall and the deformable layer 30 or the support plate 28.

[0081] In the embodiment shown in Fig. 1, deformable layer 30, typically comprising a layer of foam deeper than the depth of the resilient layer 34, is compressed under the force exerted via levers 46 and 48. The compressible nature of deformable layer 30 is sufficient to enable the deformable layer 30 to close around any inward protrusions or debris present at the leak site and which may have resulted from the leak.

[0082] When repair of the leak site may be attended to, locking pins are removed and levers 46, 48 moved in the opposite direction to arrows D and D'. The reverse movement of levers 46, 48 pulls the support plate 28

away from the leak site.

[0083] Fig. 10 is a diagrammatic representation of a clamp 166 adapted to engage a P-shaped projection extending into the vessel and connected to the interior surface of the vessel wall.

[0084] Clamp 166 comprises a first clamp segment 168 adapted to have an innermost (in use) surface complementary to a surface of the P-shaped projection, and a second clamp segment 170. Second clamp segment 170 is adapted to have an innermost (in use) surface complementary to receive a surface of the P-shaped projection. In the illustrated embodiment of Fig. 10, first clamp segment 168 is substantially rectangular with a substantially planar innermost surface 172. The second clamp segment 170 is substantially rectangular with a substantially planar innermost surface 174. A recess 176 complementary to a projecting segment of the P-shaped projection is provided in the innermost surface 174. Recess 176 may be alternatively provided in the first segment 168.

[0085] Clamp segments may be formed of any suitable material such as but not limited to wood, metals, metal alloys or plastics of suitable durability. Clamp segments may be hollow to reduce weight.

[0086] In some instances the first clamp segment 168 and the second clamp segment 170 are roughened and/or include serrations or teeth on the innermost (in use) surfaces to increase the clamping forces exerted by the clamp segments 168 and 170 in use.

[0087] Both the first clamp segment 168 and the second clamp segment 170 include a central aperture. First clamp segment 168 and second clamp segment 170 are slideably mounted on support member 178 which is received within the central apertures.

[0088] Movement of the first clamp segment 168 and the second clamp segment 170 along support member 178 enables the clamp to be tightened around the P-shaped projection. Once the segments of the clamp 166 are in position, a securing means 180 is placed over the first and second clamp segments 168, 170. Securing means 180 comprises a U-shaped glove adapted to slide over the first and second clamp segments 168, 170 when positioned in a clamping position about the P-shaped projection. Securing means 180 further includes two arm segments, 177, 179 formed of any suitable material and which extend across at least a portion of first clamp segment 168 and at least a portion of second clamp segment 170. Securing means 180 may be formed from any material of suitable strength to hold the clamp segments together, such as metal, metal alloy, plastics or wood. Securing means 180, first clamp segment 168 and second clamp segment 170 further include locking pin holes 183 188, 190, adapted to receive a locking pin such as locking pin 186.

[0089] Pivot holes 182, 184 and 192 are positioned within the clamp 166 such that one locking pin (not shown) is received by locking pin holes 182, 184 and 192. Securing means 180 may pivot between an open and a closed position. The points about which securing means 180 may pivot are defined by pivot holes 192, 184, 182. Securing means 180 may move between a closed position where the securing means is locked in place over the first and second clamp segments and an open position where the securing means is attached to one of clamp segments.

[0090] Locking pin holes 188, 183 and 185 are positioned within the clamp 166 such that one locking pin is received by locking pin holes 188, 183 and 185.

[0091] Locking pin holes 189, 190 and 187 are positioned within the clamp 166 such that one locking pin is received by locking pin holes.

[0092] As would be understood by the person skilled in the art, other multiples of pin holes may be included within the clamp 166.

[0093] Fig. 11 is a diagrammatic representation of a clamp of the present invention adapted to clamp a T-shaped projection. Clamp 194 comprises a first clamp segment 196 and a second clamp segment 198 slideably mounted on a support member 200. Second clamp segment includes an innermost (in use) surface 210 which is substantially planar. A recess 220 is provided in surface 210. Recess 220 is complementary to a surface of the T-shaped projection.

[0094] First clamp segment 196 includes an innermost (in use) surface (not shown) which is substantially planar. A recess 230 is provided in the innermost surface of first clamp segment 196. Recess 230 is complementary to a surface of the T-shaped projection.

[0095] As would be appreciated by the person skilled in the art, recess 230 and recess 220 may be the same or different shapes as determined by the contours of the projection extending from the vessel wall.

[0096] Securing means 240 is a U-shaped glove adapted to be slideably mounted on first clamp segment 196. Securing means 240 includes one arm segment 250 extending across at least a portion of the first clamp segment 196 and at least a portion of the second clamp segment 198. Arm 250 includes pivot pin holes 260, 270 which overlay pivot pin holes present in the first clamp segment 196 and the first clamp segment 198. Pivot pin holes 260, 270 are adapted to receive a pivot pin (not shown) to hold the securing means in place and to clamp the first clamp segment 196 and the second clamp segment 198 about the T-shaped projection.

[0097] As would be appreciated by the person skilled in the art, more locking pin holes and locking pins may be used with securing means 240. Additionally, securing means 240 and 180 may be used in either of the clamps of Fig.10 and Fig.11. Further, securing means 180 or 240 may be extended across both the first and second clamp segments 198, 196, 168, 170.

[0098] Fig. 12 is an illustration of a side view of a clamp closing mechanism 300 for use with a clamp of the present invention.

[0099] Clamp closing mechanism 300 includes a handle portion connected to a first pair of elongate members

320, 322. Each of the first pair of elongate members 320, 322 are coupled to extruded planar portions 324, 326 extending from the first clamp segment. Each of the extruded planar portions 324, 326 are coupled via bolts 323, 325 to the first pair of elongate members 320, 322. The extruded portions 324, 326 comprise substantially planar portions adapted to receive a bolt.

[0100] The first pair of elongate members is further coupled to a second pair of elongate members 330, 332 via bolts 331, 329. Extruded portions 334, 336 couple the second pair of elongate members 330, 332 via bolts 335, 333 to the second clamp segment. The extruded portions 334, 336 comprise substantially planar portions adapted to receive a bolt.

[0101] Preferably each of the elongate members are formed metal, metal alloy, plastic or wood of suitable strength to withstand forces operating on the clamp during clamping and also during operation of the sealing device.

[0102] The bolts may be formed of any suitable material and may be screw threaded. Alternative fixing means may be used to secure the individual components of the clamp closing means such as but not limited to locking pins.

[0103] In use, operation of the handle 310 in an outward direction, i.e. in the direction of arrow E, pushes both the first clamp segment 328 and the second clamp segment 338 towards the T-shaped projection 340 extending from the interior of the vessel wall. Handle 310 is operated in the direction of arrow E until contact is made between both the first clamp segment 328 and one side of the T-shaped projection 340 and the second clamp segment 338 and an opposing side of the T-shaped projection 340. Continued movement of the handle 310 tightens the clamp segments 328, 338about the T-shaped projection 340. Once a suitable clamping action is achieved, the clamp is secured in place as described above.

[0104] As used herein, the term vessel is taken to be any container. In some embodiments, the vessel is capable of holding a fluid, e.g. a liquid or a gas, such as air. Specifically as used herein and unless specifically stated otherwise, a vessel includes but is not limited to, ships, boats, submarines, road tankers, e.g. oil tankers, milk tankers, water tankers, and other vessels used to hold fluids such as water, petrol, foodstuffs, and gasses where leakage into or from the vessel may be an issue.

[0105] The device of the present invention, when used in ships is not limited to use in the hull or below the waterline, but may be used at any point throughout the ship where a leak may occur, e.g. weather damage to an upper portion of the ship may be subject to water egress caused by high tides, high seas, large waves or precipitation, e.g. rain or snow.

[0106] As would be understood by the person skilled in the art, as a result of damage to the hull or other portion of a vessel, the inner face of the vessel, at the breach site, will be deformed with uneven edges and substantial debris which may prevent a tight seal being formed between the sealing member and the vessel. In order to accommodate this irregular surface and to enable a seal to be formed to close off the leak, the deformable portion comprises a layer of foam or similar material which is mouldable about the debris. The deformable layer 30 may be selected to be of varying thickness depending on the size of the breach and the thickness of the vessel wall which can dictate the degree of debris resulting from the breach. In embodiments where the deformable layer 30 is detachable from the sealing device, a choice of deformable layers 30 may be kept at a convenient location within or near the vessel and added at the point of use to ensure the correct thickness is chosen.

[0107] In some embodiments, any of the layers of the sealing member may be easily removed and replaced in isolation from other layers of the sealing member and the rest of the sealing device.

[0108] As used herein, the terms, leak, breach and damage are used interchangeably and are to be understood to mean any damage of failure of a vessel wall which does or could lead to fluid leaking into or out of the vessel interior.

[0109] Modifications and deviations from the invention may be envisaged without departing from the scope of the invention.

[0110] For example, the person skilled in the art would readily appreciate that the sealing device may be assembled on site. Additionally, after use, the resilient member and/or the deformable member may be damaged and require replacement. Thus, the resilient member and/or the deformable member may be detachable from the sealing member.

[0111] The shape of the sealing member, deformable portion and resilient portions may be altered to be any shape that allows the sealing device to be used within any given hull portion. For example, hull compartments at the stern or bow may be of a shape different to those in the central sections of the hull. The person skilled in the art would readily realise that the sealing member and associated sections could be made in a different shape to allow the sealing device to seal a breach in a less accessible area of the ship or vessel.

[0112] Additionally, alternative means for locking the actuating means in place may be used without deviating from the scope of the present invention. For example bolts, screws and the like may be used to lock the levers in a given position.

[0113] A modified clamp 400 is illustrated in Fig. 13. This embodiment is particularly effective in addressing a breach in a hull of a vessel in which the damage is so extensive that the T-shaped or P-shaped projections 26 within the interior of the hull are distorted. In this embodiment a collar 401 is mounted upon the support member 18 and can slide along the support member. The clamp body comprises a substantially U-shaped member 402 with a transverse bar 403 spanning the open ends of the body. A universal coupling joint 404 connects the bar to

the collar 401. This joint allows for a twisting movement of the collar relative to the clamp body which can compensate for a degree of converse twisting in the frame of the hull.

[0114] Two spring loaded clamping arms 405 are connected to the clamp body preferably opposite to the bar 403. The surface of the arms facing the hull may be curved to assist in the rapid placement of the clamp arms over the T or P section of the hull. Alternatively the clamp as shown in Fig. 11 may be connected to the clamp body 402.

[0115] Additionally or alternatively a similar universal joint may be used to connect the sealing member 12 to the actuating means 14 as shown in Fig. 14. Here the U-shaped clamp body is replaced with a U-shaped formation 450 on the rear surface of the sealing member and a projection is formed on the actuating means through which the universal coupling joint passes. This would provide greater flexibility and movement of the sealing member during placement thereby ensuring a tight seal against the hull.

[0116] A further modification of the clamp is shown in Figs. 15-17. In this modification the clamp 500 comprises a rotational element in the form of a plate or disc 506 preferably between the collar 501 and the clamp. The plate is rotatable mounted on the collar via a pin 507 and provides for greater flexibility and movement at the clamp. The rotatable plate is illustrated as a thin disc but may have any shape and form to provide flexibility of movement and structural strength.

[0117] It would of course be understood by the skilled person that further alternative flexible elements may be incorporated into the device, particularly but not exclusively at the connections of the clamp members to the support member and the sealing member to the actuating means. These could include ball joints, wire or rope tethers or other flexible joints.

Claims

1. A device for sealing a leak in a vessel, the device comprising:

   a sealing member;
   means for locating the sealing member adjacent a leak in a vessel wall; and
   actuating means for pressing the sealing member against the vessel wall to seal the leak.

2. The device as claimed in claim 1, wherein the sealing member comprises a support plate.

3. The device as claimed in claim 2, wherein the sealing member comprises a deformable portion which is mountable on a surface of the support plate nearest to the vessel wall in use.

4. The device as claimed in claim 3, wherein the deformable portion is releasably mounted on the support plate.

5. The device as claimed in any preceding claim, wherein the sealing member further comprises at least one resilient portion.

6. The device as claimed in claim 5 when dependent upon claim 3, wherein the deformable portion is mounted between the support plate and the resilient portion.

7. The device as claimed in claim 6, wherein the device comprises one or more additional deformable and/or resilient portions in alternating layers.

8. The device as claimed in any preceding claim, wherein the sealing member further comprises at least one guide member.

9. The device as claimed in claim 8, wherein the or each guide member is engageable with a complementary receiving means provided on the actuating means.

10. The device as claimed in claim 9, wherein the at least one guide member comprises an elongate member with a slot and the receiving means comprises a projection, said projection being engageable within the slot such that the guide means moves along the receiving means.

11. The device as claimed in any preceding claim wherein the actuating means comprises a sleeve slideably mounted on the locating means.

12. The device as claimed in any preceding claim wherein the actuating means further comprises at least one lever.

13. The device as claimed in any preceding claim, wherein the actuating means comprises a locking means to hold the sealing device in a sealing position against the leak site.

14. The device as claimed in any preceding claim, wherein the locating means comprises a support member mountable within the vessel and at least one clamp adapted to engage sections of the vessel internal framework and the support member to hold the support member at a spaced position relative to the vessel wall.

15. The device as claimed in claim 14, further comprising a universal joint provided between the clamp and the support member.

16. A method of sealing a leak in a vessel comprising the steps of:

a) mounting a sealing member within the vessel
b) locating the sealing member adjacent the leak site; and
c) forcing the sealing member against the leak site to seal the leak.

17. The method as claimed in claim 16, wherein the sealing member is locked in position against the leak site.

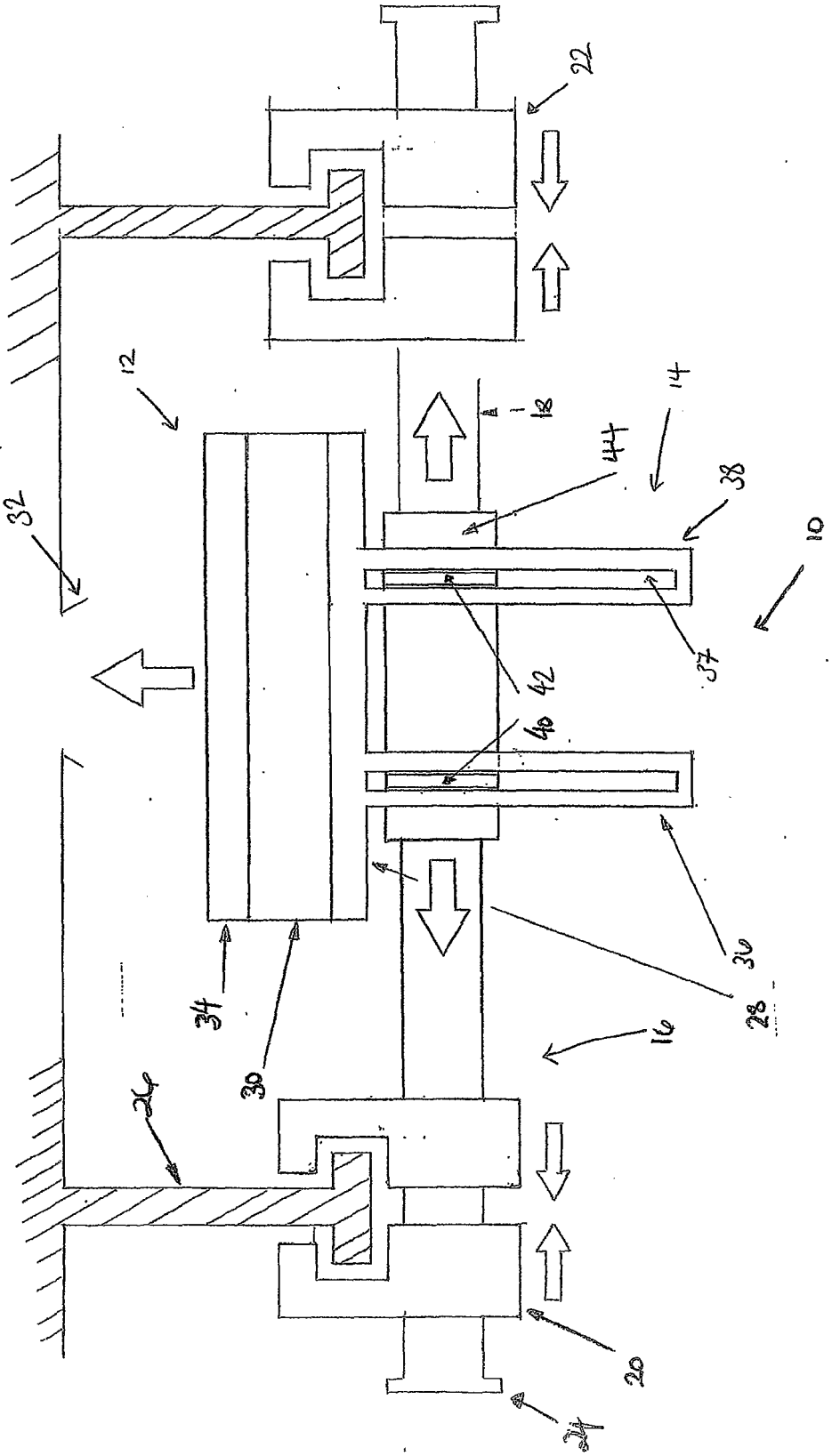
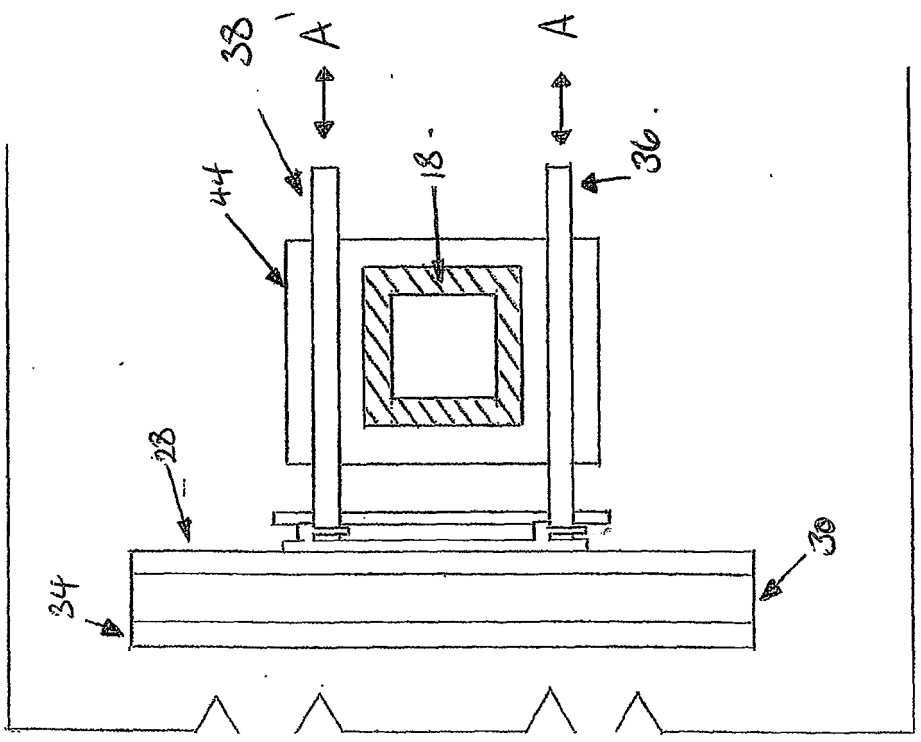


FIG 1

FIG 2.



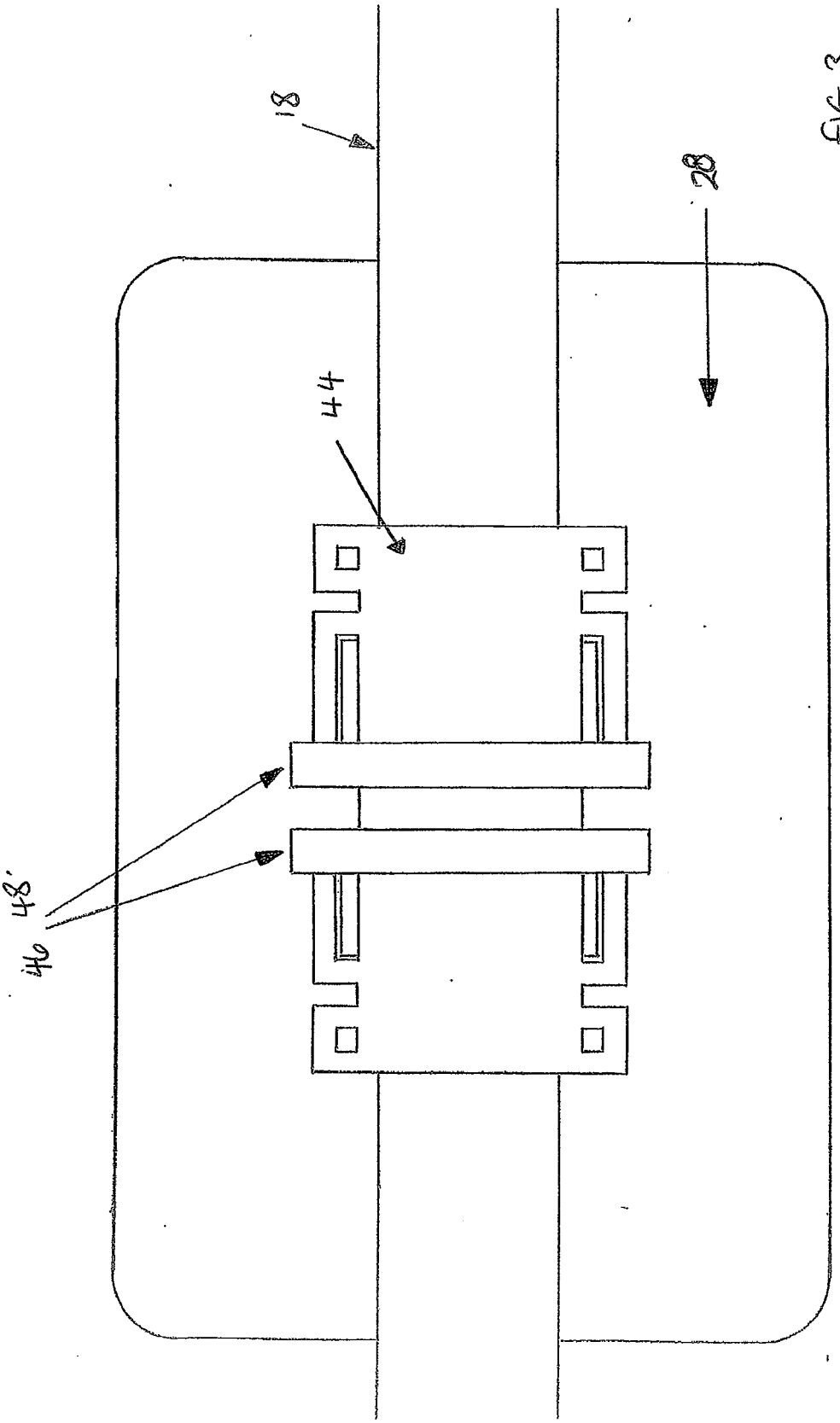


Fig 3.

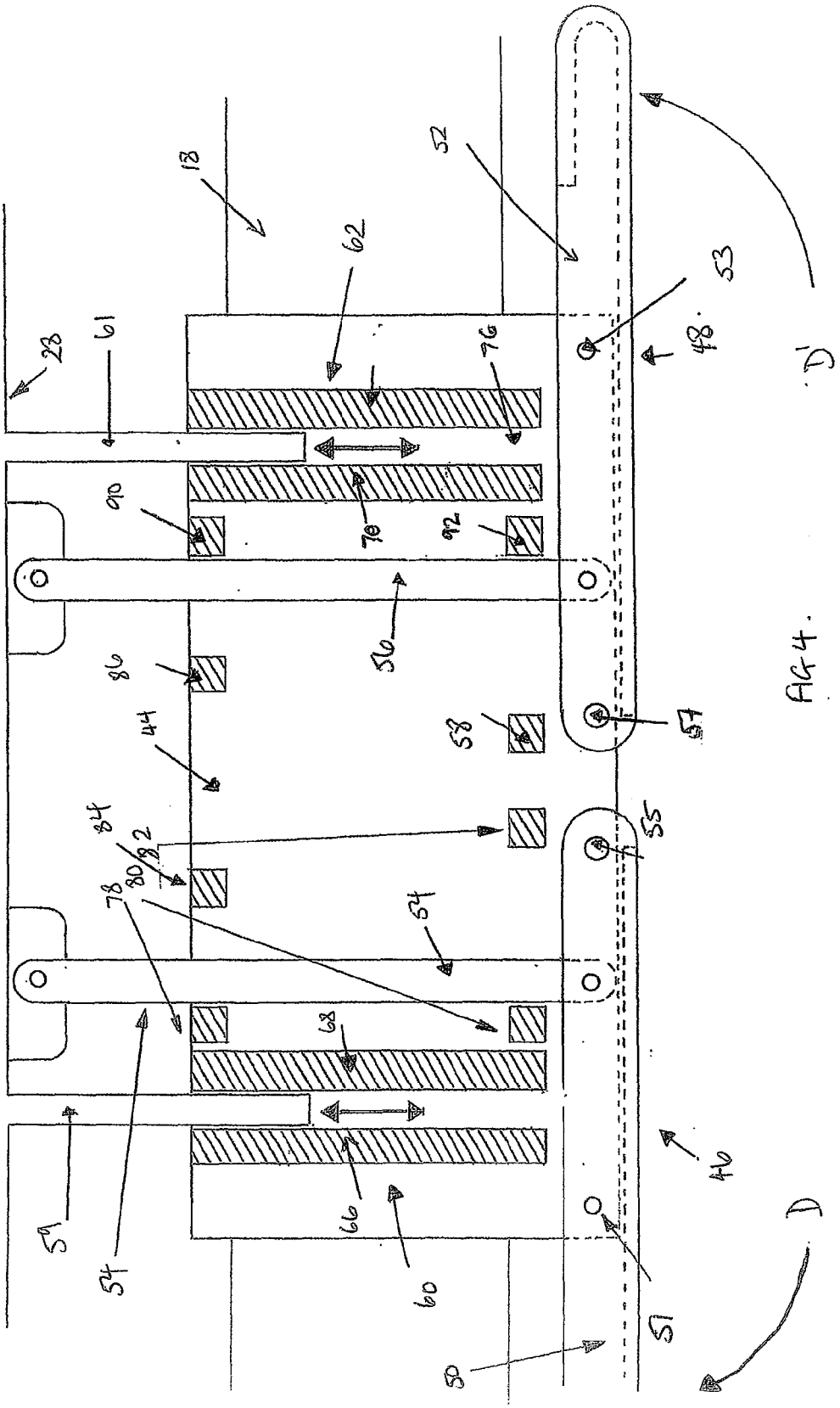

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FIG 4.

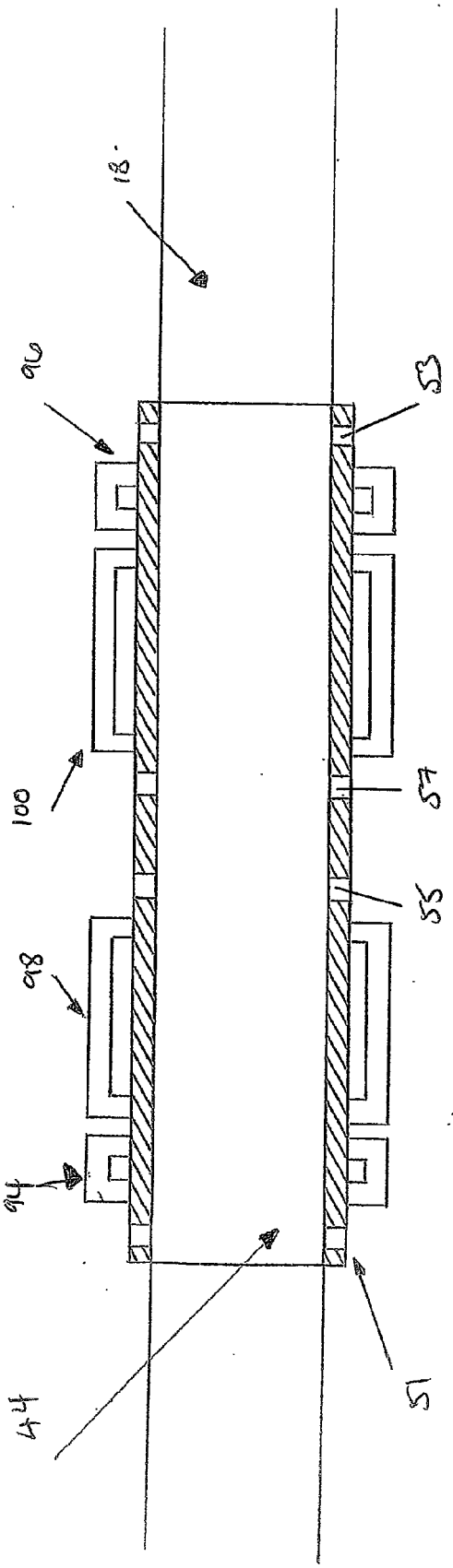

FIG 5A

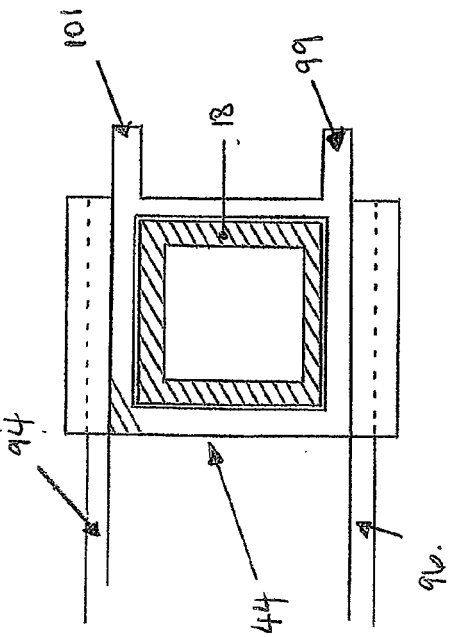

FIG 5B

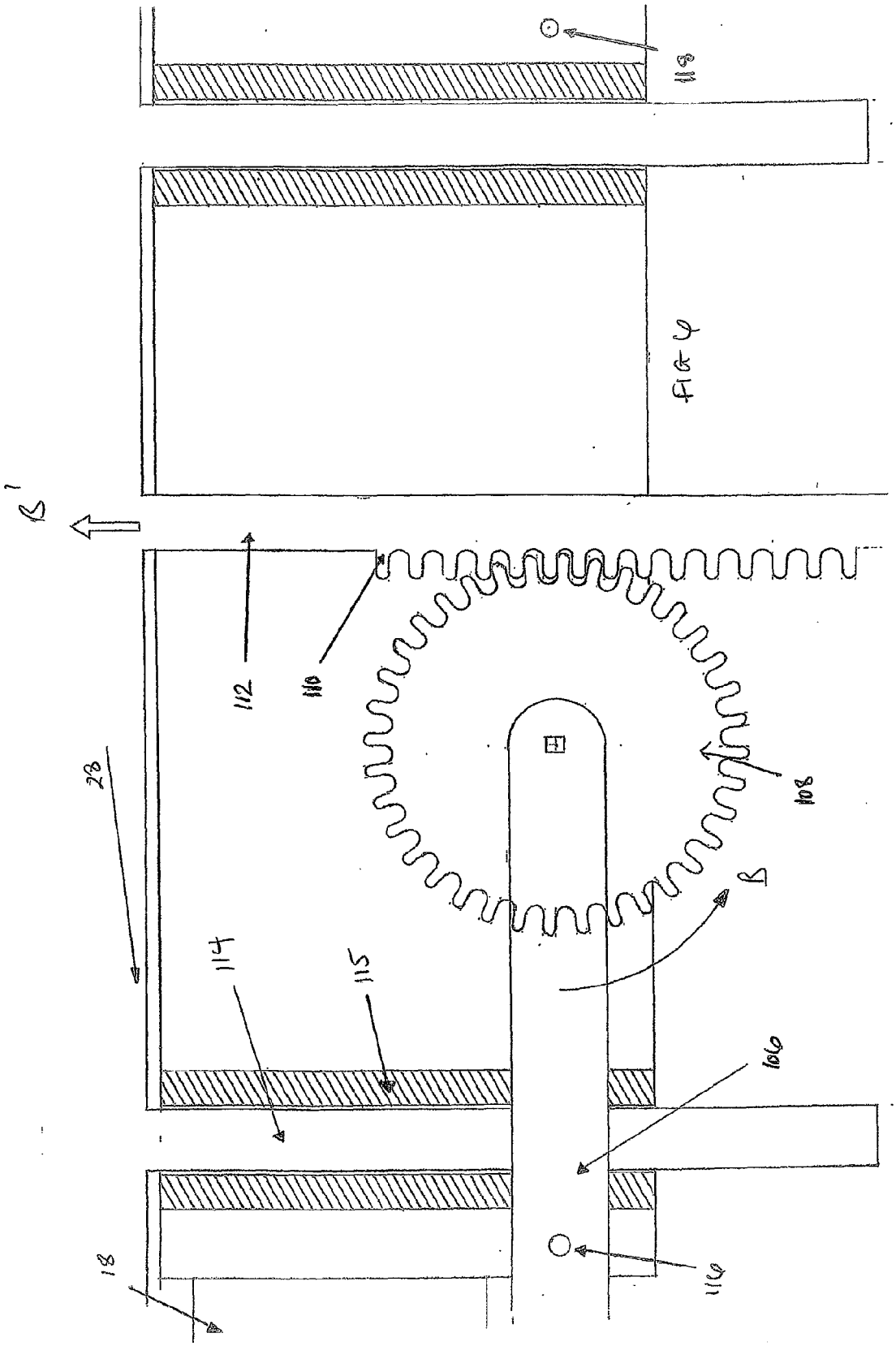

Fig 4

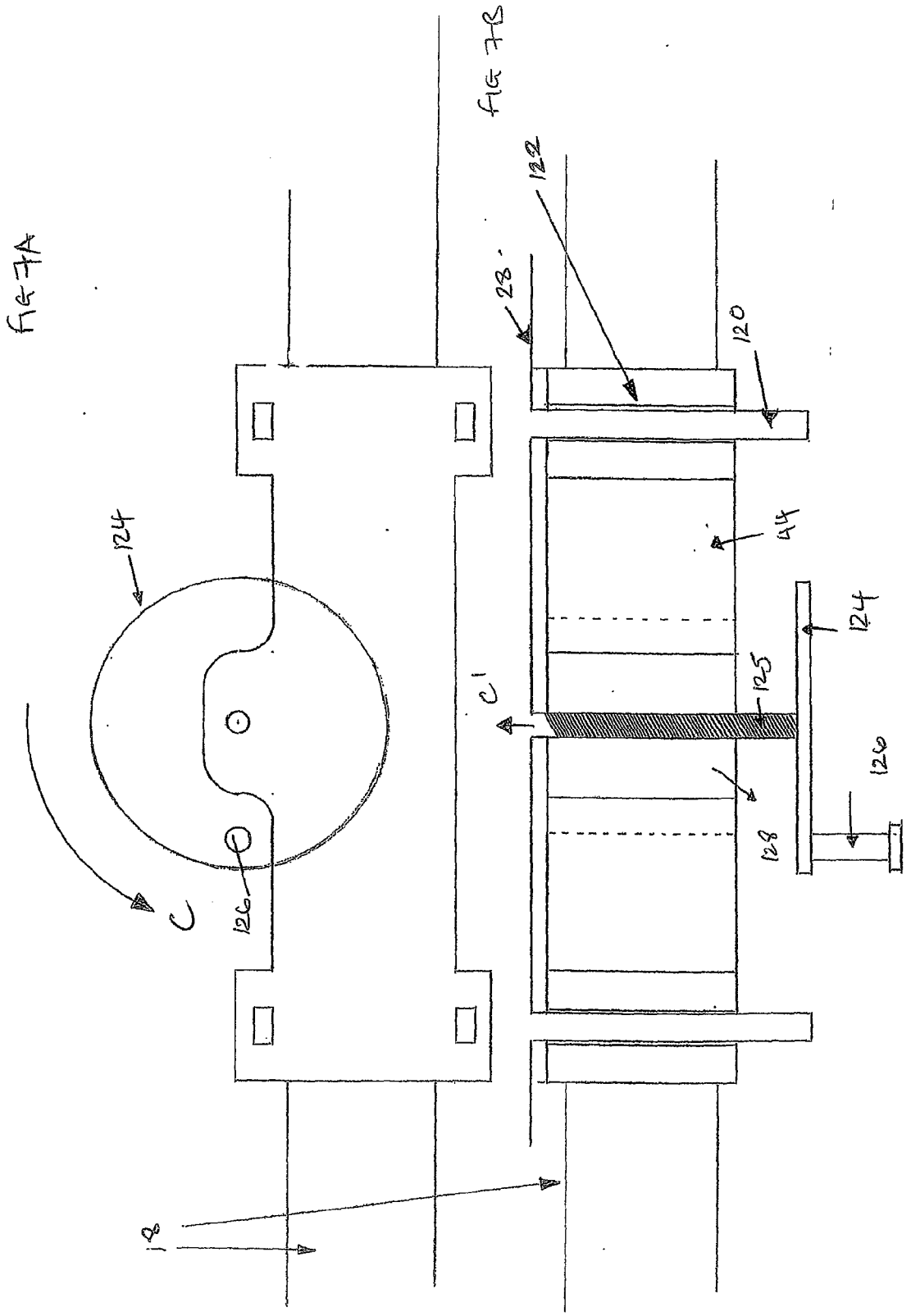
FIG 7A
FIG 7B
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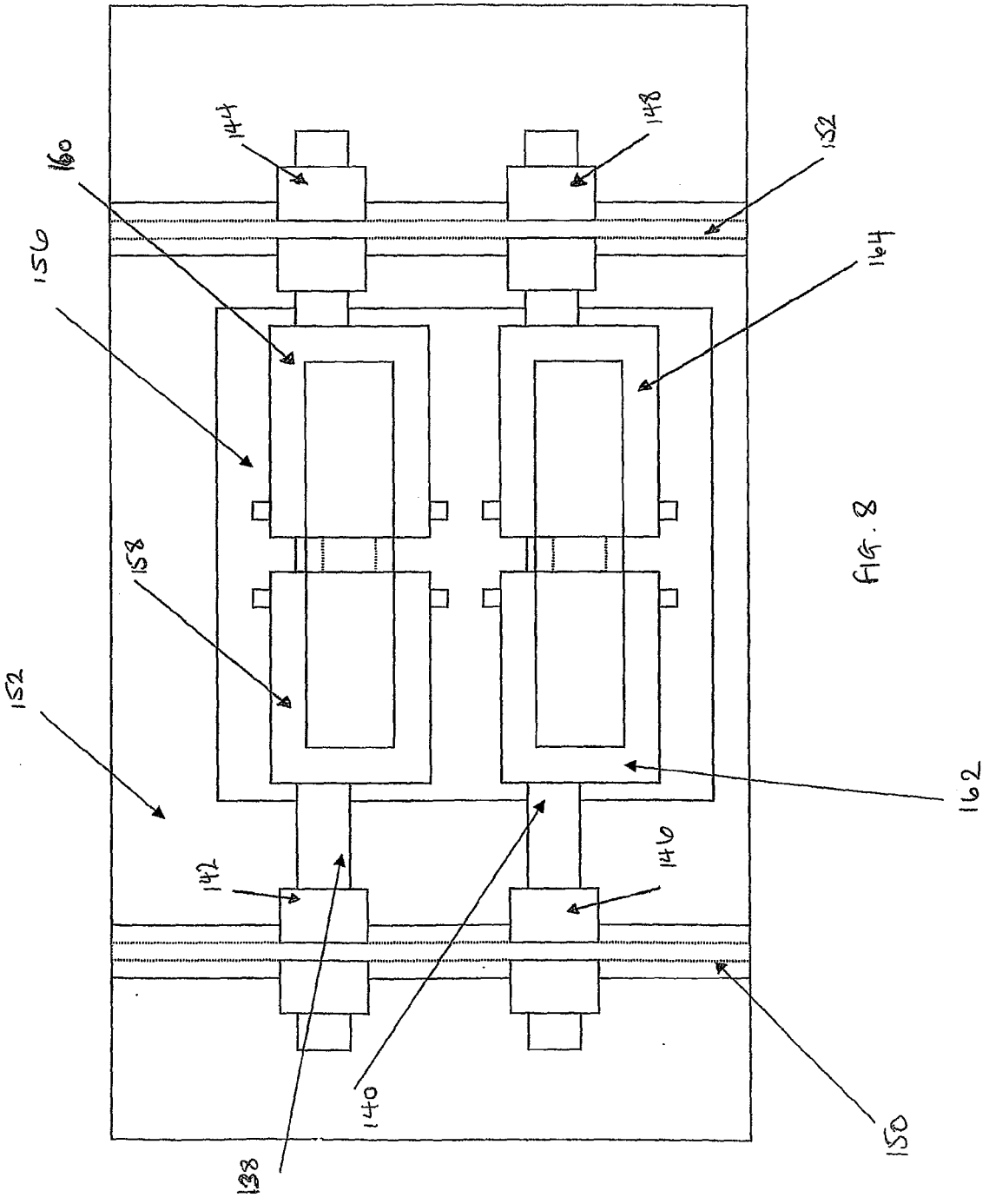

FIG. 8

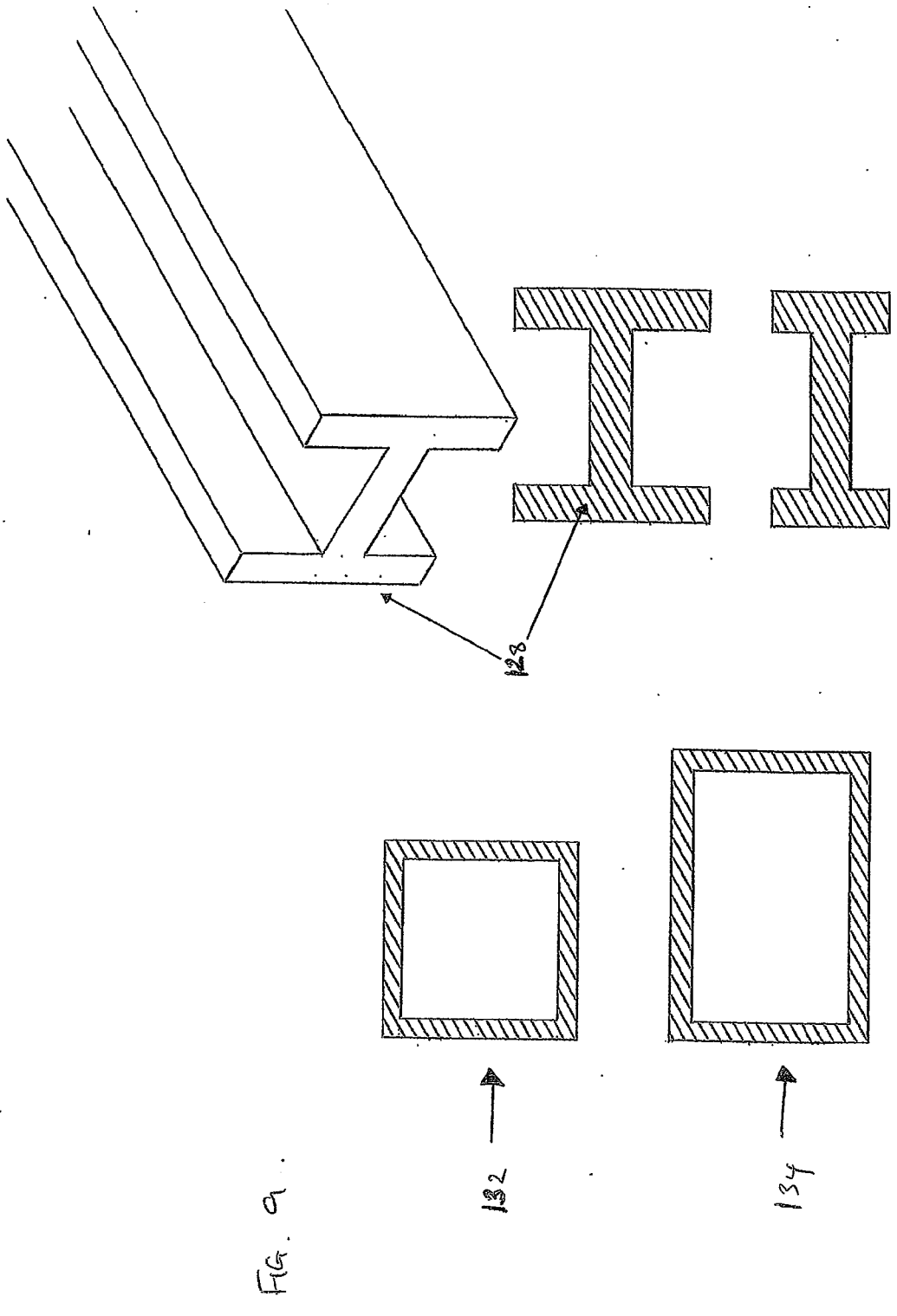

FIG. 9

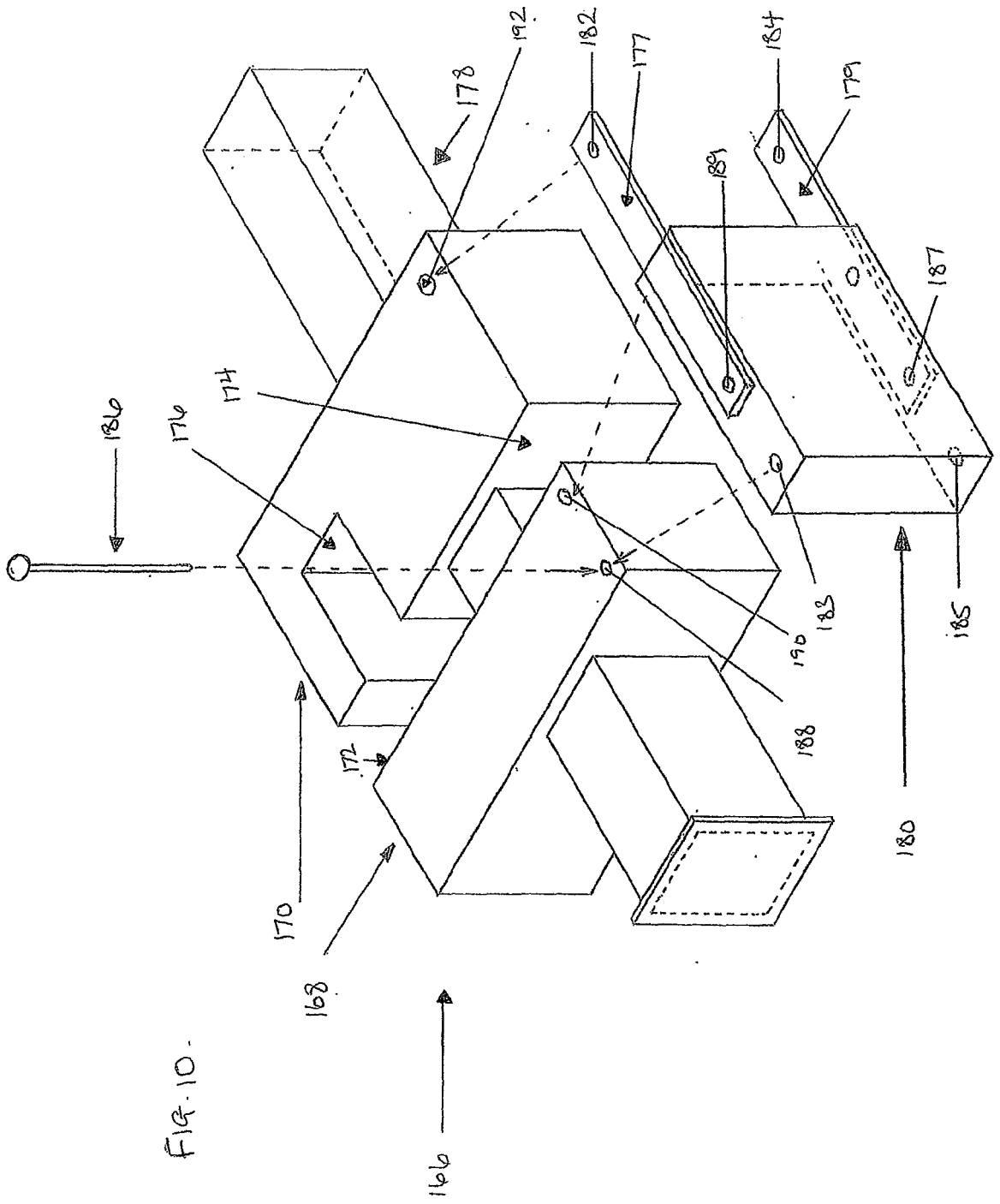
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FIG. 10.

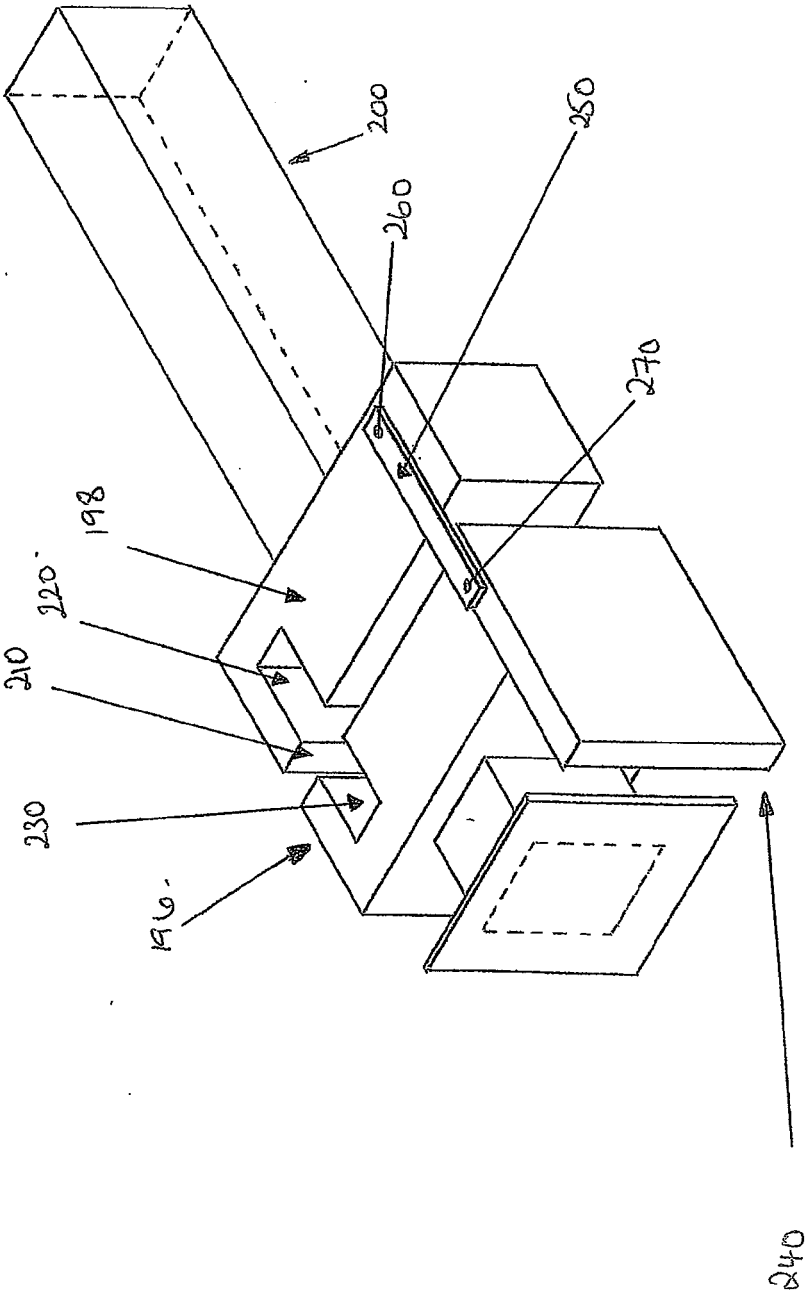

fig. 11

FIG.12

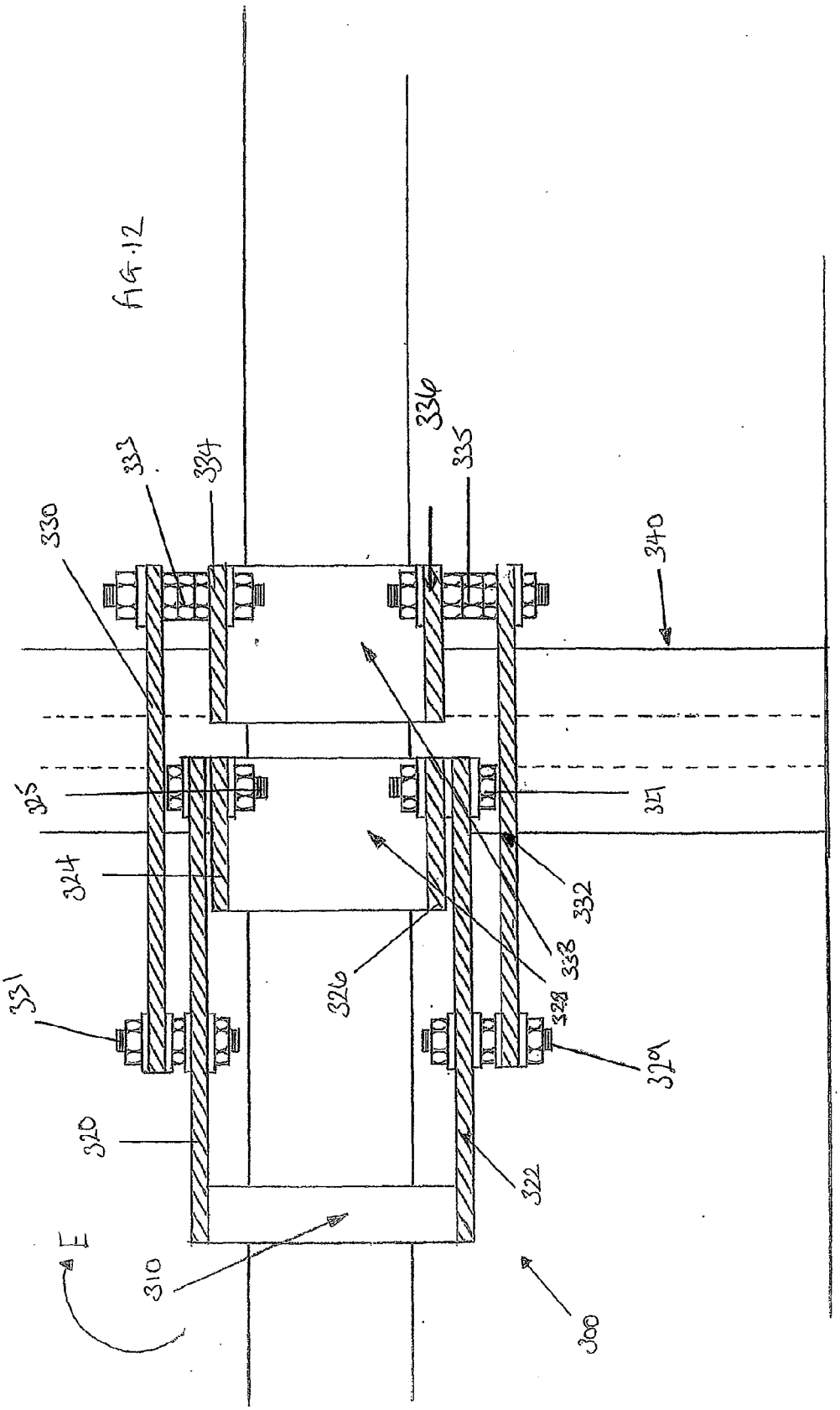
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FIG13

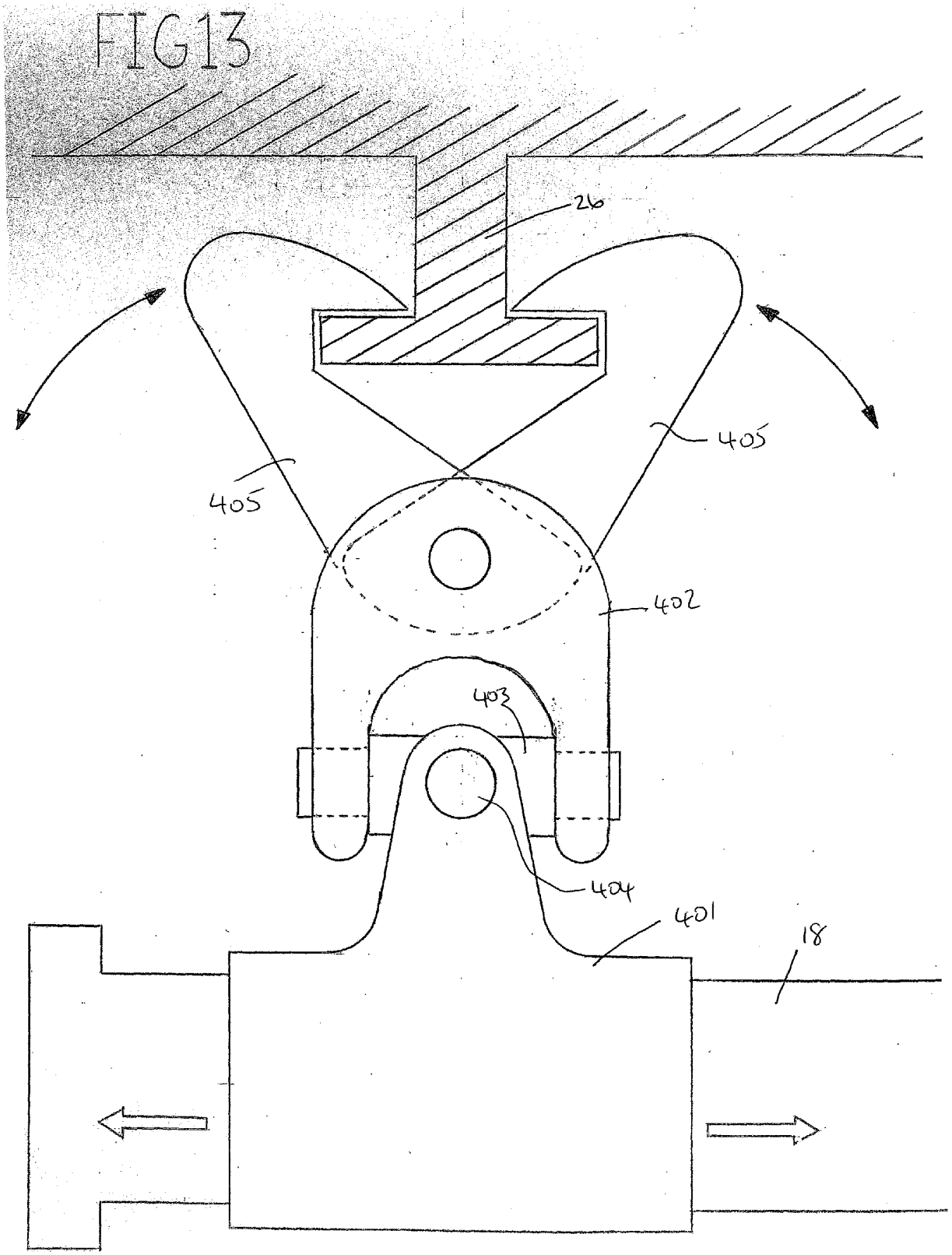
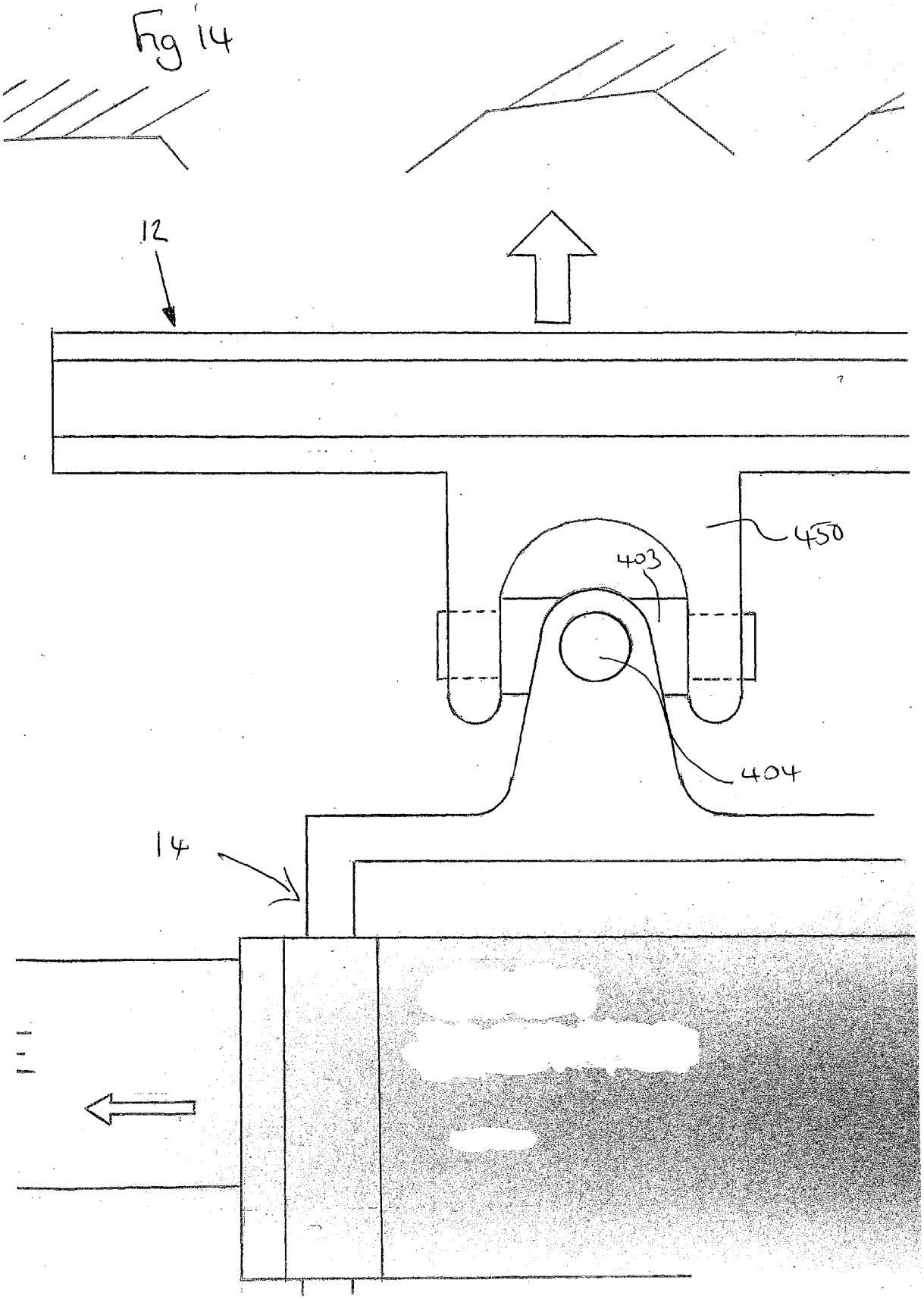


Fig 14



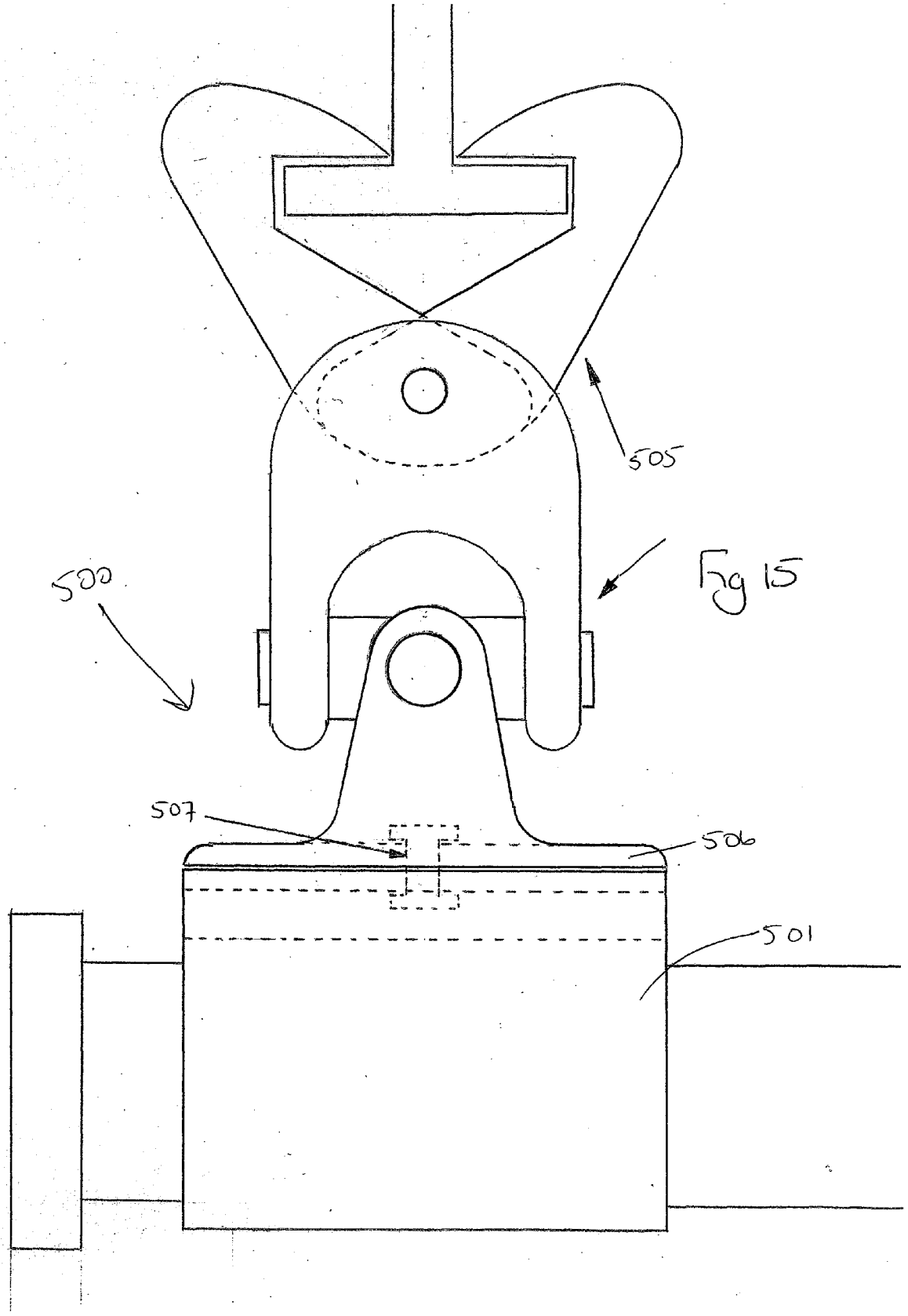


Fig 15

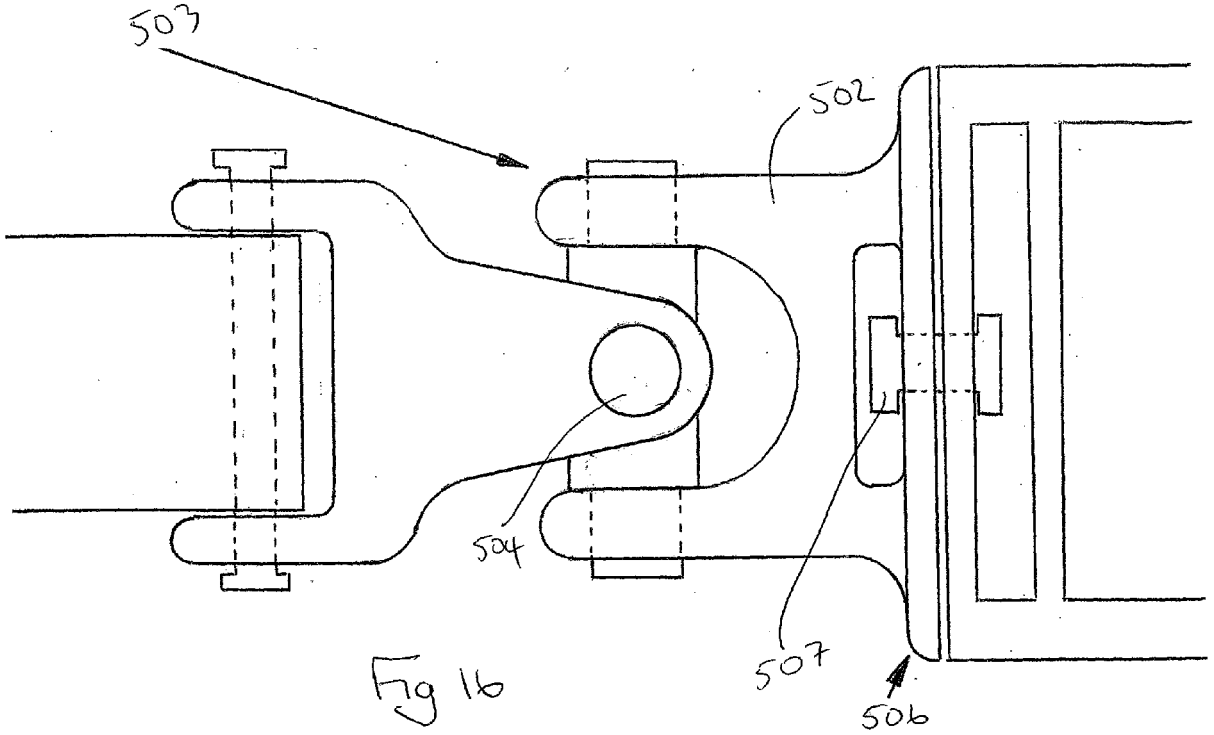


Fig 16

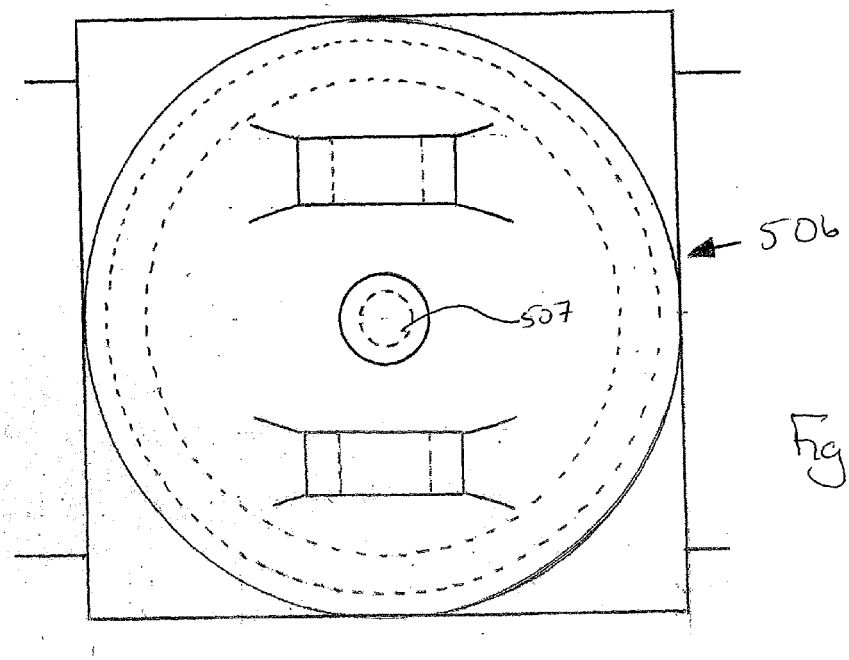


Fig 17

REFERENCES CITED IN THE DESCRIPTION

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