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Surgical retractor device

Abstract

A surgical retractor device has a housing with press arms coupled thereto, each arm having rotational movement in a plane, and a gripping member pivoting at right angle with the plane, at an outer end of the arm; an attachment means at an inner end of the arm; an opening and closing mechanism with rotatable press arm attachment structures attaching the attachment means of the press arms, symmetrically positioned from a centerline of the device; rotatable handle attachment structures, and; a transfer mechanism transferring rotation from handle attachment structures to press arm attachment structures. The device also has handles for operating the opening and closing mechanism. Each handle has a handle attachment means at an inner end of the handle for attachment to the handle attachment structures; and, a handle structure. The handles have a rotational movement in the plane and are symmetrically positioned from the centerline of the device.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS

(1) This patent application is the U.S. National Stage of International Patent Application No. PCT/NO2022/050050, filed Feb. 23, 2022, which claims the benefit of Norwegian Patent application No. 20210268, filed Feb. 26, 2021, which are each incorporated by reference.

FIELD OF THE INVENTION

(2) The invention relates to a surgical retractor device, and more specifically the invention relates to a surgical retractor device used in performing surgical exposure.

BACKGROUND OF THE INVENTION

(3) In the field of cardiothoracic surgery, for example by sternotomy or thoracotomy, it is necessary to gain access to the anatomical site of interest by use of a self-retaining retractor. Standard incisions in cardiothoracic surgery include sternotomy and thoracotomy. During the procedure of thoracotomy, a retractor is used to spread ribs and soft tissue apart, thus gaining access to the pleural space. Full or partial sternotomy is performed by a midline incision along the sternum, whereupon the sternal halves are parted by a sternal retractor to provide access to the heart and associated structures. The retractors used in these procedures have jaws which open in a single plane. Albeit any surgical exposure has the potential to provide sufficient access to the chest cavity, the degree and type of exposure needs to be weighed against morbidity as the procedure may put the patient under enormous strain. These procedures are therefore associated with a notable degree of post-operative pain and long patient recovery time.

(4) The force the surgeon applies on the surgical incision, through the device, is variable depending on the angle of the hand-cranked lever due to the design of the Finocheitto retractor. The rotation speed of the hand-cranked lever is not linearly proportional to the opening speed of the arms, leaving the user without a feel for the opening speed and force. One of the downsides to the classical retractor is the absence of force-feedback, making it difficult for the surgeon to judge the amount of force applied when accessing the anatomical site of interest. This means that the surgeon has a limited ability to know how much force is applied. It is an advantage to finely control the opening of the jaws so the operator can avoid unnecessary damage to the bones and tissue during retraction. The operator's ability to fine-tune and feel the force exerted during retraction is absent in classical retractors. The Finochietto retractor comprises moving metal-on-metal parts that requires lubrication to function optimally, if this is not done every time after sterilizing of the device, the device will function sub-optimally. Furthermore, the Finochietto retractor has the rotating lever on one side, wherein the lever transverses with the device as it rotates. Thus, the lever moves along a plane transverse of the surgical incision, causing a greater momentum on the device when operated due to the transverse displacement of the lever during retraction. When the Finochietto retractor is in its open state a bar comprising notches is exposed, and may be located inconveniently. Mainly, the exposed notches may hinder and damage surgical equipment such as tubes and cords and prevent them from moving freely during surgery. Worst-case scenario is when the fragile

pacemaker cables are cut off due to the lever-system going over the jammed pacemaker cables.
(5) Finally, following advancements in the field of cardiothoracic surgery, more types of surgical incisions are routinely being performed. Classical retractors have few interchangeable parts and do not necessarily cater to specific preferences of the surgeon or needs of the patient.
(6) Several other types of rib retractors have been developed in order to try to mitigate the downside of the Finochietto retractor.
(7) U.S. Pat. No. 10,603,025 B2 disclose a surgical rib retractor having a housing with a first shoulder and second shoulder **70**,**74**. The retractor further has a first and second arm unit **76**, **78** pivotably coupled to the first and second shoulder. The surgical rib retractor also has a first and second arm actuator **80**, **82** to pivot first and second arms up and down. Furthermore, the surgical rib retractor of U.S. Pat. No. 10,603,025 B2 has a rotatable knob **84** connected to a single actuator **84** to spread the arms **76**, **78**.
(8) The downside of the solution disclosed in U.S. Pat. No. 10,603,025 B2 is the same as for the Finochietto retractor, mainly that force is applied through the device in a skewed way by twisting the operating-wheel, hence applying a rotational moment. Moreover, the user must turn the operating wheel the same number of times to close the retractor after surgery, causing uneven forces to be transferred to a patient and slow closing of the device after a surgery is completed.
(9) European Patent EP2080480A1 disclose a sternum retractor device comprising a pair of jaws **1***a*, **1***b*; **20***a*, **20***b* configured in such a way to be inserted between the two sternal halves and shaped so as to engage firmly on said halves, actuating means **2** comprising a hydraulic cylinder **3** and piston **4** between the pair of jaws **1***a*, **1***b*; **20***a*, **20***b*. The hydraulic cylinder is actuated by a syringe. The device is not suitable surgical exposure as the actuator and the actuator arms would conceal the surgical site. The use of a syringe to actuate the actuators will not give a user any feedback on the forces applied to the patient. Furthermore, the members that forces the pair of jaws apart comprises hinged and sliding parts that may pinch and damage surgical equipment such as pacemaker wires and tubing.
(10) Document WO 2012040206 A1 discloses a surgical retractor device comprising a first press arm **122** coupled to a pivotal a holder assembly **104**, and a second press arm **126** coupled to the holder assembly **104**, and a third press arm (**316**) glideable connected to the holder assembly **104**. The solution disclosed in WO 2012040206 A1 exposes all mechanisms to the operation site making it hard to disinfect and exposes the surgical site to moving parts that can pinch and damage the patient and expose the site to non-sterile equipment.
(11) Therefore, it is an aim of the present invention to provide a device that may be operable by one hand and where the forces applied to operate the device is in the same plane as the opening of the arms and wherein the forces applied does not lead to a rotational movement of the device. Furthermore, it is an aim of the present invention to achieve a device that is user-friendly, provides the user with the ability to finetune the device and requires little force to operate and which may be closed in a rapid manner and that will leave the input lever at a stationary location.
(12) It is a further aim of the present invention to provide a device that may provide the user with feedback relating to the force applied.
(13) It is a further aim of the present invention to overcome the shortcomings of the known prior art.
(14) To achieve these objectives, a device according to the independent claims is provided.

SUMMARY OF THE INVENTION

(15) The invention is set forth and characterized in the main claims, while the dependent claims describe other characteristics of the invention.
(16) In a preferred embodiment of the invention the device comprises a housing, a first press arm pivotably coupled to the housing, and a second press arm pivotably coupled to the housing, said first and second arm having a rotational movement in a first plane. Each press arm comprises a gripping member pivoting around an axis at a right angle with the first plane, at the outer end of

each press arm, and an attachment means at the inner end of the arm. The housing comprises an opening and closing mechanism comprising, the mechanism comprising rotatable first and second press arm attachment structure for attaching the attachment means of the press arms, symmetrically positioned a distance away from a centerline of the surgical device, to the housing and rotatable first and a second handle attachment structure and a transfer mechanism to transfer rotation from said first and second handle attachment structure to said first and second press arm attachment structure. The device further comprises a first and a second handle for operating the opening and closing mechanism, each handle comprises a handle attachment means at the inner end of the handle for attaching said handles to the first and second handle attachments structures respectively, and a handle structure operable by a user, wherein the first and second handle having a rotational movement in the first plane and being symmetrically positioned a distance away from the centerline of the surgical device and wherein the two handles are pretensioned towards an open state, and wherein opposite rotational movement of the first and second handle towards the centerline causes opposite rotational movement of the first and second press arms away from the centerline.

(17) In another embodiment of the invention transfer mechanism comprises a first and second cam arms each cam arm connected to the first and second handle attachment structure, respectively, and a first and second activation arms each activation arm connected to the first and second arm attachment structure respectively, and a gear train comprising reduction gears and/or a transfer gears connected to a pinion gear, said pinion gear being connected to a worm gear. Wherein the gear train in one end is rotationally coupled to at least one of the first and second cam arm sand wherein the gear train in another end is rotationally coupled to at least one of the first and second activation arms. Whereby the transfer mechanism is adapted to translate rotation movement from at least one of the first and second cam arms to at least one of the first and second activation arms.

(18) In yet another embodiment the of invention the transfer mechanism comprises a first and second cam arms each cam arm connected to the first and second handle attachment structures, respectively, and a first and second activation arms each activation arm connected to the first and second press arm attachment structures respectively, and at least a hydraulic actuator comprising a piston rod and a cylinder wherein the hydraulic actuator in one end is coupled to at least one of the first and second cam arms and wherein hydraulic actuator in another end is coupled to at least one of the first and second activation arms, whereby the transfer mechanism is adapted to translate rotation movement from the first and second cam arms to the first and second activation arms.

(19) In yet another embodiment the of invention transfer mechanism further comprises a further hydraulic actuator comprising a further piston rod and a further cylinder. Wherein the further hydraulic actuator in one end is coupled to the second cam arm and in another end is coupled to the second activation arm, and wherein the hydraulic actuator in one end is coupled to the first cam arm and in another end is coupled to the first activation arm, whereby the transfer mechanism is adapted to translate rotation movement from the first and second cam arms to the first and second activation arms, respectively.

(20) In yet another embodiment the of invention each of the first and second cam arms comprises a protruding surface area adapted for receiving an end surface of the piston rod, and at least a partly tooted area comprising teeth or cogs, wherein the at least partly tooted area of the first and second cam arms intermesh with each other to ensure the first and second handle rotates synchronous in relation to each other.

(21) In yet another embodiment the of invention at least a spring pretension the first and second handles away from each other, towards an open state.

(22) In yet another embodiment the of invention the handle attachment means are releasably attachable, wherein a surface of the handle attachment means is adapted to receive a corresponding surface of the handle attachment structure.

(23) In yet another embodiment the of invention the arm attachment means are releasably

attachable, wherein a surface of the arm attachment means is adapted to receive a corresponding surface of the arm attachment structure.
(24) In yet another embodiment the of invention the opening and closing mechanism comprises a release valve switch and a release vale fluidly coupled to the hydraulic actuator, whereby the release valve switch opens said vale to releases pressure in the actuators, whereby the first and second press arms are movable from an open state towards an closed state.

Description

BRIEF DESCRIPTION OF THE FIGURES
(1) These and other characteristics of the invention will become clear from the following description of a preferential form of embodiment, given as non-restrictive examples, with reference to the attached schematic drawings.
(2) FIG. **1** shows the device in its closed state
(3) FIG. **2** shows the device in its open state
(4) FIG. **3** shows the device with the inner workings of the housing exposed
(5) FIG. **4** shows a close view of the housing with the inner workings of the housing exposed
(6) FIG. **5** shows a close view of the housing with the inner workings of the opening and closing mechanism
(7) FIG. **6** shows a close view of the inner workings of the opening and closing mechanism
(8) FIG. **7** shows a close view of the gear train of the opening and closing mechanism
(9) FIG. **8** shows the device with handles in an open state.
(10) FIG. **9** shows the device in multiple states.
DETAILED DESCRIPTION OF THE INVENTION
(11) The following description will use terms such as “horizontal”, “vertical”, “lateral”, “back and forth”, “up and down”, “upper”, “lower”, “inner”, “outer”, “forward”, “rear”, etc. A central axis of the instrument is defined to run horizontally along a central axis of the housing and along the centerline between the press arms. The longitudinal direction is defined as the direction along the central axis. These terms generally refer to the views and orientations as shown in the drawings and that are associated with a normal use of the invention. The terms are used for the reader's convenience only and shall not be limiting. Like numerals on different drawings describe the same feature. Numerals with apostrophe represents an additional feature represented by the same numeral, for instance the number **11** will represent one or the first of multiple or all of the multiples, and the numeral **11**′ represents an additional or a further of the same feature, like a second or multiple of the same feature.
(12) FIG. **1** illustrates a surgical retractor device **1** in its closed state. The device comprises a housing **7**, the housing being watertight, and a first press arm **2** pivotably coupled to the housing, and a second press arm **3** pivotably coupled to the housing, said first and second arm **2**, **3** having a rotational movement in a first plane. Each press arm comprising a gripping member **4***a*, **4***b*, or jaws, pivoting around an axis at a right angle with the first plane, at the outer end of each press arm. The gripping members **4***a*, **4***b* is adapted to be inserted into a surgical incision. The pivoting of the gripping members **4***a*, **4***b* in relation to the first and second arm **2**, **3** ensures the gripping members **4***a*, **4***b* always being parallel to the gripping side of the surgical incision when the arms **2**,**3** are forces apart. The arms further comprise respective attachment means **5***a*, **5***b* at the inner end of the arm to releasably attach the arms to the housing **7** or parts thereof. The gripping members **4***a*, **4***b* may be interchangeable into different shapes and sizes to cater to different needs. Although illustrated as relatively flat and square shaped, they may be elongated, curved and deeper. The gripping members **4***a*, **4***b* may comprise deeper or shallower gripping surfaces to securely grip the surface they are separating.

(13) An opening and closing mechanism **6** is located inside the housing. The housing must be watertight to ease sterilization and to contain impurities like oil, dust and grease from the opening and closing mechanism. For the housing **7** to be watertight the material of the housing may be a watertight material and any opening or excessive may comprise gaskets/and or seals to prevent the intrusion, or extrusion, of any impurities or fluids. The housing may preferably be made of a structural stiff material to contain withstand forces applied to the housing. The purpose of the mechanism **6** is to open and close the press arms **2**, **3** in a controllable, accurate and secure manner. In FIG. **2** the device is illustrated in an open state, wherein, the retraction of the press arms **2**, **3** exposes the surgical site. The press arms **2**, **3** are curved towards a centerline of the device, i.e. each arm having a convex shape with regard to the centerline, thus leaving an operational space in the central region of the chest, or operational location, when the device is in an open position, as illustrated in FIG. **2**. Furthermore, all lubrication needed for the device is confined within the housing **7**, and any external sterilization of the device will not require relubrication of the opening and closing mechanism **6**.

(14) The opening and closing mechanism must be activated by manual operation or a power source controlled by an operator. The mechanism comprising rotatable first and second press arm attachment structures **10***a*, **10***b* for attaching the attachment means **5***a*, **5***b* of the press arms, symmetrically positioned a distance away from a centerline of the surgical instrument, to the housing **7**. The arm attachment means **5***a*, **5***b* may be releasable attachable to the arm attachment structures for convenience of sterilizing and cleaning of the device. The arms **2**, **3** may be replaced with different lengths arms **2**, **3** and with different angles to cater to different needs. The arms **2**, **3** may further be angled in both the first plane and in any relation to the first plane. A surface of the arm attachment means **5***a*, **5***b* is adapted to receive a corresponding surface of the arm attachment structure **10***a*, **10***b*, in a manner not allowing relative rotation. The surface of the arm attachment means **5***a*, **5***b* may be a polygonal hollow, or negative, shape and the surface of the arm attachment structure **10***a*, **10***b* may be a protruding, or positive, corresponding surface of said first shape, or vise a versa, whereby the positive protrusion may enter into the hole or indent, but not rotate relative to each other in the first plane. The attachments structures and attachments means of both the hands and arms may comprise a securing mechanism, such as a safety pin or locking pin, to secure the attachments.

(15) The opening and closing mechanism further comprise rotatable first and a second handle attachment structure **13***a*, **13***b*. Wherein the first and a second handle attachment structure **13***a*, **13***b* protrudes from the housing and is adapted to each receive a first and a second handle **8**, **9**, respectively, for operating the opening and closing mechanism **6**. The first and second handles **8**, **9** comprises respective handle attachment means **14***a*, **14***b* at the inner end of the handle for attaching said handles to the first and second handle attachments structures **13***a*, **13***b*, respectively. A surface of the handle attachment means **14***a*, **14***b* is adapted to receive a corresponding surface of the handle attachment structure **13***a*, **13***b*, in a manner not allowing relative rotation. The handle attachment means **13***a*, **13***b* may be releasable attachable to the handle attachment structures for convenience of sterilizing and cleaning of the device, and to change to different shaped handles to cater to the needs of the user. The surface of the handle attachment means **14***a*, **14***b* may be a polygonal hollow, or negative, shape and the surface of the handle attachment structure **13***a*, **13***b* may be a protruding, or positive, corresponding surface of said first shape, or vise a versa, whereby the positive protrusion may enter into the hole or indent, but not rotate relative to each other in the first plane. Each handle **8**, **9** comprises a handle structure which is adapted to be operable by a user with one hand. The attachments structures and attachments means of both the hands and arms may comprise a securing mechanism, such as a safety pin or locking pin, to secure the attachments. Furthermore, the handle attachment means (**14***a*, **14***b*) may be releasable attachable to the handle attachments structures.

(16) When a user is to transfer the device for a closed first state to an open second state where the

press arms **2**, **3** are pressed apart the first and second handle is rotated towards each other, whereby an transfer mechanism transfer rotation from the handles **8**, **9** operated by a user via said first and second handle attachment structure **13***a*, **13***b* and to said first and second press arm attachment structure **10***a*, **10***b*. To achieve this the first and second handles **8**, **9** has a rotational movement in the first plane and being symmetrically positioned a distance away from the centerline of the surgical instrument. The two handles **8**, **9** are pretensioned towards an open state, meaning being positioned relative to each other with at least an positive angle between the handles **8**,**9**, wherein opposite rotational movement of the first and second handles **8**,**9** towards the centerline causes opposite rotational movement of the first and second press arms **2**,**3** away from the centerline. Opposite rotational movement of the first and second handles **8**,**9** should be understood as the movement caused by squeezing or pushing the end of the first and second handles **8**, **9** that are not attached to the respective handle attachment structure **13***a*, **13***b*, i.e. the outer end, towards each other. The two handles are pretensioned towards an open state and are thus able to cause a pumping action which is transferred to controlled movement of the press arms **2**, **3** by the opening and closing mechanism **6**. Both handles move symmetrically around a centerline.

(17) At least a spring **25** pretensions the first and second handles **8**, **9** away from each other, towards the open state. In FIGS. **4** and **5** a spring **25** is situated within the housing **7**, surrounding at least a part of the piston rod **16**, the piston rod being a movable in is longitudinal directing, and pushes on the piston rod **16** towards the cam arms **15***a*, **15***b*, and thereby pushes the first and second handles **8**, **9** apart. In an non illustrate embodiment, the spring **25** pushes directly on the cam arms **15***a*, **15***b*, and in another embodiment the spring **25** pushes directly on at least one of the first and second handle attachment structures **13**, a **13***b* or at least one of the first and second handles **8**, **9** or parts thereof.

(18) As the forces needed to open the device **1** and retract ribs or the sternum of a patient may be greater than what a hand can produce in one closing motion, the devices comprises an transfer mechanism that in an embodiment of the invention transfers and multiplies the force put into the handles **8**, **9** to the press arms **2**, **3**. This means that multiple pushes on the handles **8**, **9** will result in the arms being forcibly pressed apart a distance per one push on the first and second handles **8**,**9**. As the force acting from a patient on the arms **2**, **3** increases, a user will experience increased resistance on the handle **8**, **9** to give the user a tactile and tangible feel of the forces applied to the patient. The mechanism may be a mechanical gear and ratcheting mechanism or it may be a hydraulic mechanism.

(19) FIG. **3** shows the device with the inner workings exposed. In FIG. **3** an embodiment of the invention is illustrated where the transfer mechanism comprises first and second cam arms **15***a*, **15***b*. Each cam arm is connected to the first and second handle attachment structure **13***a*, **13***b*, respectively. This should be understood as the first cam arm **15***a* is connected to the first handle attachment structure **13***a*, and the second cam arm **15***b* is connected to the second handle attachment structure **13***b*. The cam arms **15***a*,**15***b* is connected to respective handle attachment structures **13***a*, **13***b* in a fixed manner, i.e. not allowing relative rotation between a cam arm and its handle attachment structure, so when a handle attachment structure **13***a*, **13***b* is rotated by one of the handles **8**, **9** the cam arm also rotates. The transfer mechanism illustrated in FIG. **3** further comprises a first and second activation arms **12***a*, **12***b*. Each activation arm is connected to the first and second press arm attachment structure **10***a*, **10***b*, respectively. The first and second press arms **2** and **3** are pretensioned towards a closed state i.e. pretensioned to be pressed together. This is achieved by at least an arm spring(s) **26**, **26′** in one end connected to the housing **7**, or parts thereof, and in another and connected at least one of the arm attachment structures **10***a*, **10***b* or parts thereof.

(20) In the illustrated embodiment of the invention the mechanism further comprises a hydraulic actuator **18** comprising a piston rod **16** and a cylinder **11**. The hydraulic actuator **18** is in one end coupled to, by being seated against, both of the first and second cam arms **15***a*, **15***b*, and in another

end is coupled to, by being seated against, both of the first and second activation arms **12***a*, **12***b*. Whereby the transfer mechanism is adapted to translate rotation movement from the first and second cam arms **15***a*, **15***b* to the first and second activation arms **12***a*, **12***b*. Each activation arm **12***a*, **12***b* is connected to the first and second arm attachment structure **10***a*, **10***b*, respectively. This should be understood as the first activation arm **12***a* is connected to the first arm attachment structure **10***a*, and the second activation arm **15***b* is connected to the second arm attachment structure **10***b*. The activation arms **12***a*, **12***b* is connected to respective arm attachment structure **10***a*, **10***b* in a fixed rotational manner, i.e. not allowing relative rotation between a an activation arm and its arm attachment structure, so when the hydraulic actuator **18** extends and pushes on the activation arms **12***a*, **12***b*, thereby rotating them about an axis going through the respective attachment structures, the activation arms **12***a*, **12***b* are rotated which in turn rotates the rotatable arm attachment structures **10***a*, **10***b* and thus presses the press arms **2**,**3** apart.

(21) FIG. **4** shows the device with the inner workings of the housing **7**. In FIG. **4** an embodiment of the invention is illustrated where the transfer mechanism comprises a first and a second hydraulic actuator **18**, **18**′. When disclosing multiple hydraulic actuators, a hydraulic actuator **18** and one further hydraulic actuator **18**′ should be understood as equivalent to at least a first hydraulic actuator **18** and a second hydraulic actuator **18**′. In the embodiment the actuator comprises a piston rod **16** and a further cylinder **11**, and the further hydraulic actuator **18**′ comprising a further piston rod **16**′ and a further cylinder **11**′. The further hydraulic actuator **18**′ in one end is coupled to the second cam arm **15***b*, and in another end is coupled to the second activation arm **12***b*. The hydraulic actuator **18** in one end is coupled to the first cam arms **15***a*, and in another end is coupled to the first activation arm **12***a*. Whereby the transfer mechanism is adapted to translate rotation movement from the first and second cam arms **15***a*, **15***b* to the first and second activation arms **12***a*, **12***b*, respectively, when the handles **8**, **9** are pressed together. In FIG. **4** the first and second handles **8**, **9** are illustrated symmetrically spaced apart, which is the handles **8**, **9** open state.

(22) FIG. **5** illustrates a detailed view of the transfer mechanism. In the illustrated embodiment of the invention shown in FIG. **5**, the transfer mechanism comprises two hydraulic actuators **18**, **18**′. Each actuator comprises a movable piston rod **16**, **16**′, wherein the piston rod comprises an end surface seated against, and thus movably coupled, to at least one of the respective protruding surface areas **17**, **17**′ of the cam arms **15***a*, **15***b*. The opposite end of the piston rods **16**, **16** comprises a sealing portion which seals of a hydraulic fluid volume confined by a piston chamber, said piston chamber being in fluid contact with a check valve. The check valve is further fluidly coupled to a fluid volume **29**, **29**′ confined by the main cylinder **11**, **11**′ and a sealing end portion of the main cylinder rod **27**, **27** within the main cylinder **11**, **11**′. Wherein the main cylinder **11**, **11**′ is translational movable in relation to the main cylinder rod **27**, **27**′. In another non-illustrated embodiment, a cylinder rod pushes on the handle attachment structures **13***a*, **13***b* and the main cylinders **11**, **11**′ are stationary.

(23) The method for a user to open the press arms **2**, **3** is initiated with a user pressing together the first and second handles **8**, **9**—said handles being connected to the first and second handle attachment structures **13***a*, **13***b*—the first and second cam arms **15***a*, **15***b* are rotated, which pushes on the piston rods **16**, **16**′ which causes translational movement of said rods and the hydraulic fluid volume within the piston chamber decreases. At least a part of the hydraulic fluid within the piston chamber is then pushed through the check valve and into the volume **29**, **29**′ in the main cylinders **11**, **11**′. This cause the cylinders **11**, **11**′ and main cylinder rods **27**, **27**′ to extend in relation to each other—as the hydraulic fluid volume in the main cylinders **11**, **11**′ increases—and the main cylinders **11**, **11** pushes away from the cylinder rods **27**, **27**′ towards and against the activation arms **12***a*, **12***b*. Thereby, the arm attachment structures **10***a*,**10***b* are rotated which opens the press arms **2**, **3**.

(24) When the handles **8**,**9** are released, the springs **25**, **25**′ pushes the pistons **16**, **16**′ backwards—causing translational movement of the piston rods **16**, **16**′—against the cam arms **15***a*, **15***b*. This

rotates the handles **8**, **9** simultaneously with hydraulic fluid is introduced, from a fluid reservoir **28**, through a second check valve and into the increasing volume of the piston chamber. An additional squeeze on the handles **8**,**9** will result in another sequential repetition of the above-mentioned sequence, and the press mars **2**, **3** will be pressed apart one further distance. With repeated squeezes on the handles **8**, **9** a user may open the press arms **2**, **3** to the desired width. During use the handles **8**, **9** will remain symmetrical along the centerline. The greater the force applied externally on the press arms, from a surgical wound or similar, the greater the force needed to be applied by a user on the handles. This ensures the user to feel and gauge the forces applied by the arms **2**, **3** on a patient or object. In a non-illustrated embodiment of the invention, the device may comprise a strain gauge and/or momentum gage and/or a torque measurement device, to measure force acting on the arms **2**, **3** i.e. the resistance from a body acting on the device. The device may furthered comprise a force or momentum indicator, ether as a visual indicator comprising a scale, or as an indicator that stops the handles **8**, **9** from being activated when a certain force on the arms **2**, **3** is reached. This indication may be achieved by a torque wrench type gauge such as a deflecting beam-type indicator, a slipper type indicator, a click type indicator or an electronic device comprising a strain gauge. Said indication may also indicate the pressure of the hydraulic fluid to indicate the achieved pressure of the press arms **2**, **3**

(25) The method for a user to return the device **1** to its closed state i.e. to close the press arms **2**,**3** together, comprises the user to activate a release valve switch **24**. The release valve switch **24** is in communication with a release valve, the release valve being fluidly coupled to the main cylinder(s) **11**, **11** and the reservoir **28**, **28**′. When the release valve switch **24** is activated the release valve opens up and the hydraulic fluid flows from the main cylinder(s) **11**, **11** and back into the fluid reservoir **28**, **28**, relisting the fluid pressure within the main cylinder(s) **11**, **11**. Thereafter, the pretensioned arm springs **26**, **16**′ together with any outside forces that may act upon the arms **2**, **3**, pulls the arms **2**, **3** together. In FIG. **5** the first and second handles **8**, **9** are illustrated symmetrically together, which is the handles **8**, **9** closed state. The release valve switch **24** and the corresponding release valve ensures smooth and fast closing of the arms **2**, **3**. The release valve switch **24** can be operated such that the arms **2**, **3** parley closes or fully closes, either in one fluid motion or step-vise closing. A user may thereby close the arms **2**, **3** partly or fully and thereby engage the handles **8**, **9** to open the arms **2**, **3** if adjustments is needed. The instant release of the pressure inside the main cylinder(s) **11**, **11** by activation of the valve results in an fast closing in the arms **2**, **3** which may be beneficial if the device is used for surgery, such that any surgical would is not exposed longer than absolutely necessary.

(26) In FIG. **5** the spring(s) **26**, **26**′ in one end connected to the housing **7** (not shown), or parts thereof, and in another and connected at least one of the arm attachment structures **10***a*, **10***b* via attachment means **30**, **30**′ protruding from the arm attachment structures **10***a*, **10***b*.

(27) In FIG. **3** and embodiment of the invention which uses one hydraulic actuator **18** is illustrated. The transfer mechanism for said embodiment may comprise the same features as the above disclosed embodiment illustrated in FIG. **5**, but with one hydraulic actuator **18**, comprises a movable piston rod **16** wherein the piston rod comprises an end surface seated against, and thus movably coupled, to at least one of the respective protruding surface areas **17**, **17**′ of the cam arms **15***a*, **15***b*. The opposite end of the piston rods **16** comprises a sealing portion (not shown) which seals of a hydraulic fluid volume confined by a piston chamber, said piston chamber being in fluid contact with a check valve. The check valve is further fluidly coupled to a fluid volume confined by the main cylinder **11** and a sealing end portion of the main cylinder rod (not shown) within the main cylinder **11**. Wherein the main cylinder **11**, is translational movable in relation to the main cylinder rod **27**.

(28) FIG. **6** shows the device with the inner workings of the housing **7** in an embodiment of the invention wherein the invention comprises means to ensure that a user rotates the first and second handle **8**,**9** at the same rate and distance. This will ensure that press arms **2**, **3** are opened at the

same rate and the same distance from the centerline. A user may use both left or right hand to operate the device and the device shall not favor any hand, as would be the case if a handle was stationary in relation to the other. To ensure that an even pressure is translated from both hands to the press arms **2**, **3** through the transfer mechanism, each of the first and second cam arms **15***a*, **15***b* comprises at least a partly tooted areas **23**, **23′** comprising teeth or cogs. The respective partly tooted areas **23**, **23′** protrudes a distance away from the handle attachment structures **13***a*, **13***b*, and wherein the at least partly tooted areas **23**, **23′** of the first and second cam arms **15***a*, **15***b* intermesh with each other to ensure the first and second handle **8**, **9** rotates synchronous in relation to each other.

(29) In FIG. **7** it is further illustrated that each of the first and second cam arms **15***a*, **15***b* comprises respective protruding surface areas **17**, **17′** adapted for receiving an end of the hydraulic actuators **18**, **18′**. In the illustrated example the hydraulic actuators **18**, **18′** each comprises an end surface on the piston rods **16**, **16′** adapted to be seated against, and thus movably coupled, to the protruding surface areas **17**, **17′** of the cam arms **15***a*, **15***b*.

(30) FIG. **7** shows the device with the inner workings of the housing **7** in an alternative embodiment of the invention wherein the transfer mechanism comprises a gear train **19**, said gear train **19** comprises reduction gears and/or a transfer gears **20** connected to a pinion gear **21**, said pinion gear being connected to a worm gear **22**. The gear train **19** is in one end rotationally coupled to at least one of the first and second cam arms **15***a*, **15***b* via circumferential toothed areas **23**, **23′**. The gear train **19** is in another end rotationally coupled to at least one of the first and second activation arms **12***a*, **12***b*, wherein the at least one of the first and second activation arms **12***a*, **12***b* comprises a toothed section corresponding to a worm gear screw. The transfer mechanism comprising the gear train **19** is adapted to translate rotation movement from at least one of the first and second cam arms **15***a*, **15***b* to at least one of the first and second activation arms **12***a*, **12***b*. The handle attachment structures may comprise a pawl and ratchet mechanism (not shown) for repeated squeezing of the handles to open the press arms **2**, **3**.

(31) In FIG. **8** the device **1** is illustrated with the first and second handle **8**, **9** in their fully open position, whereby the handles are opened up fully or partly folded over or under the housing **7**. Thus, the handles minimally protrude the edge of the housing and are thereby not hindering or catching any surgical equipment such as tubes and wires, if used for said purpose.

(32) FIG. **9** illustrates the device in a fully closed state, a fully opened state a partly opened and closed state where in press arms **2**, **3** are between the opened and closed state. In FIG. **8** the centerline CL is illustrated, wherein the arms **2**, **3** are symmetrically positioned around the centerline in the open state and wherein the gripping members **4***a*, **4***b* meet at the centerline in the closed state.

(33) Although not illustrated, the handle attachment structures **13***a*, **13***b* and arm attachment structures **10***a*, **10***b*, and thus the arms **2**, **3** and the handles **8**, **9**, may both protrude the housing **7** on the same side of the housing, either on a upward facing side or on a downward facing side, or they may be protruding the housing **7** on opposing sides, such that the arm attachment structures **10***a*, **10***b* protrudes the housing **7** on a upward facing side and the arm attachment structures **10***a*, **10***b* on the downwards facing side, or visa versa. Such that both the arms **2**, **3** and the handles may be positioned as to not be to hinder the movement of a user and a be out of the way for any tubes or cords used for other means. The arms **2**, **3** and handles **8**, **9** may also extend form side portions of the housing **7**.

(34) Although specific embodiments of the invention have been described and illustrated herein, it is recognized that modifications and variations may readily occur to those skilled in the art, and consequently, it is intended that the claims be interpreted to cover such modifications and equivalents.

REFERENCE NUMERALS P33138NO00

(35) **1** Surgical retractor instrument **2** first press arm **3** second press arm **4***a*, **4***b* gripping member

5*a*, **5***b* arm attachment means **6** opening and closing mechanism **7** housing **8** first handle **9** second handle **10***a*, **10***b* arm attachment structure **11**, **11′** main cylinder(s) **12***a*, **12***b* first and second activation arms **13***a*, **13***b* handle attachment structure **14***a*, **14***b* handle attachment means **15***a*, **15***b* first and second cam arms **16**, **16′** piston rod(s) **17**, **17′** protruding surface area on cam(s) **18**, **18′** hydraulic actuator(s) **19** gear train **20** gear **21** pinion gear **22** worm gear **23**, **23′** tooted area(s) **24** release valve switch **25** lever spring(s) **26** arm spring(s) **27**, **27′** main cylinder rod (**5**) **28**, **28′** hydraulic fluid reservoir(s) **29**, **29′** fluid volume(s) confined within the main cylinder **30**, **30′** spring attachment means(s)

Claims

1. A surgical retractor device comprising: a housing; a first press arm pivotably coupled to the housing, and; a second press arm pivotably coupled to the housing; said first press arm and second press arm each having a rotational movement in a first plane; each first and second press arm comprising: a gripping member pivoting around an axis at a right angle with the first plane, at an outer end of the press arm, an arm attachment means at an inner end of the press arm, wherein the housing comprises: an opening and closing mechanism, the opening and closing mechanism comprising: a rotatable first press arm attachment structure and a rotatable second press arm attachment structure for attaching the arm attachment means of the first and second press arms, symmetrically positioned a distance away from a centerline of the surgical retractor device, to the housing, and; a rotatable first handle attachment structure and a rotatable second handle attachment structure, and; a transfer mechanism to transfer rotation from said rotatable first and second handle attachment structure to said rotatable first and second press arm attachments wherein the surgical retractor device further comprises a first handle and a second handle for operating the opening and closing mechanism, each first and second handle comprising: a handle attachment means at an inner end of the handle for attaching said handle to the first and second handle attachment structures, respectively, and; a handle structure operable by a user, the first handle and the second handle each having a rotational movement in the first plane and being symmetrically positioned a distance away from the centerline of the surgical device, and; wherein the first and second handles are pretensioned towards an open state, and; wherein opposite rotational movement of the first and second handles towards the centerlines causes opposite rotational movement of the first and second press arms away from the centerline.
2. The surgical retractor device according to claim 1, wherein the transfer mechanism comprises: a first cam arm and a second cam arm each first and second cam arm connected to the rotatable first and second handle attachment structure respectively, and; a first activation arm and a second activation arm each first and second activation arm connected to the rotatable first arm and second arm attachment structure, respectively, and; a gear train comprising reduction gears and/or a transfer gear connected to a pinion gear, said pinion gear being connected to a worm gear, wherein the gear train in one end is rotationally coupled to at least one of the first and second cam arms, and; wherein the gear train in another end is rotationally coupled to at least one of the first and second cam arms to at least one of the first and second activation arms.
3. The surgical retractor device according to claim 2, wherein at least a spring pretensions the first and second handles away from each other, towards an open state.
4. The surgical retractor device according to claim 2, wherein the handle attachment means are releasably attachable, wherein a surface of the handle attachment means is adapted to receive a corresponding surface of the first and second handle attachment structures.
5. The surgical retractor device according to claim 2, wherein the arm attachment means are releasably attachable, wherein a surface of the arm attachment means is adapted to receive a corresponding surface of the first and second press arm attachment structures.
6. The surgical retractor device according to claim 1, wherein the transfer mechanism comprises: a

first cam arm and a second arm each first and second cam arm connected to the rotatable first and second handle attachment structures respectively, and; a first and a second activation arm connected to the rotatable first and second press arm attachment structures respectively, and; at least a hydraulic actuator comprising a piston rod and a cylinder, wherein the hydraulic actuator in one end is coupled to at least one of the first and second cam arms, and; wherein the hydraulic actuator in another end is coupled to at least one of the first and second activation arms, wherein the transfer mechanism is adapted to translate rotation movement from the first and second cam arms to the first and second activation arms.

7. The surgical retractor device according to claim 6, wherein the transfer mechanism further comprises: a further hydraulic actuator comprising a further piston rod and a further cylinder, wherein the further hydraulic actuator in one end is coupled to the second cam arm, and in another end is coupled to the second activation arm, and; wherein the hydraulic actuator in one end is coupled to the first cam arm, and in another end is coupled to the first activation arm, wherein the transfer mechanism is adapted to translate rotation movement from the first and second cam arms to the first and second activation arms, respectively.

8. The surgical retractor device according to claim 7, wherein each of the first and second cam arms comprises: a protruding surface area adapted for receiving an end surface of the piston rod, and; at least a partly toothed area comprising teeth or cogs, wherein the at least partly toothed area of the first and second cam arms intermesh with each other to ensure the first and second handles rotate synchronous in relation to each other.

9. The surgical retractor device according to claim 7, wherein the opening and closing mechanism comprises a release valve switch and a release valve fluidly coupled to the hydraulic actuator, whereby the release valve switch opens said valve to release pressure in the actuator(s) wherein the first and second press arms are movable from an open state towards a closed state.

10. The surgical retractor device according to claim 6, wherein each of the first and second cam arms comprises: a protruding surface area adapted for receiving an end surface of the piston rod, and; at least a partly toothed area comprising teeth or cogs, wherein the at least partly toothed area of the first and second cam arms intermesh with each other to ensure the first and second handles rotate synchronous in relation to each other.

11. The device according to claim 6, wherein the opening and closing mechanism comprises a release valve switch and a release valve fluidly coupled to the hydraulic actuator, whereby the release valve switch opens said valve to release pressure in the actuator wherein the first and second press arms are moveable from an open state towards a closed state.

12. The surgical retractor device according to claim 1, wherein at least a spring pretensions the first and second handles away from each other, towards an open state.

13. The surgical retractor device according to claim 1, wherein the handle attachment means are releasably attachable, wherein a surface of the handle attachment means is adapted to receive a corresponding surface of the first and second handle attachment structures.

14. The device according to claim 1, wherein the arm attachment means are releasably attachable, wherein a surface of the arm attachment means is adapted to receive a corresponding surface of the first and second press arm attachment structures.