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(54) **STORAGE ELEMENT FOR WEFT THREAD**

SPICHERELEMENT FÜR SCHUSSFADEN

ÉLÉMENT DE STOCKAGE POUR FIL DE TRAME

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(56) References cited:
DE-A1- 2 030 343 GB-A- 2 092 188
US-A- 3 430 664 US-A- 3 848 820

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Description

[0001] The invention relates to a storage element, more particularly to a storage element with a cavity delimited by sidewalls for storing weft thread for a weaving machine, the storage element comprising an inlet for supplying weft thread to the cavity and an outlet positioned opposite the inlet for removing weft thread from the cavity, the transverse width of the cavity decreases in size in the longitudinal direction of the cavity toward the outlet. The invention also relates to a device for feeding weft thread to a weaving machine comprising a storage element according to the invention. The invention also relates to a weaving machine comprising a device for feeding weft thread according to the invention. The invention also relates to a method for feeding weft thread in a weaving machine according to the invention.

[0002] A device for feeding or supplying weft threads to a shed of an airjet weaving machine is for example known from US 4,947,898 or US 4,821,781. In this case, this device comprises a storage element, also referred to as an accumulator or supply store or storage unit, which displays a cylindrical shape or tubular shape and which is provided with openings. According to US 4,947,898 or US 4,821,781, the storage element is provided with a cavity and a clamp element for a weft thread which is attached in proximity to the outlet of the cavity, which can be closed for storing a weft thread and which can be opened for releasing the weft thread. A blowing device, also referred to as a nozzle or injector, blows a weft thread into the cylindrical storage element, the openings causing the weft thread to stack up in the tubular storage element in windings. A device of this type allows a weft thread to be stored in the storage element under low tension, so that the weft thread can be removed from the storage element under low tension, allowing higher weaving speeds to be reached or weft thread to be brought into the shed with less air consumption and lower tension.

[0003] As the weft thread stacks up in this case in the storage element in the form of windings, plugs, which may also be referred to as bundles, can be formed. As described in CH 678 865, these can be removed from the storage element as plugs. If these plugs are not stretched or unwound during the insertion and before the beating-up of the weft thread, this can result in weaving faults.

[0004] WO 86/07102 shows a storage element with a cavity having an adaptable height. The transverse width of the cavity increases in size from the inlet to the outlet and the weft thread is stacked up in the storage element in windings. Owing to the widening of the cavity, the resistance for removing a weft thread is lowered. The thread eye at the outlet is however disadvantageous for removing weft threads from the storage element. Furthermore, a storage element having a transverse width which increases in size toward the outlet is even more susceptible to the forming of plugs.

[0005] US 3,712,526 describes a storage element with a flat cavity having parallel sidewalls. The cavity is arched and perforations are provided at the level of the bottom wall. The outlet opening is smaller than the transverse width of the cavity at the outlet, and plugs can be formed during the removing of weft thread from the storage element. In US 3,712,526 the cavity displays a perforated bottom wall through which air can escape from the cavity. The outlet of the cavity can be closed by a closure element which impedes an air flow along the outlet of the cavity, but which allows the passage of weft thread. The closure element is mounted in a horizontally arranged groove extending perpendicularly to the longitudinal direction of the storage element.

[0006] GB 2092188 shows a storage element with a cavity narrowing toward the outlet. The height and the width of the cavity are however relatively large, so that the weft thread is stacked up in windings, and plugs are also formed. Also, the openings at the inlet and the outlet are relatively small. However, the small opening at the outlet causes friction with the weft thread and provisions have to be made to avoid wear at this opening. In addition to the plugs, the friction is also disadvantageous for weaving.

[0007] It is an object of the invention to form a storage element which can prevent plugs from leaving the storage element, which plugs can cause faults in the woven material, such as loops in the weft thread which are woven into the woven material. It is a further object of the invention to provide a device for feeding weft threads and a weaving machine with an associated storage element.

[0008] This object is achieved by a storage element with a cavity delimited by sidewalls for storing weft thread, weft thread being supplied via an inlet in the storage element and being removed from the storage element via an outlet positioned opposite the inlet, weft thread being stored between the sidewalls in the cavity, the transverse width between the sidewalls of this cavity decreasing slightly in the longitudinal direction of the cavity in the direction from the inlet toward the outlet, the cavity having a substantially flat shape and the transverse width between the sidewalls of the cavity decreasing slightly in the direction toward the outlet, so that the weft thread stored between the sidewalls in the cavity is prevented by the sidewalls of the cavity from moving in the cavity in the direction from the inlet to the outlet. The flat shape and the sidewalls, which approach each other slightly in the direction toward the outlet, of the cavity allow weft thread to be stored in a zigzag pattern with a number of zigzag loops between the sidewalls in the cavity, each zigzag loop being prevented by the sidewalls, which approach each other slightly in the direction toward the outlet, from moving through the cavity in the direction toward the outlet. Over the length of the storage element, this allows each part of a weft thread stored in the cavity of the storage element to be prevented by the sidewalls of the cavity of the storage element from moving through the storage element. The flat shape of the cavity is above

all advantageous for the storing, ordered in a zigzag fashion, of weft thread in the cavity while the weft thread is supplied into the cavity. The term "flat" refers in this case to the fact that the height is sufficiently low to prevent weft thread from being stored in windings; in practice, this means that, in the case of weft threads such as are used in airjet weaving machines, the height is of the order of magnitude of 1.2 mm and preferably less than 1.4 mm.

[0009] The sidewalls of the cavity are slightly inclined with respect to the longitudinal direction of the cavity, so that the transverse width decreases slightly toward the outlet. According to the invention, a "slight inclination" is defined as an inclination having an angle of not more than 8°, preferably not more than 5°, and in particular an angle of less than 3° between the sidewalls of the cavity.

[0010] Preferably, a clamp element for a weft thread is arranged in proximity to the outlet of the storage element, which clamp element can be closed prior to the storing of weft thread in the storage element and can be opened for removing weft thread from the storage element. The clamp element can also serve to close the storage element in proximity to the outlet. A method of controlling the clamp element and/or a method for controlling the storing and the removing of weft thread in and out of the storage element can take place as described in for example US 4,947,898.

[0011] By providing a storage element with a relatively narrow or flat cavity displaying a slightly decreasing transverse width toward the outlet, each weft thread stored in zigzag loops in the cavity can be prevented from advancing in packages toward the outlet. The storage element according to the invention offers the advantage that each part of the weft thread stored in the storage element is held in place during removal thereof from the storage element, so that during the removal of weft thread from the cavity of the storage element the formation of yarn packages, plugs, knots or loops is prevented which pass through the storage element or leave the storage element and which can still be present in the woven material after the insertion of the weft thread into a shed. As the transverse width of the cavity decreases just slightly, the part of the weft thread which is removed from the cavity hardly enters into contact with the sidewalls of the storage element, so that there is produced at the level of the sidewalls no friction which can impede the removal of weft thread from the storage element. The fact that the sidewalls of the storage element converge toward one another to a limited extent from the inlet to the outlet allows the weft thread still to be stored, ordered in a zigzag fashion, between the sidewalls. The term "storing, ordered in a zigzag fashion" means that weft threads are stored without weft threads being placed partly over one another.

[0012] The converging arrangement of the sidewalls prevents parts of the weft threads in the form of a yarn package or a plug from being able to advance into the narrowing storage element because the distance between the sidewalls of the cavity decreases continuously

toward the outlet and in this way each yarn package is held in place. This prevents the weft threads in the form of a yarn package or plug from being able to move to the outlet of the storage element. The narrowing cross section allows the part of the weft threads that is positioned in proximity to the inlet in the storage element to be held in place, while weft thread is removed via the outlet. This is above all advantageous if, during the removal of weft thread, weft thread is still supplied to the storage element by means of the blowing device. This means that it is possible to supply weft thread into the cavity via the inlet, while weft thread stored in the cavity is already removed from the cavity via the outlet. The blowing device, which is arranged in proximity to the inlet of the storage element, forces the weft thread in the direction of movement from the inlet to the outlet; this is also advantageous for preventing parts of weft threads from coming to lie one above another.

[0013] The invention also offers the advantage that weft thread stored in the storage element at low tension can be brought into a shed at low tension or at higher speed. In airjet weaving machines, this allows inter alia the weaving speed to be increased or the consumption of compressed air necessary for inserting a weft thread to be lowered. The consumption of compressed air can be lowered by lowering the pressure of the compressed air and/or by reducing the amount of compressed air supplied.

[0014] According to a preferred embodiment, the transverse width between the sidewalls of the cavity decreases continuously from the inlet to the outlet of the cavity. The decreasing from the inlet toward the outlet allows the storage element to be embodied in a simple manner. Preferably, the sidewalls of the cavity of the storage element are embodied so as to narrow conically from the inlet to the outlet. A storage element narrowing conically in this way prevents a yarn package from advancing during the filling and/or during the emptying of the storage element. This means that, as a result of the conically narrowing part, the loops of the weft thread which are stored in the cavity in a zigzag fashion are held in place by the sidewalls of the storage element. According to an alternative, the sidewalls are provided with steps, the transverse width between the sidewalls of the cavity decreasing discontinuously or in stages. The provision of walls with steps can be advantageous for preventing stored weft thread, more particularly loops of weft thread stored in a zigzag fashion, from being able to advance through the cavity.

[0015] According to a preferred embodiment, the sidewalls of the cavity are arranged in such a way that, viewed from above, the cavity displays a substantially isosceles trapezoidal shape. This is simple to carry out. In order to promote the laying of weft thread in the cavity in zigzag form, the transverse width of the cavity is in this case embodied so as to be relatively narrow in proximity to the outlet, in such a way that the long side of the zigzag shape is positioned substantially perpendicularly to the direction

of movement of the weft thread or to the longitudinal direction of the cavity. The transverse width of the cavity in proximity to the outlet is narrower than the transverse width of the inlet of the cavity. The outlet should however be sufficiently large in order not to obstruct a weft thread when said weft thread is removed from the cavity and to prevent friction of the weft thread with the outlet. A relatively small transverse width in proximity to the outlet is also advantageous to promote starting of the storage of weft thread in the cavity in a zigzag fashion, while a larger transverse width in proximity to the inlet allows more weft thread to be stored in the storage element; this can be important for example in wider weaving machines.

[0016] According to one embodiment, the height of the cavity of the storage element also decreases slightly in the longitudinal direction of the cavity toward the outlet. According to a simple embodiment, the height between the upper wall and the bottom wall increases conically from the inlet toward the outlet. This decreasing height of the cavity allows reliable ordering of the weft thread in a zigzag pattern during storage, is advantageous for preventing overlapping of the zigzag loops and is advantageous for preventing the advancement of packages of weft thread. This is also advantageous for preventing a yarn package or plug from passing through the storage element. According to one embodiment, the height between the upper wall and the bottom wall can be adjusted. Use may be made in this case of thickness plates or adjusting screws. The use of thickness plates is advantageous in order to attach the upper wall and the bottom wall at a defined distance from each other. The thickness plates can be embodied both in a beam-shaped manner and with a substantially continuous variable thickness in their longitudinal direction.

[0017] In a storage element according to the invention, a small space at the level of the outlet also offers the advantage that the weft thread can be stored in zigzag form without risk at the level at the outlet. In this case, the relatively larger space in proximity to the inlet offers the advantage that, as a result, a relatively large amount of weft thread can be stored in the storage element. The dimensions in proximity to the outlet should however be sufficiently large in order not to impede the removal of weft threads, while the dimensions in proximity to the inlet should be sufficiently limited in order also to allow the weft threads to be stored, ordered in zigzag form. Tests have revealed that a weft thread which is stored, ordered in a zigzag fashion in the cavity, is arranged centrally in the cavity during removal from the cavity and substantially does not rub with the sidewalls and the outlet of the storage element.

[0018] According to one embodiment, the sidewalls of the cavity are formed by plates, the height of the cavity being defined by the thickness of the plates. In one embodiment, the plates have a slightly conical shape in order to allow the formation of a cavity, the height of which decreases toward the outlet. The dimensions of the cavity, more particularly of the plates, can be selected as a

function of the properties of the weft thread to be woven.

[0019] For weft threads as used in conventional woven materials, the transverse width at the inlet can be selected so as to be of the order of magnitude of between 7 mm and 10 mm, preferably between 8 mm and 9 mm. In this case, the transverse width at the outlet can be selected so as to be of the order of magnitude of between 1 mm and 5 mm, preferably between 2 mm and 4 mm. The length of the cavity can be about 100 mm, while the height of the cavity can be selected so as to be of the order of magnitude of between 0.5 mm and 1.5 mm, preferably between 0.8 mm and 1.2 mm. In proximity to the inlet, the height can be less than 1.5 mm, for example 1.2 mm, while in proximity to the outlet the height can be greater than 0.5 mm, for example 0.8 mm. These preferred dimensions are suitable for most of the conventional weft threads woven using airjet weaving machines. The height of the cavity, more particularly the height between the upper wall and the bottom wall, in one embodiment is selected so as to allow knots or thickenings which are locally present in a weft thread to be able to pass through the cavity of the storage element according to the invention.

[0020] According to one embodiment, the upper wall and/or the bottom wall and/or the sidewalls of the cavity of the storage element are embodied so as to be air-permeable. Preferably, the storage element comprises an upper wall and a bottom wall, openings or perforations being formed in the upper wall and/or in the bottom wall in order to assist the storing or the filling of the cavity with weft thread in a zigzag pattern. The openings or perforations cover for example between 10 % and 20 % of the wall surface area. In this case, preferably both the upper wall, the bottom wall and the sidewalls are provided with perforations. In one embodiment, the perforations have a diameter of between 0.4 mm and 0.8 mm. The perforations should be sufficiently small to prevent the weft thread from being able to penetrate or enter the perforations. The perforations should be sufficiently large to allow compressed air or dust to be removed through the perforations. The perforations should also be embodied so as to be smooth in order not to impede the removal of dust. Preferably, the perforations in the direction of movement of the weft thread, i.e. from the inlet to the outlet of the storage element, are distributed in a selected pattern. This pattern can be selected, for example so as to be constant, variable, uniform or non-uniform.

[0021] The perforations in proximity to the outlet are advantageous in order to bring the weft thread, during storage in the storage element, to the outlet of the storage element, while perforations in proximity to the inlet are advantageous in order to allow compressed air and dust to escape when the storage element is already partly filled. The air-permeability of the storage element is above all advantageous in order to fill the storage element with weft thread, more particularly in order to store the weft thread in an ordered fashion in the storage element.

[0022] According to one embodiment, the storage el-

ement comprises openings in the sidewalls. In this case, provision may be made to blow compressed air into the storage element via the openings in the sidewalls. This can influence the flow of air in the storage element, in such a way that weft thread is introduced into and stored in the storage element in a more ordered fashion in a zigzag pattern.

[0023] According to one embodiment, the storage element comprises a movably arranged wall, for example a rotatably supported upper wall. In this case, this wall can be opened in order to clean the storage element. For this purpose, a pivot axis preferably is formed parallel to the longitudinal axis of the cavity in order to allow the wall to revolve in relation to this pivot axis. According to one embodiment, a wall, for example the upper wall, is transparent in order to allow visual inspection.

[0024] The object is also achieved by a device comprising a storage element according to the invention and a blowing device, the blowing device being arranged in proximity to the inlet of the storage element for feeding weft thread to the storage element and for blowing weft thread from the inlet to the outlet of the storage element.

[0025] According to one embodiment, the blowing device comprises a tube, the outlet of which is arranged in proximity to the inlet of the storage element, also referred to as the fill tube, in order to blow a weft thread to and into the storage element. A fill tube of this type in one embodiment has a shape of a tube for a conventional main nozzle of an airjet weaving machine, and can be embodied both cylindrically as conically. Preferably, a fill tube of this type is embodied so as to diverge conically in the direction toward the outlet, such as a tube of a main nozzle used in airjet weaving machines. Preferably, the tube is sufficiently long to be able to blow weft thread into the storage element at a uniform air flow; for example, the tube can display a length of between 100 mm and 300 mm, for example 200 mm. A uniform flow of air is advantageous for the ordering of weft thread in a zigzag fashion in the storage element.

[0026] The force of the air flow from the blowing device should be sufficient in order to blow a weft thread as rapidly as necessary into the storage element, but may not be too strong in order to prevent weft threads from being blown onto one another during the stacking-up of weft thread in the storage element. Furthermore, the force is selected so as not to be too strong so that the weft thread is not blown to the outlet when the stored weft thread has already been removed from the storage element. The sidewalls, which narrow slightly toward one another in the direction toward the outlet, of the storage element according to the invention allow blowing to be carried out at greater force, without weft threads being blown onto one another or being blown through the storage element during the removal of the weft thread. Preferably, the pressure of the compressed air supplied to the blowing device, the flow rate of compressed air which is supplied to the storage element and the blowing time can be adapted to the weft thread, to the weaving speed,

to other conditions and the like.

[0027] According to one embodiment, the blowing device can also comprise elements and can be arranged in order to blow compressed air along the sidewalls of the storage element. A blowing device of this type can blow via openings in the sidewalls. By blowing compressed air into the cavity along the sidewalls, the stacking-up of weft thread in zigzag form and the removal of the weft thread stored in a zigzag fashion can be improved.

[0028] According to a preferred embodiment, the device comprises a transition element which is arranged between the blowing device and the storage element, more particularly which connects the outlet of the fill tube to the inlet of the storage element. In this case, this transition element, which may also be referred to as the transfer element, can connect to the outlet of the fill tube and to the inlet of the storage element. The storage element according to the invention is provided with a flat shape in proximity to the inlet, while the outlet or the end of the fill tube of the blowing device is cylindrical. This transition element forms a transition between the end of the blowing device and the flat inlet of the storage element. A transition element arranged between the fill tube and the storage element offers the advantage of providing a continuous flow of air from the fill tube to the storage element, allowing a weft thread to be brought into the storage element with an advantageous flow of air. A transition element serves to guide a flow of air and a weft thread from the fill tube of the blowing device to the storage element. The transition element also serves to prevent accumulation of dust between the blowing device and the storage element.

[0029] According to one embodiment, the walls of the transition element are air-permeable, more particularly provided with openings. These openings are formed, in the direction of movement of the weft thread, substantially in the center of the transition element. Preferably, no openings are provided in proximity to the inlet and the outlet of the transition element. As the surface of the cross section of the outlet of the blowing device and the surface of the cross section of the inlet of the storage element usually differ in their embodiment, the cross section of the transition element will change continuously between the outlet of the blowing device and the inlet of the storage element. The openings in the transition element allow compressed air to escape and a build-up of pressure to be compensated for if the cross section of the transition element decreases, in the direction of movement of the weft thread, from the inlet to the outlet of the transition element. The openings should be sufficiently small to prevent weft thread from becoming caught in the transition element.

[0030] According to one embodiment, the surface of the outlet of the blowing device and the surface of the inlet of the storage element have the same cross section, wherein the transition element preferably is embodied in such a way that the surface of the cross section of the

transition element remains constant in the direction of movement of the weft thread. In this case, it is also possible to dispense with openings in the walls of the transition element.

[0031] According to one embodiment, the transition element, which connects to the fill tube, is formed integrally with the fill tube. According to one embodiment, the transition element, which connects to the fill tube, is formed integrally with the storage element. According to one embodiment, the transition element is formed as a separate element and mounted between the fill tube and the storage element. Nothing prevents the transition element from being made to penetrate the storage element over a certain distance.

[0032] According to one embodiment, the device comprises at least one sensor to detect the feeding of the storage element with weft thread and/or the removal of weft thread from the storage element. Sensors can be attached along the storage element to measure the presence of weft thread at the level of a defined position, more particularly to measure at the level of the sensor. The information from these sensors can be used for controlling the main nozzles, relay nozzles and the blowing device according to the invention. If, as according to the invention, the advancing of the weft thread stored in a zigzag fashion in the storage element is prevented, sensors of this type provide reliable information and an effective control system can be obtained on the basis of information from sensors of this type.

[0033] It is another object of the invention to form a storage element with a cavity wherein dust is prevented from accumulating in proximity to the cavity.

[0034] This object is achieved by a storage element with a cavity delimited by walls for storing a weft thread, comprising an inlet for supplying weft thread to the cavity, an outlet positioned opposite the inlet for removing weft thread from the cavity and a closure device arranged in proximity to the outlet of the storage element for closing the outlet of the cavity, wherein the closure device can interact with a wall of the cavity for closing the outlet of the cavity and wherein the aforementioned wall is provided with an impact-compensating contact area for reducing an impact of the closure device on the aforementioned wall during closing of the outlet of the cavity.

[0035] Providing a movable closure device which can interact with a wall of the cavity allows the outlet of the cavity to be closed in an air-tight manner. During the closing, the closure device can generate an impact on the aforementioned wall. In particular, if the storage element comprises a number of walls which are joined together to form a housing delimiting the cavity, an impact of this type can have the consequence that the wall on which the impact takes place would lift somewhat from the other walls, in other words would move over a small distance away from the other walls. In this case, a little compressed air would be able to escape between said walls. As a result of this escaping of compressed air, dust which moves along with said compressed air can accumulate

between said walls, so that the distance between said wall and the other walls changes over the course of time. According to the invention, an impact-compensating contact area is provided to ensure that an impact is limited or that an impact does not spread or propagate through the storage element. The aforementioned invention prevents the wall on which the closure device exerts an impact from lifting somewhat. This prevents dust from being able to accumulate in proximity to the wall on which the closure device acts.

[0036] Preferably, a split is formed in a pattern through the wall comprising the contact area. This split is preferably as narrow as possible to prevent weft threads from being able to enter the split. For example, the split can display a width of a few tenths of a millimeter, for example less than 0.4 mm, more particularly about 0.1 mm. If the split is formed with the aid of a laser, the width can be about 0.04 mm. The width can be selected as a function of the thickness of the associated wall. The shape of the pattern is in this case adapted to allow good reducing and/or good damping of the forces to be attributed to an impact. In the event of an impact, in this case only the impact-compensating contact area can lift somewhat, while the wall is prevented from lifting.

[0037] According to a preferred embodiment, the wall provided with an impact-compensating contact area is formed by the upper wall of the storage element. In this case, this wall may be a movably arranged wall.

[0038] In one embodiment, the closure device comprises a movable closing element which is formed for example by a plunger of a clamp element for clamping a weft thread in proximity to the outlet of the cavity of the storage element.

[0039] According to one embodiment, at least a first wall of the cavity, for example the upper wall, is provided with openings through which air which has been blown into the cavity can escape. Preferably, all the openings provided in this first wall are formed in the region of the cavity. In other words, preferably, not one of the openings is partly or completely covered by for example parts in proximity to walls of the cavity. According to one embodiment, the cavity narrows, the cross section of the cavity decreasing in the longitudinal direction of the storage element toward the outlet of the cavity. When the cavity narrows, the openings can be formed for example in lines which are for example inclined with respect to the longitudinal direction of the cavity.

[0040] When weft thread is stored in the storage element and/or when weft thread is removed from the storage element, there is a risk that weft thread cannot be conveyed effectively through the storage element. According to one embodiment, sidewalls of the cavity are at least partly air-permeable; for example, the sidewalls are provided with openings. The openings are preferably connected to a compressed air source and compressed air can be blown into the cavity via the openings.

[0041] It is another object of an invention to improve the forming of loops of weft thread in a cavity of a storage

element according to the invention.

[0042] This object is achieved by a storage element with a cavity delimited by walls for storing a weft thread, a first wall of the cavity, for example the upper wall, being provided with openings through which air blown into the cavity can escape, a second wall, positioned opposite the first wall, being air-permeable, more particularly the second wall being provided with openings or perforations, and the second wall being connected to a compressed air source to blow compressed air into the cavity.

[0043] The openings or perforations preferably are formed by means of a laser. By blowing air into the cavity via the second wall, which is positioned opposite the first wall, the spreading or distribution of the air flow within the cavity is promoted. This improves the storing of weft thread in the cavity, more particularly the arrangement of the loops of weft thread next to one another. The flow of air out of the aforementioned openings can have a component which is directed toward the outlet of the storage element.

[0044] When compressed air is blown into the cavity of the storage element via the inlet and/or via an air-permeable wall, it can occur, for example as a function of the type of weft thread being used, that the air cannot adequately escape from the cavity along the openings in the wall. In order to improve the guiding of the air in the cavity, according to one embodiment, in the longitudinal direction of the cavity, grooves for guiding air are formed at the level of a wall, for example in the second wall which is positioned opposite the first wall which is provided with openings through which air can escape from the cavity. Preferably, the second wall is in this case also at least partly air-permeable, more particularly provided with openings or perforations in order to blow compressed air into the cavity via the second wall. For example, the air can in this case be blown into the cavity via the second wall at the level of the grooves, more particularly via openings or perforations formed at the level of the grooves. By blowing air into the cavity at the level of the grooves and by forming the grooves in the longitudinal direction of the cavity, the guiding of air in the cavity can be further improved. This ensures that the air does not become trapped in the cavity and that an arrangement of the loops of weft thread in the cavity is improved.

[0045] The object is also achieved by a weaving machine comprising a device for feeding a weft thread according to the invention. The weaving machine is fed primarily with weft threads in a substantially tension-free state, which are stored in a storage element according to the invention.

[0046] The invention also relates to a method utilizing a device according to the invention, wherein weft thread is prevented from shifting into the storage element, while weft thread is supplied to the storage element and while weft thread is removed from the storage element. A method for feeding a weft thread to a weaving machine is provided, wherein the weft thread is filled into and removed from a storage element, the weft thread is stored

in the storage element in a zigzag pattern with a number of zigzag loops, the dimensions of the zigzag loops increase in the longitudinal direction of the storage element toward the inlet of the storage element, more particularly increase from the outlet to the inlet of the storage element or decrease from the inlet to the outlet of the storage element, and the zigzag loops are successively unwound and removed from the storage element. The decreasing dimensions of the loops toward the outlet prevent the loops from shifting through or into the cavity of the storage element. As a result, the loops are unwound before leaving the storage element and weaving faults are avoided. In this case, weft thread can at the same time be filled via the inlet and be removed via the outlet of the storage element.

[0047] The aforementioned inventions are inventions which are per se independent inventions and may or may not be combined with the other aforementioned inventions which are per se also independent inventions.

[0048] Further features and advantages of the invention will emerge from the subsequent description of the embodiments represented in the drawings, in which:

figure 1 is a perspective view of a weaving machine with four devices according to the invention;
figure 2 is a perspective view of a device according to the invention with a storage element;
figure 3 is another perspective view of the device from figure 2;

figure 4 is an enlarged view of a part from figure 3;
figure 5 shows the device from figure 4 in the opened state;

figure 6 shows a part of a variant device according to the invention;

figure 7 is a longitudinal section of a device according to figure 6;

figure 8 is an enlarged view of a part of the longitudinal section from figure 7;

figure 9 is a cross section along line IX-IX of the storage element according to figure 7;

figure 10 is a cross section along line X-X of the storage element according to figure 7;

figure 11 shows a state during the filling of a storage element according to the invention;

figure 12 shows a state at the start of the removal from the storage element from figure 11 while the storage element continues to be filled;

figure 13 shows a state at the end of the filling and the further removal from the storage element from figure 11;

figure 14 shows a state at the end of the removal from the storage element from figure 11;

figure 15 shows a further device according to the invention in the dismantled state;

figure 16 is a perspective view of a further device according to the invention;

figure 17 shows the device from figure 16 in the dismantled state;

figure 18 is a cross section of a variant device according to the invention;
 figure 19 shows the cross section from figure 18 in a different position;
 figure 20 is a side view of a device according to figures 18 and 19 in a first position;
 figure 21 shows the side view from figure 21 in a different position;
 figure 22 shows a variant of figure 18;
 figure 23 shows a variant of figure 5;
 figure 24 shows a part of a variant of figure 23;
 figure 25 is a partial cross section of the variant from figure 24;
 figure 26 shows a variant of figure 23;
 figure 27 shows a part of a longitudinal section of the variant of figure 26; and
 figure 28 shows a variant of figure 26.

[0049] The weaving machine represented in figure 1 comprises thread stores or bobbins (not shown), four prewinders 11, 12, 13 and 14, optionally in proximity to each prewinder a schematically represented thread brake 15, four devices 10 according to the invention for feeding and storing weft thread, four main nozzles 16, 17, 18 and 19 which are arranged next to the shed 28 and a plurality of relay nozzles 29 that can enter into the shed 28. One embodiment for the main nozzles 16 to 19 and the arrangement thereof with respect to the shed 28 is described in more detail in EP 985 062 B1, the description of which forms part of this description. The main nozzles and the relay nozzles can be attached to a sley (not shown) in order to move back and forth with the sley. According to one variant, the thread brake 15 is a separate thread brake arranged between a prewinder and a device 10 according to the invention. The prewinders and the thread brakes preferably are controlled via a control unit (not shown). In addition to or instead of a thread brake 15, a thread compensator or thread damper can also be provided. Between each device 10 according to the invention and an associated main nozzle moving along with the sley and arranged in proximity to the shed 28, optionally at least one further fixedly arranged main nozzle and/or a thread brake can be provided. A thread brake of this type arranged between the device 10 and the shed 28 can serve to brake a weft thread drawn out of a device 10 during the end of the insertion of said weft thread.

[0050] As illustrated in figures 2 to 14, the device 10 comprises a storage element 20 with an inlet 21 and an outlet 22 for a weft thread. The device 10 also comprises a blowing device 23 having a fill tube 24 which is arranged in proximity to the inlet 21 of the storage element 20 and which blows in the direction toward the outlet 22. The device 10 comprises a transition element 25 which is arranged between the fill tube 24 and the inlet 21 and which connects the end or the outlet 26 of the fill tube 24 to the inlet 21 of the storage element 20. The blowing device 23 having a relatively long fill tube 24 blows weft

thread into the storage element 20 at a uniform flow of air. The blowing device 23 blows weft thread into the storage element 20 via the inlet 21 and blows weft thread from the inlet 21 to the outlet 22 of the storage element 20. The inlet 36 of the transition element 25 connects substantially to the outlet 26 of the fill tube 24, while the outlet 37 of the transition element 25 connects substantially to the inlet 21 of the storage element 20. The transition element 25 consists in this embodiment of a tubular element with a relatively thin wall. The transition element 25 can also comprise openings 38 allowing compressed air to escape. The transition element 25 is arranged in the extension of the fill tube 24 and connects to the outlet 26 of the fill tube 24.

[0051] As is illustrated schematically in figure 7, the blowing device 23 comprises a housing 30 with an air supply 31 and an insert element 32 arranged in a longitudinal bore of the housing 30. In the blowing device 23, a weft thread is guided, in a manner similar to that described in EP 985 062 B1, through the insert element 32 and, from the air supply 31 between the insert element 32 and the housing 30, compressed air is blown toward the fill tube 24 in order to guide compressed air and weft thread through the fill tube 24. The inlet 27 of the fill tube 24 is arranged in the housing 30. The length of the fill tube 24 is sufficiently long to obtain a uniform or constant flow of air in proximity to the outlet 26 of the fill tube 24 and in order to be able to generate sufficient force to obtain a sufficiently high filling speed. In practice, a fill tube 24 has a length of between 100 mm and 300 mm, and for example 200 mm. The fill tube 24 has a substantially round cross section and is preferably embodied so as to diverge somewhat toward the end 26 in order to improve the flow of air through the fill tube 24. The fill tube 24 displays for example a diameter of between 3 mm and 4 mm. The fill tube 24 serves to blow weft thread to the storage element 20.

[0052] The force at which the blowing device 23 blows should be such that weft thread is brought into the storage element 20 at a sufficient filling speed. The blowing device 23 is in this case embodied in a similar manner to a main nozzle for a weaving machine. If the storage element 20 according to the invention is not utilized, the blowing device 23 can function as an auxiliary main nozzle for a weaving machine. The time, the flow rate and/or the pressure with which compressed air is supplied to the blowing device 23 can be set and regulated in such a way that the weft thread is brought to the storage element 20 at the desired moment and at the desired speed. The time, the flow rate and/or the pressure can be adapted during weaving automatically as a function of weaving parameters.

[0053] The storage element 20 has a cavity 40 delimited by sidewalls 41, 42 for storing weft thread, an inlet 21 for supplying weft thread to the cavity 40 and an outlet 22 positioned opposite the inlet 21 for removing weft threads from the cavity 40. In this case, weft thread can be stored in the cavity 40. As is illustrated in figures 9

and 10, the cavity 40 has a substantially flat shape. As is illustrated in figures 5 and 6, the transverse width between the sidewalls 41, 42 of the cavity 40 decreases slightly in the longitudinal direction L of the cavity 40 toward the outlet 22; more particularly, the transverse width decreases continuously from the inlet 21 of the cavity 40 to the outlet 22 of the cavity 40. The sidewalls 41, 42 form part of plates 43, 44. In this case, the height of the cavity 40 is defined by the thickness of the plates 43, 44. As may be seen in figures 11 to 14, the plates 43, 44 are formed so that the cavity 40 with the sidewalls 41, 42 narrows toward the outlet 22 and has a substantially isosceles trapezoidal shape.

[0054] The height of the cavity 40 of the storage element 20 can decrease slightly, for example from 1.2 mm to 0.8 mm, in the longitudinal direction L of the cavity 40 toward the outlet 22. This is achieved as the thickness of the plates 43, 44 decreases toward the outlet 22. It is also possible to set the height of the storage element 20 in a different manner, for example using adjusting screws, thickness plates and the like. In the illustrated embodiments of figures 2 to 5 and figures 11 to 17, the upper wall 33 of the cavity 40 is embodied so as to be air-permeable, while in the illustrated embodiment of figures 6 to 10 both the upper wall 33 and the bottom wall 34 of the cavity 40 are embodied so as to be air-permeable. In this case, a plurality of openings 35 are formed in the upper wall 33 and in the bottom wall 34. Thus, the storage element 20, which is provided with openings 35, is air-permeable. The openings 35 are formed at the level of the cavity 40 of the storage element 20 to promote the storage of weft thread in the storage element 20.

[0055] The storage element 20 comprises in the depicted embodiment also a movably arranged upper wall 33. This allows the storage element 20 to be opened, for example in order to clean or for the purposes of inspection. This is possible for example by arranging the upper wall 33 so that it can fold open. Also, the storage element can in this case be embodied so as to be transparent in order to allow visual inspection. For example, for this purpose, a wall of the storage element 20 that is directed toward the weaver side can be embodied in a transparent manner. The upper wall 33 is arranged in a frame 51 which is arranged so as to be rotatable about a pivot axis 39 with a relatively high degree of play, which pivot axis 39 is arranged so as to be substantially parallel to the longitudinal direction L of the storage element 20. Play is provided to allow plates 43, 44 having various thicknesses to be used without having to change the position of the pivot axis 39.

[0056] A clamp element 45 for clamping a weft thread is arranged in proximity to the outlet 22 of the storage element 20. The storage element 20 is arranged between the transition element 25 and the clamp element 45. The clamp element 45 serves in this case also to close, in the closed state, the outlet 22 of the storage element 20 in order to prevent, in the closed state, compressed air from escaping via the outlet 22, i.e. to close the outlet 22 in a

substantially air-tight manner. The clamp element 45 comprises, as is represented in greater detail in figures 7 and 8, a plunger 46 which is commanded by an electro magnet 47 and which can make contact with a stopper 48 attached to the frame 51 carrying the upper wall 33. The plunger 46 is arranged in a frame 49 which is mounted by bolts 57, 58 to the frame 50 of the device 10. The pivot axis 39, the blowing device 23 and the bottom wall 34 are also mounted to this frame 50. A thread eye 52, which is mounted in an element 64, is also attached to the frame 49 between the clamp element 45 and an associated main nozzle in order to guide the weft thread.

[0057] The plates 43, 44 are attached to the frame 50 by bolts 57, 58. In this case, the plates 43, 44 are positioned by positioning pins 59 with respect to the frame 50 and respectively mounted to the frame 50 by a bolt 57, 58 which passes with play through the associated plate 43, 44. The frame 51 comprises, as illustrated in figure 5, at least one magnet 60, 61 allowing the frame 51 to be held in a closed state with respect to the frame 50. In this case, the magnetic force is selected so as to be sufficiently strong so that during blowing the frame 51 of the storage element 20 does not open, but nevertheless remains sufficiently restricted to allow the frame 51 to be opened manually. Of course, the frame 51 can, in accordance with a variant (not shown), be held in a closed state with the aid of springs, clamps or other locking elements.

[0058] As is represented in figures 7 and 8, the device 10 comprises a sensor 53 to detect the filling of the storage element 20 with weft thread and/or the removing of weft thread from the storage element 20. In this case, the sensor 53 can be an optical sensor which can detect the presence of weft thread at the level of said sensor 53. If only a stretched weft thread is present in the storage element 20, the sensor 53 will generate for example a low signal, while if the weft thread is stored in a zigzag fashion at the level of the sensor 53, the sensor 53 will generate a high signal. Of course, in addition to the sensor 53, other similar sensors 54 and 55 can also be attached in order to be able to detect weft threads at the level of various positions along the storage element 20. This allows the position of weft thread stored in a zigzag fashion in the storage element 20 to be defined. Both the settings of the blowing device 23 and the setting of main nozzles 16 to 19 and the relay nozzles 29 in one embodiment are set and regulated on the basis of signals from the sensors. For this purpose, the blowing device 23 preferably is provided with compressed air from a compressed air source 5 via a valve system 4 controlled by a control unit 3. The control unit 3 is also connected to the clamp element 45, more particularly to the electro magnet 47. The sensors 53, 54, 55 are connected to the control unit 3. A sensor of this type can also ascertain the amount of weft thread removed from the storage element 20 and be used to appropriately control relay nozzles in a manner as known from WO 2007/057217. An advantage of a storage element 20 wherein weft threads

do not advance in the direction of movement of the weft thread is the fact that the signal from the sensors 53, 54, 55 arranged along the storage element 20 is relatively accurate and is not influenced by advancing yarn packages in the storage element 20. The preventing of advancement also allows a blowing device 23 to blow harder without weft threads being blown onto one another or being blown in packages through the storage element 20.

[0059] Figures 9 and 10 show the flat shape of the storage element 20 and the transverse width which decreases from the inlet 21 toward the outlet 22. The term "a flat shape" refers in this case to a shape wherein the height of the storage element 20 is much smaller than the transverse width of the storage element 20.

[0060] The mode of operation for feeding weft thread with the aid of the device 10 according to the invention will be explained in greater detail with reference to figures 11 to 14. In this case, weft thread 1 is filled into and removed from a storage element 20. In the position of figure 11, the clamp element 45 is closed, weft thread 1 is supplied into the storage element 20 and stored in a zigzag pattern with a number of zigzag loops 2 in the storage element 20. During the supplying of weft thread 1, the blowing device 23 blows and the pin 56 of the associated prewinder (figure 1) is opened to release weft threads on the prewinder. The dimensions of the zigzag loops 2, more particularly the width of the zigzag loops, increase in the longitudinal direction of the storage element 20 toward the inlet 21 of the storage element 20. Subsequently, a main nozzle associated with the device 10 is energized with compressed air. Subsequently, the clamp element 45 is opened so that weft thread is at the same time removed from the storage element 20 via the outlet 22 and is stored in the storage element 20 via the inlet 21. During the removal of weft thread 1, the zigzag loops 2 are successively unwound and removed from the storage element 20. In this case, the blowing device 23 continues to blow and a position of figure 12 is reached. Subsequently, weft thread 1 continues to be supplied to the storage element 20 via an inlet 21 in the direction of movement of the weft thread 1, while weft thread 1 is removed from the storage element 20 via an outlet 22 positioned opposite the inlet 21. According to the invention, the weft thread 1, which is stored in loops 2 between the sidewalls 41, 42 in the cavity 40, is prevented by the sidewalls 41, 42 of the cavity 40 from moving in the cavity 40 in the direction toward the outlet 22. Subsequently, the pin 56 of the associated prewinder is closed, thus preventing weft thread 1 from continuing to be released to the prewinder and a position of figure 13 is reached, the filling of the storage element 20 being concluded. Subsequently, the weft thread 1, which is still present in the storage element 20, continues to be removed until the position of figure 14 is reached. Then, the clamp element 45 is re-closed while the associated main nozzle is no longer energized. In this case, the main nozzle may have already ceased to have been energized earlier or energizing thereof can be concluded while the clamp el-

ement 45 is re-closed. Subsequently, the aforementioned cycle is repeated again. A method for activating the pin 56 of the prewinder, the blowing device 23, the clamp element 45 and the associated main nozzle is also described in US 4,947,898.

[0061] According to the invention, the blowing force of the blowing device 23 is set in such a way that the filling of the storage element 20 ends substantially at the moment when weft thread ceases to be removed from the storage element 23. It is in this case intended for the blowing device 23 to blow substantially continuously and to supply weft thread to the storage element 20 substantially continuously. Signals from the sensors 53, 54 and 55 can also be used for this purpose. The sensors preferably are attached at an advantageous position in order advantageously to influence the controlling of the blowing device 23, for example distributed over the length of the storage element. Winding signals from a prewinder can also be used for this purpose, in other words a signal which a prewinder issues in a known manner each time that a winding is drawn off. However, nothing prevents the amount of weft thread supplied in the storage element 20 from being measured, for example using a motion sensor. In order to save compressed air, it can be advantageous to blow on a weft thread at as low a pressure as possible, meaning at as low a force as possible, in order to bring said weft thread to the storage element 20. However, for forming zigzag loops in the storage element 20, it has been found that the pressure of the compressed air should nevertheless be sufficiently high, meaning that the zigzag loops can be formed better if weft thread is brought into the storage element at sufficient speed.

[0062] The invention also offers the advantage that if a plurality of channels are used for weaving, that means that use is made of a plurality of devices 10 according to the invention supplying weft thread to a shed 28 in a pattern. In this case, the storage element 20 can be filled during a plurality of weaving cycles, while weft thread is removed from the storage element 20 during just one single weaving cycle.

[0063] It will be clear that if an additional thread brake is arranged between the prewinder and the device 10 according to the invention or if a thread clamp is arranged in proximity to a main nozzle, these are controlled in an appropriate manner, in other words in such a way that they brake and clamp at a moment when braking or clamping should be carried out. The blowing force of the main nozzles can also be regulated and set.

[0064] For selecting the dimensions of the storage element 20, allowance has been made for the natural bending radius of the weft threads (this is the radius which weft threads can take up if they are stored in loops 2). It has been found that a cavity 40 having a decreasing transverse width, i.e. the transverse width perpendicular to the longitudinal direction L, is possible from a transverse width of the order of magnitude of less than 10 mm and a height perpendicular to this transverse width of the order of magnitude of less than 1.5 mm. Preferably, how-

ever, use is made of a storage element having a transverse width of 9 mm in proximity to the inlet 21, a transverse width of 4 mm in proximity to the outlet 22, a height of 1.2 mm in proximity to the inlet 21 and a height of 0.8 mm in proximity to the outlet 22. According to a variant, the height has a constant value, for example 1 mm. In this case, the openings 35 in the upper wall 33 and in the bottom wall 34 can be formed in a uniform pattern, for example as represented in the figures.

[0065] According to a possible variant, the sidewalls 41, 42 of the cavity 40 of the storage element 20 are formed so as to be air-permeable. For this purpose, bores or cutouts (not shown) in one embodiment are formed in the plates 43, 44. These bores or cutouts can also be connected to a compressed air source to allow compressed air to be blown laterally into the cavity 40 via said bores or cutouts. According to a variant (not shown), a rougher structure is provided for the sidewalls 41 and 42, so that the sidewalls 41 and 42 offer greater frictional resistance for the weft threads.

[0066] The embodiment of figure 15 presents a device 10 according to the invention which is embodied in a similar manner to the embodiment of figure 2. In this case, the plates 43, 44 are attached to the frame 50 by magnets 62. Furthermore, use is made of an intermediate element 63, consisting of damping material, which is arranged between the frame 51 and the stopper 48. The transition element 25 is in this case formed integrally with the fill tube 24. The bolts 57, 58 can mesh with slots provided at the level of an end of the plates 43, 44 so that the plates 43, 44 can be slid under the bolts 57, 58 while the bolts 57, 58 are already partly screwed into the frame 50. The upper wall 33 is in this case perforated, while the bottom wall 34 is formed by a wall of the frame 50.

[0067] The embodiment of figures 16 and 17 presents a further variant wherein a support element 65 for the pivot axis 39 is attached to the frame 50. Furthermore, a flexible locking element 66 is provided to lock the frame 51 with respect to the frame 50. The upper wall 33 is reinforced by two support plates 67 which can be mounted to the frame 51. The blowing device 23 is mounted by a mounting element 68 to the frame 50 and comprises a connection 69 for compressed air. The frame 50 can be mounted to a frame of the weaving machine via a muffle 70 and a support piece 71. A plurality of bolts 72 are also shown to mount the elements to one another. The transition element 25 comprises in this embodiment a beam-shaped outer shape and an inner shape as in the remaining embodiments, which inner shape starts with a round inlet which can connect to the fill tube and ends with a flat outlet 37 which can connect to the inlet of the cavity for storing weft thread. The inner shape of the transition element 25 can for example be produced by sparking.

[0068] In order to allow for example relatively thick knots or thickenings in the weft thread to pass through the storage element, the perforated upper wall 33 preferably is made in the embodiment of figures 16 and 17

of a relatively resilient material, so that the upper wall 33 for example can deform during the passing of the weft thread with a relatively thick knot or thickening through the storage element. According to a variant, the upper wall 33 is made of a relatively rigid and perforated plate, while for example in this case the support plates 67 are made of resilient material.

[0069] Figures 18 to 21 show a variant wherein the bottom wall 34 can be moved up and down with respect to the frame 50 by means of a setting device 73. This allows the height of the cavity 40 to be set between the bottom wall 34 and the upper wall 33 provided with openings 35. The setting device 73 comprises in this case a rotatably arranged element 74 with an eccentric part 77 which can mesh with a slot 75 formed in the bottom wall 34. By rotating the element 74, it is possible to set the height of the cavity 40 between the position of figure 18 and the position of figure 19. Also, a further fixing element 76 can be provided to fix the element 74 in a defined angular position.

[0070] The upper wall 33 is in this case rotatable about a pivot axis 39 which is mounted to a support element 65 attached to the frame 50. The upper wall 33 can be locked with respect to the frame 50 via a locking element 66. A scale 78, which allows an operator to set the element 74 with respect to a reference point 79 of the frame 50, can be attached to the element 74.

[0071] Figure 22 shows a variant wherein the element 74 can be driven by means of a controlled motor 80. In this case, the motor 80 can be controlled and regulated by a control unit (not shown) optionally comprising a feedback system. This allows for example the height of the cavity 40 to be set via a control unit. According to one possibility, if for example a knot is detected by a sensor arranged, in the direction of movement of the weft thread, to a location before the device 10, for example at the level of the bobbins, the motor 80 can be commanded in such a way that the height of the cavity 40 is increased by moving the bottom wall 34 away from the upper wall 33. This allows a knot to pass simply through the device 10, while if no knot is present the device 10 has a limited height as possible.

[0072] Figure 23 shows a variant wherein a cavity 40 is delimited by an upper wall 33, a bottom wall 34 and two sidewalls 41 and 42 jointly forming a housing. The cavity 40 has an inlet 21 and an outlet 22. A closure device 6, which can interact with a wall, more particularly with the upper wall 33 of the storage element 20, is arranged in proximity to the outlet 22. In this case, the upper wall 33 is arranged, as in the embodiment of figure 5, so as to be rotatable with respect to the frame 50. The closure device 6 can close the cavity 40 in a substantially air-tight manner in proximity to the outlet 22. The upper wall 33 is provided with an impact-compensating contact area 7 which can make contact with the closure device 6 and which allows the impact of the closure device 6 on the upper wall 33 to be reduced during the forming of an aforementioned contact. For this purpose, the upper wall

33 comprises a split 8 with a pattern formed in proximity to the contact area 7. This split 8 is formed by a narrow opening which extends through the upper wall 33 and which is as narrow as possible, that is to say, the split 8 displays a width of the order of magnitude of one or more tenths of a millimeter. The width of the split 8 is selected so as to be sufficiently narrow to prevent weft threads from entering the split 8. The split 8 can be formed in the upper wall 33 by a laser beam. The shape of the pattern is in this case adapted to allow, at the level of the contact area 7, forces resulting from impact of the closure device 6 on the upper wall 33 to be limited. In this case, the upper wall 33 remains at all times in contact with the plates 43 and 44, thus preventing dust from accumulating between the upper wall 33 and one of the plates 43 or 44.

[0073] The closure device 6 comprises a movable closure element 9. In this case, the movable closure element 9 is formed by the plunger 46 of the clamp element 45 which is driven for example by an electro magnet (not shown) for the clamp element 45. In this case, the closure element 9 also functions as a clamp element for clamping a weft thread in proximity to the outlet 22 of the cavity 40 of the storage element 20. In this embodiment, the closure element 9 can make direct contact with the upper wall 33, more particularly with the contact area 7 of the upper wall 33. Of course, it is also possible for the closure element 9 to make contact with a contact area 7 attached to the upper wall 33, for example a thin, wear-resistant layer which is connected to or is attached to the upper wall 33.

[0074] The upper wall 33, which also comprises the split 8, is provided with openings 35 through which air which has been blown into the cavity 40 can escape. The openings 35 are formed in the region of the cavity so that not one of the openings 35 is partly or completely covered by for example the plates 43, 44 which are located in proximity to the sidewalls 41, 42 of the cavity 40. As the cavity 40 narrows toward the outlet 22, the openings 35 are formed in lines which are inclined with respect to the longitudinal direction of the storage element 20.

[0075] In order to allow weft thread to be conveyed through the storage element 20 and/or in order to promote the forming of loops of weft thread, the plates 43, 44 with the sidewalls 41, 42 are, as represented schematically in figure 23, be at least partly air-permeable. For this purpose, openings 81 are for example provided in the plates 41, 42. The openings 81 can be connected to a compressed air source (not shown) so that compressed air can be blown into the cavity 40 via the openings 81 during a period which can be set. The compressed air from the openings 81 is provided with a component toward the outlet 22 in order to blow compressed air in the direction toward the outlet 22.

[0076] For forming and/or arranging loops of weft thread in the cavity 40, in one embodiment the bottom wall 34 is also air-permeable. For this purpose, the bottom wall 34 comprises for example a number of openings 82 which are connected to a compressed air source (not

shown) in order to blow compressed air into the cavity 40, which compressed air can then escape from the cavity 40 via the opposite upper wall 33 provided with openings 35. The jet of compressed air from the openings 82 has a component toward the outlet 22 in order to blow compressed air in the direction toward the outlet 22. The openings 82 are for example formed by means of a laser or can consist of bores.

[0077] In the embodiment of figures 24 and 25, grooves 83 are formed in the longitudinal direction of the cavity 40 to further improve the guiding of air in the cavity 40 and/or the arrangement of loops of weft thread in the cavity 40. The grooves 83 for guiding air are arranged at the level of the bottom wall 34 which is positioned opposite the upper wall 33 through which air can escape from the cavity 40. In this case, the bottom wall 34 can also be provided with openings 82 in order to blow compressed air into the cavity 40 via the bottom wall 34. In this case, the openings 82 are arranged at the level of the grooves 83, more particularly at the level of the base of the grooves 83. The jet of compressed air from the openings 83 has a component toward the outlet 22 in order to blow compressed air in the direction toward the outlet 22. The openings 82 can be connected to a compressed air source (not shown) so that compressed air can be blown into the cavity 40 via the openings 82 during a period which can be set.

[0078] In the embodiment of figures 26 and 27, the frame 50 comprises collars 84 and 85 which are provided with the sidewalls 41 and 42; more particularly, the frame 50 is embodied in a U-shaped manner and the sidewalls 41, 42 and the bottom wall 34 are embodied in one piece. The openings 35 are arranged along parallel lines so that not one of the openings 35 is partly or completely covered by for example one of the collars 84 and 85. For this purpose, the rows have differing lengths. Furthermore, the frame 50 comprises a number of openings 82 to blow air into the cavity 40. In this case, the openings 82 are also directed, as illustrated in figure 27, in such a way that the jets of air from said openings 82 comprises a component toward the outlet 20.

[0079] The embodiment of figure 28 presents a variant wherein the impact-compensating contact area 7 is formed by the formation of a split 8 in the upper wall 33 with a pattern which is different from the pattern as shown in the embodiments of figures 23 to 27. In the embodiment of figure 28, the openings 35 are formed in the upper wall 33 in a plurality of parallel rows in a defined arrangement.

[0080] It will be clear that the terms "upper wall" and "bottom wall" do not necessarily mean that the upper wall is arranged above the bottom wall and/or the bottom wall below the upper wall, but that the terms "upper wall" and "bottom wall" are intended solely to indicate a first wall and a second wall.

[0081] It will be clear that the upper wall need not necessarily be arranged in a movable manner, but that according to a variant another wall of the storage element

is movably arranged, for example the bottom wall. It will be clear that the storage element needs not necessarily narrow conically from the inlet 21 to the outlet 20, but that the storage element in another embodiment narrows with a different course in the direction toward the outlet.

[0082] If a weaving machine has not woven for a specific time, before the weaving machine is restarted, all weft thread present in the storage elements can be removed in order to prevent weaving faults resulting from the weft threads which have become damaged as a result of long-term storage in the storage element. This removal can take place in a manner such as is known from EP 421 511 B1 or manually.

[0083] According to a variant (not shown), the clamp element 45 can be replaced by a thread clamp which is attached in proximity to a main nozzle and which can command the releasing of weft thread.

[0084] Experiments have revealed, during weaving of a specific type of weft thread at a single weaving speed, that, in a known weaving machine, the provision of a device according to the invention results in the fact that the pressure on the main nozzles can be lowered, for example from 7 bar to 6 bar and that the pressure on the relay nozzles can also be lowered, for example from 6 bar to 5 bar. If weaving is carried out at the same pressures, in a specific type of weft thread, the weaving speed can be increased, for example from 800 insertions/minute to 900 insertions/minute.

[0085] The device according to the invention is above all advantageous for the ordered storage of weft thread in the storage element 20, for keeping the weft thread stored in an ordered manner in the storage element 20, and allows weft thread to be easily removed from the storage element 20. As a result of the openings 35, as a result of the relatively large outlet 22 and as a result of the narrowing shape from the inlet 21 toward the outlet 22, a device 10 according to the invention is relatively insensitive to weaving dust, making it particularly suitable for use in weaving machines. The device 10 according to the invention can store weft thread in an ordered manner under low tension, thus allowing weft thread to be brought without faults into a shed, with little air consumption at high speed.

[0086] It will be clear that the dimensions of a device 10 according to the invention can be selected as a function of the weft threads used. Although in the illustrated weaving machine four devices according to the invention are used, use may be made of just one device according to the invention or of a different number of devices according to the invention. If for example weaving is carried out from a plurality of channels, it is possible for a device according to the invention to be used merely in some of said channels or in all channels.

[0087] Since the transverse width of the storage element decreases merely to a limited extent from the inlet 21 toward the outlet 22, removing weft thread from the storage element 20 is not impeded, and stacking up weft thread in the storage element 20 is also not impeded.

Also, the decreasing transverse width is advantageous for the flow of air in the storage element 20, as it allows a sufficient throughflow of compressed air to be maintained irrespective of the escaping of compressed air along the walls of the storage element 20. The transverse width should however decrease sufficiently to prevent packages of weft thread from advancing through the storage element.

[0088] It will be clear that the device according to the invention is particularly suitable for use in airjet weaving machines. Of course, the device according to the invention can also be used in other types of weaving machines, such as in water jet weaving machines, rapier weaving machines, projectile weaving machines and other types of weaving machines.

[0089] The illustrated exemplary embodiments serve merely to illustrate the invention. Variants are readily possible, in particular in relation to the embodiment of the blowing device, the transition element, the storage element and the clamp element. Also possible are combinations of the illustrated embodiments coming under the scope of protection of the claims.

Claims

1. A storage element with a cavity (40) delimited by sidewalls (41, 42) for storing weft thread (1), comprising an inlet (21) for supplying weft thread (1) to the cavity (40) and an outlet (22) positioned opposite the inlet (21) for removing weft thread (1) from the cavity (40), wherein weft thread (1) being stored between the sidewalls (41, 42) in the cavity (40), wherein the cavity (40) is provided with a substantially flat shape and the transverse width between the sidewalls (41, 42) of the cavity (40) decreases slightly in the longitudinal direction (L) of the cavity (40) toward the outlet (22), wherein an angle between the sidewalls (41, 42) is not more than 8°, so that the weft thread stored between the sidewalls (41, 42) in the cavity (40) is prevented by the sidewalls (41, 42) of the cavity (40) from moving in the cavity (40) in the direction toward the outlet (22).
2. The storage element as claimed in claim 1, **characterized in that** the transverse width between the sidewalls (41, 42) of the cavity (40) decreases conically from the inlet (21) of the cavity (40) to the outlet (22) of the cavity (40).
3. The storage element as claimed in claim 1 or 2, **characterized in that** the height of the cavity (40) of the storage element (20) decreases in the longitudinal direction (L) of the cavity (40) toward the outlet (22).
4. The storage element as claimed in one of claims 1 to 3, **characterized in that** at least one of the upper wall (33), the bottom wall (34) or the sidewalls (41,

42) of the cavity (40) of the storage element (20) is embodied so as to be air-permeable.

5. The storage element as claimed in one of claims 1 to 4, **characterized in that** the storage element (20) comprises a movably arranged wall (33). 5
6. The storage element as claimed in one of claims 1 to 5, **characterized in that** the storage element (20) comprises a closure device (6) arranged in proximity to the outlet (22) for closing the outlet (22) of the cavity (40), **in that** the closure device (6) can interact with a wall of the cavity (40) for closing the outlet (22) of the cavity (40) and **in that** the aforementioned wall is provided with an impact-compensating contact area (7) for reducing an impact of the closure device (6) on the aforementioned wall during closing of the outlet (22) of the cavity (40). 10
7. The storage element as claimed in claim 6, **characterized in that** a split (8) is formed in a pattern in the wall comprising the contact area (7). 15
8. A device for feeding weft thread to a weaving machine, **characterized in that** the device (10) comprises a storage element (20) as claimed in one of claims 1 to 7 comprising an inlet (21) and an outlet (22) for weft thread (1). 20
9. The device as claimed in claim 8, **characterized in that** the device (10) comprises a blowing device (23), the blowing device (23) being arranged in proximity to the inlet (21) of the storage element (20) for blowing weft thread (1) to the storage element (20) and in the direction toward the outlet (22) of the storage element (20). 25
10. The device as claimed in claim 9, **characterized in that** the blowing device (23) comprises a fill tube (24) which is arranged in proximity to the inlet (21) of the storage element (20) to blow weft thread (1) into the storage element (20) at a uniform air flow. 30
11. The device as claimed in one of claims 9 or 10, **characterized in that** the device (10) comprises a transition element (25) which is arranged between the blowing device (23) and the storage element (20), more particularly which connects the outlet (26) of the fill tube (24) to the inlet (21) of the storage element (22). 35
12. The device as claimed in one of claims 8 to 11, **characterized in that** the device comprises at least one sensor (53, 54, 55) to detect the filling of the storage element (20) with weft thread (1) and/or the removing of weft thread (1) from the storage element (20). 40
13. A weaving machine, **characterized in that** the 45

weaving machine comprises a device (10) for feeding weft thread (1) as claimed in one of claims 8 to 12.

14. A method for feeding a weft thread to a weaving machine, the weft thread (1) being filled in and removed from a storage element (20) according to claim 1, **characterized in that** the weft thread (1) is stored in the flat storage element (20) in a zigzag pattern with a number of zigzag loops (2), the dimensions of the zigzag loops (2) increase in the longitudinal direction (L) of the storage element (20) toward the inlet (21) of the storage element (20) and **in that** the zigzag loops (2) are successively unwound and removed from the storage element (20). 50
15. The method as claimed in claim 14, **characterized in that** a weft thread (1) is at the same time filled via the inlet (21) and is removed via the outlet (22) of the storage element (20). 55

Patentansprüche

1. Ein Speicherelement mit einem durch Seitenwände (41, 42) begrenzten Hohlraum (40) zum Speichern von Schussfaden (1), umfassend einen Einlass (21) zum Zuführen von Schussfaden (1) zu dem Hohlraum (40) und einen gegenüber dem Einlass (21) positionierten Auslass (22) zum Entfernen von Schussfaden (1) aus dem Hohlraum (40), wobei Schussfaden (1) zwischen den Seitenwänden (41, 42) in dem Hohlraum (40) gespeichert ist, wobei der Hohlraum (40) mit einer im wesentlichen flachen Form versehen ist und die Querbreite zwischen den Seitenwänden (41, 42) des Hohlraums (40) in der Längsrichtung (L) des Hohlraums (40) in Richtung auf den Auslass (22) leicht abnimmt, wobei ein Winkel zwischen den Seitenwänden (41, 42) nicht mehr als 8° ist, so dass der zwischen den Seitenwänden (41, 42) in dem Hohlraum (40) gespeicherte Schussfaden durch die Seitenwände (41, 42) des Hohlraums (40) daran gehindert ist, sich in dem Hohlraum (40) in Richtung auf den Auslass zu bewegen. 50
2. Das Speicherelement nach Anspruch 1, **dadurch gekennzeichnet, dass** die Querbreite zwischen den Seitenwänden (41, 42) des Hohlraums (40) konisch abnimmt von dem Einlass (21) des Hohlraums (40) zu dem Auslass (22) des Hohlraums (40). 55
3. Das Speicherelement nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** die Höhe des Hohlraums (40) des Speicherelements (20) abnimmt in der Längsrichtung (L) des Hohlraums (40) in Richtung auf den Auslass (22).
4. Das Speicherelement nach einem der Ansprüche 1

- bis 3, **dadurch gekennzeichnet, dass** mindestens eine der oberen Wand (33), der Bodenwand (34) oder den Seitenwänden (41, 42) des Hohlraums (40) des Speicherelements (20) so ausgebildet ist um luftdurchlässig zu sein.
5. Das Speicherelement nach einem der Ansprüche 1 bis 4, **dadurch gekennzeichnet, dass** das Speicherelement (20) eine beweglich angeordnete Wand (33) enthält.
6. Das Speicherelement nach einem der Ansprüche 1 bis 5, **dadurch gekennzeichnet, dass** das Speicherelement (20) eine Verschlussvorrichtung (6) enthält, angeordnet in der Nähe des Auslasses (22) zum Schließen des Auslasses (22) des Hohlraums (40), dass die Verschlussvorrichtung (6) interagieren kann mit einer Wand des Hohlraums (40) zum Schließen des Auslasses (22) des Hohlraums (40) und dass die genannte Wand versehen ist mit einem Aufprall-kompensierende Kontaktfläche (7) zum Reduzieren eines Aufpralls der Verschlussvorrichtung (6) auf der genannten Wand beim Schließen des Auslasses (22) des Hohlraums (40).
7. Das Speicherelement nach Anspruch 6, **dadurch gekennzeichnet, dass** ein Spalt (8) geformt wird in einem Muster in der Wand enthaltend den Kontaktbereich (7).
8. Eine Vorrichtung zum Zuführen von Schussfaden zu einer Webmaschine, **dadurch gekennzeichnet, dass** die Vorrichtung (10) ein Speicherelement (20) umfasst nach einem der Ansprüche 1 bis 7 umfassend einen Einlass (21) und einen Auslass (22) für Schussfaden (1).
9. Die Vorrichtung nach Anspruch 8, **dadurch gekennzeichnet, dass** die Vorrichtung (10) eine Blasvorrichtung (23) enthält, wobei die Blasvorrichtung (23) angeordnet ist in der Nähe des Einlasses (21) des Speicherelements (20) zum Blasen von Schussfaden (1) zu dem Speicherelement (20) und in Richtung auf den Auslass (22) des Speicherelements (20).
10. Die Vorrichtung nach Anspruch 9, **dadurch gekennzeichnet, dass** die Blasvorrichtung (23) ein Füllrohr (24) enthält das in der Nähe des Einlasses (21) des Speicherelements (20) angeordnet ist zum Blasen von Schussfaden (1) in das Speicherelement (20) mit einer gleichmäßigen Luftströmung.
11. Die Vorrichtung nach einem der Ansprüche 9 oder 10, **dadurch gekennzeichnet, dass** die Vorrichtung (10) ein Übergangselement (25) enthält, das zwischen der Blasvorrichtung (23) und dem Speicherelement (20) angeordnet ist, insbesondere das den

Auslass (26) des Füllrohrs (24) mit dem Einlass (21) des Speicherelements (22) verbindet.

12. Die Vorrichtung nach einem der Ansprüche 8 bis 11, **dadurch gekennzeichnet, dass** die Vorrichtung mindestens einen Sensor (53, 54, 55) enthält zum Erfassen der Füllung des Speicherelements (20) mit Schussfaden (1) und/oder zum Entfernen von Schussfaden (1) aus dem Speicherelement (20).
13. Eine Webmaschine, **dadurch gekennzeichnet, dass** die Webmaschine eine Vorrichtung (10) enthält zum Zuführen von Schussfaden (1), nach einem der Ansprüche 8 bis 12.
14. Ein Verfahren zum Zuführen eines Schussfadens zu einer Webmaschine, wobei der Schussfaden (1) gefüllt wird in und entfernt wird aus einem Speicherelement (20) nach Anspruch 1, **dadurch gekennzeichnet, dass** der Schussfaden (1) in dem flachen Speicherelement (20) in einem Zickzackmuster mit einer Anzahl Zickzack-Schlingen (2) gespeichert wird, wobei die Abmessungen der Zickzack-Schlingen (2) sich in der Längsrichtung (L) des Speicherelements (20) in Richtung auf den Einlass (21) des Speicherelements (20) vergrößern, und dass die Zickzack-Schlingen (2) nacheinander aus dem Speicherelement (20) abgewickelt und entfernt werden.
15. Das Verfahren nach Anspruch 14, **dadurch gekennzeichnet, dass** ein Schussfaden (1) gleichzeitig über den Einlass (21) gefüllt wird und über den Auslass (22) des Speicherelements (20) entfernt wird.

Revendications

1. Un élément de stockage avec une cavité (40) délimitée par des parois latérales (41, 42) pour stocker de fil de trame (1), comprenant une entrée (21) pour délivrer de fil de trame (1) à la cavité (40) et une sortie (22) positionnée en face de l'entrée (21) pour enlever de fil de trame (1) de la cavité (40), dans lequel de fil de trame (1) étant stocké entre les parois latérales (41, 42) dans la cavité (40), dans lequel la cavité (40) est prévue d'une forme sensiblement plate et la largeur transversale entre les parois latérales (41, 42) de la cavité (40) diminue légèrement dans la direction longitudinale (L) de la cavité (40) vers la sortie (22), dans lequel un angle entre les parois latérales (41, 42) n'est pas supérieur à 8°, de sorte que le fil de trame stocké entre les parois latérales (41, 42) dans la cavité (40) est empêché par les parois latérales (41, 42) de la cavité (40) de se déplacer dans la cavité (40) dans la direction vers la sortie (22).

2. L'élément de stockage selon la revendication 1, **caractérisé en ce que** la largeur transversale entre les parois latérales (41, 42) de la cavité (40) diminue coniquement de l'entrée (21) de la cavité (40) à la sortie (22) de la cavité (40). 5
3. L'élément de stockage selon la revendication 1 ou 2, **caractérisé en ce que** la hauteur de la cavité (40) de l'élément de stockage (20) diminue dans la direction longitudinale (L) de la cavité (40) vers la sortie (22). 10
4. L'élément de stockage selon l'une des revendications 1 à 3, **caractérisé en ce qu'**au moins une de la paroi supérieure (33), la paroi de fond (34) ou les parois latérales (41, 42) de la cavité (40) de l'élément de stockage (20) est réalisé de manière à être perméable à l'air. 15
5. L'élément de stockage selon l'une des revendications 1 à 4, **caractérisé en ce que** l'élément de stockage (20) comprend une paroi (33) disposée de façon mobile. 20
6. L'élément de stockage selon l'une des revendications 1 à 5, **caractérisé en ce que** l'élément de stockage (20) comprend un dispositif de fermeture (6) disposé à proximité de la sortie (22) pour fermer la sortie (22) de la cavité (40), **en ce que** le dispositif de fermeture (6) peut interagir avec une paroi de la cavité (40) pour fermer la sortie (22) de la cavité (40) et **en ce que** ladite paroi est prévue d'une zone de contact (7) de compensation d'impact pour réduire un impact du dispositif de fermeture (6) sur ladite paroi lors de la fermeture de la sortie (22) de la cavité (40). 25
30
35
7. L'élément de stockage selon la revendication 6, **caractérisé en ce qu'**une fente (8) est formée dans un rapport dans la paroi comprenant la zone de contact (7). 40
8. Un dispositif pour alimenter de fil de trame pour une machine à tisser, **caractérisé en ce que** le dispositif (10) comprend un élément de stockage (20) selon l'une quelconque des revendications 1 à 7, comprenant une entrée (21) et une sortie (22) pour fil de trame (1). 45
9. Le dispositif selon la revendication 8, **caractérisé en ce que** le dispositif (10) comprend un dispositif de soufflage (23), le dispositif de soufflage (23) étant disposé à proximité de l'entrée (21) de l'élément de stockage (20) pour souffler de fil de trame (1) à l'élément de stockage (20) et dans la direction vers la sortie (22) de l'élément de stockage (20). 50
55
10. Le dispositif selon la revendication 9, **caractérisé en ce que** le dispositif de soufflage (23) comprend un tube de remplissage (24) qui est disposé à proximité de l'entrée (21) de l'élément de stockage (20) pour souffler de fil de trame (1) dans l'élément de stockage (20) à un flux d'air uniforme.
11. Le dispositif selon l'une quelconque des revendications 9 ou 10, **caractérisé en ce que** le dispositif (10) comprend un élément de transition (25) qui est disposé entre le dispositif de soufflage (23) et l'élément de stockage (20), plus particulièrement, qui relie la sortie (26) du tube de remplissage (24) à l'entrée (21) de l'élément de stockage (22).
12. Le dispositif selon l'une des revendications 8 à 11, **caractérisé en ce que** le dispositif comprend au moins un détecteur (53, 54, 55) pour détecter le remplissage de l'élément de stockage (20) avec du fil de trame (1) et/ou l'enlèvement de fil de trame (1) de l'élément de stockage (20).
13. Une machine à tisser, **caractérisée en ce que** la machine à tisser comprend un dispositif (10) pour alimenter de fil de trame (1) selon l'une quelconque des revendications 8 à 12.
14. Un procédé pour alimenter un fil de trame à une machine à tisser, le fil de trame (1) étant rempli dans et enlevé d'un élément de stockage (20) selon la revendication 1, **caractérisé en ce que** le fil de trame (1) est stocké dans l'élément de stockage (20) plat dans un rapport en zigzag avec un nombre de boucles en zigzag (2), les dimensions des boucles en zigzag (2) augmente dans la direction longitudinale (L) de l'élément de stockage (20) vers l'entrée (21) de l'élément de stockage (20) et **en ce que** les boucles en zigzag (2) sont déroulés et enlevés successivement de l'élément de stockage (20).
15. Le procédé selon la revendication 14, **caractérisé en ce qu'**un fil de trame (1) est en même temps rempli par l'entrée (21) et enlevé par la sortie (22) de l'élément de stockage (20).

Fig. 1

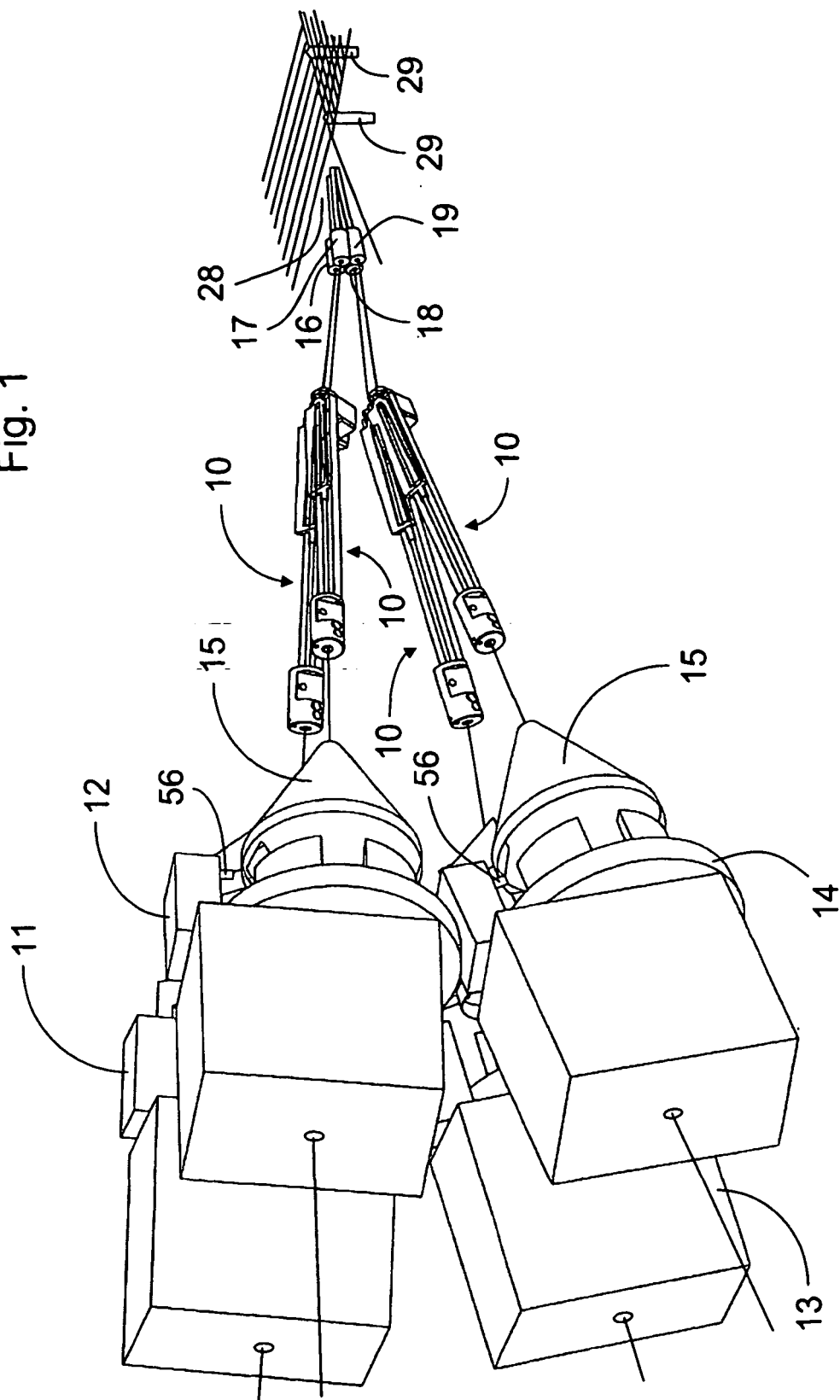


Fig. 2

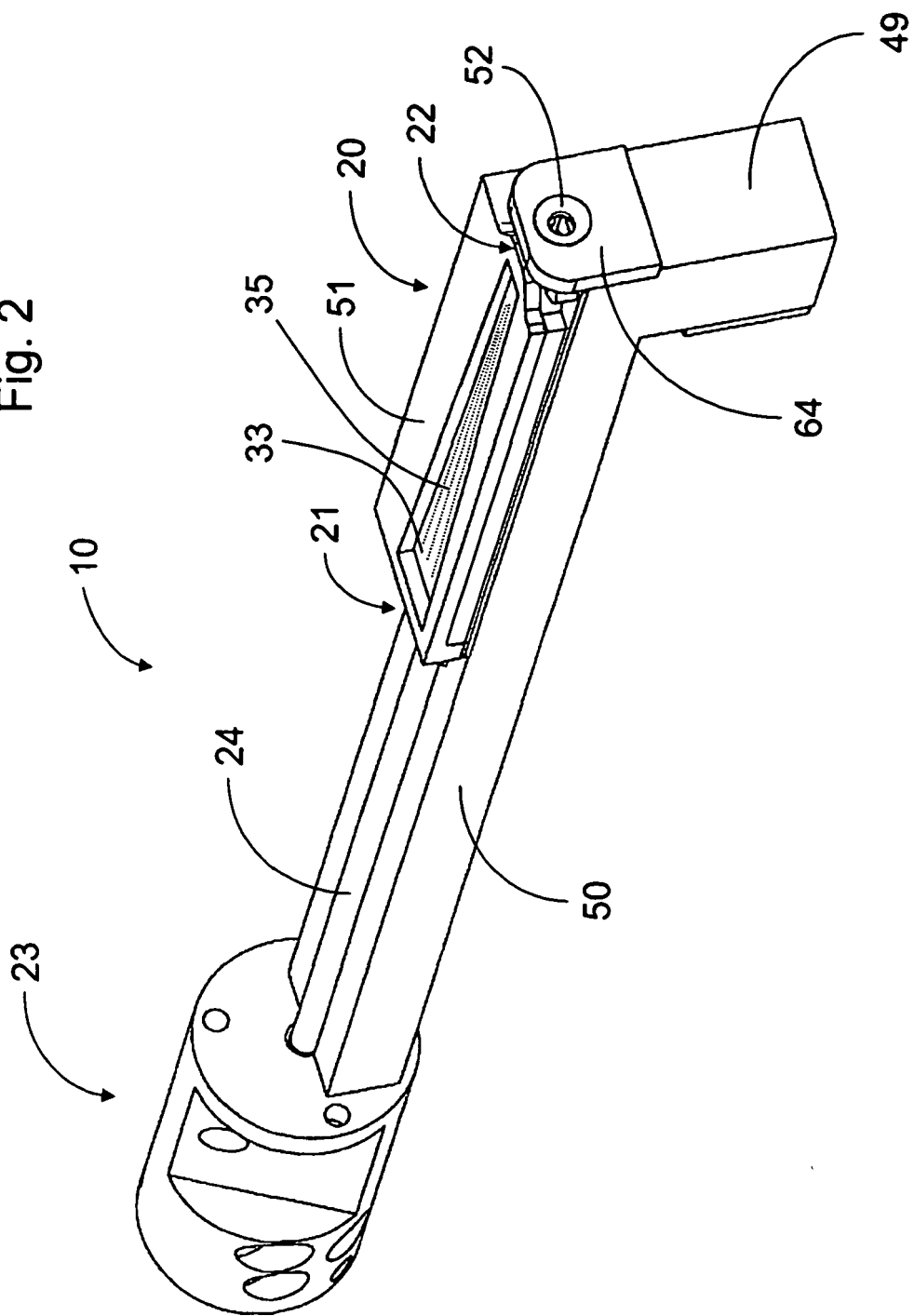
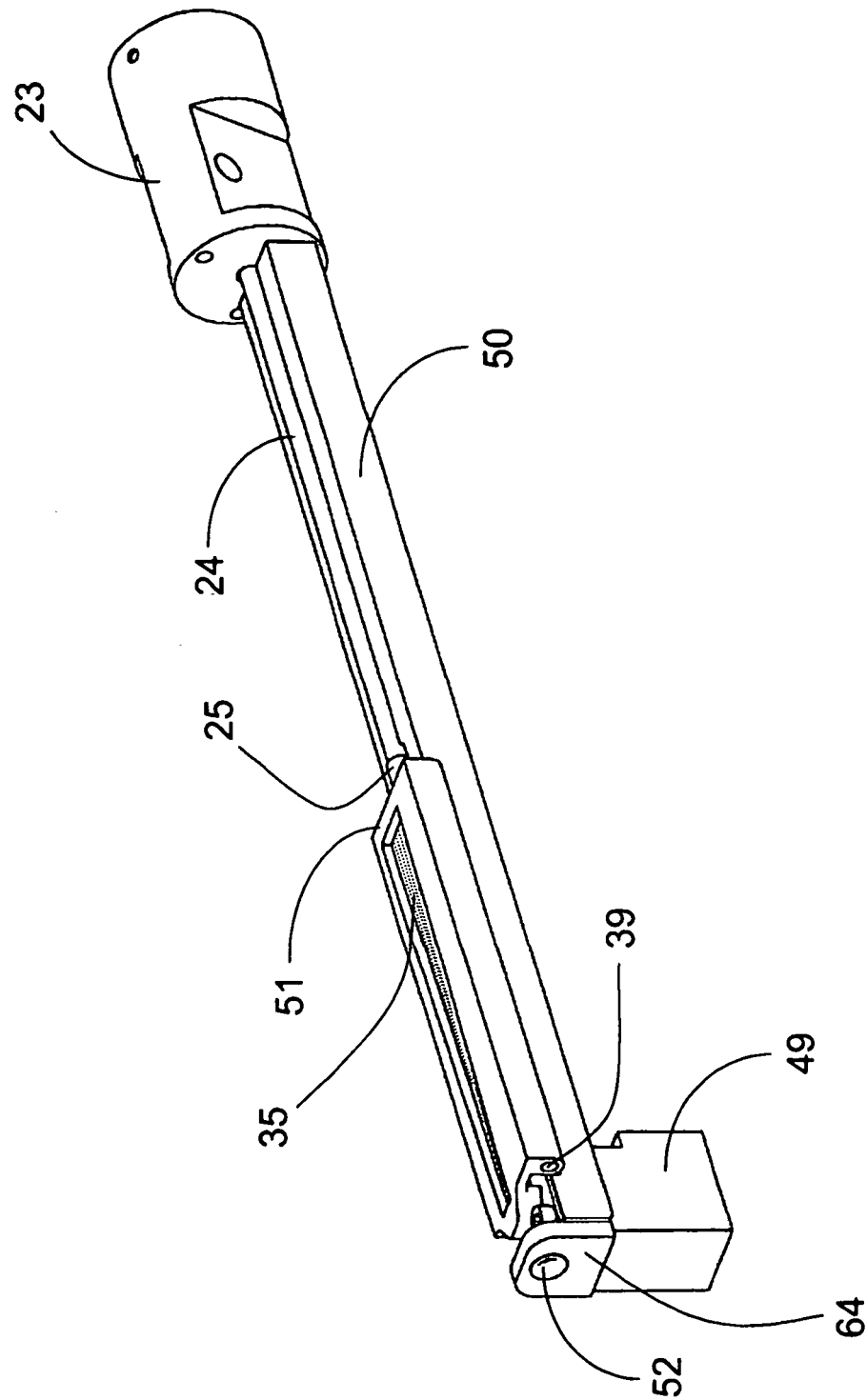


Fig. 3



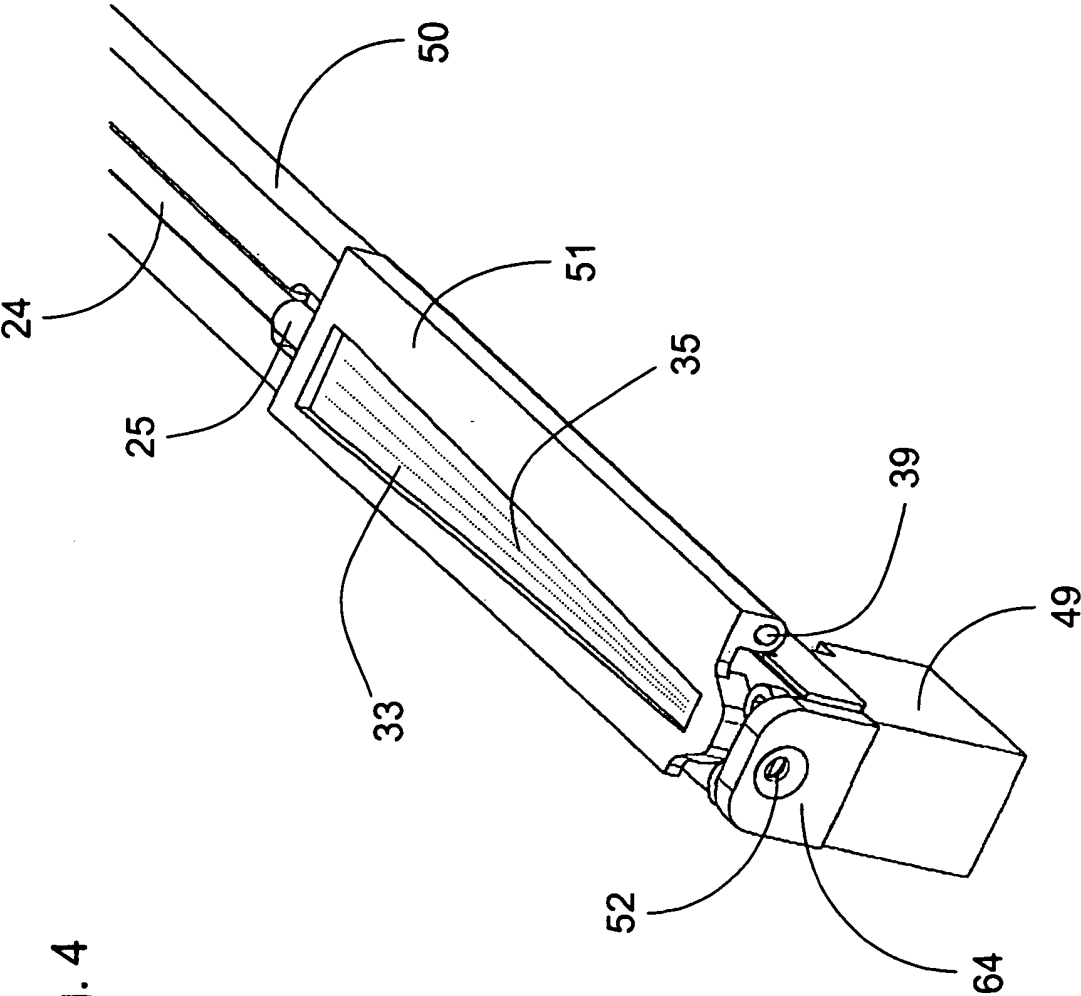


Fig. 4

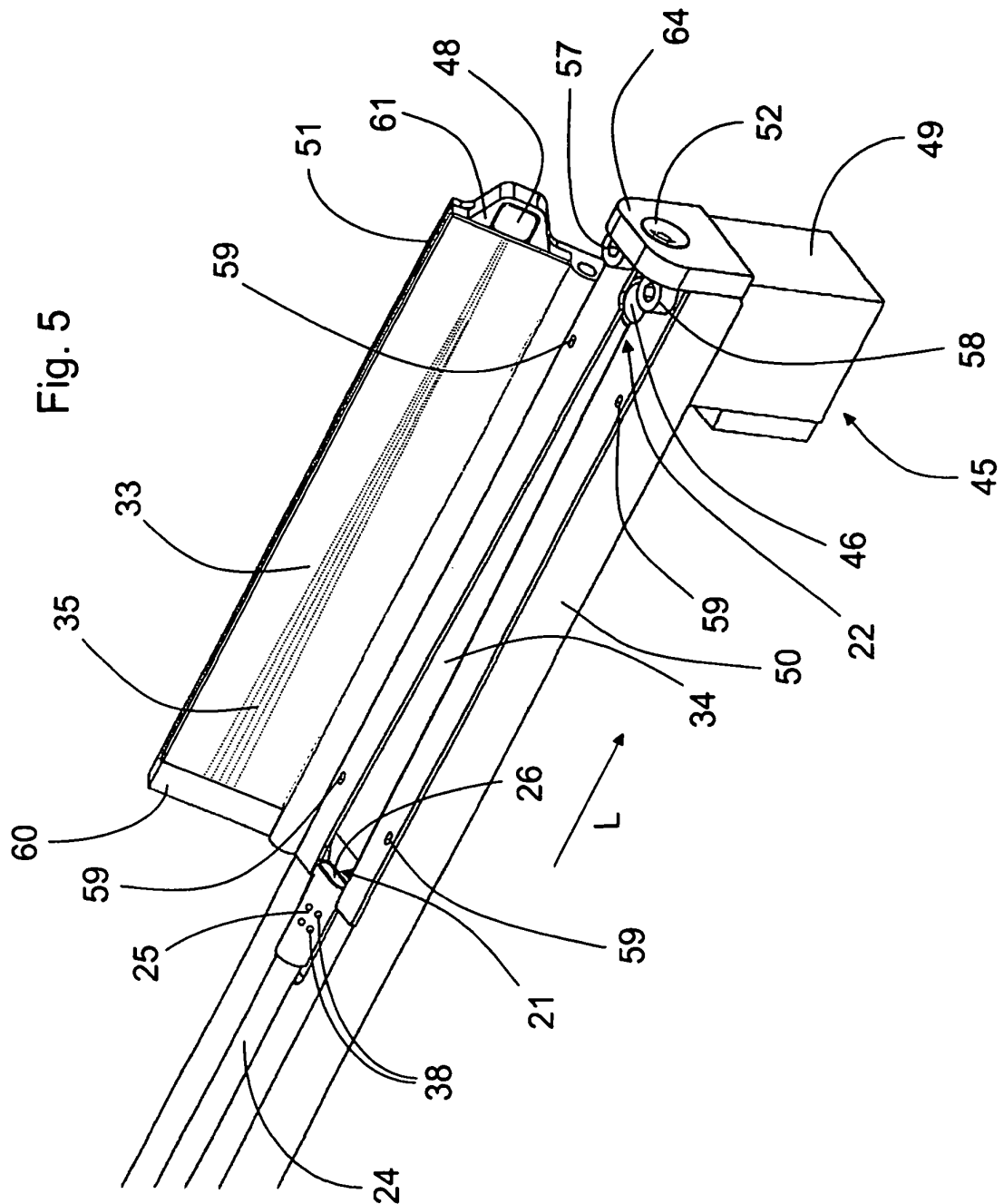


Fig. 6

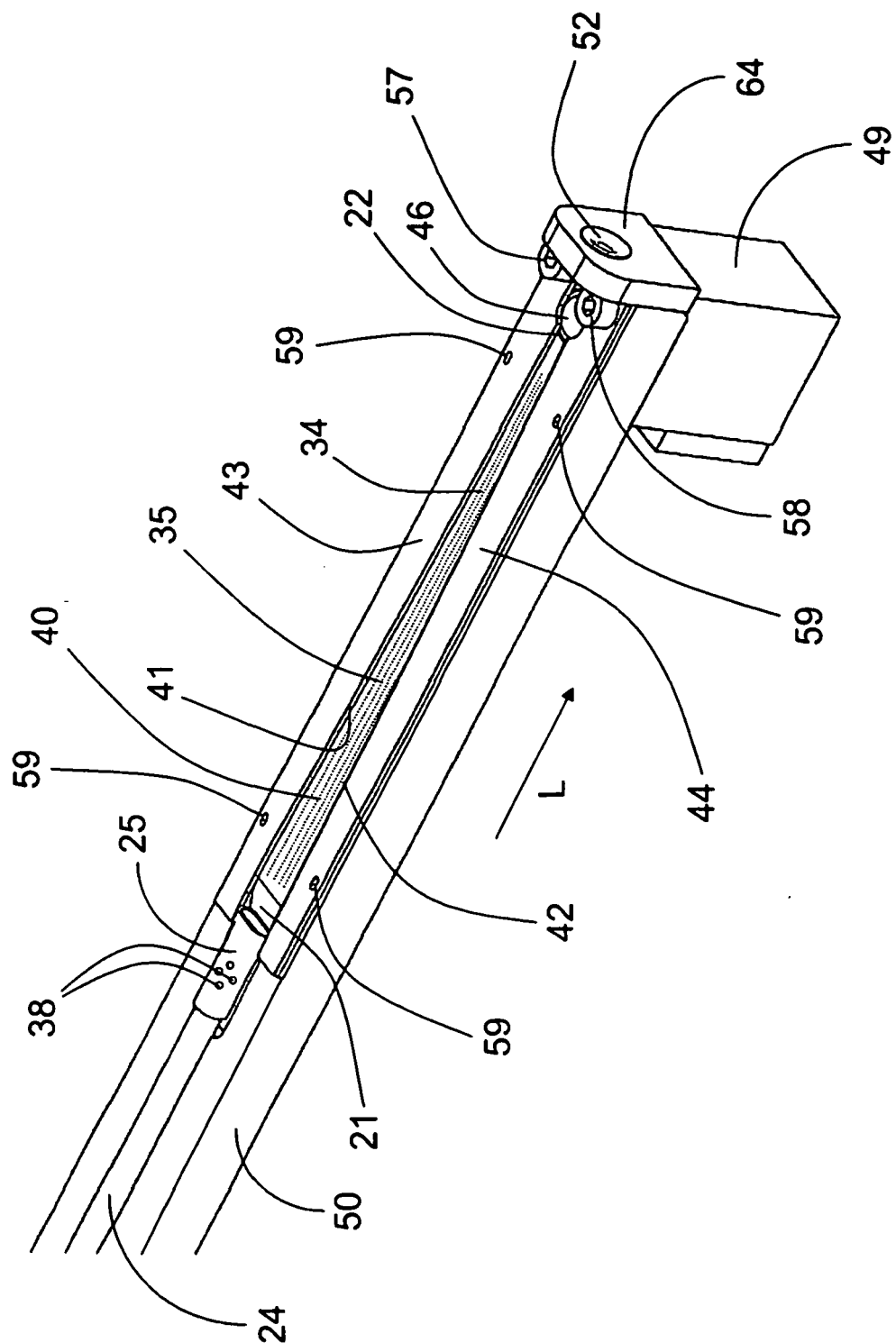


Fig. 7

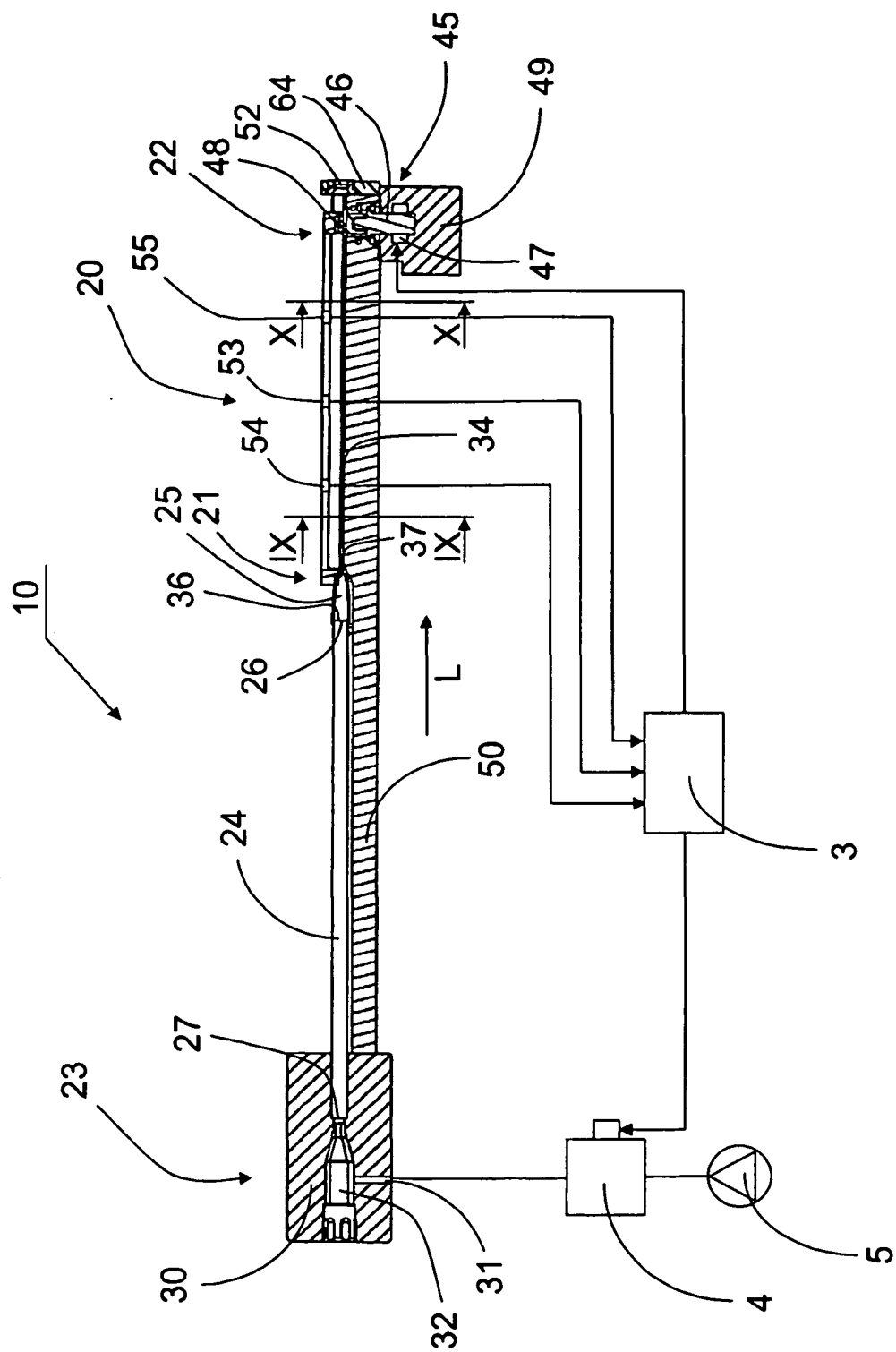


Fig. 8

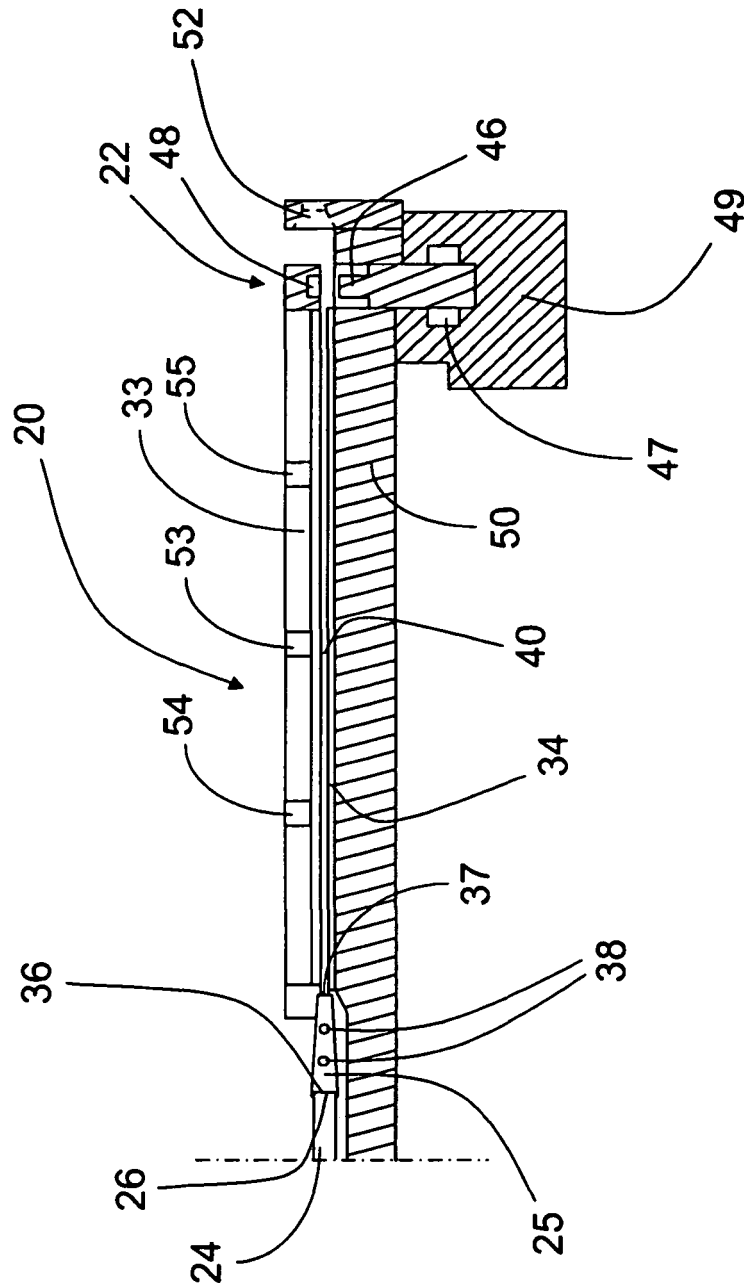


Fig. 9

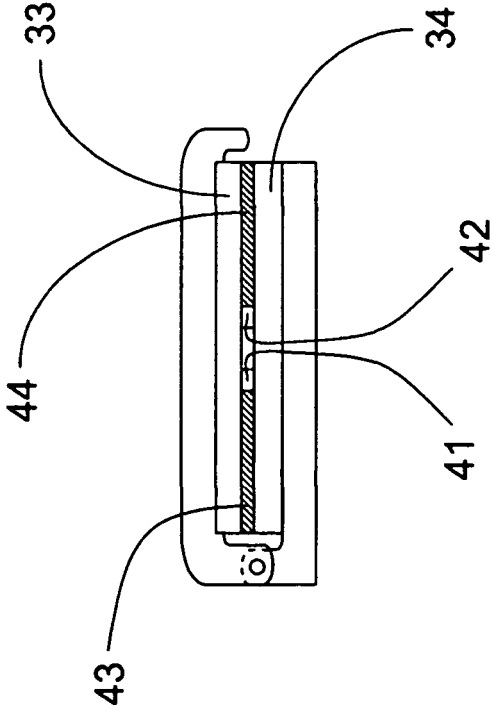


Fig. 10

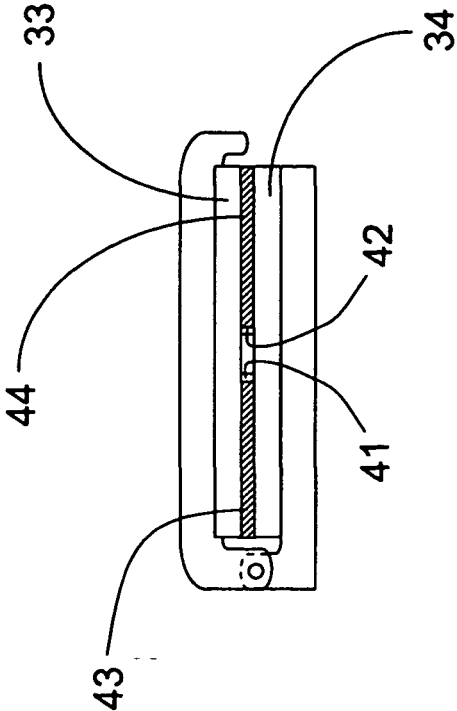


Fig. 11

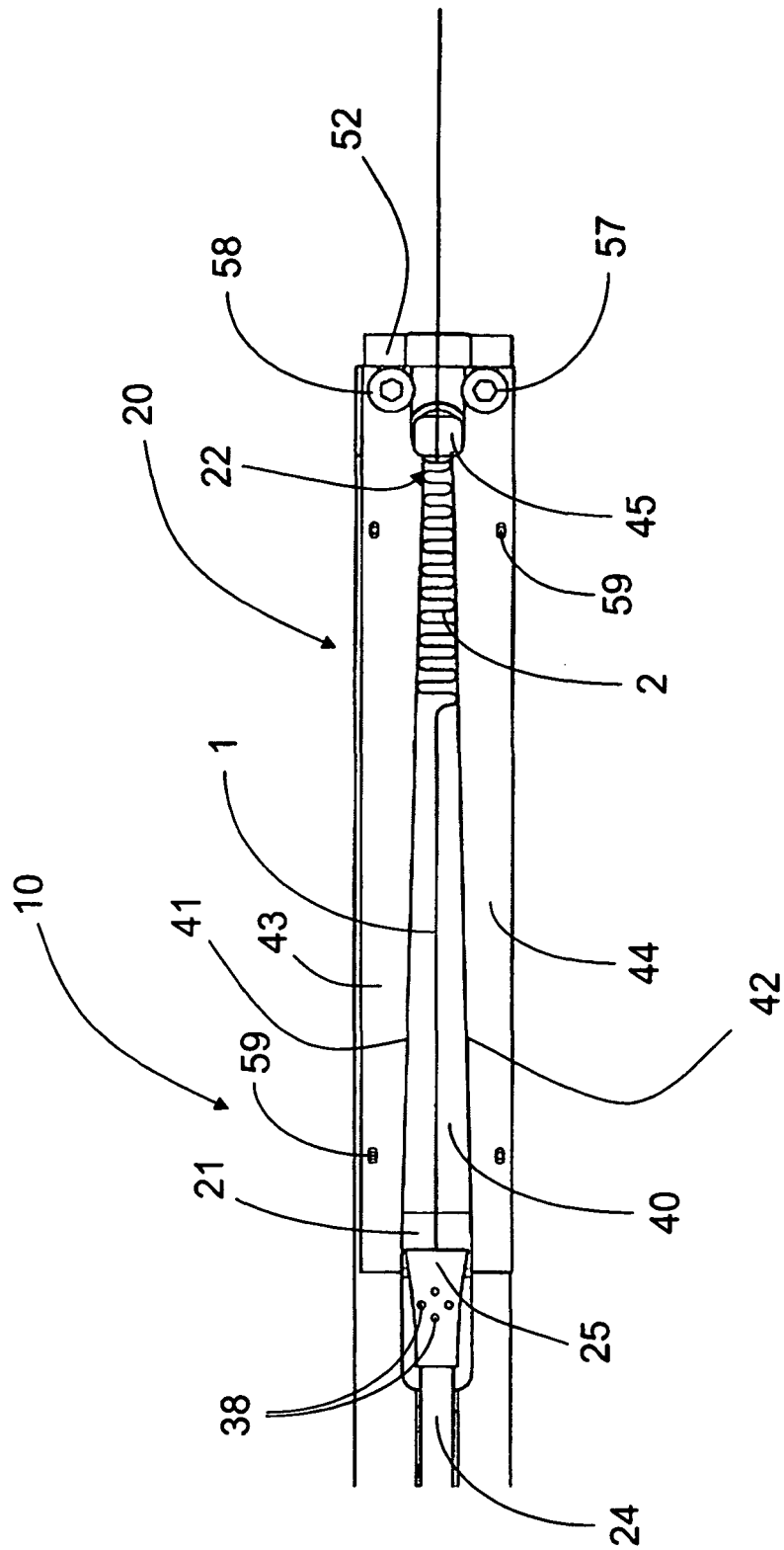


Fig. 12

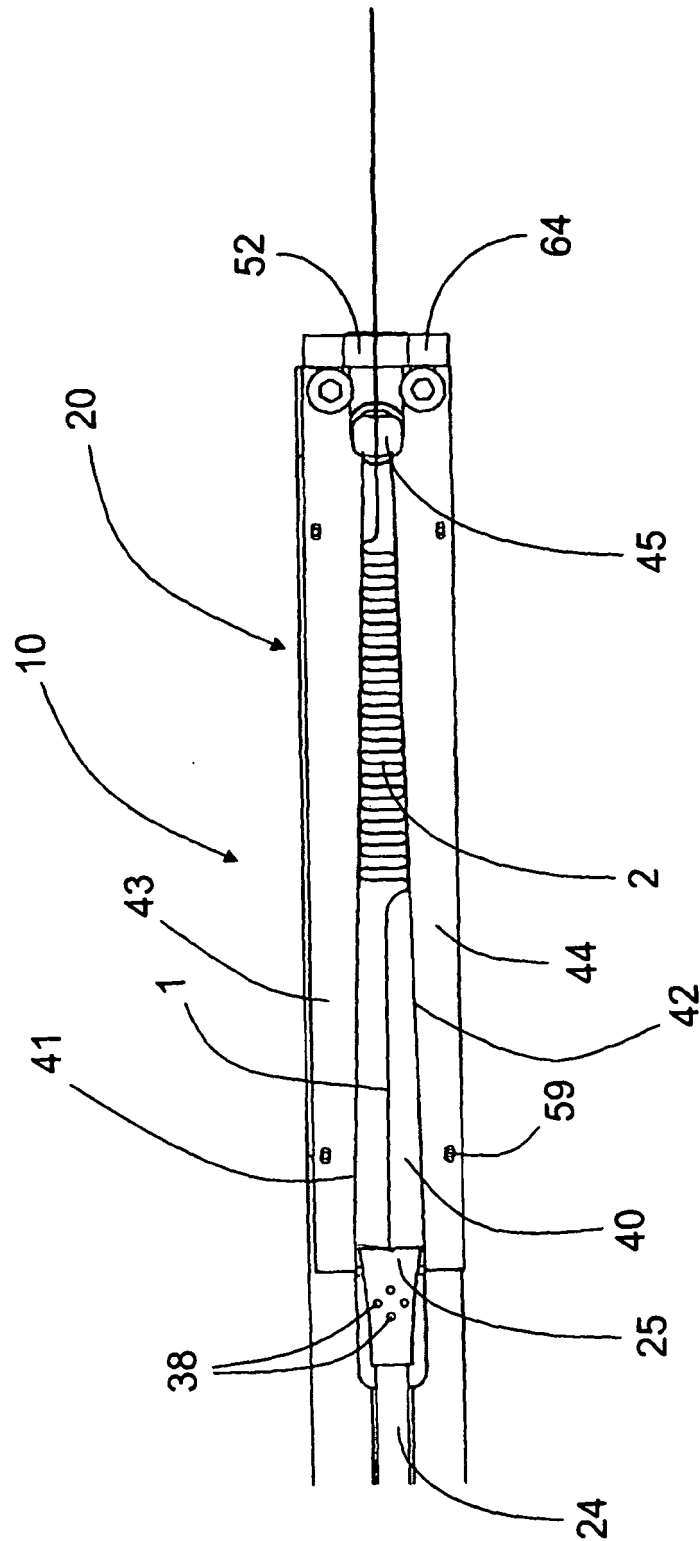


Fig. 13

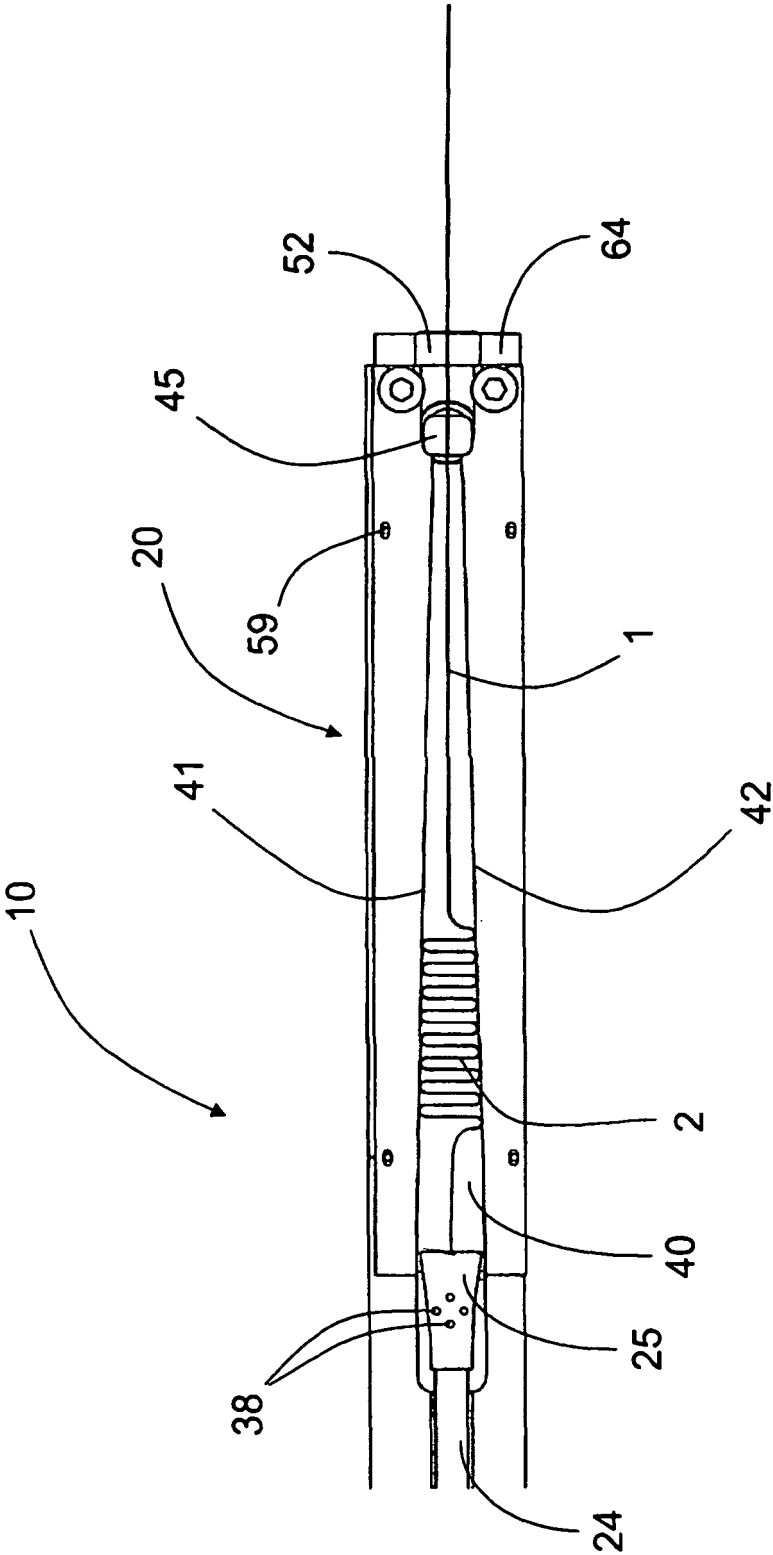
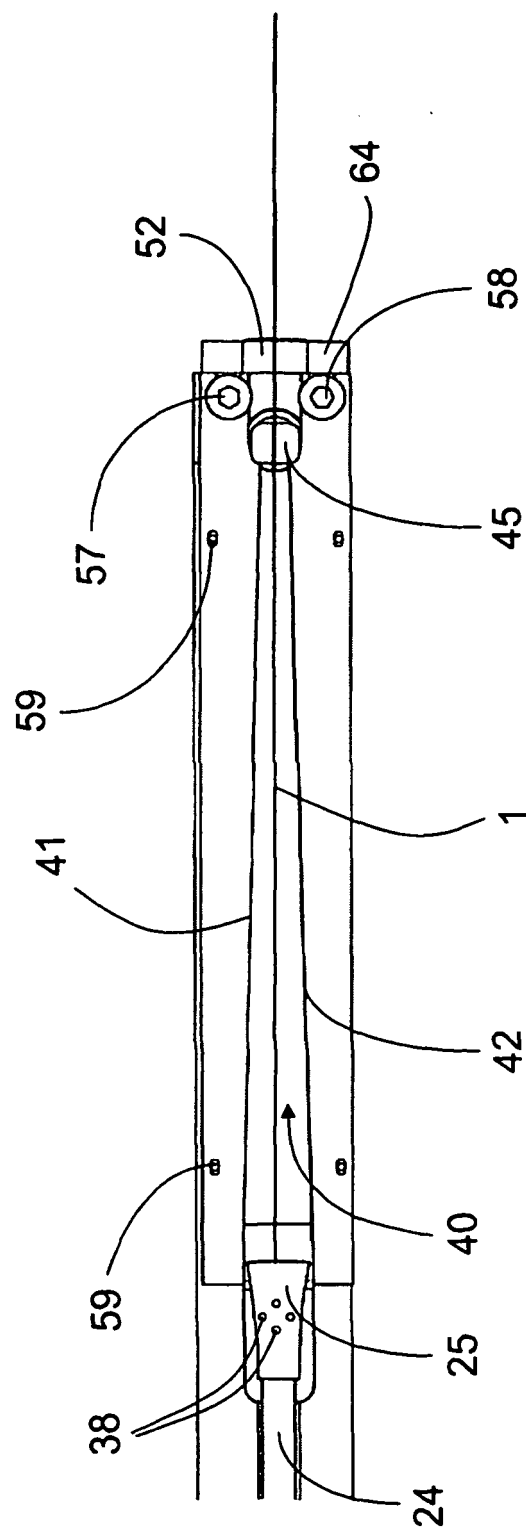


Fig. 14



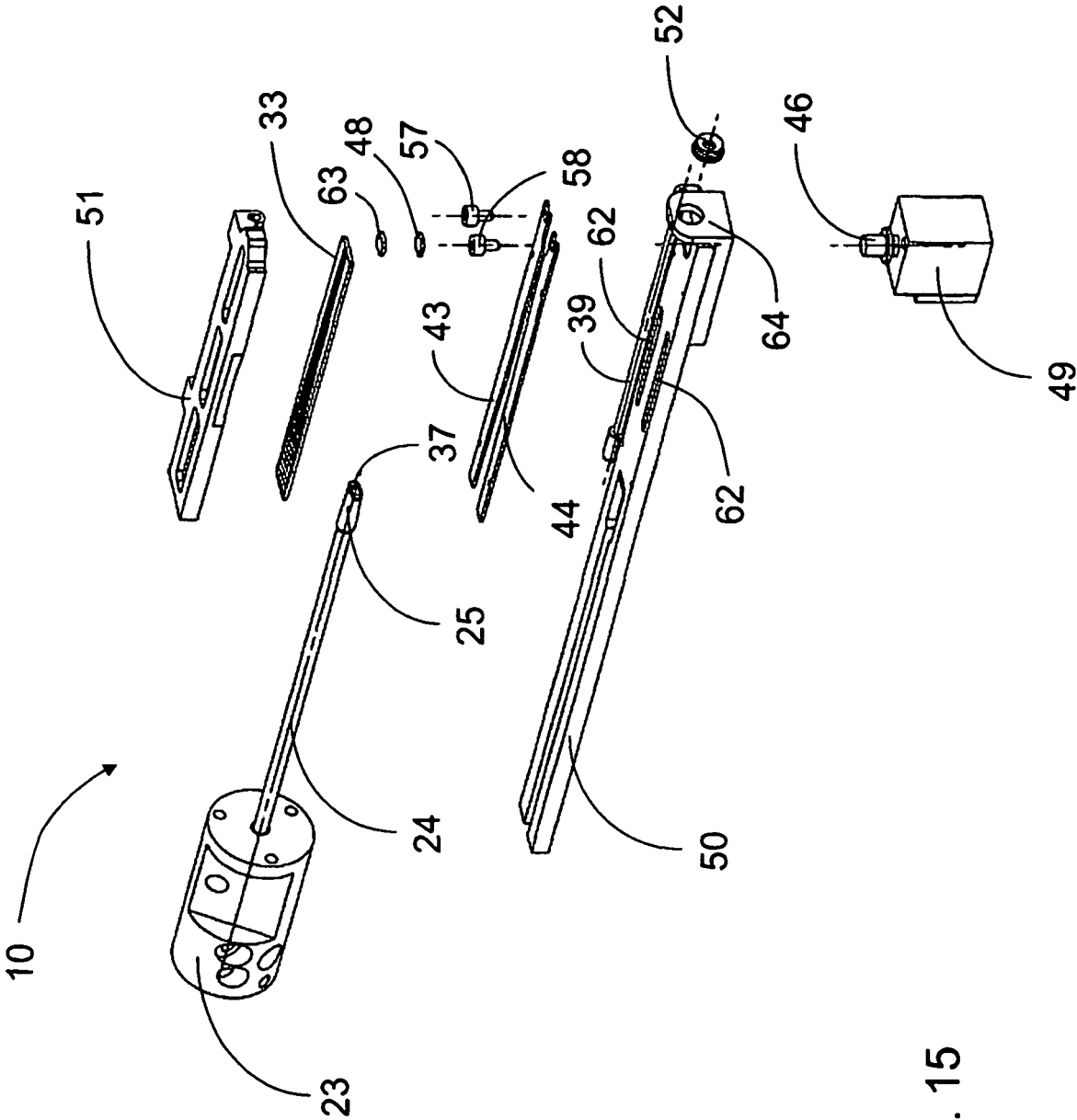
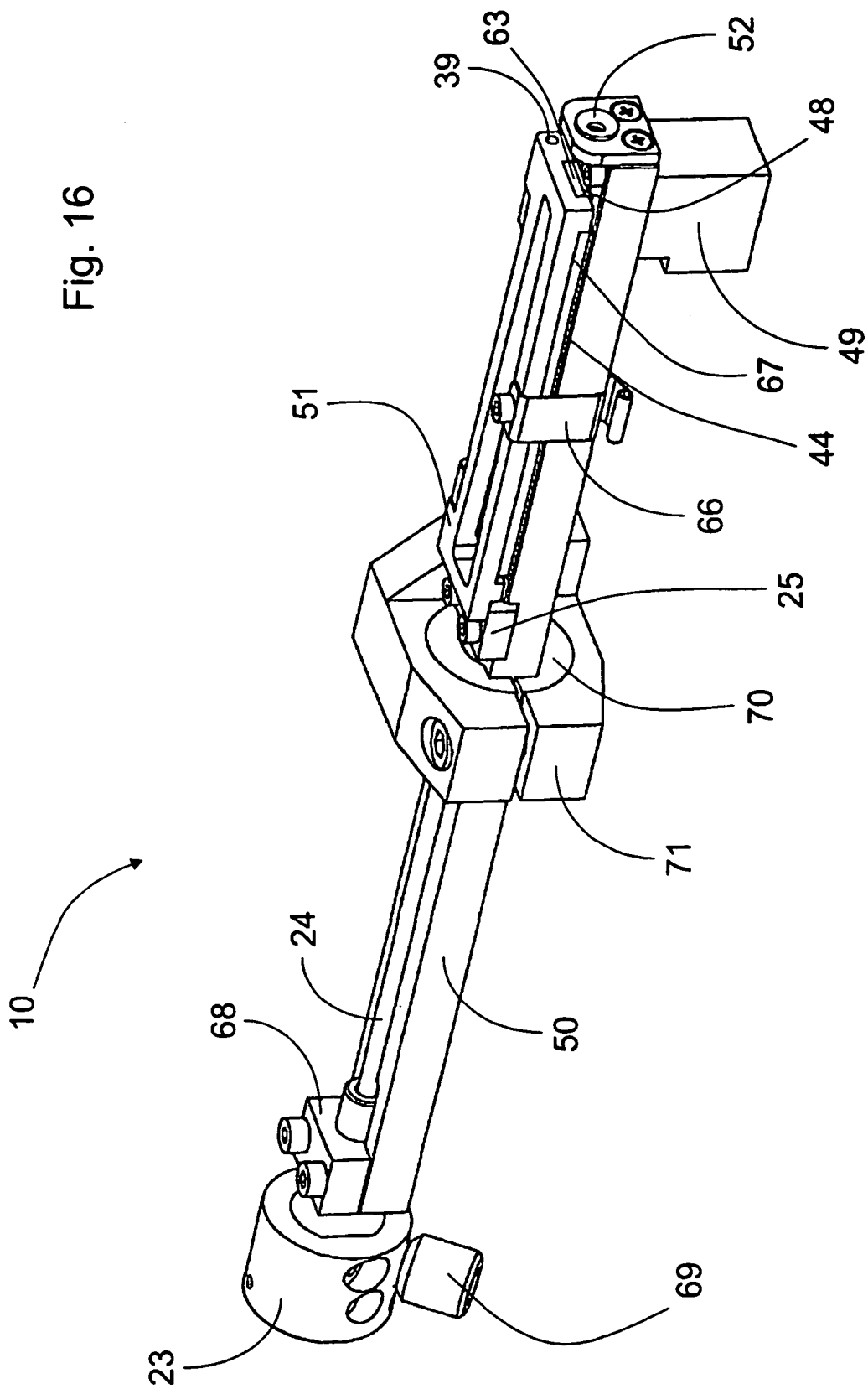


Fig. 15

Fig. 16



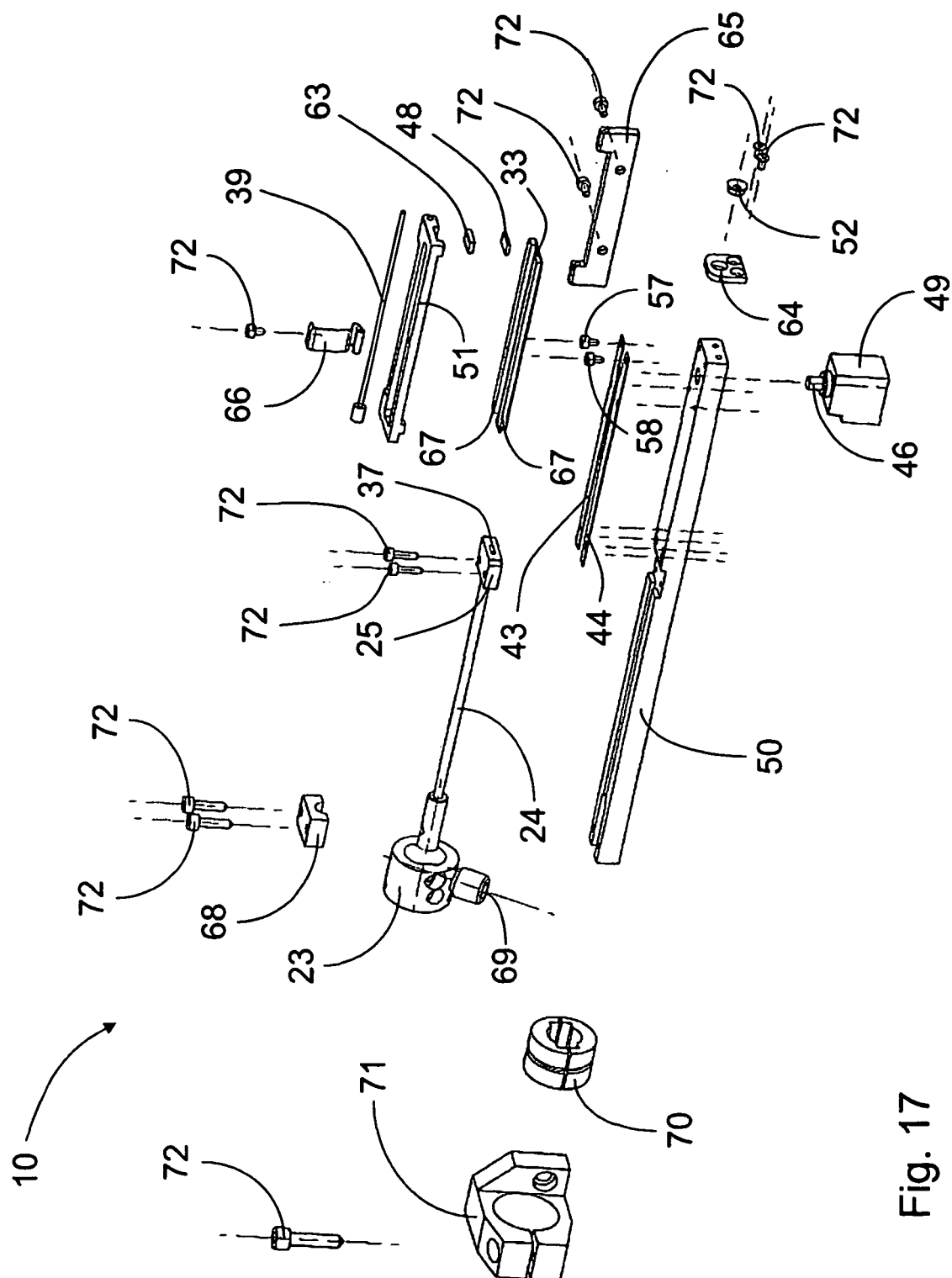


Fig. 17

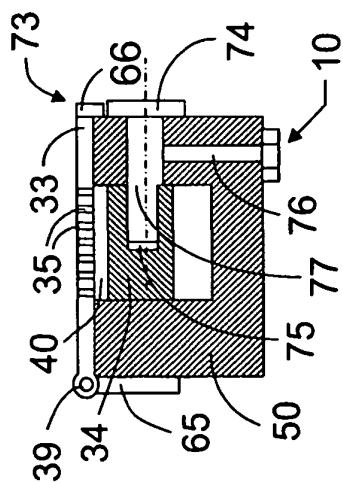


Fig. 18

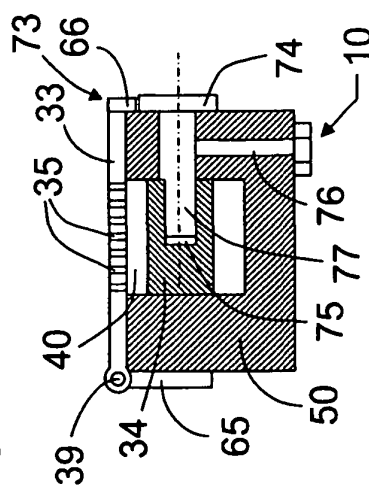


Fig. 19

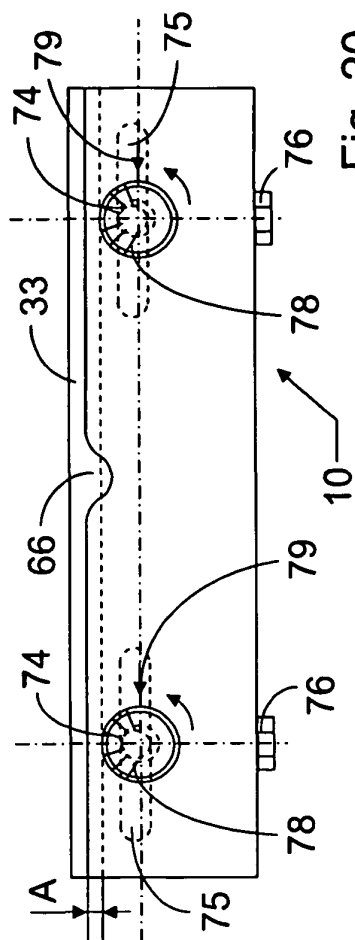


Fig. 20

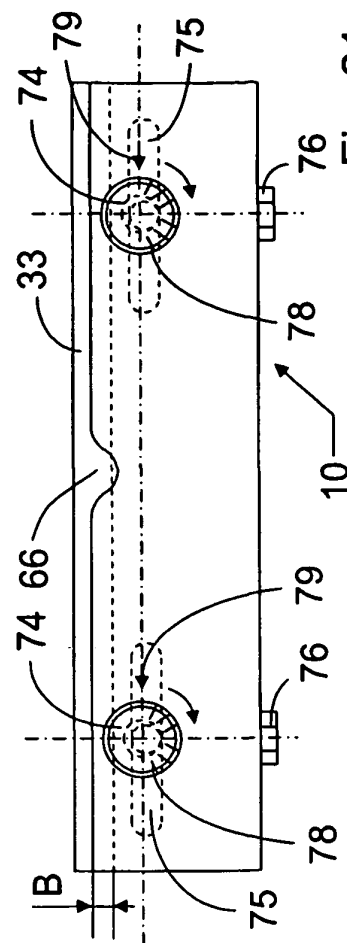


Fig. 21

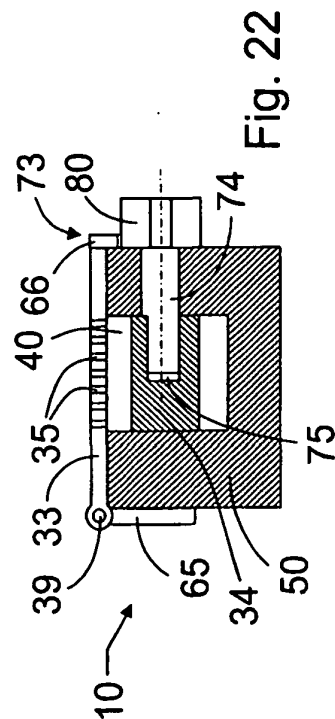
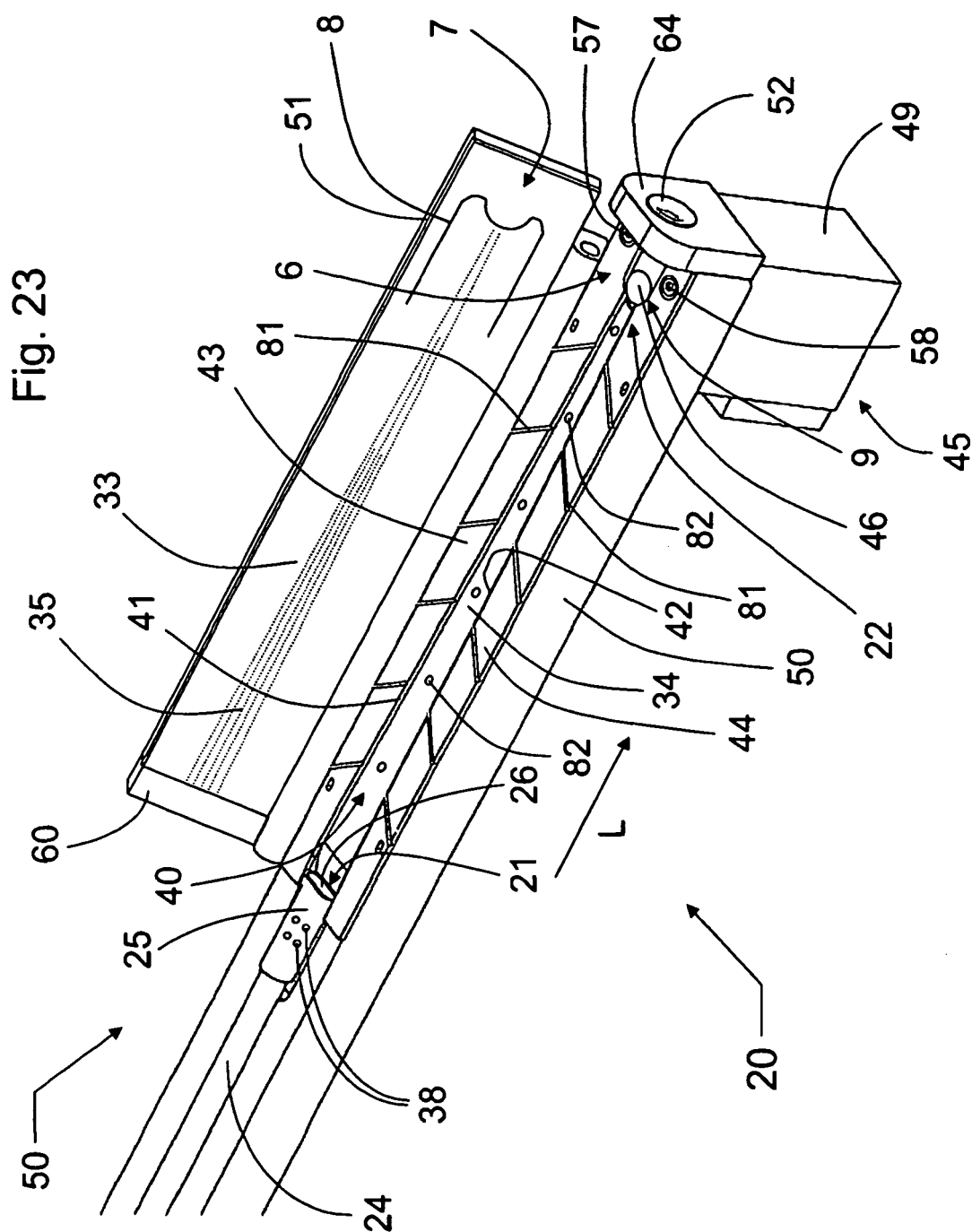
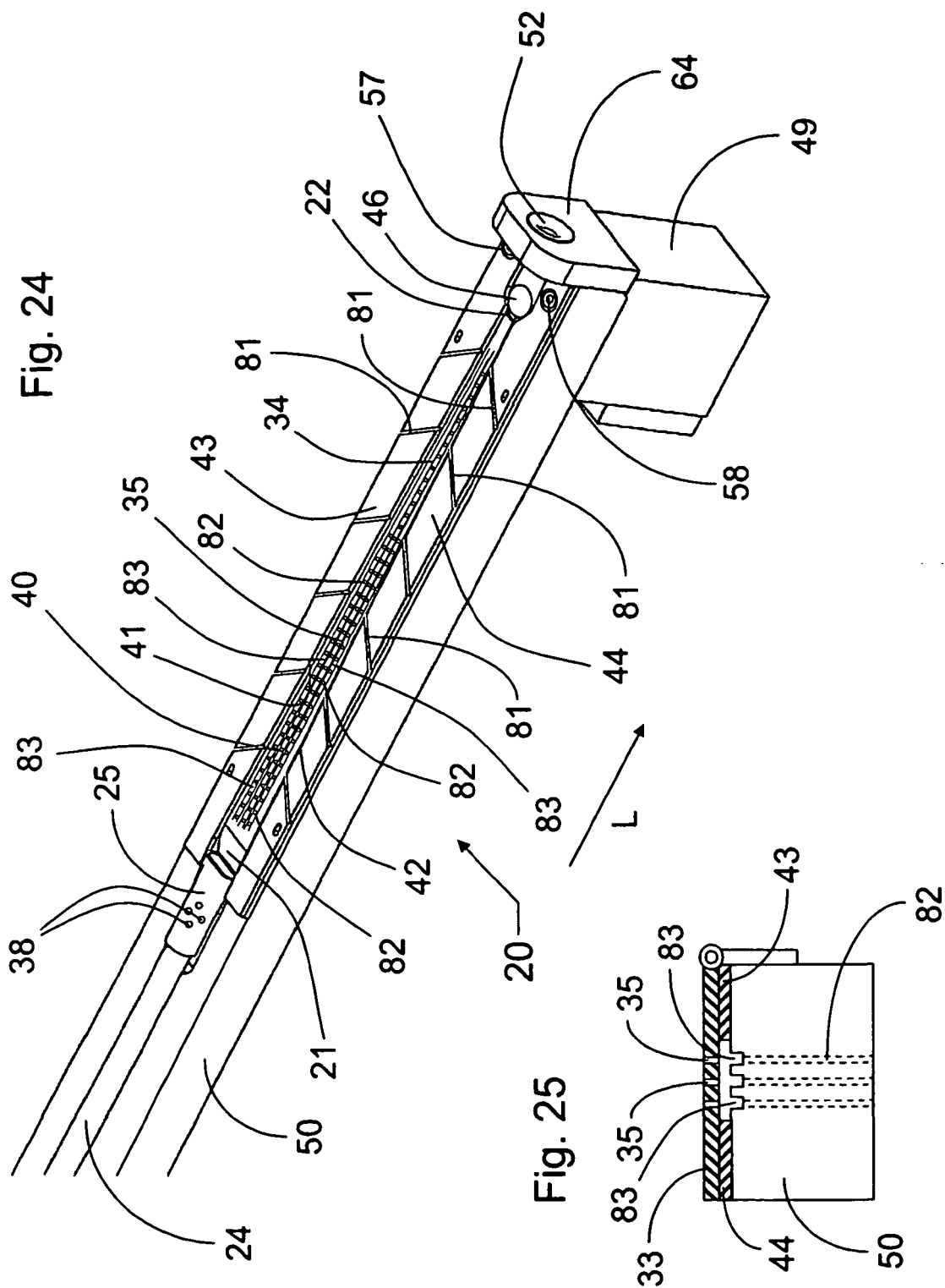


Fig. 22





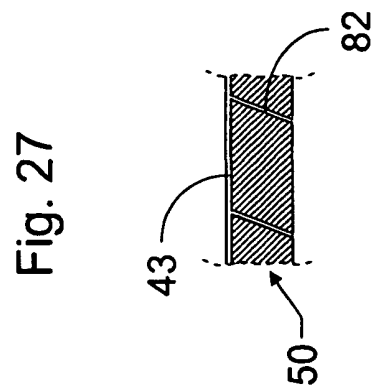
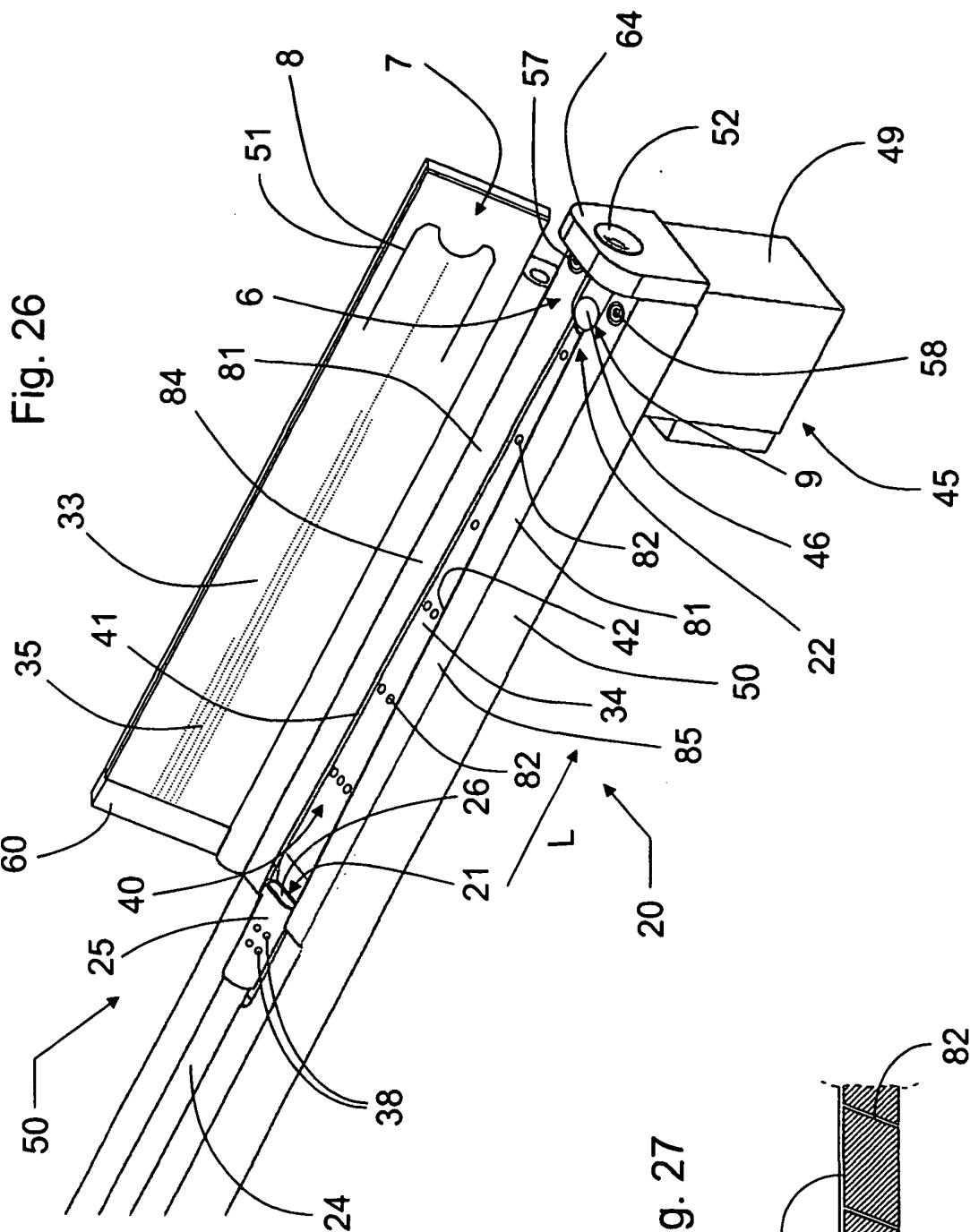
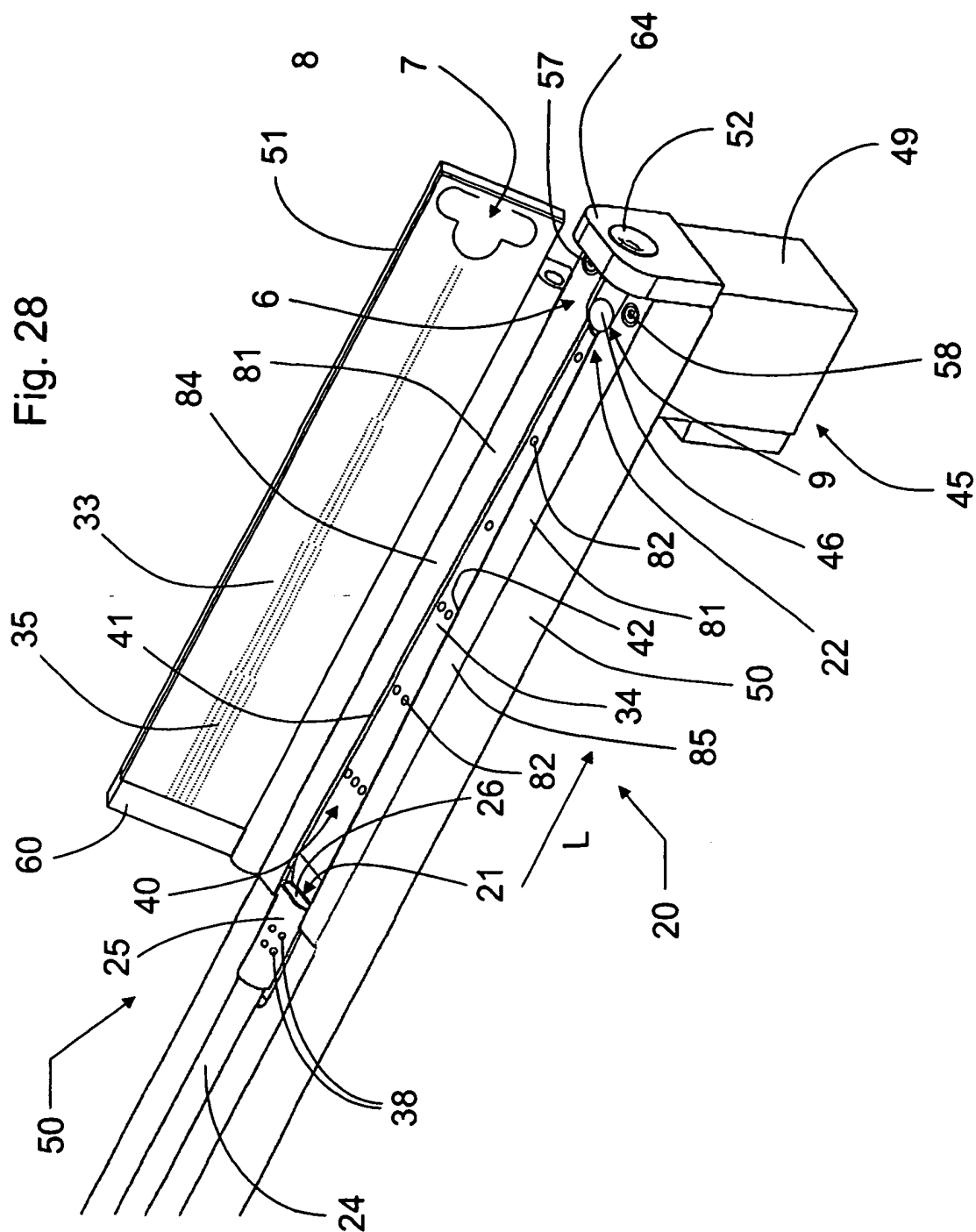


Fig. 28



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 4947898 A [0002] [0010] [0060]
- US 4821781 A [0002]
- CH 678865 [0003]
- WO 8607102 A [0004]
- US 3712526 A [0005]
- GB 2092188 A [0006]
- EP 985062 B1 [0049] [0051]
- WO 2007057217 A [0058]
- EP 421511 B1 [0082]