

Description

Technical field

This invention relates to devices for driving staples to join adjacent bone portions.

Background art

Devices are known that facilitate manual hammering of staples into adjacent bone portions, such as is described in U.S. Patent No. 4,263,903. EP—A—0,081,578 teaches the use of a stapler that rapidly and reproducibly imparts a controlled amount of energy to propel a staple into bone portions and which provides many advantages over devices of the type described in U.S. Patent No. 4,263,903. The teachings in that patent, however, were based on tests with a commercially available manually actuatable staple gun (i.e., the Model T-50 Staple Gun Tacker manufactured by Arrow Manufacturing Co.) that is impractical for surgical use.

U.S. Patent No. 4,380,312 describes a stapling tool for applying staples to a workpiece to fasten an article, such as electrical cable, to the workpiece. The stapling tool is adapted to provide multiple driving strokes to the staple. That tool includes a compressible foot for limiting the drive distance of a plunger to a position dependent on the thickness of the article being stapled, and a retainer activated by the compressible foot to prevent the advancement of the next staple to its drive position while multiple drive strokes are being applied to the previous staple. U.S. Patent No. 3,017,636 also describes a stapler that applies multiple driving strokes to a staple.

U.S. Patent No. 3,717,294 describes a stapler for skin and fascia. That stapler includes a mechanism for preventing the retraction of a flexible staple housing belt during rearward movement of the pusher. That patent also describes a gas activated powering unit that develops a rectilinear thrust for advancing and forming staples.

U.K. Published Patent Application No. 2 074 078 describes a stapling device developed for orthopedic use. That stapling device includes a tubular locator having two locating pins that are driven lightly into bone to stabilize the locator. A punch is then inserted into the locator and hammered to drive a staple into the bone. Shoulders are provided on the punch and within the locator to prevent the staple being driven into bone beyond the head of the staple.

Disclosure of the invention

The present invention provides a stapling device having novel design features which provide additional safety when driving staples into bone portions during surgery.

Generally, the bone stapler according to the present invention is a stapler of the type adapted for use with generally U-shaped staples each comprising two generally parallel leg portions projecting in the same direction from opposite ends of the central portion. The stapler comprises

a housing having a passageway extending from an inlet opening to an outlet opening, which passageway is adapted to guide a single staple moved from the inlet to the outlet opening with distal ends of the leg portions of the staple leading. Means are provided for biasing a stack of staples into the inlet opening, together with a driver having an end portion adapted to engage the central portion of one of the staples and being mounted on the housing for sliding movement between a load position with the driver spaced from the inlet opening to afford movement of one of the staples into the passageway, along the passageway with the end portion pushing the staple, to an eject position at which the end portion of the driver pushes the staple out the outlet opening, and at which eject position the driver is stopped by the housing. Drive means are adapted to be manually activatable by a trigger for rapidly and forcefully propelling the driver along the passageway from the load position to the eject position to move one of the staples from the inlet opening to the outlet opening and for returning the driver from the eject position to the load position after activation of the drive means. The subject invention is characterised by means for releasably latching a piston to thereby lock the driver in the load position comprising latch means adapted for automatic engagement between the housing and the piston when the driver returns to the load position from the eject position, manually activatable button means mounted on the housing for movement from an outer position affording engagement of the latch means to an inner position engaged with and releasing with the latch means to afford movement of the driver to the eject position, and means for biasing the button means to the outer position. The means for releasably latching the driver in the load position has the advantage of producing additional safety by preventing inadvertent driving of a staple by pulling the trigger.

The invention preferably has a drive means which comprises an air cylinder assembly including a cylinder having a first and second ends with a portion of the driver extending into the cylinder from the second end, and having an inner surface between the first and second ends around and aligned with the driver, and a piston within the cylinder fixed to the driver and in slidable sealing engagement with the inner surface, the piston being movable along the inner surface from a first position adjacent the first end when the driver is in the load position to a second position adjacent the second end when the driver is in the eject position; and a valve assembly on the housing, the valve assembly comprising a body having an inlet port and first and second outlet ports, an actuator manually movable along the body from a blocking position closing the inlet port and connecting the outlet ports and an activate position connecting the inlet port and the first outlet port and closing the second outlet port, and means for biasing the actuator to the blocking position; the housing having an outlet passage-

way communicating with the cylinder adjacent the second end, communicating with the second outlet port, and being adapted to be coupled to a hose leading to air at atmospheric pressure; the housing having an inlet passageway coupled to the inlet port and adapted to be coupled to a source of air under greater than atmospheric pressure, and a transfer passageway coupled between the first outlet port and communicating with the cylinder adjacent the first end.

The provision of such features provides a structure which ensures that air is not discharged toward a patient.

Conveniently the means for biasing a stack of staples into the inlet opening comprises a cartridge including a case adapted to engage the housing, the stack of staples being within the case, and the cartridge further including a follower on the side of the stack of staples opposite the passageway and movable within the case with the stack of staples, manually actuatable means for releasably retaining the case in engagement with the housing and means for biasing the follower toward the passageway; the bone stapler further being arranged so that the housing and driver both comprise first and second parts, the first part of the housing defining the inlet and outlet openings, carrying the first part of the driver, and releasably carrying the cartridge, and the second part of the housing carrying the drive means and the second portion of the driver; and the bone stapler further including manually actuated means for releasably engaging the first and second parts of the housing and of the driver to afford using first parts adapted for staples of different sizes with the second parts. The provision of such a feature of providing the stapler and driver into parts facilitates the use of different size staples.

The invention will now be described by way of example with reference to the accompanying drawings wherein:—

Figure 1 is a top view of a bone stapler;

Figure 2 is a side view of the bone stapler of Figure 1;

Figure 3 is an enlarged sectional view taken along line 3—3 of Figure 1;

Figure 4 is an enlarged sectional view taken along line 3—3 of Figure 1 and similar to Figure 3, but in which drive means has been activated to drive a staple;

Figure 5 is an enlarged fragmentary sectional view taken approximately along lines 3—3 of Figure 1 and similar to Figure 3 but in which a driver included in the stapler is in an intermediate position;

Figure 6 is a sectional view taken approximately along line 6—6 of Figure 5;

Figure 7 is an enlarged fragmentary sectional view taken approximately along lines 3—3 of Figure 1 and similar to Figure 3 except that a staple cartridge is shown separated from the rest of the staples and a cartridge holding mechanism is shown in an open position;

Figure 8 is an enlarged top view of the cartridge shown separated in Figure 7;

Figure 9 is a sectional view taken approximately along line 9—9 of Figure 8;

Figure 10 is a sectional view taken approximately along line 10—10 of Figure 9;

Figure 11 is an enlarged sectional view taken approximately along line 11—11 of Figure 4; and

Figure 12 is a sectional view showing a safety button assembly according to the present invention.

Detailed description

Referring now to Figures 1 through 10 there is illustrated a bone stapler generally designated by the reference numeral 10.

The stapler 10 is adapted for use with generally U-shaped staples 11 (Figure 8), each of which staples 11 comprises a central portion 12 and two generally parallel leg portions 13 having pointed distal ends and projecting generally in the same direction from opposite ends of its central portion 12 and preferably diverging by about 1 or 2 degrees so that the driven staple will provide a compressive effect on portions of bone joined by it. Generally the stapler 10 comprises a pistol-shaped housing 14 having a passageway 16 (Figures 3 through 6) extending from an inlet opening 18 to an outlet opening 20, which passageway 16 is adapted to guide one of the staples 11 from the inlet opening 18 to the outlet opening 20 with the distal ends of the staple 11 leading. Means are provided for biasing a stack of the staples 11 contained in a replaceable cartridge 21 into the inlet opening 18. A driver 22 having an end portion 24 adapted to engage the central portion 12 of one of the staples 11 is mounted on the housing 14 for sliding movement between a load position (Figure 3) with the driver 22 spaced from the inlet opening 18 to afford movement of one of the staples 11 into the passageway 16, along the passageway 16 with its end portion 24 pushing the staple, to an eject position (Figure 4) at which the end portion 24 of the driver 22 pushes the staple 11 out of the outlet opening 20 and at which eject position the driver 22 is stopped. Drive means including an air cylinder assembly 26 powered by air under greater than atmospheric pressure and adapted to be manually activated by pulling an actuating trigger 27 into a handle-portion 25 of the housing 14 are provided for rapidly and forcefully propelling the driver 22 along the passageway 16 from the load position to the eject position to move the staple 11 from the inlet opening 18 to the outlet opening 20.

The driver 22 comprises a longitudinally slotted blade-like portion on which its end portion 24 is formed and which is guided along the housing 14 by a headed pin 15 fixed in the housing 14 that projects through the slot in the blade-like portion. Also included in the driver 22 is a cylindrical portion 17 that moves within a cylindrical guide bore 19 in the housing 14, to which cylindrical portion 17 the blade-like portion is attached at a frusto conical end plug 23 that slides in close-fitting engagement in the guide bore 19.

The drive means for propelling the driver 22

comprises the air cylinder assembly 26 which includes a cylinder 28 partially defined by a cylindrical inner surface 29 of the housing 14 concentric with the guide bore 19, which cylinder 28 has first and second ends 30 and 31, and a piston 32 within the cylinder 28 integral with an end portion of the driver 22 opposite its end portion 24. The piston 32 is in slidable sealing engagement with the cylindrical inner surface 29, and is movable along the inner surface 29 between a first position adjacent the first end 30 of the cylinder 28 at which the piston 32 is located when the driver 22 is in its load position and to which the piston 32 is biased by a main spring 33 within the piston 32 and the housing 14; and a second position adjacent the second end 31 of the cylinder 28 at which the piston 32 is positioned when the driver 22 is in its eject position.

The end of the main spring 33 opposite the piston 32 is supported against an annular inwardly projecting ledge on a guide collar 35 which guide collar 35 has an outwardly projecting rim fixed against an inwardly projecting lip in the housing 14 by an anchor ring 35b threadably engaged with the housing 14. The inner surface of the inwardly projecting ledge is in close engagement around the driver 22 and carries a pin 35c positioned in a longitudinal groove in the driver 22 to allow longitudinal movement of the driver 22 between its load and eject positions while the pin 35c prevents rotation of the driver 22 relative to the housing 14.

The actuating trigger 27 by which the air cylinder assembly 26 is actuated is included in a valve assembly 34 comprising the housing having a bore opening through the front of its handle portion 25 in which a guide spool 39 is fixed and having an inlet port 36 and first and second outlet ports 37 and 38 communicating with the bore. An actuator 40 coupled to the actuating trigger 27 by a set screw (not shown) is manually movable within the guide spool 39 from an outer blocking position (Figure 3) at which an O-ring 41 around a groove in the actuator 40 engages a seat around and closes the inlet port 36, and clearance between a small diameter portion 42 of the actuator 40 and the inner surface of the guide spool 39 connects the outlet ports 37 and 38 through transverse passageways in the guide spool 39; and an inner activate position (Figure 4) with the O-ring 41 separated from the seat to connect the inlet port 36 and the first outlet port 37 past the small diameter portion 42 of the actuator 40, and at which a larger diameter 43 portion of the actuator 40 essentially closes the transverse passageways in the guide spool 39 leading to the second outlet port 38. A spring 44 provides means for biasing the actuator 40 to its outer blocking position, against which spring 44 the actuator 40 may be manually moved or pulled to its activate position by the actuating trigger 27. The housing 14 has an outlet passageway 46 which communicates with the cylinder 28 adjacent its second end 31, communicates with the

second outlet port 38, and is adapted to be coupled to a portion of a hose (not shown) leading to air at atmospheric pressure through a conventional surgical air inlet connector, a female half 45 of which is formed in the housing 14. The housing 14 also has an inlet passageway 47 including an enlarged reservoir portion 48 (which provides sufficient air volume to quickly move the piston 32) coupled to the inlet port 36 and a smaller portion 49 adapted to be coupled to a source of air under greater than atmospheric pressure through the female coupling half 45. Also included is a transfer passageway 51 coupled between the first outlet port 37 and communicating with the cylinder 28 adjacent the first end 30. Thus, when the stapler 10 is activated by the actuating trigger 27 being pulled into the housing 14 to move the actuator 40 to its activate position (Figure 4), air under greater than atmospheric pressure in the reservoir 48 and from the supply will flow through the inlet port 36, past the small diameter actuator portion 42 and out the transfer passageway 51 to the first end 30 of the cylinder 28, while the larger diameter portion 43 of the actuator 40 precluded any significant amount of the high pressure air from escaping into the outlet passageway 46. As the piston 32 starts to move from its first to its second position under the influence of the high pressure air, air between the piston 32 and the second end 31 of the cylinder 28 will flow out the outlet passageway 46 and to the atmosphere through a hose (not shown) coupled at the female coupling half 45. When the actuating trigger 27 is subsequently released (Figure 3), the actuator 40 will return to its deactivate position under the influence of the spring 44 so that the inlet port 36 is closed, and the first and second outlet ports 37 and 38 are connected past the small diameter portion 42 of the actuator 40 so that the high pressure air can escape from behind the piston 32 via the transfer passageway 51, bore 35 and outlet passageway 46, and air at atmospheric pressure as needed can flow to the front of the piston 32 via the outlet passageway 46.

The means for biasing the stack of staples 11 into the inlet opening 18, best seen in Figure 5, comprises the cartridge 21 which is releasably received in the housing 14 and includes a case 54 comprising a pair of opposed hook-like projections 55 providing guide wall means defining an inner surface 56 at one end of the stack of staples 11, and side walls 57 projecting normal to the inner surface 56. The side walls 57 have opposed transverse openings 58 adjacent the inner surface 56 and aligned with the passageway 16 when the cartridge 21 is engaged in the housing 18 so that the inner surface 56 defines a portion of the passageway 16 at its inlet opening 18, and so that the driver 22 is movable through the transverse openings 58 and along the inner surface 56 between its load and eject positions. The cartridge 21 further includes a follower 60 on the side of the stack of staples 11 opposite the inner surface 56 and passageway 16 and guided along a

central rib 59 included in the case 54, which follower 60 is movable within the case 54 with the stack of staples 11. One of the side walls 57 of the case 54 has a pair of longitudinal slots 61 disposed generally at a right angle to the passageway 16 and the transverse openings 58. A pusher 62 has one end portion pivotably mounted on a retaining bracket 66 (included in the means for releasably retaining the cartridge 21 on the housing 14 as will later be explained) at a pin 63 and has two opposite distal end portions 64 projecting through the longitudinal slots 61 and in engagement with the side of the follower 60 opposite the stack of staples 11. Means in the form of a spring 65 is provided for biasing the distal end portions 64 of the pusher 62, and thus the stack of staples 11, toward the projections 55. Thus as the driver 22 moves through the transverse openings 58 and along the inner surface 56 defined by the projections 55 during movement from its load to its eject position, the driver 22 will carry with it the staple 11 pressed against the inner surface 56 by the follower 60, pusher 62 and spring 65. When removed, the cartridge 21 will carry with it all of the staples 11 remaining in the stapler 10 so that with the cartridge 21 removed it will be impossible to inadvertently fire a staple 11 from the stapler 10.

The hook-like projections are preferably integrally molded with the case 54 in positions projecting at about right angles to side walls 57 of the case 54 as is shown in dotted outline in Figure 9, and are then pivoted and frictionally pressed into grooves between rails 67 molded along the side walls 57 (see Figure 8) to their opposed positions described above.

The means for releasably retaining the cartridge 21 in the housing 14 comprises a socket in the housing 14 adapted to closely conform to and receive an end portion of the case 54 including the opposed projections 55 to key the proper location of case 54 in the housing 14 with its inner surface 56 aligned with one side of the passageway 16, and the retaining bracket 66 which is pivotably mounted on the housing 14 at a pin 63 for manual movement between a closed position (Figures 2 through 5) at which a transverse ledge 69 on the retaining bracket 66 engages the end of the case 54 opposite the housing 14 and holds the case 54 in the socket and at which the pusher 62 carried by the bracket 66 is biased against the follower 60 by the spring 65; and an open position (Figure 7) with the ledge 69 spaced from the cartridge 21 when it is in the socket to afford removal or insertion of the cartridge 21 with respect to the socket. Means are also provided for releasably retaining the retaining bracket 66 in its closed position, comprising a pair of hook like members 71 fixed to the housing 14 flanking the retaining bracket 66 and defining slots opening toward the front end of the housing 14; and a transverse rod 73 slidably mounted in spaced slots in the retaining bracket 66 for movement between an inner position (to which the rod 73 is biased by a spring 74 between the rod 73 and an anchor pin 75 on

the retaining bracket 66) and an outer position at the end of the slots opposite the anchor pin 75. When the retaining bracket 66 is in its closed position and the rod 73 is in its inner position, engagement of the rod 73 with the slots in the hook like members 71 will hold the retaining bracket 66 in its closed position. Manual movement of the rod 73 to its outer position against the bias of the spring 74 will afford pivoting of the retaining bracket 66 from its closed to its open position. Subsequent movement of the retaining bracket 66 from its open toward its closed position will cause the rod 73 to move toward its outer position along camming surfaces 76 defined along the distal edges of the hook-like members 71 until the rod 73 again engages the slots in the hook-like member 71 to hold the retaining bracket 66 closed.

The bone stapler 10 also includes blocking means for automatically preventing movement of the driver 22 to its load position from an intermediate position between its load and eject positions with a portion of the driver 22 projecting partially through the cartridge 21 and across the inlet opening 18 to passageway 16 (Figures 5 and 6) after the driver 22 has moved from its load to its eject position. Thus, with the driver 22 initially in its load position, the drive means may be manually activated a first time by pulling the actuating trigger 27 to drive a staple 11 through the outlet opening 20 and may subsequently be manually activated an additional number of times by pulling the actuating trigger 27 so that the driver 22 will be again propelled to its eject position to further impact that driven staple 11 as may be needed to fully seat the driven staple 11, without driving an additional staple 11 from the cartridge 21. Also included are reset means manually activated by a reset member or trigger 79 for resetting the blocking means to allow return movement of the driver 22 from its intermediate to its load position so that another staple 11 may be driven. Even with the driver 22 in its intermediate position extending partially through the cartridge 21, the cartridge 21 may be removed and replaced. The driver 22 has arcuate notches 78 along its sides (Figure 6) that align with the projections 55 when the driver 22 is in its intermediate position to allow the projections 55 to be withdrawn from the cartridge 21 receiving socket in the housing 14 through the notches 78.

The blocking means in the bone stapler 10 comprises a plunger 80 axially slidably mounted in a bore in the housing 14 communicating with the cylinder 28 at its first end 30 for movement in a direction normal to the axis of the cylinder 28 between a nonblocking position (Figure 3) spaced from within the cylinder 28, to a blocking position (Figure 4) partially within the cylinder 28 to which the plunger 80 is biased by a spring 81, so that engagement between the plunger 80 and the side of the piston 32 adjacent the first end 30 of the cylinder 28 will define the intermediate position for the piston 32. When the piston 32 is in its first position corresponding to the load position of the

driver 22, the periphery of the piston 32 will retain the plunger 80 in its non-blocking position in opposition to the biasing of the spring 81 (Figure 3). Upon movement of the piston 32 from its first position toward its second position corresponding to the eject position of the driver 22, however, the plunger 80 will automatically move to its blocking position under the influence of the spring 81 (Figure 4) to thus preclude the piston 32 from returning to its first position and thus preclude the driver 22 from returning to its load position until the reset means is operated by the reset trigger 79.

The reset means comprises the reset trigger 79 fastened by a set screw (not shown) to an outer end portion of a spindle 83, which spindle 83 is slidably mounted in a sleeve 82 fixed in a bore opening through the front of the handle portion 25 of the housing 14 for longitudinal sliding movement between an outer position (Figures 3 and 4) and an inner position (not shown). Also included in the reset means are means in the form of a spring 85 for biasing the reset trigger 79 to its outer position, and cam means on the spindle 83 and reset trigger 79 for moving the plunger 80 from its blocking to its nonblocking position against the bias of spring 81 upon manual movement of the spindle 83 from its outer to its inner position via the re-set trigger 79. The cam means comprise a semispherical tip 88 on the inner end of the spindle 83, and a surface 89 inclined with respect to the axis of the spindle 83 partially defining a slot in the plunger 80 in which the tip 88 is received to prevent rotation of the plunger 80. The slot in the plunger 80 is sufficiently long to afford movement of the plunger 80 from its nonblocking to its blocking position under the influence of the spring 81 after the driver moves toward its eject position. With the plunger 80 in its blocking position the reset trigger 79 may be manually pulled toward the handle portion 25 of the housing 14 which will cause the tip 88 to engage the inclined surface 89 so that the plunger 80 will be pulled back to its nonblocking position. This will allow the piston to return to its first position, and cause the driver 22 to return to its load position under the influence of the main spring 33.

The bone stapler 10 is designed to afford driving staples of different sizes in that it is made in two separable assemblies including a handle assembly 91 which includes the drive means mounted on one part of the housing 14, and a barrel assembly 92 which defines the passageway 16 and receives the cartridge 21 for staples 11 of one size on another part of the housing 14. Means are provided for releasably engaging the parts of the housing 14, and the driver 22 is separable into a second part 93 included in the handle assembly 91 and connected to the piston 32, and a first part 94 including its end portion 24 which is included in the barrel assembly 92. Different barrel assemblies that each have a housing part defining a passageway, a driver part and accept cartridges of a different size of staple may be substituted for

the barrel assembly 92 to afford driving stapler of different sizes.

Means are provided for releasably engaging the first and second parts 94 and 93 of the driver 22 and for releasably engaging the handle and barrel assemblies 91 and 92. These means comprise walls on the first part 94 of the driver 22 opposite its end portion 24 defining a socket with an outer portion 96 having a square cross section and an inner portion 97 with a circular cross section; and a tip on the first part 94 of the driver 22 including a distal square portion 99 adapted to slide within the socket through its outer portion 96 and to rotate in its inner portion 97 out of alignment with the outer portion 96 (see Figure 11) with the walls defining the outer portion 96 around a reduced diameter cylindrical portion 100 of the drivers first part 94. The part of the housing 14 included in the barrel assembly 92 includes a collar 101 at its end opposite the outlet opening 20 received in a socket in the part of the housing 14 included in the handle assembly 91 with the square portion 88 of the tip out of alignment with the outer portion 96 of the wall defining the socket, with four evenly spaced radially outwardly projecting pins 102 fixed on the collar 101 received in four longitudinally extending slots opening through the end of the housing part included in the handle assembly 91, and with hooks 105 on a ring 103 mounted for rotation about its axis on the housing part included in the handle assembly 91 in engagement with the pins 102 to releasably latch the handle and barrel assemblies 91 and 92 together. The barrel assembly 92 can thus be located at different orientations displaced 90 degrees from each other with respect to the handle assembly 91 to provide various orientations of a driven staple 11 relative to the handle portion 25 of the housing 14. To release the handle and barrel assemblies 91 and 92 from each other, the ring 103 is rotated against the bias of a coil spring 104 to move the hooks 105 from around the pins 102. The handle and barrel assemblies 91 and 92 are pulled apart axially of the driver 22 which pulls the pins 102 from the slots in which they are received and pulls the part of the housing 14 on the barrel assembly 92 along the driver 22 until the headed pin 15 reaches the end of the slot in the driver 22, at which position a spring loaded ball 107 carried by the housing part on the barrel assembly engages a groove 107b around the end plug 23, which engagement will keep the end plug 23 from moving into the guide bore 19 after the handle and barrel assemblies 91 and 92 are separated. The handle and barrel assemblies 91 and 92 are then rotated about 45 degrees relative to each other about the axis of the driver 22 to align the square position 99 of the tip with the outer portion 96 of the socket, whereupon the tip may be pulled from the socket and the assemblies 91 and 92 may be separated. Reengagement of the handle and barrel assemblies 91 and 92 is accomplished by reversing the steps listed above. Upon pressing the pins 102 into the slots, camming surfaces 105b of the

hooks 105 will cause the collar 101 to automatically rotate to engage the hooks 105 around the pins 102.

The bone stapler 10 also includes means for indicating to a user ready to fire the stapler 10 whether the driver 22 is in its load position from which a staple 11 can be driven or in its intermediate position. An indicating spool 106 is centrally slidably mounted in a removable plug 108 providing a portion of the housing 14 at the first end 30 of the cylinder 28. The indicating spool 106 is slidable between an inner position with a flange 109 at its outer end against the outer surface of the plug 108 to which the indicating spool 106 is biased by a spring 110, and an outer position with a portion of the spool 106 adjacent the flange 109, which is painted red, projecting from the plug 108. The piston 32 carries a central headed pin 112 at its end adjacent the first end 30 of the cylinder 28 around which pin 112 is a slidable washer 114 biased against the head of the pin 112 by a spring 113 with a greater spring constant than the spring 110. When the driver 22 is in its load position, the head of the pin 112 will enter an opening in the spool 106 while the washer 114 will be pressed against the adjacent end of the indicating spool 106 under the influence of the spring 113 causing the spool 106 to move to its outer position at which its red periphery indicates that the driver 22 is in its load position. When the driver 22 moves away from its load position, the indicating spool 106 will move to its inner position under the influence of the spring 110, thereby indicating to a user that the driver 22 is in its intermediate position.

Referring now to Figure 12 there is shown a safety means that is according to the present invention incorporated in a bone stapler 120 instead of the indicating means including the indicating spool 106 shown in Figure 2. In describing this safety means, portions of the stapler 120 that are essentially the same as corresponding portions of the stapler 10 will be identified by the same reference numeral to which has been added the suffix "a".

The safety means includes means for releasably latching a piston 32a at a first end 30a of a cylinder 28a to thereby lock a driver 22a in its load position. The safety means comprises latch means adapted for automatic engagement between a housing 14a and the piston 32a when the driver 22a returns to its load position from its eject position, manually activatable button means including a button 121 mounted on the housing 14a for axial sliding movement from an outer position affording engagement of the latch means to an inner position engaged with and releasing the latch means to afford movement of the driver 22a to its eject position, and means provided by air pressure in the cylinder 28a for biasing the button 121 to its outer position.

The latch means comprises a headed pin 123 projecting centrally from the end of the piston 32a adjacent the first end 30a of the cylinder 28a, and two pairs of resiliently flexible opposed canti-

levered hooks 125 disposed in a circular array, having one end fixed on the plug 108a, and projecting toward the pin 123. Distal camming surfaces on the pin 123 and hooks 125 are shaped to cause resilient outward deflection and engagement of the hooks 125 over the head of the pin 123 when the piston 32a returns to its first position corresponding to the load position of the driver 22a. Such engagement will prevent movement of the piston 32a that would cause movement of the driver 22a to its eject position even when the drive means (not shown) is activated by pulling a main trigger. The latch means can be released, however, by manually pressing the button 121 inwardly so that a cam surface 127 on the inner end of the button 121 will engage and separate the hooks 125, moving them radially out of engagement with the head of the pin 123, whereupon the driver may be moved to drive a staple by pulling the main trigger to activate the drive means.

Operation

The operation of the bone stapler 10 by a user will now be described assuming that a cartridge 21 containing a stack of staples 11 is held in the housing 14 by the retaining bracket 66 and the stapler 10 is connected at the coupling half 45 to a hose assembly (not shown) including a central supply of air under greater than atmospheric pressure coupled to the inlet passageway 47 and an outer hose leading to air at atmospheric pressure coupled to the outlet passageway 46. The user can utilize a pair of pointed locating members 130 fixed to the housing 14 in positions flanking the outlet opening 20 and projecting generally parallel to the axis of the driver 22 to help position and stabilize bone portions to be stapled in the same plane. When the bone portions are thus positioned, the stapler 10 can be activated by manually activating button means 121 and pulling the actuating trigger 27 so that air under greater than atmospheric pressure is coupled through the reservoir 48, valve assembly 34 and transfer passageway 51 to the first end 30 of the cylinder 28 which will cause rapid movement of the piston 32 and thereby the driver 22 from its load position spaced from the staple inlet opening 18, and through the cartridge 21 along its inner surface 56 to push the adjacent staple 11 in the stack along the passageway 16 to the outlet opening 20 and drive that staple 11 into adjacent portions of bone, the driver 22 being stopped at its eject position at the outlet opening 20 by engagement of the piston 32 with a rubber collar 131 at the second end 31 of the cylinder 28. As the piston 32 thus is moved away from the first end 30 of the cylinder 28, the plunger 80 will move into the cylinder 28 under the influence of the spring 81 so that, after the actuating trigger 27 is released and the high pressure air at the first end 30 of the cylinder 28 escapes through the transfer passageway 51, valve assembly 34 and outlet passageway 46 to the hose coupled to atmospheric pressure and the piston 32 moves back

toward its first position under the influence of the main spring 33, the piston will be stopped against the periphery of the plunger 80 with the end portion 24 of the driver 22 at an intermediate position extending through the cartridge 21 so that the next staple 11 in the stack of staples 11 can not move into the inlet opening 18 to the passageway 16. The user, if desired, can then again rapidly move the driver 22 to its eject position by again pulling the actuating trigger 27 as may be desired to further, drive or seat the staple 11 previously driven into the bone portions.

When the user desires to drive a second staple 11, he can pull the re-set trigger 79 which will move the tip 88 of the spindle 83 against the inclined surface 89 to cam the plunger 80 out of the cylinder 28 to its non-blocking position so that the main spring 33 can return the piston 32 to its first position and thereby the driver 22 to its load position allowing the uppermost staple 11 in the cartridge 21 to move against the inner surface 56 of the cartridge 21 at the inlet opening 18 so that subsequent activation of the drive means by releasing the latch means 123, 125 and actuating trigger 27 will drive that staple 11.

If the user wishes to remove the cartridge 21 because it is empty, or to insure that the stapler 10 can not fire another staple 11, or to insert staples with different length leg portions 13, he may do so by manually retracting the rod 73 out of the slots in the hook-like portions 71 against the bias of the spring 74, and pivoting the retaining bracket 66 from its closed position (Figures 2 through 5) to its open position (Figure 7) so that the cartridge 21 can be removed from the socket in the housing 14. He can then be sure that no staples 11 remain in the stapler 10, since the entire remaining stack of staples 11 (if any) remains in the cartridge 21. The same or a new cartridge 21 of staples 11 may again be loaded into the stapler 10 by inserting the cartridge 21 into the socket in the housing 14 and moving the retaining bracket 66 to its closed position, which will cause the rod 73 to move along the camming surfaces 76 of the hook-like portions 71 and subsequently into the slots therein to hold it closed.

If the user wishes to drive staples of a different width along its central portion 12, he may also do that by substituting an appropriate different barrel assembly for the barrel assembly 92 being used, which different barrel assembly is adapted to accommodate staples 11 of that width. Such substitution is easily accomplished by rotating the locking collar 103 to release the two parts of the housing 14, pulling and relatively rotating the housing parts with respect to the longitudinal axis of the driver 22 (as is described in greater detail above) which will cause the square portion 99 on the first part 94 of the driver 22 to align with the square cross section portion 96 of walls defining the socket in the second part 93 of the driver 22 in which the square portion 99 is received, and pulling the first and second parts

of the housing 14 and driver 22 away from each other to pull the square portion 99 from the socket and separate them. The different barrel assembly can then be assembled on the handle assembly 91 by reversing the separating steps.

Claims

1. A bone stapler (10) adapted for use with generally U-shaped staples (11) each comprising a central portion (12) and two generally parallel leg portions (13) projecting in the same direction from opposite ends of its central portion (12) and having distal ends, the stapler (10) comprising:

a housing (14; 14a) having a passageway (16) extending from an inlet opening (18) to an outlet opening (20), the passageway (16) being adapted to guide a single staple (11) moved from the inlet (18) to the outlet opening (20) with the distal ends of the staple (11) leading;

means (21, 60, 62, 63, 64, 65 and 66) for biasing a stack of staples (11) into said inlet opening (18);

a driver (22; 22a) having an end portion (24) adapted to engage the central portion (12) of one of the staples (11) and being mounted on the housing (14; 14a) for sliding movement between a load position (Figure 3) with the driver (22; 22a) spaced from the inlet opening (18) to afford movement of one of the staples (11) into the passageway (16), along the passageway (16) with the end portion (24) pushing the staple (11), to an eject position (Figure 4) at which the end portion (24) of the driver (22; 22a) pushes the staple (11) out the outlet opening (20) and at which eject position the driver (22; 22a) is stopped by the housing (14; 14a); and

drive means (26) adapted to be manually activatable by a trigger (27) for rapidly and forcefully propelling the driver (22; 22a) along the passageway (16) from the load position (Figure 3) to the eject position (Figure 4) to move one of the staples (11) from the inlet opening (18) to the outlet opening (20) and for returning the driver (22; 22a) from the eject position to the load position after activation of the drive means (26);

characterized in that means (Figure 12) is provided for releasably latching a piston (32a) to thereby lock the driver (22a) in the load position (Figure 3) comprising latch means (123 and 125) adapted for automatic engagement between the housing (14a) and the piston (32a) when the driver (22a) returns to the load position from the eject position, manually activatable button means (121) mounted on the housing (14a) for movement from an outer position affording engagement of the latch means (123 and 125) to an inner position engaged with and releasing the latch means (123 and 125) to afford movement of the driver (22) to the eject position (Figure 4), and means (28a) for biasing the button means (121) to the outer position, said latch means (123, 125) preventing movement of the driver (22a) even when the drive means (26) is activated by pulling the trigger (27).



toward its first position under the influence of the main spring 33, the piston will be stopped against the periphery of the plunger 80 with the end portion 24 of the driver 22 at an intermediate position extending through the cartridge 21 so that the next staple 11 in the stack of staples 11 can not move into the inlet opening 18 to the passageway 16. The user, if desired, can then again rapidly move the driver 22 to its eject position by again pulling the actuating trigger 27 as may be desired to further, drive or seat the staple 11 previously driven into the bone portions.

When the user desires to drive a second staple 11, he can pull the re-set trigger 79 which will move the tip 88 of the spindle 83 against the inclined surface 89 to cam the plunger 80 out of the cylinder 28 to its non-blocking position so that the main spring 33 can return the piston 32 to its first position and thereby the driver 22 to its load position allowing the uppermost staple 11 in the cartridge 21 to move against the inner surface 56 of the cartridge 21 at the inlet opening 18 so that subsequent activation of the drive means by releasing the latch means 123, 125 and actuating trigger 27 will drive that staple 11.

If the user wishes to remove the cartridge 21 because it is empty, or to insure that the stapler 10 can not fire another staple 11, or to insert staples with different length leg portions 13, he may do so by manually retracting the rod 73 out of the slots in the hook-like portions 71 against the bias of the spring 74, and pivoting the retaining bracket 66 from its closed position (Figures 2 through 5) to its open position (Figure 7) so that the cartridge 21 can be removed from the socket in the housing 14. He can then be sure that no staples 11 remain in the stapler 10, since the entire remaining stack of staples 11 (if any) remains in the cartridge 21. The same or a new cartridge 21 of staples 11 may again be loaded into the stapler 10 by inserting the cartridge 21 into the socket in the housing 14 and moving the retaining bracket 66 to its closed position, which will cause the rod 73 to move along the camming surfaces 76 of the hook-like portions 71 and subsequently into the slots therein to hold it closed.

If the user wishes to drive staples of a different width along its central portion 12, he may also do that by substituting an appropriate different barrel assembly for the barrel assembly 92 being used, which different barrel assembly is adapted to accommodate staples 11 of that width. Such substitution is easily accomplished by rotating the locking collar 103 to release the two parts of the housing 14, pulling and relatively rotating the housing parts with respect to the longitudinal axis of the driver 22 (as is described in greater detail above) which will cause the square portion 99 on the first part 94 of the driver 22 to align with the square cross section portion 96 of walls defining the socket in the second part 93 of the driver 22 in which the square portion 99 is received, and pulling the first and second parts

of the housing 14 and driver 22 away from each other to pull the square portion 99 from the socket and separate them. The different barrel assembly can then be assembled on the handle assembly 91 by reversing the separating steps.

Claims

1. A bone stapler (10) adapted for use with generally U-shaped staples (11) each comprising a central portion (12) and two generally parallel leg portions (13) projecting in the same direction from opposite ends of its central portion (12) and having distal ends, the stapler (10) comprising:

a housing (14; 14a) having a passageway (16) extending from an inlet opening (18) to an outlet opening (20), the passageway (16) being adapted to guide a single staple (11) moved from the inlet (18) to the outlet opening (20) with the distal ends of the staple (11) leading;

means (21, 60, 62, 63, 64, 65 and 66) for biasing a stack of staples (11) into said inlet opening (18);

a driver (22; 22a) having an end portion (24) adapted to engage the central portion (12) of one of the staples (11) and being mounted on the housing (14; 14a) for sliding movement between a load position (Figure 3) with the driver (22; 22a) spaced from the inlet opening (18) to afford movement of one of the staples (11) into the passageway (16), along the passageway (16) with the end portion (24) pushing the staple (11), to an eject position (Figure 4) at which the end portion (24) of the driver (22; 22a) pushes the staple (11) out the outlet opening (20) and at which eject position the driver (22; 22a) is stopped by the housing (14; 14a); and

drive means (26) adapted to be manually activatable by a trigger (27) for rapidly and forcefully propelling the driver (22; 22a) along the passageway (16) from the load position (Figure 3) to the eject position (Figure 4) to move one of the staples (11) from the inlet opening (18) to the outlet opening (20) and for returning the driver (22; 22a) from the eject position to the load position after activation of the drive means (26);

characterized in that means (Figure 12) is provided for releasably latching a piston (32a) to thereby lock the driver (22a) in the load position (Figure 3) comprising latch means (123 and 125) adapted for automatic engagement between the housing (14a) and the piston (32a) when the driver (22a) returns to the load position from the eject position, manually activatable button means (121) mounted on the housing (14a) for movement from an outer position affording engagement of the latch means (123 and 125) to an inner position engaged with and releasing the latch means (123 and 125) to afford movement of the driver (22) to the eject position (Figure 4), and means (28a) for biasing the button means (121) to the outer position, said latch means (123, 125) preventing movement of the driver (22a) even when the drive means (26) is activated by pulling the trigger (27).



2. A bone stapler (10) according to claim 1 wherein the drive means (26) comprises:

an air cylinder assembly (26) including a cylinder (28; 28a) having first and second ends (30 and 31; 30a) with a portion of the driver (22; 22a) extending into the cylinder (28; 28a) from the second end (31), and having an inner surface (29; 29a) between the first and second ends (30 and 31; 30a) around and aligned with the driver (22; 22a), and a piston (32; 32a) within the cylinder (28; 28a) fixed to the driver (22; 22a) and in slidable sealing engagement with the inner surface (29; 29a), the piston (32; 32a) being movable along the inner surface (29; 29a) from a first position (Figure 3) adjacent the first end (30; 30a) when the driver (22; 22a) is in the load position to a second position (Figure 4) adjacent the second end (31) when the driver (22; 22a) is in the eject position; and

a valve assembly (34) on the housing (22), the valve assembly (34) comprising a body having an inlet port (36) and first and second outlet ports (37 and 38), an actuator (40) manually movable along the body from a blocking position (Figure 3) closing the inlet port (36) and connecting the outlet ports (37 and 38) and an activate position (Figure 4) connecting the inlet port (36) and the first outlet port (37) and closing the second outlet port (38), and means (44) for biasing the actuator (40) to the blocking position;

the housing (14) having an outlet passageway (46) communicating with the cylinder (28) adjacent the second end (31), communicating with the second outlet port (38), and being adapted to be coupled to a hose leading to air at atmospheric pressure; and housing (14) having an inlet passageway (47) coupled to the inlet port (36) and adapted to be coupled to a source of air under greater than atmospheric pressure, and a transfer passageway (51) coupled between the first outlet port (37) and communicating with the cylinder (28) adjacent the first end (30).

3. A bone stapler (10) according to claim 1 or 2 wherein the means (21, 60, 62, 63, 64, 65 and 66) for biasing a stack of staples (11) into the inlet opening (18) comprises a cartridge (21) including a case (54) adapted to engage the housing (14), the stack of staples (11) being within the case (54), and the cartridge (21) further including a follower (60) on the side of the stack of staples (11) opposite the passageway (16) and movable within the case (54) with the stack of staples (11), manually actuatable means (66, 71, 73, 74 and 76) for releasably retaining the case (54) in engagement with the housing (14) and means (65) for biasing the follower (60) toward the passageway (16);

the bone stapler (10) further being arranged so that:

the housing (14) and driver (22) both comprise first and second parts (92 and 91, and 94 and 93), the first part (92) of the housing (14) defining the inlet and outlet openings (18 and 20), carrying the first part (94) of the driver (22), and releasably carrying the cartridge (21), and the second part

(91) of the housing (14) carrying the drive means (26, 27) and the second portion (93) of the driver (22); and

the bone stapler (10) further including manually actuated means (96, 97, 99, 100, 101, 102, 103 and 105) for releasably engaging the first and second parts (92 and 91, and 94 and 93) of the housing (14) and of the driver (22) to afford using first parts (92, 94) adapted for staples (11) of different sizes with the second parts (91, 93).

Patentansprüche

1. Knochenklammervorrichtung (10) für die Verwendung mit allgemein U-förmigen Klammern (11), von denen jede einen mittleren Teil (12) und zwei allgemein parallele Schenkel (13) besitzt, die von einander entgegengesetzten Enden des mittleren Teils (12) in derselben Richtung vorstehen und distale Enden haben, wobei die Klammervorrichtung (10) umfaßt:

ein Gehäuse (14; 14a) mit einem sich von einer Eintrittsöffnung (18) zu einer Austrittsöffnung (20) erstreckenden Kanal (16), der zum Führen einer einzigen Klammer (11) geeignet wird, die mit vorlaufenden distalen Enden der Klammer (11) von der Eintritts- (18) zur Austrittsöffnung (20) bewegt wird;

Mitteln (21, 60, 62, 63, 64, 65 und 66) zum Vorbelasten eines Stapels von Klammern (11) in die Eintrittsöffnung (18) hinein;

einen Stößel (22, 22a) mit einem Endteil (24), der zum Angriff an dem mittleren Teil (12) einer der Klammern (11) geeignet ist und der auf dem Gehäuse (14; 14a) für eine Bewegung längs des Kanals (16) zwischen einer Ladestellung (Figur 3), in der sich der Stößel (22; 22a) im Abstand von der Eintrittsöffnung (18) befindet, um eine Bewegung einer der Klammern (11) in den Kanal (16) zu ermöglichen, längs des Kanals (16), und einer Ausstoßstellung (Figur 4) verschiebbar gelagert ist, wobei der Endteil (24) die Klammer (11) schiebt und in der Ausstoßstellung der Endteil (24) des Stößels (22; 22a) die Klammer (11) aus der Austrittsöffnung (20) herausschiebt und der Stößel (22; 22a) in der Ausstoßstellung von dem Gehäuse (14; 14a) arretiert wird; und

einer mittels eines Abzuges (27) handbetätigbaren Antriebseinrichtung (26) zum schnellen und kräftigen Vorschub des Stößels (22; 22a) längs des Kanals (16) aus der Ladestellung (Figur 3) in die Ausstoßstellung (Figur 4) derart, daß eine der Klammern (11) von der Eintrittsöffnung in die Austrittsöffnung (20) bewegt wird, und zum Zurückstellen des Stößels (22; 22a) aus der Ausstoßstellung in die Ladestellung nach einer Aktivierung der Antriebseinrichtung (26);

dadurch gekennzeichnet, daß eine Einrichtung (Figur 12) vorgesehen ist, die dazu dient, einen Kolben (32a) auslösbar zu verrasten und dadurch den Stößel (22a) in der Ladestellung (Figur 3) festzulegen, und die Rastmittel (123 und 125) aufweist, die zum automatischen Verriegeln des Gehäuses (14a) mit dem Kolben (32a) geeignet sind, wenn der Stößel (22a) aus der Ausstoßstel-



lung in die Ladestellung zurückkehrt, ferner eine auf dem Gehäuse (14a) montierte, handbetätigbare Knopfseinrichtung (121), die aus einer äußeren Stellung, in der sie ein Verrasten der Rastmittel (123 und 125) ermöglicht, in eine innere Stellung bewegbar ist, in der sie an den Rastmitteln (123 und 125) angreift und diese ausrückt, um eine Bewegung des Stößels (22) in die Ausstoßstellung (Figur 4) zu ermöglichen, sowie eine Einrichtung (28a) zum Vorbelasten der Knopfseinrichtung (121) zu der äußeren Stellung hin, wobei die Rastmittel (123, 125) eine Bewegung des Stößels (22a) auch dann verhindern, wenn die Antriebseinrichtung (26) durch Drücken des Abzuges (27) aktiviert ist.

2. Knochenklammervorrichtung nach Anspruch 1, dadurch gekennzeichnet, daß die Antriebseinrichtung (26) umfaßt:

Eine Luftzylinderanordnung (26) mit einem Zylinder (28; 28a), der ein erstes und ein zweites Ende (30 und 31; 30a) besitzt, wobei sich ein Teil des Stößels (22; 22a) von dem zweiten Ende (31) des Zylinders (28; 28a) in diesen erstreckt und der Zylinder zwischen dem ersten und dem zweiten Ende (30 und 31; 30a) eine den Stößel (22; 22a) umgebende und mit ihm fluchtende Innenwandung (29; 29a) besitzt, und mit einem in dem Zylinder (28; 28a) angeordneten und an dem Stößel (22; 22a) befestigten Kolben (32; 32a), der mit der Innenwandung (29; 29a) in dichtender Gleitberührung steht und der längs der Innenwandung (29; 29a) aus einer dem ersten Ende (30; 30a) benachbarten ersten Stellung (Figur 3), in der sich der Stößel (22; 22a) in der Ladestellung befindet, in eine dem zweiten Ende (31) benachbarte zweite Stellung (Figur 4) bewegbar ist, in der sich der Stößel (22; 22a) in der Ausstoßstellung befindet; und

eine auf dem Gehäuse (22) vorgesehene Ventilanordnung (34), die ein Gehäuse mit einem Einlaß (36) und einem ersten und einem zweiten Auslaß (37 und 38) aufweist, ferner ein Stellglied (40), das von Hand längs des Gehäuses aus einer Sperrstellung (Figur 3), in der es den Einlaß (36) verschließt und die Auslässe (37 und 38) miteinander verbindet, in eine Aktivstellung (Figur 4) bewegbar ist, in der es den Einlaß (36) und den ersten Auslaß (37) miteinander verbindet und den zweiten Auslaß (38) schließt; sowie eine Einrichtung (44) zum Vorbelasten des Stellgliedes (40) in die Sperrstellung;

wobei das Gehäuse (14) einen Austrittskanal (46) besitzt, der mit dem Zylinder (28) im Bereich des zweiten Endes (31) in Verbindung steht und der mit dem zweiten Auslaß (38) in Verbindung steht und mit einem Schlauch kuppelbar ist, der unter atmosphärischen Druck stehende Luft führt; und das Gehäuse (14) einen mit dem Einlaß (36) gekuppelten Einlaßkanal (47) besitzt, der mit einer Quelle von unter einem Überdruck stehender Luft kuppelbar ist, sowie einen Überströmkanal (51), der mit dem ersten Auslaß (37) gekuppelt ist und im Bereich des ersten Endes (30) mit dem Zylinder (28) in Verbindung steht.

3. Knochenklammervorrichtung (10) nach

Anspruch 1 oder 2, dadurch gekennzeichnet, daß die Einrichtung (21, 60, 62, 63, 64, 65 und 66) zum Vorbelasten eines Stapels von Klammern (11) in die Eintrittsöffnung (18) eine Patrone (21) aufweist, die eine zum Angriff an dem Gehäuse (14) geeignete Hülse (54) besitzt, und die Patrone (21) ferner auf der dem Kanal (16) entgegengesetzten Seite des Stapels von Klammern (11) ein mitnehmbares Gleid (60) besitzt, das zusammen mit dem Stapel von Klammern (11) in der Hülse (54) zusammen bewegbar ist, ferner eine handbetätigbare Einrichtung (66, 71, 73, 74 und 76) zum lösbaren Anhaften der Hülse (54) an das Gehäuse (14) und eine Einrichtung (65) zum Vorbelasten des mitnehmbaren Gliedes (60) zu dem Kanal (16) hin; wobei die Knochenklammervorrichtung (10) ferner so angeordnet ist, daß:

sowohl das Gehäuse (14) als auch der Stößel (22) aus je einem ersten und einem zweiten Teil (92 und 91; 94 und 93) bestehen, der erste Teil (92) des Gehäuses (14) die Eintritts- und die Austrittsöffnung (18 und 20) begrenzt und den ersten Teil (94) des Stößels (22) und die von dem ersten Teil des Gehäuses abnehmbare Patrone (21) trägt und der zweite Teil (91) des Gehäuses (14) die Antriebseinrichtung (26) und den zweiten Teil (93) des Stößels (22) trägt; und

die Knochenklammervorrichtung (10) ferner eine handbetätigbare Einrichtung (96, 97, 99, 100, 101, 102, 103 und 105) trägt, die zum aufhebbaren Angriff des ersten und des zweiten Teils (92 und 91; 94 und 93) des Gehäuses (14) und des Stößels (22) aneinander dient, so daß mit den zweiten Teilen (91, 93) für Klammern (11) verschiedener Größen geeignete erste Teile (92, 94) verwendet werden können.

Revendications

1. Dispositif d'agrafage d'os (10) destiné à s'utiliser avec des agrafes (11) conformées d'une façon générale en U, comprenant chacune une partie centrale (12) et deux branches d'allure générale parallèle (13) se présentant en saillie dans le même sens depuis les extrémités opposées de la partie centrale (12) et présentant des extrémités distales, ce dispositif d'agrafage (10) comprenant:

un logement (14; 14a) comportant un passage (16) s'étendant depuis une ouverture d'entrée (18) vers une ouverture de sortie (20), le passage (16) étant destiné à guider une seule agrafe (11) déplacée depuis l'ouverture d'entrée (18) vers l'ouverture de sortie (20), les extrémités distales de l'agrafe (11) se trouvant en avant;

des moyens (21, 60, 62, 63, 64, 65 et 66) pour solliciter une pile d'agrafes (11) vers l'ouverture d'entrée susdite (18);

un dispositif d'entraînement (22; 22a) comportant une partie extrême (24) destinée à agir sur la partie centrale (12) de l'une des agrafes (11), et monté sur le logement (14; 14a) en vue d'un mouvement de glissement entre une position de chargement (Figure 3) dans laquelle le dispositif d'entraînement (22; 22a) est espacé de l'ouver-



ture d'entrée (18) pour assurer le déplacement de l'une des agrafes (11) vers et dans le passage (16), la partie extrême (24) poussant cette agrafe (11), et une position d'éjection (Figure 4) dans laquelle la partie extrême (24) du dispositif d'entraînement (22; 22a) pousse l'agrafe (11) hors de l'ouverture de sortie (20), position d'éjection dans laquelle le dispositif d'entraînement (22; 22a) est arrêté par le logement (14; 14a); et

un dispositif de commande (26) destiné à être actionné manuellement par une gâchette (27) en vue d'une propulsion rapide et forcée du dispositif d'entraînement (22; 22a) le long du passage (16) depuis la position de chargement (Figure 3) vers la position d'éjection (Figure 4) pour déplacer l'une des agrafes (11) depuis l'ouverture d'entrée (18) vers l'ouverture de sortie (20) et pour renvoyer le dispositif d'entraînement (22; 22a) depuis la position d'éjection vers la position de chargement après activation du dispositif de commande (26);

caractérisé en ce que des moyens (Figure 12) sont prévus pour verrouiller de façon libérable un piston (32a) pour bloquer ainsi le dispositif d'entraînement (22a) dans la position de chargement (Figure 3), ces moyens comprenant un dispositif de verrouillage (123 et 125) destiné à assurer un engagement automatique entre le logement (14a) et le piston (32a) lorsque le dispositif d'entraînement (22a) retourne vers la position de chargement depuis la position d'éjection, un dispositif à bouton (121) pouvant être commandé à la main et monté sur le logement (14a) en vue d'un déplacement depuis une position extérieure assurant la coopération des moyens de verrouillage (123 et 125) vers une position intérieure libérant les moyens de verrouillage (123 et 125) pour assurer le déplacement du dispositif d'entraînement (22) vers la position d'éjection (Figure 4), et des moyens (28a) destinés à solliciter le dispositif à bouton (121) vers la position extérieure, les moyens de verrouillage susdits (123, 125) empêchant un déplacement du dispositif d'entraînement (22a), même lorsque le dispositif de commande (26) est activé en agissant sur la gâchette (27).

2. Dispositif d'agrafage d'os (10) suivant la revendication 1, caractérisé en ce que le dispositif de commande (26) comprend:

un ensemble pneumatique (26) comprenant un cylindre (28; 28a) présentant une première et une seconde extrémité (30 et 31; 30a), une partie du dispositif d'entraînement (22; 22a) s'étendant dans le cylindre (28; 28a) depuis la seconde extrémité (31), et présentant une surface intérieure (29; 29a) entre la première et la seconde extrémité (30 et 31; 30a) autour du dispositif d'entraînement (22; 22a) et en alignement avec celui-ci, et un piston (32; 32a) prévu dans le cylindre (28; 28a), fixé au dispositif d'entraînement (22; 22a) et en contact d'étanchéité et de glissement avec la surface intérieure (29; 29a), le piston (32; 32a) étant mobile le long de la surface intérieure (29; 29a) depuis une première position (Figure 3) adjacente à la première extrémité (30;

30a) lorsque le dispositif d'entraînement (22; 22a) se trouve dans la position de chargement, vers une seconde position (Figure 4) adjacente à la seconde extrémité (31) lorsque le dispositif d'entraînement (22; 22a) se trouve dans la position d'éjection; et

un assemblage formant vanne (34) prévu sur le logement (22), cet assemblage formant vanne (34) comprenant un corps présentant une lumière d'entrée (36) et une première et une seconde lumière de sortie (37 et 38), un élément d'actionnement (40) déplaçable manuellement le long du corps depuis la position de blocage (Figure 3) fermant la lumière d'entrée (36) et reliant les lumières de sortie (37 et 38), et une position d'activation (Figure 4) dans laquelle la lumière d'entrée (36) et la première lumière de sortie (37) sont reliées et la seconde lumière de sortie (38) est fermée, et des moyens (44) sollicitant l'élément d'actionnement (40) vers la position de blocage;

le logement (14) comportant un passage de sortie (46) communiquant avec le cylindre (28) au voisinage de la seconde extrémité (31), communiquant avec la seconde lumière de sortie (38) et étant adapté pour être relié à un conduit menant à de l'air sous pression atmosphérique; le logement (14) comportant un passage d'entrée (47) relié à la lumière d'entrée (36) et destiné à être connecté à une source d'air se trouvant sous une pression supérieure à la pression atmosphérique, et un passage de transfert (51) relié à la première lumière de sortie (37) et communiquant avec le cylindre (38) au voisinage de la première extrémité (30).

3. Dispositif d'agrafage d'os (10) suivant la revendication 1 ou la revendication 2, caractérisé en ce que les moyens (21, 60, 62, 63, 64, 65 et 66) destinés à solliciter une pile d'agrafes (11) vers l'ouverture d'entrée (18) comprend une cartouche (21) comportant une boîte (54) destinée à coopérer avec le logement (14), la pile d'agrafes (11) se trouvant dans la boîte (54), et cette cartouche (21) comprenant en outre un plateau (60) prévu du côté de la pile des agrafes (11), qui est opposé au passage (16) et mobile à l'intérieur de la boîte (54) avec la pile d'agrafes (11), des moyens pouvant être actionnés manuellement (66, 71, 73, 74 et 76) destinés à retenir de façon libérable la boîte (54) en coopération avec le logement (14), et des moyens (65) pour solliciter le plateau (60) vers le passage (16);

ce dispositif d'agrafage d'os (10) étant en outre agencé pour que:

le logement (14) et le dispositif d'entraînement (22) comprenant tous deux une première et une seconde partie (92 et 91, et 94 et 93), la première partie (92) du logement (14) définissant les ouvertures d'entrée et de sortie (18 et 20), en portant la première partie (94) du dispositif d'entraînement (22), et portant de façon libérable la cartouche (21), la seconde partie (91) du logement (14) portant le dispositif de commande (26, 27) et une seconde partie (93) du dispositif d'entraînement (22); et



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le dispositif d'agrafage d'os (10) comprenant en outre des moyens actionnés manuellement (96, 97, 99, 100, 101, 102, 103 et 105) pour la coopération de manière libérable de la première et de la seconde partie (92 et 91, et 94 et 93) du logement

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(14) et du dispositif d'entraînement (22), en permettant l'utilisation de premières parties (92, 94) adaptées pour l'utilisation d'agrafes (11) de dimensions différentes, avec les secondes parties (91, 93).

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