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(54) **Strapping unit and method**

(57) A strapping unit (1) comprising main punch members (11a, 11b), a security punch member (21), main die members (31a-d) forming a first and a second main jaw and security die members (41a, 41b) forming a first and a second auxiliary jaw. The punch members are displaceable to and fro between a retracted position and an advanced punching position. The jaws are moveable towards and away from each other between a retracted open position and an advanced active position, and the auxiliary jaws are moveable in relation to the main jaws. The main die members and the main punch members are arranged to co-operate so as to cut mutually interlocking incisions in overlapping portions at the ends of a loop of metal strap received in the strapping unit. The security die members and the security punch member are arranged to co-operate so as to cut security incisions in said overlapping metal strap portions.

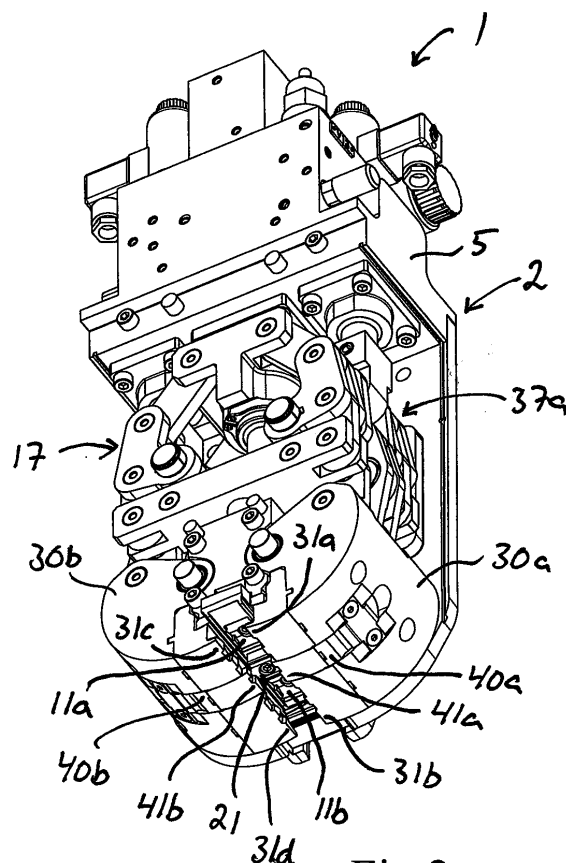


Fig 2

Description

FIELD OF THE INVENTION AND PRIOR ART

[0001] The present invention relates to a strapping unit according to the preamble of claim 1 and a method for forming a sealless joint in overlapping portions at the ends of a loop of metal strap by means of such a strapping unit.

[0002] A strapping unit according to the preamble of claim 1 is previously known from US 4 154 158 A, US 3 794 086 A and GB 2 040 825 A. A disadvantage with these known strapping units is that they achieve a sealless joint in overlapping portions at the ends of a loop of metal strap which will only lock said overlapping metal strap portions to each other in one direction under the effect of a tensile force in the loop. The sealless joint could therefore be broken, and the overlapping metal strap portions consequently released from each other, if the tensile force in the loop is released.

SUMMARY OF THE INVENTION

[0003] The object of the present invention is to achieve a further development of a strapping unit of the type according to the preamble of claim 1 so as to overcome the above-mentioned drawback of the previously known strapping units.

[0004] According to the invention, this object is achieved by a strapping unit having the features defined in claim 1.

[0005] The strapping unit according to the invention comprises:

- a housing,
- a main punch holder, which is displaceably mounted in the housing and which carries one or more main punch members, said one or more main punch members being displaceable, together with the main punch holder, to and fro between a retracted position and an advanced punching position,
- a first main die holder, which is moveably mounted in the housing and which carries one or more main die members that form a first main jaw,
- a second main die holder, which is moveably mounted in the housing and which carries one or more main die members that form a second main jaw located opposite said first main jaw,
- a security punch holder, which is displaceably mounted in the housing and which carries a security punch member, said security punch member being displaceable, together with the security punch holder, to and fro between a retracted position and an advanced punching position,
- a first security die holder, which is moveably mounted in the housing and which carries a first security die member that forms a first auxiliary jaw, and
- a second security die holder, which is moveably

mounted in the housing and which carries a second security die member that forms a second auxiliary jaw located opposite said first auxiliary jaw.

[0006] The main jaws are moveable towards and away from each other, together with the respective main die holder, between a retracted open position and an advanced active position, the main jaws in the active position together forming a supporting surface for a metal strap received in a passage formed between the main jaws and said one or more main punch member. The auxiliary jaws are moveable towards and away from each other, together with the respective security die holder, between a retracted open position and an advanced active position. The auxiliary jaws are also moveable in relation to the main jaws so as to allow the auxiliary jaws to remain in or be moved to the active position when the main jaws are moved away from the active position after the cutting of mutually interlocking incisions in overlapping portions at the ends of a loop of metal strap received in said passage. Said main die members and said one or more main punch members are arranged to co-operate so as to cut mutually interlocking incisions in overlapping portions at the ends of a loop of metal strap received in said passage, when the respective main punch member is displaced to the punching position with the main jaws located in the active position, whereas said security die members and said security punch member are arranged to co-operate so as to cut security incisions in said overlapping metal strap portions when the security punch member is displaced to the punching position with the auxiliary jaws located in the active position.

[0007] The incisions formed by the main die members and the main punch members are configured to lock the overlapping metal strap portions to each other in a first direction under the effect of a tensile force in the loop, whereas the security incisions formed by the security die members and the security punch member are configured to lock the overlapping metal strap portions to each other in a second direction opposite said first direction. The security incisions will thereby prevent the sealless joint from being broken due to a possible release of the tension in the loop.

[0008] According to an embodiment of the invention, the first security die holder is received in a recess in the first main die holder, and the second security die holder is received in a recess in the second main die holder. Hereby, the strapping unit can be given a compact design.

[0009] Another embodiment of the invention is **characterized in:**

- **that** the strapping unit comprises:
 - a first die actuator,
 - a first link mechanism, through which the first main die holder and the first security die holder are connected to the first die actuator,

- a second die actuator, and
 - a second link mechanism, through which the second main die holder and the second security die holder are connected to the second die actuator;
- that the first main jaw and the first auxiliary jaw are moveable between open position and active position and in relation to each other under the effect of the first die actuator and the first link mechanism; and
 - that the second main jaw and the second auxiliary jaw are moveable between open position and active position and in relation to each other under the effect of the second die actuator and the second link mechanism.

[0010] Thus, a main jaw and the associated auxiliary jaw are moveable in relation to the housing and in relation to each other by one and the same actuator, and the number of actuators required for controlling the operation of the strapping unit can thereby be reduced.

[0011] Another embodiment of the invention is **characterized in:**

- **that** the main punch holder is displaceable by means of a first punch actuator, which comprises a piston rod connected to a hydraulically or pneumatically actuated piston;
- that the security punch holder is displaceable by means of a second punch actuator, which comprises a piston rod connected to a hydraulically or pneumatically actuated piston; and
- that the piston rods of said first and second punch actuators are coaxially arranged with one piston rod extending through the other piston rod.

[0012] Hereby, the strapping unit can be given a compact design.

[0013] Further advantages as well as advantageous features of the strapping unit according to the invention will appear from the following description and the dependent claims.

[0014] The invention also relates to a method according to claim 13 for forming a sealless joint in overlapping portions at the ends of a loop of metal strap by means of a strapping unit of the present invention.

BRIEF DESCRIPTION OF THE DRAWING

[0015] With reference to the appended drawing, a specific description of preferred embodiments of the invention cited as examples follows below. In the drawings:

Fig 1 is a perspective view from above of a strapping unit according to an embodiment of the present invention,

Fig 2 shows the strapping unit of Fig 1 in a per-

spective view from below,

Fig 3a shows the strapping unit of Figs 1 and 2 in a planar view from below at a first stage in an operating sequence for forming a sealless joint in overlapping portions at the ends of a loop of metal strap,

Fig 3b shows the strapping unit of Figs 1 and 2 in a front view at said first stage,

Fig 3c shows the strapping unit of Figs 1 and 2 in a sectional view according to the line A-A in Fig 3b, as seen at said first stage,

Figs 4a-c shows the strapping unit of Figs 1 and 2 at a second stage in the operating sequence and in views corresponding to the views of Figs 3a-3c,

Figs 5a-c shows the strapping unit of Figs 1 and 2 at a third stage in the operating sequence and in views corresponding to the views of Figs 3a-3c,

Figs 6a-c shows the strapping unit of Figs 1 and 2 at a fourth stage in the operating sequence and in views corresponding to the views of Figs 3a-3c,

Figs 7a-c shows the strapping unit of Figs 1 and 2 at a fifth stage in the operating sequence and in views corresponding to the views of Figs 3a-3c, and

Fig 8 is a planar view of a sealless joint formed in overlapping metal strap portions by means of a strapping unit according to the invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS OF THE INVENTION

[0016] Figs 1 and 2 show a strapping unit 1 according to an embodiment of the present invention for forming a sealless joint in overlapping portions at the ends of a loop of metal strap. The strapping unit 1 is here illustrated without a protective cover, which is to cover the central part of the strapping unit in order to protect the mechanisms included therein.

[0017] The strapping unit 1 comprises a housing 2. A main punch holder 10 (see Fig 3c) is displaceably mounted in the housing 2 and carries a number of main punch members 11a, 11b. In the illustrated embodiment, two main punch members 11a, 11b are detachably mounted to the main punch holder 10 by means of fastening elements in the form of screws or the similar so as to enable a replacement of the respective main punch member.

The main punch members 11a, 11b are displaceable, together with the main punch holder 10, to and fro between a retracted position (see Fig 3c) and an advanced punching position (see Fig 5c) by means of a first punch actuator. In the illustrated embodiment, this punch actuator comprises a piston rod 13 connected to a hydraulically or pneumatically actuated piston 14, which is displaceably mounted in a first piston cavity 15 in the housing 2. This piston cavity 15 is divided by the piston 14 into an upper chamber 15a and a lower chamber 15b (see Fig 4c). The respective chamber 15a, 15b is connected to a pressure medium system (not shown) for feeding pressure medium in the form of hydraulic oil or compressed air to the chamber in order to control the displacement of the piston 14 in the piston cavity 15. In the illustrated embodiment, the main punch holder 10 is connected to the piston rod 13 of first punch actuator through a link mechanism 17, which is arranged to transfer a linear movement of the piston rod 13 into a linear movement of the main punch holder 10.

[0018] A cutting member 16 is mounted to the main punch holder 10 so as to move together with the main punch members 11a, 11b under the effect of the first punch actuator.

[0019] A security punch holder 20 (see Fig 3c) is displaceably mounted in the housing 2 and carries a security punch member 21. The security punch member 21 is detachably mounted to the security punch holder 20 by means of a fastening element in the form of a screw or the similar so as to enable a replacement of the security punch member. In the illustrated embodiment, the security punch member 21 is located between the two main punch members 11a, 11b. The security punch member 21 is displaceable, together with the security punch holder 20, to and fro between a retracted position (see Fig 3c) and an advanced punching position (see Fig 6c) by means of a second punch actuator. In the illustrated embodiment, this punch actuator comprises a piston rod 23 connected to a hydraulically or pneumatically actuated piston 24, which is displaceably mounted in a second piston cavity 25 in the housing 2. This piston cavity 25 is divided by the piston 24 into an upper chamber 25a and a lower chamber 25b (see Fig 4c). The respective chamber 25a, 25b is connected to a pressure medium system (not shown) for feeding pressure medium in the form of hydraulic oil or compressed air to the chamber in order to control the displacement of the piston 24 in the piston cavity 25.

[0020] The piston rods 13, 23 of the first and second punch actuators are with advantage coaxially arranged with one piston rod extending through the other piston rod, as illustrated in Figs 3c-7c. In the illustrated embodiment, the piston rod 23 of the second punch actuator extends through the piston 14 and the piston rod 13 of the first punch actuator and through the main punch holder 10.

[0021] A first main die holder 30a is moveably mounted in the housing 2 and carries a number of main die mem-

bers 31a, 31b, which form a first main jaw 36a. A second main die holder 30b is moveably mounted in the housing 2 and carries a number of main die members 31c, 31d, which form a second main jaw 36b located opposite said first main jaw 36a. In the illustrated embodiment, two main die members are detachably mounted to the respective main die holder 30a, 30b by means of fastening elements in the form of screws or the similar so as to enable a replacement of the respective main die member. The main jaws 36a, 36b are moveable towards and away from each other, together with the respective main die holder 30a, 30b, between a retracted open position (see Figs 7a and 7b) and an advanced active position (see Figs 4a and 4b). In the active position, the main jaws 30a, 30b together form a supporting surface for a metal strap 3 received in a passage 4 formed between the main jaws 30a, 30b and the main punch members 11a, 11b.

[0022] A first security die holder 40a is moveably mounted in the housing 2 and carries a first security die member 41a, which forms a first auxiliary jaw 46a. A second security die holder 40b is moveably mounted in the housing 2 and carries a second security die member 41b, which forms a second auxiliary jaw 46b located opposite said first auxiliary jaw 46a. The respective security die member 41a, 41b is detachably mounted to the associated security die holder 40a, 40b by means of fastening elements in the form of screws or the similar so as to enable a replacement of the respective security die member. In the illustrated embodiment, the security die member 41a of the first security die holder 40a is located between the two main die members 31a, 31b of the first main die holder 30a, and the security die member 41b of the second security die holder 40b is located between the two main die members 31c, 31d of the second main die holder 30b. The first security die holder 40a is received in a recess in the first main die holder 30a, and the second security die holder 40b is received in a recess in the second main die holder 30b. In the illustrated embodiment, the first main die holder 30a and the first security die holder 40a are pivotally mounted to a common pivot shaft 9a, whereas the second main die holder 30b and the second security die holder 40b are pivotally mounted to another common pivot shaft 9b.

[0023] The auxiliary jaws 46a, 46b are moveable towards and away from each other, together with the respective security die holder 40a, 40b, between a retracted open position (see Figs 7a and 7b) and an advanced active position (see Figs 6a and 6b). The auxiliary jaws 46a, 46b are also moveable in relation to the main jaws 36a, 36b so as to allow the auxiliary jaws 46a, 46b to remain in or be moved to the active position when the main jaws 36a, 36b are moved away from the active position after the cutting of mutually interlocking incisions in overlapping portions at the ends of a loop of metal strap received in the above-mentioned passage 4.

[0024] The first main jaw 36a and the first auxiliary jaw 46a are moveable between open position and active position and in relation to each other under the effect of a

first die actuator 32a and a first link mechanism 37a, whereas the second main jaw 36b and the second auxiliary jaw 46b are moveable between open position and active position and in relation to each other under the effect of the second die actuator 32b and a second link mechanism 37b. In the illustrated embodiment, the respective die actuator 32a, 32b comprises a piston rod 33a, 33b connected to a hydraulically or pneumatically actuated piston (not shown), which is displaceably mounted in a piston cavity (not shown) in the housing 2. The respective piston cavity is divided by the associated piston into an upper chamber and a lower chamber, the respective chamber being connected to a pressure medium system (not shown) for feeding pressure medium in the form of hydraulic oil or compressed air to the chamber in order to control the displacement of the piston in the piston cavity. The piston rod 33a of the first die actuator 32a is connected to the first main die holder 30a and the first security die holder 40a through the first link mechanism 37a, which is arranged to transfer a linear movement of the piston rod 33a into a pivotal movement of the first main die holder 30a and the first security die holder 40a. The piston rod 33b of the second die actuator 32b is connected to the second main die holder 30b and the second security die holder 40b through the second link mechanism 37b, which is arranged to transfer a linear movement of the piston rod 33b into a pivotal movement of the second main die holder 30b and the second security die holder 40b.

[0025] A gripping element 50 is displaceably mounted in the housing 2. This gripping element 50 is provided with a gripping surface 51 (see Fig 6c) on its underside and the respective main jaw 36a, 36b is at its rear provided with a corresponding gripping surface 38 on its upper side. The gripping element 50 is displaceable to and fro between a retracted strap releasing position (see Fig 6c) and an advanced strap gripping position (see Fig 4c) by means of an actuator. In the illustrated embodiment, this actuator comprises a piston rod 53 connected to a hydraulically or pneumatically actuated piston 54, which is displaceably mounted in a piston cavity 55 in the housing 2. This piston cavity 55 is divided by the piston 54 into an upper chamber 55a and a lower chamber 55b (see Fig 6c). The respective chamber 55a, 55b is connected to a pressure medium system (not shown) for feeding pressure medium in the form of hydraulic oil or compressed air to the chamber in order to control the displacement of the piston 54 in the piston cavity 55. The gripping surface 51 of the gripping element 50 and the gripping surface 38 of the respective main jaw 36a, 36b are arranged to co-operate so as to grip a metal strap 3 extending between the gripping element 50 and the main jaws 36a, 36b when the gripping element 50 is displaced to the advanced strap gripping position with the main jaws 36a, 36b located in the active position.

[0026] The gripping element 50 is provided with a channel 56, through which a metal strap 3 is intended to be fed into the above-mentioned passage 4. The cutting

member 16 is arranged to slide against the gripping element 50 so that it will pass the outlet opening of the channel 56, and thereby cut off a metal strap extending through this outlet opening, when the main punch members 11a, 11b are displaced to the punching position.

[0027] The housing 2 comprises a pneumatic or hydraulic block 5. The above-mentioned piston cavities and the pressure medium channels leading to these piston cavities are formed in this block 5.

[0028] The main punch members 11a, 11b and the main die members 31a, 31b, 31c, 31d are arranged to co-operate so as to cut mutually interlocking incisions 6 (see Fig 8) in overlapping portions at the ends of a loop of metal strap 3 received in the passage 4, when the main punch members 11a, 11b are displaced to the punching position with the main jaws 36a, 36b located in the active position. The security punch member 21 and the security die members 41a, 41b are arranged to co-operate so as to cut security incisions 7 (see Fig 8) in said overlapping metal strap portions when the security punch member 21 is displaced to the punching position with the auxiliary jaws 46a, 46b located in the active position. In the illustrated example, each main punch member 11a, 11b is designed to form four incisions 6 and the security punch member 21 is designed to form two security incisions 7. The incisions 6 formed by the main punch members 11a, 11b are configured to lock the overlapping metal strap portions to each other in a first direction under the effect of a tensile force in the metal strap loop, whereas the security incisions 7 formed by the security punch 21 are configured to lock the overlapping metal strap portions to each other in a second direction opposite said first direction.

[0029] The strapping unit 1 is intended to form part of a strapping machine, which is to be used for securing a loop of metal strap around an object or a bundle of objects. Such a strapping machine also comprises a feeding unit for feeding a metal strap through the channel 56 of the gripping element 50 and into the above-mentioned passage 4 of the strapping unit 1, around an object 8 or bundle of objects (see Fig 3c) and then back into the passage 4.

[0030] An operating sequence for securing a loop of metal strap around an object 8 with the aid of the above-described strapping unit 1 will now be described with reference to Figs 3-7. The metal strap 3 and the object 8 to be strapped are only illustrated in Fig 3c and are omitted in the other figures.

[0031] In a first step (see Fig 3a-3c), a metal strap 3 is fed forwards by means of a feeding unit (not shown) through the channel 56 of the gripping element 50, into the passage 4, in a loop around the object 8, under the gripping element 50 and then back into the passage 4. Hereby, two mutually overlapping portions of the metal strap 3 will be provided in the passage 4 between the punch members 11a, 11b, 21 and the die members 31a, 31b, 31c, 31d, 41a, 41b. During this feeding, the main jaws 36a, 36b and the auxiliary jaws 46a, 46b are in the

active position or close to the active position and will thereby prevent the metal strap from falling out of the passage 4, whereas the punch members 11a, 11b, 21 and the gripping element 50 are in the retracted position. When the feeding has been completed, the gripping element 50 is displaced to the strap gripping position (see Fig 4c) so as to lock the end of the metal strap 3 to the strapping unit 1 by clamping between the gripping surface 51 of the gripping element 50 and the gripping surfaces 38 of the main jaws 36a, 36b. Thereafter the metal strap 3 is pulled backwards by the feeding unit so as to pull the metal strap 3 tightly around the object 8. A tension is hereby developed in the metal strap loop. When the tightening of the metal strap has been completed, the main punch members 11a, 11b are displaced to the punching position (see Fig 5c) so as to press the overlapping metal strap portions against the main die members 31a, 31b, 31c, 31d and thereby cut through these metal strap portions for the formation of incisions 6 therein. At the same time, the cutting member 16 will be displaced across the outlet opening of the channel 56 in the gripping element 50 and cut off the part of the metal strap extending through this outlet opening. During this displacement of the main punch members 11a, 11b and the cutting member 16, the main jaws 36a, 36b are located in the advanced active position, as illustrated in Fig 5a, and the gripping element 50 is located in the gripping position. In the next step (see Figs 6a-6c), the gripping element 50 and the main punch members 11a, 11b are returned to the retracted position, whereupon the main jaws 36a, 36b are moved a short distance away from the active position, as illustrated in Fig 6a, so as to make the main die members 31a, 31b, 31c, 31d loose their locking engagement with the overlapping metal strap portions and allow these metal strap portions to slide longitudinally in relation to the main die members. Said short distance may be in the order of a few millimeters. The overlapping metal strap portions at the ends of the loop are now free to slide a short distance (about 1-2 millimeters) in relation to each other in the longitudinal direction of the metal strap under the effect of the inherent tension in the loop until the incisions 6 in the upper metal strap portion engage firmly with the corresponding incisions 6 in the lower metal strap portion. The overlapping metal strap portions have now been joined to each other by means of the mutually interlocking incisions 6. The joint will tighten further if the metal strap loop is subjected to increased tension. In the next step, the security punch member 21 is displaced to the punching position (see Fig 6c) so as to press the overlapping metal strap portions against the security die members 41a, 41b and thereby cut through these metal strap portions for the formation of security incisions 7 therein. During this displacement of the security punch member 21, the auxiliary jaws 46a, 46b are located in the advanced active position, as illustrated in Fig 6a. The security incisions 7 will prevent the overlapping metal strap portions from sliding backwards in relation to each other and will thereby secure a firm joint

between the overlapping metal strap portions together with the previously formed incisions 6. Finally, the security punch member 21 is returned to the retracted position (see Fig 7c) and the main jaws 36a, 36b and auxiliary jaws 46a, 46b are moved to the open position (see Figs 7a and 7b) so as to release the metal strap loop from the strapping unit 1. The jaws 36a, 36b, 46a, 46b are then returned to the starting position (see Figs 3a and 3b) so as to allow a new length of metal strap to be fed forward for the formation of a new loop of metal strap around the object or around a new object.

[0032] The invention is of course not in any way restricted to the embodiments described above. On the contrary, many possibilities to modifications thereof will be apparent to a person with ordinary skill in the art without departing from the basic idea of the invention such as defined in the appended claims.

Claims

1. A strapping unit for forming a sealless joint in overlapping portions at the ends of a loop of metal strap, the strapping unit comprising:

- a housing (2),
 - a main punch holder (10), which is displaceably mounted in the housing (2) and which carries one or more main punch members (11a, 11b), said one or more main punch members being displaceable, together with the main punch holder (10), to and fro between a retracted position and an advanced punching position,
 - a first main die holder (30a), which is moveably mounted in the housing (2) and which carries one or more main die members (31a, 31b) that form a first main jaw (36a), and
 - a second main die holder (30b), which is moveably mounted in the housing (2) and which carries one or more main die members (31c, 31d) that form a second main jaw (36b) located opposite said first main jaw (36a),
- wherein the main jaws (36a, 36b) are moveable towards and away from each other, together with the respective main die holder (30a, 30b), between a retracted open position and an advanced active position, the main jaws (36a, 36b) in the active position together forming a supporting surface for a metal strap received in a passage (4) formed between the main jaws (36a, 36b) and said one or more main punch members (11a, 11b), and wherein said main die members (31a, 31b, 31c, 31d) and said one or more main punch members (11a, 11b) are arranged to cooperate so as to cut mutually interlocking incisions in overlapping portions at the ends of a loop of metal strap received in said passage (4), when the respective main punch member (11a,

11b) is displaced to the punching position with the main jaws (36a, 36b) located in the active position,

characterized in:

- **that** the strapping unit (1) further comprises:

- a security punch holder (20), which is displaceably mounted in the housing (2) and which carries a security punch member (21), said security punch member being displaceable, together with the security punch holder (20), to and fro between a retracted position and an advanced punching position,
- a first security die holder (40a), which is moveably mounted in the housing (2) and which carries a first security die member (41a) that forms a first auxiliary jaw (46a), and
- a second security die holder (40b), which is moveably mounted in the housing (2) and which carries a second security die member (41b) that forms a second auxiliary jaw (46b) located opposite said first auxiliary jaw (46a);

- **that** said auxiliary jaws (46a, 46b) are moveable towards and away from each other, together with the respective security die holder (40a, 40b), between a retracted open position and an advanced active position;

- **that** the auxiliary jaws (46a, 46b) are moveable in relation to the main jaws (36a, 36b) so as to allow the auxiliary jaws (46a, 46b) to remain in or be moved to the active position when the main jaws (36a, 36b) are moved away from the active position after the cutting of mutually interlocking incisions in overlapping portions at the ends of a loop of metal strap received in said passage (4); and

- **that** said security die members (41, 41b) and said security punch member (21) are arranged to co-operate so as to cut security incisions in said overlapping metal strap portions when the security punch member (21) is displaced to the punching position with the auxiliary jaws (46a, 46b) located in the active position.

2. A strapping unit according to claim 1, **characterized in that** the first main die holder (30a) and the first security die holder (40a) are pivotally mounted to a common pivot shaft (9a), and that the second main die holder (30b) and the second security die holder (40b) are pivotally mounted to another common pivot shaft (9b).
3. A strapping unit according to claim 2, **characterized in that** first security die holder (40a) is received in a

recess in the first main die holder (30a), and that the second security die holder (40b) is received in a recess in the second main die holder (30b)

4. A strapping unit according to any of claims 1-3, **characterized in:**

- **that** the first main die holder (30a) carries two main die members (31a, 31b);
- **that** the second main die holder (30b) carries two main die members (31c, 31d);
- **that** the first security die member (41a) is located between the two main die members (31a, 31b) carried by the first main die holder (30a);
- **that** the second security die member (41b) is located between the two main die members (31c, 31d) carried by the second main die holder (30b);
- **that** the main punch holder (10) carries two main punch members (11a, 11b); and
- **that** the security punch member (21) is located between the two main punch members (11a, 11b).

5. A strapping unit according to any of claims 1-4, **characterized in:**

- **that** the strapping unit (1) comprises:

- a first die actuator (32a),
- a first link mechanism (37a), through which the first main die holder (30a) and the first security die holder (40a) are connected to the first die actuator (32a),
- a second die actuator (32b), and
- a second link mechanism (37b), through which the second main die holder (30b) and the second security die holder (40b) are connected to the second die actuator (32b);

- **that** the first main jaw (36a) and the first auxiliary jaw (46a) are moveable between open position and active position and in relation to each other under the effect of the first die actuator (32a) and the first link mechanism (37a); and

- **that** the second main jaw (36b) and the second auxiliary jaw (46b) are moveable between open position and active position and in relation to each other under the effect of the second die actuator (32b) and the second link mechanism (37b).

6. A strapping unit according to claim 5, **characterized in that** the respective die actuator (32a, 32b) comprises a hydraulically or pneumatically actuated piston displaceably mounted in a piston cavity in the housing (2).

7. A strapping unit according to any of claims 1-6, **characterized in:**

- **that** the main punch holder (10) is displaceable by means of a first punch actuator, which comprises a piston rod (13) connected to a hydraulically or pneumatically actuated piston (14);
- **that** the security punch holder (20) is displaceable by means of a second punch actuator, which comprises a piston rod (23) connected to a hydraulically or pneumatically actuated piston (24); and
- **that** the piston rods (13, 23) of said first and second punch actuators are coaxially arranged with one piston rod (23) extending through the other piston rod (13).

8. A strapping unit according to claim 7, **characterized in that** the piston rod (23) of the second punch actuator extends through the piston rod (13) of the first punch actuator.

9. A strapping unit according to claim 8, **characterized in:**

- **that** the piston (14) of the first punch actuator is displaceably mounted in a first piston cavity (15) in the housing (2);
- **that** the piston (24) of the second punch actuator is displaceably mounted in a second piston cavity (25) in the housing (2) located above said first piston cavity (15).

10. A strapping unit according to any of claims 1-9, **characterized in:**

- **that** the strapping unit (1) comprises a gripping element (50), which is displaceably mounted in the housing (2), the gripping element (50) being displaceable to and fro between a retracted strap releasing position and an advanced strap gripping position;
- **that** the gripping element (50) is provided with a gripping surface (51) on its underside;
- **that** the respective main jaw (36a, 36b) at its rear end is provided with a gripping surface (38) on its upper side; and
- **that** the gripping surface (51) of the gripping element and the gripping surface (38) of the respective main jaw are arranged to co-operate so as to grip a metal strap extending between the gripping element (50) and the main jaws (36a, 36b) when the gripping element is displaced to the advanced strap gripping position with the main jaws located in the active position.

11. A strapping unit according to claim 10, **characterized in that** the gripping element (50) is displaceable

by means of an actuator which comprises a hydraulically or pneumatically actuated piston (54) mounted in a piston cavity (55) in the housing (2).

12. A strapping unit according to any of claims 6, 9 or 11, **characterized in that** the housing (2) comprises a pneumatic or hydraulic block (5), the respective piston cavity and pressure medium channels leading to the respective piston cavity being formed in this block.

13. A method for forming a sealless joint in overlapping portions at the ends of a loop of metal strap by means of a strapping unit (1) according to any of claims 1-12, the method comprising the following consecutive steps:

- feeding of a metal strap (3) into the passage (4) formed between the main jaws (36a, 36b) and the main punch members (11a, 11b) so as to form a tensioned loop of metal strap with mutually overlapping metal strap portions received between the main die members (31a, 31b, 31c, 31d) of the main jaws (36a, 36b) and the main punch members (11a, 11b);
- displacement of the main punch members (11a, 11b) to the punching position with the main jaws (36a, 36b) located in the active position so as to cut mutually interlocking incisions (6) in said overlapping metal strap portions by co-operation between the main punch members (11a, 11b) and the main die members (31a, 31b, 31c, 31d);
- withdrawal of the main punch members (11a, 11b) from the punching position and movement of the main jaws (36a, 36b) away from the active position so as to release the overlapping metal strap portions from the main die members (31a, 31b, 31c, 31d) and allow them to slide axially in relation to each other under the effect of the inherent tension in the loop, thereby allowing the incisions (6) in said overlapping metal strap portions to interlock with each other; and
- displacement of the security punch member (21) to the punching position with the auxiliary jaws (46a, 46b) located in the active position so as to cut security incisions (7) in the overlapping metal strap portions by co-operation between the security punch member (21) and the security die members (41a, 41b).

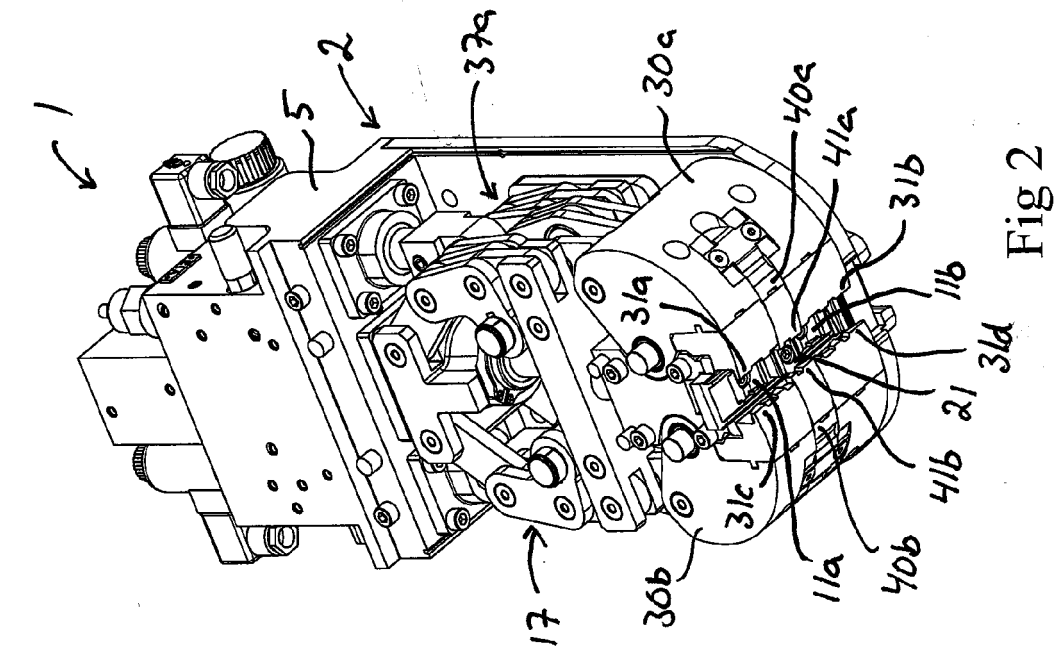


Fig 1

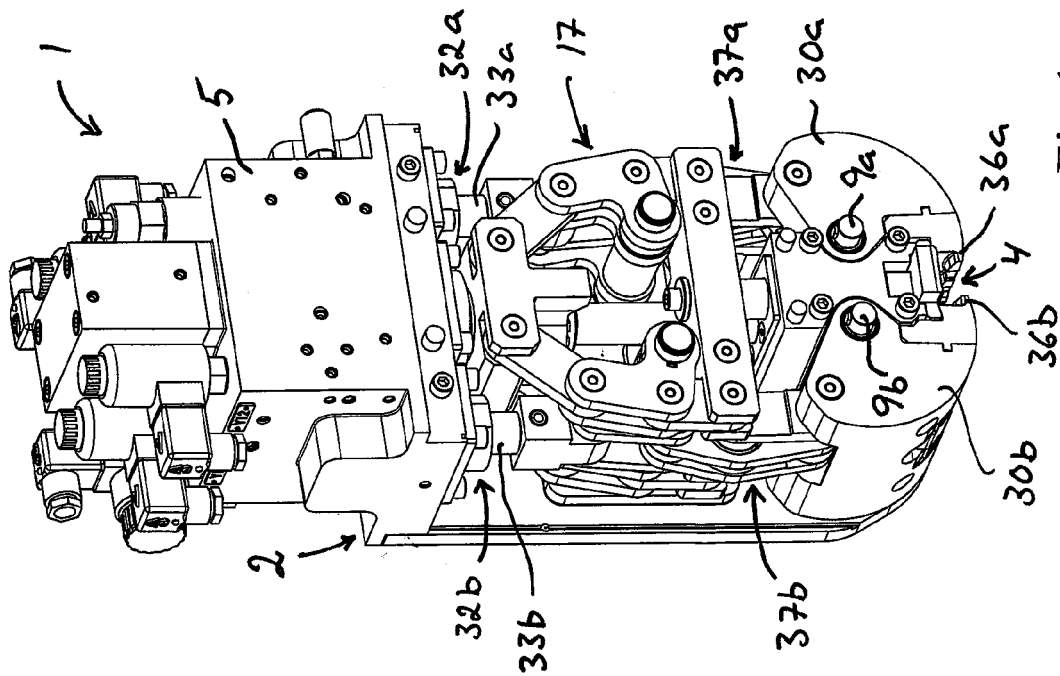
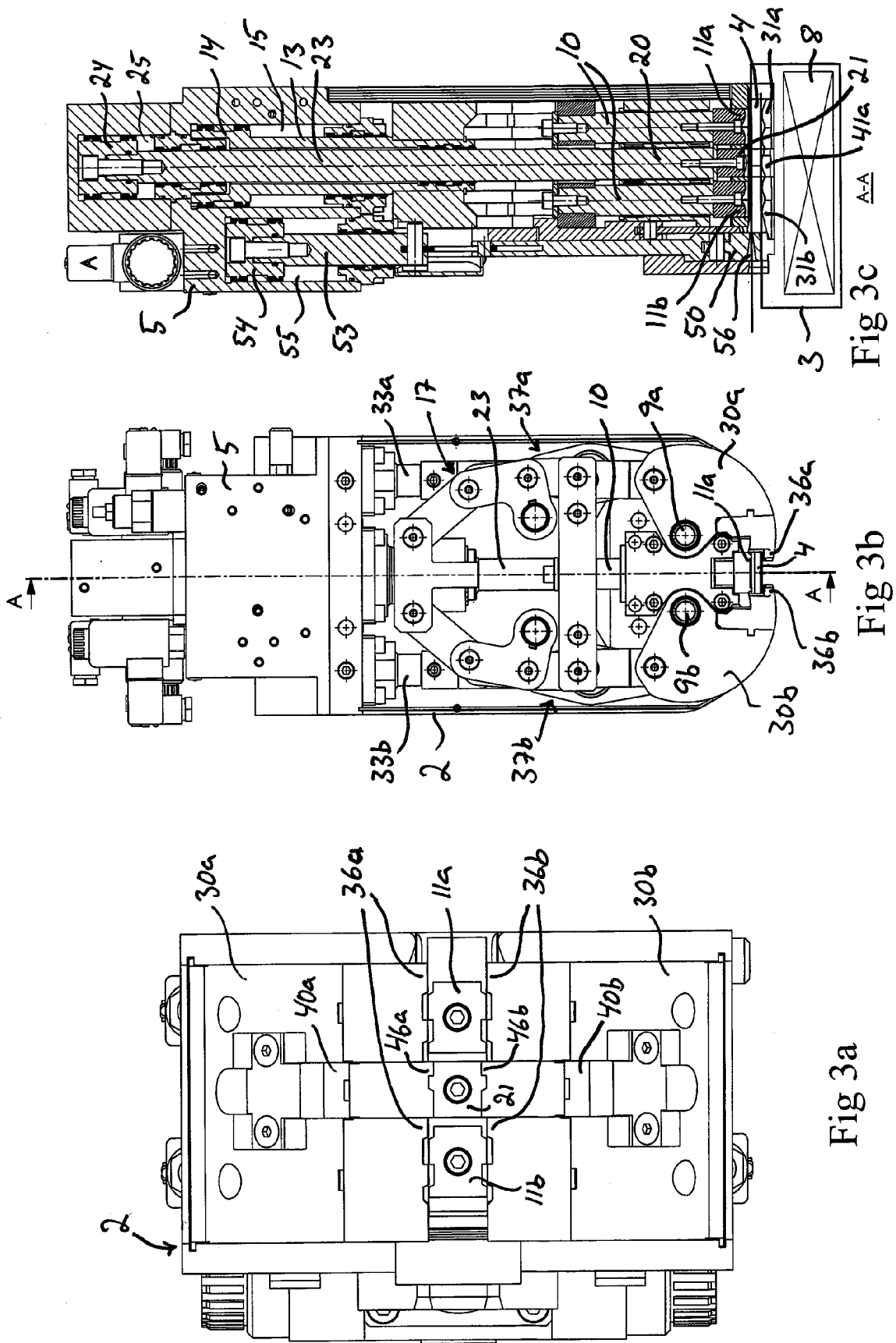
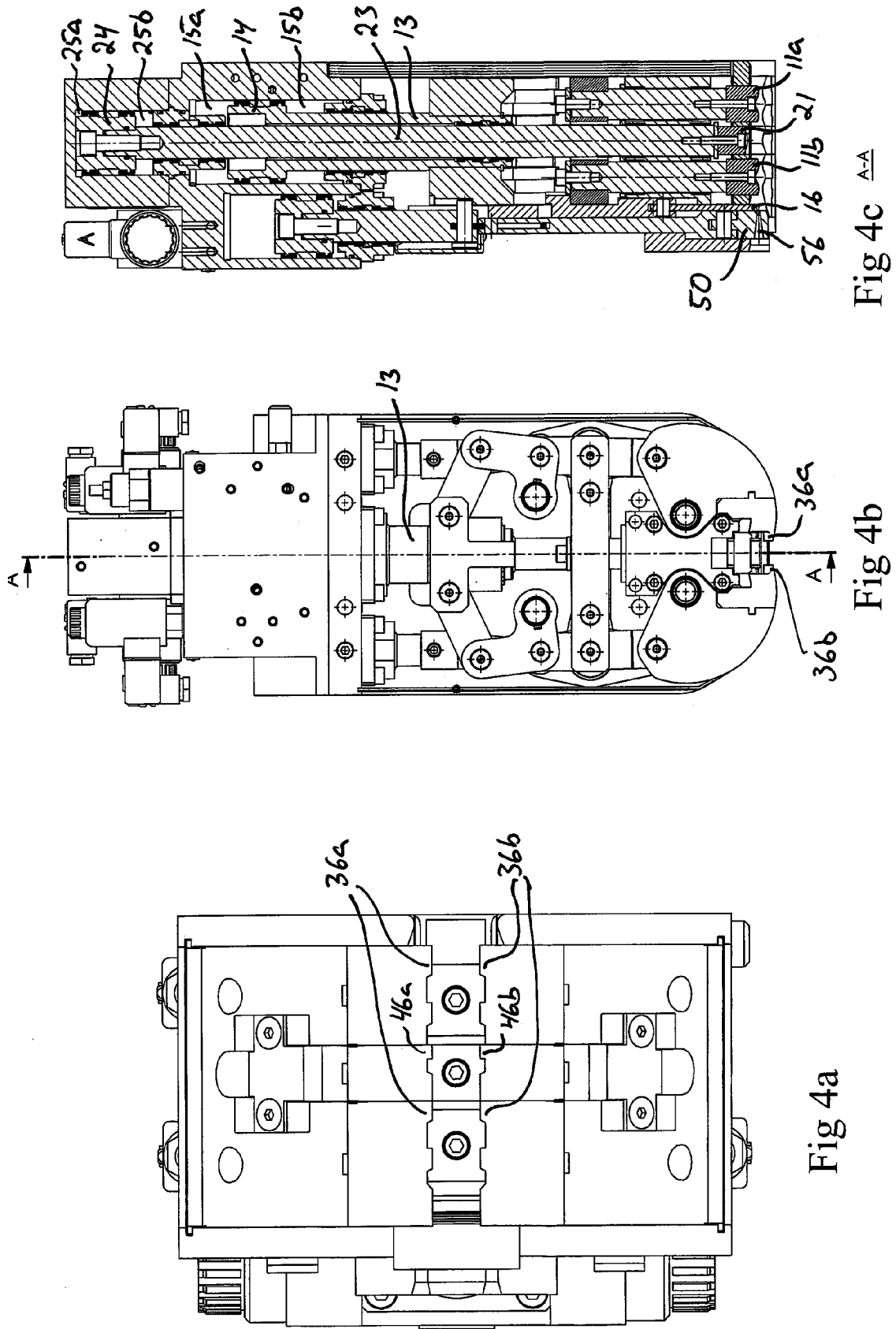


Fig 2





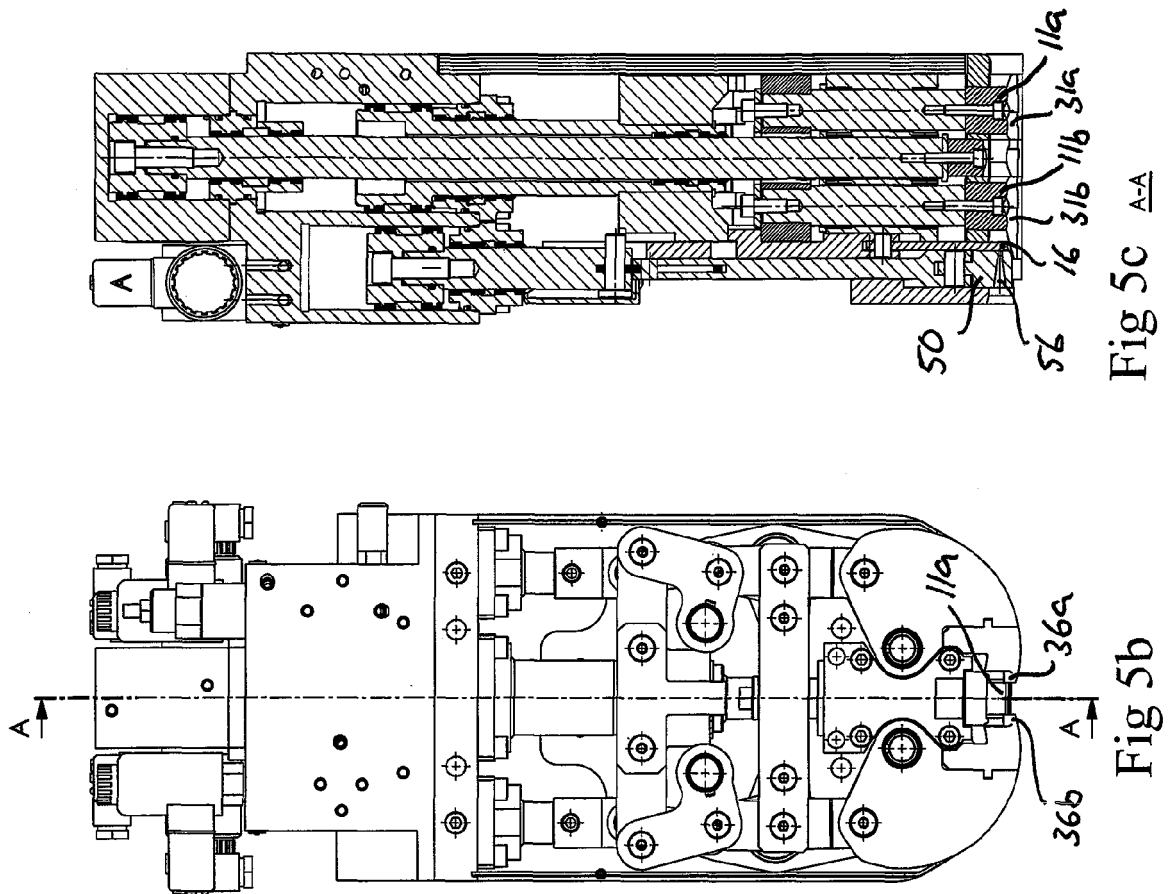
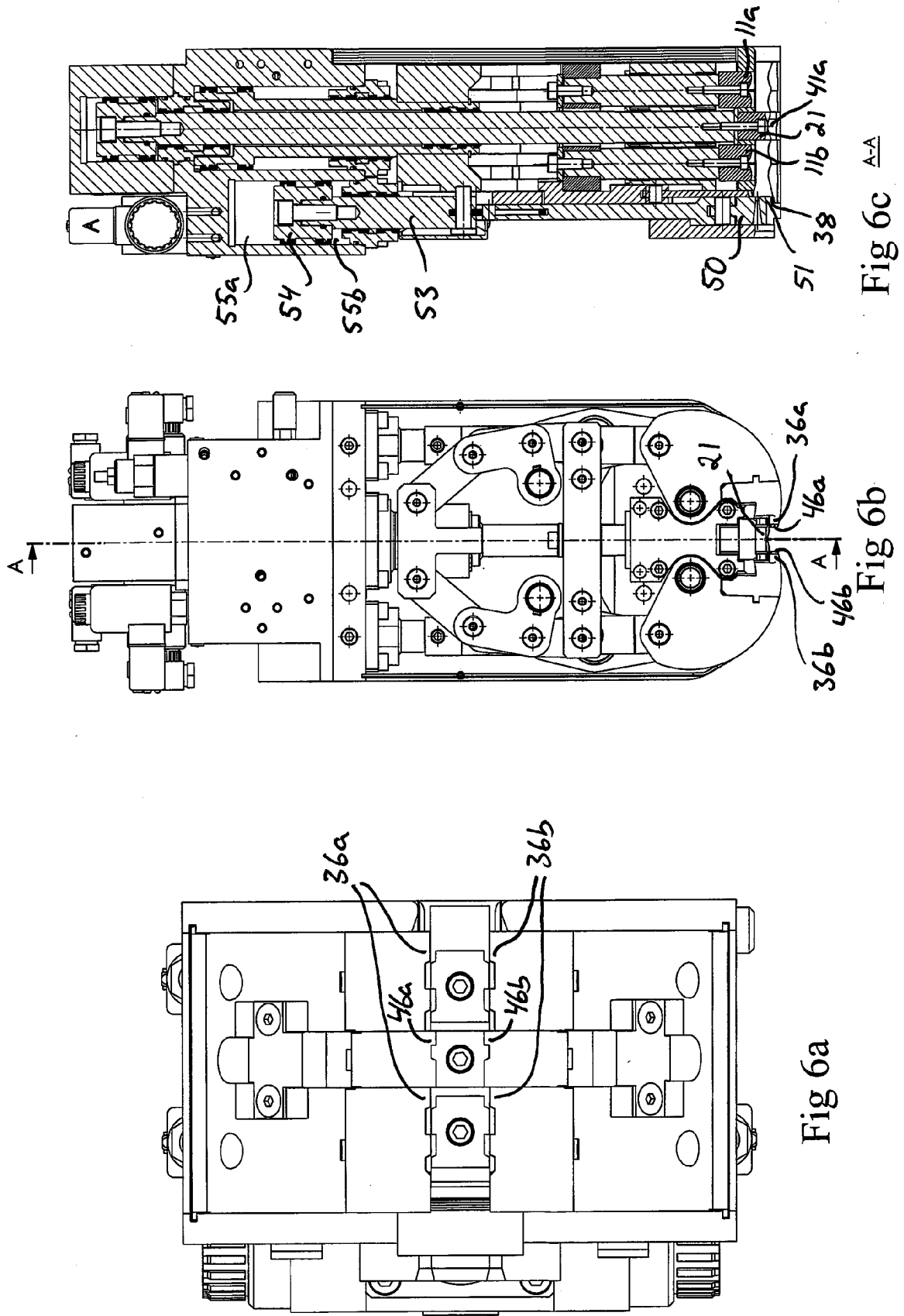


Fig 5a

Fig 5b

Fig 5c A-A



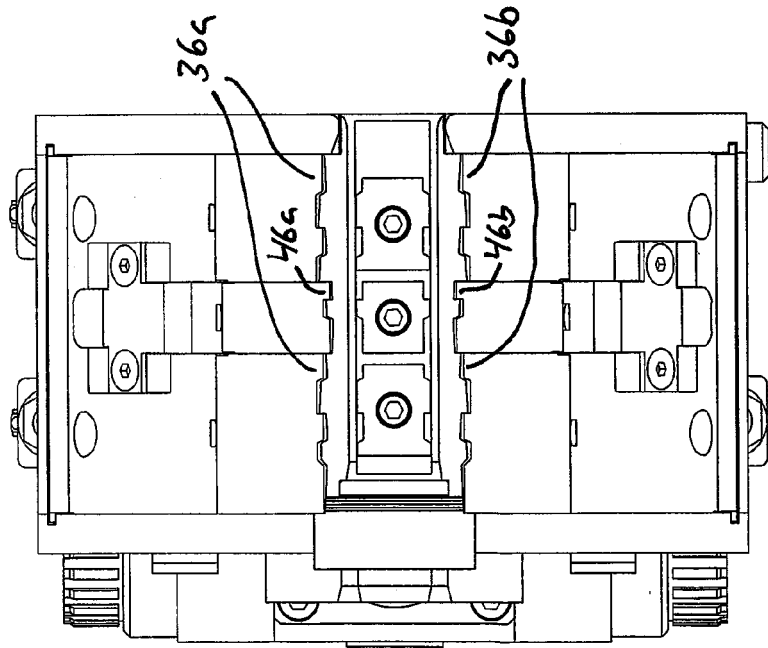
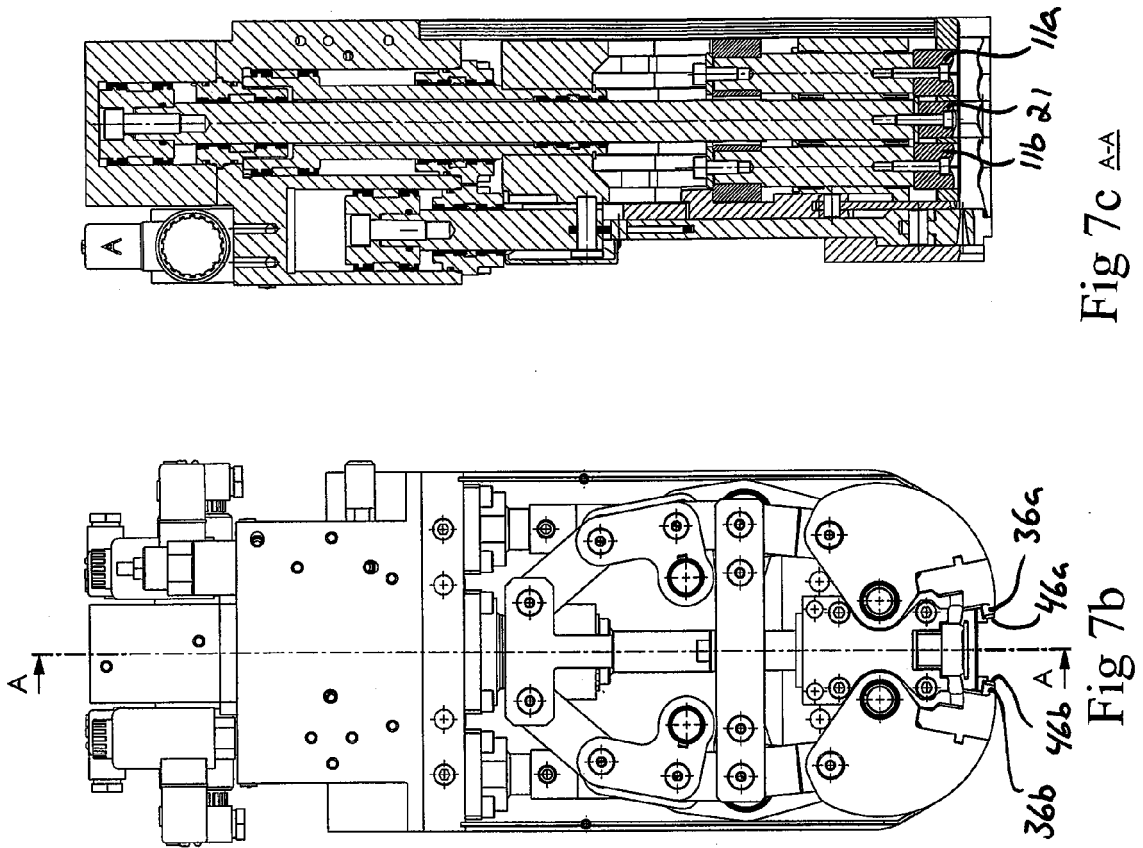


Fig 7a

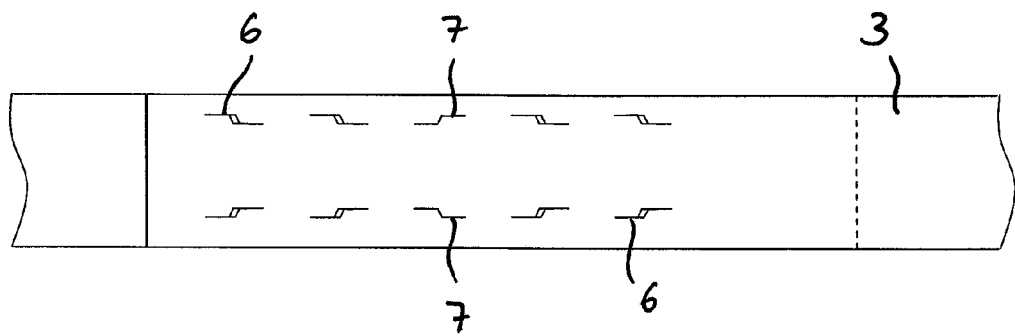


Fig 8



EUROPEAN SEARCH REPORT

Application Number
EP 09 15 8691

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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A	DE 675 862 C (ALEXANDRE GIBAUSET; MAURICE MARTIGNON) 19 May 1939 (1939-05-19) * page 1, line 29 - line 51 * * page 3, line 6 - line 17; figures *	1-13	
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A	GB 1 336 950 A (TITAN VERPACKUNGSSYSTEME GMBH) 14 November 1973 (1973-11-14) * figure 5 *		
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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 10 September 2009	Examiner Lawder, M
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EPO FORM 1503 03.82 (P04C01)

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