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(54) **DEVICE AND METHOD FOR FORMING A THICKENED HEAD ON THE HEAD ENDS OF A METAL ROD ELEMENT**

(57) The invention relates to, in combination, at least a first clamping body (15) and a second clamping body (14), wherein each clamping body (14, 15) is provided with a clamping surface (50,51) in which a longitudinal groove (53,54) is made, wherein the clamping surfaces (50,51) of the clamping bodies (14,15) can be placed one against the other such that the longitudinal grooves (53,54) form a receiving cavity for receiving a portion of a metal rod element (2). The first clamping body (15) is provided with a hook-shaped projection (56) projecting from the clamping surface (51) thereof. The second clamping body (14) is provided with a recess (60) made in the clamping surface (50) thereof. The hook-shaped projection of the first clamping body can be received in the recess of the second clamping body when the clamping surfaces of the clamping bodies abut one against the other.

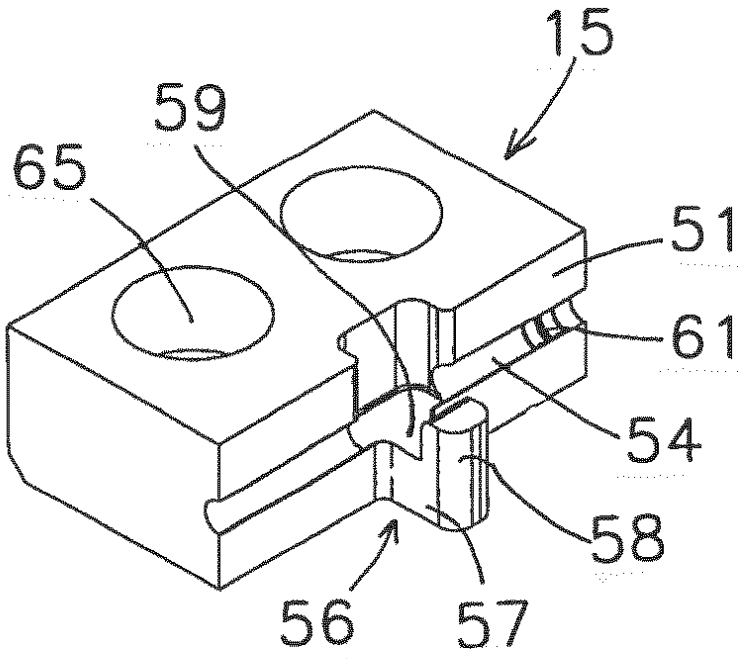

Fig 11a

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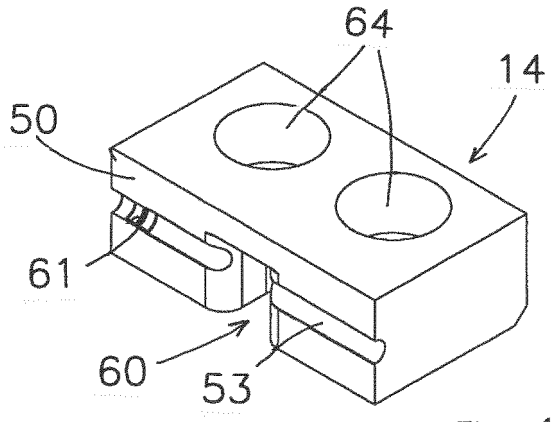

Fig 12a

Description

[0001] The invention relates according to a first aspect to a device for forming a thickened head on a head end of a metal rod element, which device is provided with:

- a clamping device for clamping the metal rod element, whilst leaving an end portion having the head end free,
- a deformation body for plastically deforming the end portion of the metal rod element in order to form the thickened head,
- a drive device for driving the deformation body.

[0002] A bucket handle fitting machine for fitting metal handles to buckets is generally known. With this bucket handle fitting machine, handles can be made from straight metal rod elements. The straight metal rod elements are loaded into a magazine of the bucket handle fitting machine. A displacement mechanism displaces the straight metal rod elements individually to a device for forming a thickened head on the head ends of the straight metal rod element.

[0003] The device for forming the thickened head comprises a lowermost clamping body, an uppermost clamping body and a deformation member for the plastic deformation of a head end of the straight metal rod element for the forming of a thickened head. The lowermost clamping body is fixedly fastened to the bucket handle fitting machine, whilst the uppermost clamping body is movable by a first hydraulic cylinder between an open and closed position. The deformation member can be driven by a second hydraulic cylinder.

[0004] In the open position of the clamping bodies, the straight metal rod element is placed between the clamping bodies and the head end thereof which is to be plastically deformed is aligned against the deformation member. Next, the first hydraulic cylinder displaces the uppermost clamping body into the closed position, so that the straight metal rod element is laterally clamped between the clamping bodies, whilst that head end of the straight metal rod element which is to be plastically deformed projects over a short length relative to the clamping bodies.

[0005] Whilst the straight metal rod element is clamped between the clamping bodies, the second hydraulic cylinder forces the deformation member against the projecting head end portion of the straight metal rod element with a force which is sufficiently large to plastically deform that head end portion ("cold upsetting"). This produces the thickened head on one end of the straight metal rod element.

[0006] After this, a thickened head is formed in the same way on the opposite end of the straight metal rod element. Next, both ends having the thickened heads are bent over at right angles and the metal rod element is bent around a forming plate in order to arrive at the desired handle shape. The formed metal handle is then fitted in the bucket handle fitting machine to a bucket.

[0007] In the adaptation of the bucket handle fitting machine to metal rod elements of a different length and/or different diameter, it is necessary to disassemble the system of the hydraulic cylinders for driving the deformation members and install a spacer. This leads to a relatively long conversion time, whilst the need for small batches of different handles is increased.

[0008] An object of the first aspect of the invention is to provide an improved device for forming a thickened head on the head ends of a metal rod element, in particular for use in connection with a device for forming a metal handle for a bucket or a bucket handle fitting device for fitting a metal handle to a bucket.

[0009] This object is achieved according to the first aspect of the invention by a device for forming a thickened head on a head end of a metal rod element, which device is provided with:

- a clamping device for clamping the metal rod element, whilst leaving an end portion having the head end free,
- a deformation body for plastically deforming the end portion of the metal rod element in order to form the thickened head,
- a drive device for driving the deformation body,

which drive device is provided with:

- a drive unit,
- a transmission element drivably connected to the drive unit, which transmission element is pivotable about a pivot axis and is provided with a cam track,
- a lever arm, which at one end abuts against the cam track of the transmission element and at an opposite end is provided with the deformation body, which lever arm is hingeable about a hinge axis running substantially parallel to the pivot axis.

[0010] According to the invention, the drive device for driving the deformation member comprises a drive unit, a transmission element and a lever arm. Through the driving of the drive unit, the transmission element pivots about the pivot axis. During the pivoting of the transmission element, the end of the lever arm which abuts against the cam track is radially displaced relative to the pivot axis of the transmission element. As a result, the lever arm pivots about the hinge axis thereof and the end of the lever arm to which the deformation member is fastened moves towards the head end of the clamped metal rod element. The metal rod element is, for example, a straight metal rod element having a constant cross section over the entire length thereof, such as a round cross section. The deformation member crushes the projecting end portion having the head end by means of plastic deformation, so that the thickened head on the end of the clamped metal rod is formed.

[0011] The lever arm and the transmission element

having the cam track increase the force delivered by the drive unit. As a result, a drive unit of relatively low power is sufficient to generate the relatively large forces which are necessary for the plastic deformation of the projecting end portion having the head end. At the same time, the height and width of the drive device remains limited, so that the device according to the invention occupies a relatively small floor surface.

[0012] According to the invention, the drive unit can be constructed in various manners. The drive unit comprises, for example, a linear drive unit, such as a pneumatic cylinder. The maximum force which a pneumatic cylinder can exert is less than that of a hydraulic cylinder. The use of a pneumatic cylinder is possible, however, since the required drive power with the drive device according to the invention is relatively small.

[0013] It is possible that the drive unit is provided with a drive rod which can be reciprocated and which is hingeably connected to the transmission element. As a result of the outward movement of the drive rod, the transmission element pivots about the pivot axis thereof. During this pivot movement, the end of the lever arm which abuts against the cam track moves over the cam track. As a result of the shape of the cam track, the distance between that end of the lever arm and the pivot axis of the transmission element changes. In other words, the cam track pushes that end of the lever arm away from the pivot axis of the transmission element, so that the lever arm articulates about the hinge axis thereof and the deformation body is pressed against the head end of the metal rod element. Through the inward displacement of the drive rod, the reverse movement is performed.

[0014] In one embodiment, the cam track of the transmission element comprises a curved track. The curved track forms a curve path, i.e. the curved track is non-circular. The curved track has a varying distance to the pivot axis, i.e. the distance from the pivot axis to that end of the lever arm which follows the curved track changes during the pivot movement of the transmission element. The curvature is such that that end of the lever arm performs a continuous movement.

[0015] It is possible in that case that the curved track is provided with a path having a start point, and wherein each point of the path is determined by the distance between that point of the path and the pivot axis and the angle between the connecting line from that point to the pivot axis and the connecting line from the start point to the pivot axis, and wherein said distance is directly proportional to said angle. As a result of the proportionality, each degree of angular displacement of the transmission member gives an equal displacement of the end of the lever arm which abuts against the path relative to the pivot axis.

[0016] Where a drive unit having a drive rod which can be reciprocated and which is hingeably connected to the transmission element is used, each mm of travel of the drive rod leads to a proportional displacement of the end of the lever arm which abuts against the path. This means that the angular displacement of the lever arm is also proportional, so that the deformation body on the opposite end of the lever arm exerts a substantially constant force during the cold upsetting.

[0017] In one embodiment, the device is provided with a stop element for the head end of the metal rod element to be clamped, wherein the stop element is adjustable in a direction parallel to the rod element to be clamped. The stop element determines the length of the end portion having the head end, which, following the clamping, projects relative to the clamping device, i.e. the quantity of material which the deformation body is to deformplastically. If too large or too small a quantity of material is upset, the thickened head acquires an unwanted shape. In order to accurately position the metal rod element to be clamped, the head end thereof is placed against the stop element. The stop element is displaceable and fastenable to a guide running substantially parallel to the rod element to be clamped. The position of the stop element can be easily adjusted if a metal rod element of a different length is used.

[0018] In one embodiment, the clamping device is provided with a fixed clamping body and a movable clamping body, wherein the movable clamping body is movable between a first position, in which the metal rod element can be brought between the clamping bodies, and a second position, in which the metal rod element can be laterally clamped between the clamping bodies whilst leaving the end portion having the head end free.

[0019] It is possible in that case that the device comprises a second drive device, which is configured to drive the movable clamping body, wherein the second drive device is provided with:

- a second drive unit,
- a second transmission element, which is drivably connected to the second drive unit, which second transmission element is pivotable about a pivot axis and is provided with a cam track,
- a second lever arm, which at one end abuts against the cam track of the second transmission element and at an opposite end is provided with the movable clamping body, which second lever arm is hingeable about a hinge axis running substantially parallel to the pivot axis of the second transmission element.

[0020] The second drive device for driving the movable clamping body is configured in the same way as the drive device for driving the deformation body. The above-stated description of the components, operation and advantages of the drive device for driving the deformation body is therefore also applicable to the second drive device for driving the movable clamping body. For example, the drive unit of the second drive device and the cam track of the second transmission element can be configured according to one or more of the features according to one of more of claims 2-5.

[0021] According to a second aspect, the invention re-

lates to, in combination, at least a first clamping body and a second clamping body, wherein each clamping body is provided with a clamping surface in which a longitudinal groove is made, and wherein the clamping surfaces of the clamping bodies can be placed one against the other such that the longitudinal grooves form a receiving cavity for receiving a portion of a metal rod element. Such a combination is a "kit of parts".

[0022] As described above with regard to the first aspect of the invention, a bucket handle fitting machine for fitting metal handles to buckets is generally known. In the open position of the clamping bodies, a portion of the straight metal rod element is placed between the longitudinal grooves of the clamping bodies and the head end is aligned against the deformation member. Next, the first hydraulic cylinder displaces the uppermost clamping body into the closed position, so that the straight metal rod element is laterally clamped between the longitudinal grooves of the clamping bodies, whilst the end portion of the straight metal rod element which comprises the head end and is to be plastically deformed projects over a short length relative to the clamping bodies.

[0023] Whilst the straight metal rod element is clamped between the longitudinal grooves of the clamping bodies, the second hydraulic cylinder forces the deformation member against the head end of the straight metal rod element with a force which is sufficiently large to plastically deform the projecting end portion having that head end ("cold upsetting"). This produces the thickened head on one end of the straight metal rod element.

[0024] In order to remove the straight metal rod element having the formed thickened head on one end thereof from the longitudinal grooves of the clamping bodies, the first hydraulic cylinder moves the uppermost clamping body back into the open position. Since the straight metal rod element, during the cold upsetting, is tightly clamped between the longitudinal grooves of the clamping bodies, there is the risk that, when the uppermost clamping body is moved into the open position, the straight metal rod element remains fixed in the longitudinal groove of the lowermost or uppermost clamping body.

[0025] An object of the second aspect of the invention is to provide an improved combination of at least two clamping bodies, in particular for use in connection with a device for forming a metal handle for a bucket or a bucket handle fitting device for fitting a metal handle to a bucket.

[0026] This object is achieved according to the second aspect of the invention by virtue of the fact that the first clamping body is provided with a hook-shaped projection projecting from the clamping surface thereof, and the second clamping body is provided with a recess made in the clamping surface thereof, and the hook-shaped projection of the first clamping body can be received in the recess of the second clamping body when the clamping surfaces of the clamping bodies abut one against the other.

[0027] Between the longitudinal grooves of the clamping surfaces of the clamping bodies, which clamping surfaces are placed one against the other, a metal rod element can be clamped, for example a straight metal rod element having a constant cross section over the entire length thereof, such as a round cross section, so that the cold upsetting against a head end of the metal rod element in order to form the thickened head is possible. When the clamping surfaces of the clamping bodies are placed one against the other, the hook-shaped projection of the first clamping body can be received in the recess of the second clamping body. The presence of the hook-shaped projection and the recess therefore has no impact, or scarcely any impact, on the clamping of the metal rod element. After the forming of the thickened head, the clamping surfaces of the clamping bodies move apart. The hook-shaped projection thereby engages laterally on the metal rod element and therefore pulls loose the metal rod element accommodated between the longitudinal grooves. The removal of the metal rod element after the cold upsetting of the thickened head is hereby strongly improved.

[0028] In one embodiment, the hook-shaped projection is provided with a support part, which extends substantially transversely from the clamping surface of the first clamping body, and a hook part, which extends substantially transversely from the support part at a distance from the longitudinal groove in the clamping surface of the first clamping body. In order to clamp a metal rod element between the longitudinal grooves of the clamping bodies, the metal rod element is first placed on the support part. The metal rod element is then located between the longitudinal groove and the hook part of the first clamping body. Next, the clamping surfaces of the clamping bodies move towards each other, so that the metal rod element is pushed by the longitudinal groove of the second clamping body, via the support part, to the longitudinal groove of the first clamping body, until the metal rod element is captured between the longitudinal grooves. After the cold upsetting of the thickened head, the clamping surfaces of the clamping bodies move apart, whereupon the hook part of the first clamping body pulls the metal rod element out of the longitudinal groove of the second clamping body.

[0029] It is possible in that case that the support part is provided with a support surface for the depositing of a metal rod element thereon, wherein the support surface is aligned relative to the longitudinal groove of the first clamping body. When the support surface is aligned relative to the longitudinal groove of the first clamping body, a substantially fluid or continuous transition is found between the support surface and the longitudinal groove of the first clamping body. The clamping of the metal rod element is hereby reliable.

[0030] In one embodiment, the longitudinal grooves of the clamping bodies are each provided with at least one clamping rib, wherein the clamping ribs are configured to, when the clamping surfaces of the clamping bodies

abut one against the other and a metal rod element is accommodated in the receiving cavity, laterally clamp that metal rod element. When the metal rod element is captured between the longitudinal grooves of the clamping bodies, the clamping ribs are pressed laterally into the metal rod element. For example, a circumferential groove of small depth is hereupon formed in the metal rod element by plastic deformation. By means of the clamping ribs, it is possible to tightly clamp the metal rib element in the axial direction.

[0031] In one embodiment, the clamping bodies are each provided with a substantially flat stop face, which extends substantially perpendicularly to the longitudinal groove, wherein the stop faces of the clamping bodies can be aligned in a common plane when the surfaces of the clamping bodies abut one against the other, and wherein, when a metal rod element is accommodated in the receiving cavity, the head end thereof projects relative to the stop faces, and wherein the combination comprises a deformation body, which is provided with a deformation surface which is configured to, when the clamping surfaces of the clamping bodies abut one against the other and a metal rod element, having a head end projecting relative to the stop faces, is accommodated in the receiving cavity, plastically deform that head end in order to form the thickened head.

[0032] It is possible in that case that the deformation surface is provided with a deformation cavity which substantially corresponds to the thickened head to be formed. The deformation cavity is made in the deformation surface of the deformation body such that, when the clamping surfaces of the clamping bodies abut one against the other and a metal rod element is accommodated between the longitudinal grooves with a head end projecting relative to the stop faces of the clamping bodies, that head end ends up in the deformation cavity when the deformation body is placed with the deformation surface against the stop faces. That end portion of the metal rod element which comprises that head end is hereupon plastically deformed in the deformation cavity in order to form the thickened head.

[0033] It is possible that the first clamping body and the second clamping body are each provided with at least one fastening hole for the releasable fastening of that clamping body. The clamping bodies are, for example, releasably fastened to a device for forming a metal handle for a bucket. The releasable fastening can be constructed in various manners. For example, each clamping body comprises at least one bolt hole for the bolting of the clamping body.

[0034] The releasable fastening of the clamping bodies enables the clamping bodies to be easily exchanged. This is favourable if a bucket handle fitting device or a device for forming a metal handle for a bucket is converted for use in connection with metal handles of a different diameter. Given a different diameter of the metal rod elements, the head end is no longer accurately aligned relative to the deformation cavity in the deformation surface of the deformation body. The position of the deformation cavity is usually fixed. By exchanging the combination of clamping bodies for a different combination of clamping bodies, the diameter of the longitudinal grooves and the height of the support surface of the hook-shaped projection can be easily adapted to the position of the deformation cavity.

[0035] The clamping bodies and/or the deformation body can comprise various materials which are suitable for the clamping and cold upsetting of the metal rod element. For example, the first clamping body and/or the second clamping body and/or the deformation body can be made of hardened steel.

[0036] The invention further relates to a clamping device for clamping a metal rod element, comprising a combination of clamping bodies as described above. In this case, for example, the first clamping body can be movable, whilst the second clamping body is fixed. The invention also relates to a device for forming a thickened head on a head end of a metal rod element, comprising a combination of clamping bodies as described above, and/or such a clamping device. The invention also relates to a device for forming or manufacturing a metal handle for a bucket, comprising a combination of clamping bodies as described above, and/or sucha device for forming a thickened head on a head end of a metal rod element. In addition, the invention relates to a bucket handle fitting device for fitting a metal handle to a bucket, comprising a combination of clamping bodies as described above, and/or such a device for forming or manufacturing a metal handle for a bucket.

[0037] The invention will now be explained in greater detail with reference to an illustrative embodiment represented in the figures.

Figure 1 shows a schematic top view of a device for forming metal handles for plastic buckets.

Figure 2a shows an enlarged detail IIa of Figure 1,

Figure 2b shows a perspective view of a portion of the device shown in Figure 1.

Figures 3a-3g show top views of a metal rod element as realized at various places in the device shown in Figure 1.

Figure 4 shows a perspective view of a portion of a device for forming a thickened head on a head end of the metal rod element of the device shown in Figure 1.

Figure 5 shows a top view of the device shown in Figure 4.

Figure 6 shows a side view of the device shown in Figure 4.

Figures 7a, 7b show schematically the operation of the drive device for driving the deformation body of the device shown in Figure 4.

Figures 8a, 8b, 9 and 10 show the clamping bodies of the device shown in Figure 4.

Figures 11a-11d show the movable clamping body of the device shown in Figure 4.

Figures 12a-12d show the fixed clamping body of the device shown in Figure 4.

[0038] The device for forming metal handles for plastic buckets is denoted in its entirety with reference numeral 1 in Figure 1. The device 1 forms part, for example, of a bucket handle fitting machine for fitting plastic buckets with metal handles. The metal handles are produced from straight metal rod elements 2, which are accommodated in a magazine of the device 1 (not represented). The device 1 comprises a displacement mechanism for step-by-step displacement of the straight metal rod elements 2 through the device 1 - from bottom to top in Figure 1. In this illustrative embodiment, the displacement mechanism comprises two movable horizontal bars 4, which are each provided with notches for supporting the straight metal rod elements 2. The movable bars 4 can displace the straight metal rod elements 2 in the horizontal and vertical directions.

[0039] The displacement mechanism guides a straight metal rod element 2 derived from the magazine firstly along a first device 6 for forming a thickened head or upsetting head 5 on a head end of the straight metal rod element 2 (on the left in Figure 1). After the left-hand end of the straight metal rod element 2 has been provided with a thickened head 5, the rod element 2 is brought along a second device 6 for forming a thickened head 5 on a head end of the straight metal rod element 2 (on the right in Figure 1). The second device 6 forms a second thickened head 5 on the right-hand end of the straight metal rod element 2.

[0040] After this, the straight metal rod element 2 having the thickened heads 5 on both ends is led through to a device 7 for bending over the head ends of the rod element 2 at right angles. Next, a forming device 9 bends the metal rod element 2 having the bent-over head ends 8 around a forming plate 10, so that the desired handle shape for the bucket is formed. The various shapes of the metal rod element 2 as it passes through the device 1 are represented in Figures 3a-3g.

[0041] The device 6 for forming a thickened head 5 on a head end of the straight metal rod element 2 shall now be described in greater detail.

[0042] The device 6 comprises a clamping device for the tight clamping of the metal rod element 2. The clamping device is provided with a fixed clamping body 14 (fixed clamping nipple) and a movable clamping body 15 (movable clamping nipple). The movable clamping body 15 is movable between a first, open position and a second, closed position.

[0043] In the open position, the movable clamping body 15 is located at a distance from the fixed clamping body 14, so that the straight metal rod element 2 can be lowered between the clamping bodies 14, 15 and can be removed from therebetween. In the closed position, the clamping bodies 14, 15 press one against the other and the straight metal rod element 2, by an end portion thereof, is laterally clamped between the clamping bodies 14, 15.

[0044] As represented in Figures 8-12, the fixed clamping body 14 comprises a first clamping surface 50 and the movable clamping body 15 comprises a second clamping surface 51. In each clamping surface 50, 51, a longitudinal groove 53 and 54, respectively, is made. The longitudinal grooves 53, 54 of the clamping bodies 14, 15 jointly form in the closed position a receiving cavity for receiving an end portion of the straight metal rod element 2. When the end portion of the straight metal rod element 2 is captured in the receiving cavity, buckling of the end portion is prevented.

[0045] In order to prevent axial displacement of the straight metal rod element 2 through the receiving cavity, the longitudinal grooves 53, 54 of the clamping bodies 14, 15 each possess a plurality of clamping ribs 61. In the closed position of the movable clamping body 15, the clamping surfaces 50, 51 of the clamping bodies 14, 15 press tightly one against the other, whereby the clamping ribs 61 laterally engage on the metal rod element 2. The exerted pressing force is, for example, such that the clamping ribs 61, by plastic deformation, form circumferential grooves in the clamped end portion of the metal rod element 2.

[0046] The clamping bodies 14, 15 each comprise a substantially flat stop face 62 and 63, respectively, which extends substantially perpendicularly to the longitudinal grooves 53, 54. The clamping bodies 14, 15 are aligned relative to each other such that the stop faces 62, 63 lie in a common plane. The stop faces 62, 63 form an anvil surface, which shall be explained below.

[0047] The device 6 is provided with a stop element 32 having a stop face for the head end of the metal rod element 2 to be clamped (see Figures 2a and 2b). The stop face of the stop element 32 runs substantially parallel to and at a distance from the stop faces 62, 63 of the clamping bodies 14, 15. In order to accurately position the metal rod element 2, the head end of the metal rod element 2 to be clamped, in the axial direction thereof, is aligned against the stop face of the stop element 32, for example by means of a pneumatic cylinder which pushes against the opposite head end. The distance between the stop face of the stop element 32 and the stop faces 62, 63 of the clamping bodies 14, 15 determines the length over which the head end of the straight metal rod element 2 projects relative to the stop faces 62, 63 of the clamping bodies 14, 15.

[0048] In order to be able accurately to adjust the length over which the head end projects, the stop element 32 is displaceably fastened to a guide 33, which extends substantially parallel to the rod element 2 to be clamped. The stop face of the stop element 32 can hereby be fixed at various distances from the stop faces 62, 63 of the clamping bodies 14, 15. As shown in Figure 1, the adjustable stop element 32 is freely accessible from above, so that the adjustment of the stop element 32 is quick and simple.

[0049] The device 6 comprises a deformation body 6

(upsetting nipple) for the plastic deformation of the end portion of the metal rod element 2 which projects relative to the stop faces 62, 63 of the clamping bodies 14, 15 after the straight metal rod element 2 has been tightly clamped. The deformed end portion of the metal rod element 2 forms the thickened head 5. The plastic deformation takes place at room temperature ("cold upsetting").

[0050] The deformation body 16 is provided with a deformation surface facing towards the stop faces 62, 63 of the clamping bodies 14, 15. The deformation surface is provided with a deformation cavity which substantially conforms to the thickened head 5 to be formed. The deformation body 16 is movable between a first, rest position and a second, upsetting position. In the rest position, the deformation surface of the deformation body 16 is located at a distance from the head end of the metal rod element 2. In the upsetting position, the deformation body 16 is displaced from the rest position to the stop faces 62, 63 of the clamping bodies 14, 15 and the projecting end portion of the metal rod element 2 is plastically deformed in the deformation cavity of the deformation body 16.

[0051] The length over which the end portion projects determines a quantity of material which, through plastic deformation, leads to the thickened head 5. If too much or too little material is deformed, the thickened head 5 does not acquire the desired shape. In the event of an excessively projecting end portion, the material is forced during the upsetting, for example, outside the deformation cavity of the deformation body 16. With the above-stated stop element 32, the projecting length is accurately adjustable, so that the shape of the thickened head 5 is assured.

[0052] After the thickened head 5 has been formed, the movable clamping body 15 moves back into the open position. As shown in Figures 11a-11d, the movable clamping body 15 is provided with a hook-shaped projection 56 projecting from the clamping surface 51. The hook-shaped projection 56 comprises a substantially horizontal support part 57 and a substantially vertical hook part 58. The support part 57 has an uppermost support surface 59, on which the metal rod element 2 rests after the placement of the rod element 2 between the clamping bodies 14, 15 in the open position. As can most clearly be seen in Figures 11a and 11d, the support surface 59 continues continuously into the longitudinal groove 54. The hook part 58 juts up from the end of the support part 57 which faces away from the clamping surface 51.

[0053] The fixed clamping body 14 comprises a recess 60 in the clamping surface 50. When the clamping surfaces 50, 51 are placed one against the other and the metal rod element 2 is tightly clamped, the hook-shaped projection 56 of the movable clamping body 15 is accommodated in the recess 60 of the fixed clamping body 14. The hook part 58 then back-grips the clamped metal rod element 2.

[0054] When the mutually abutting clamping surfaces 50, 51 of the clamping bodies 14, 15 are moved apart by displacement of the movable clamping body 15 from the closed position back into the open position, the hook-shaped projection 56 transports the metal rod element 2 out of the longitudinal groove 53 in the fixed clamping body 14.

[0055] The fixed clamping body 14 and the movable clamping body 15 are releasably fastened by means of bolts in bolt holes 64, 65. The clamping bodies 14, 15 are made, for example, of hardened steel. Nevertheless, the working life of the clamping bodies 14, 15, as a result of the considerable loads, is limited to about 2 million upsetting actions. After this, the clamping bodies 14, 15 must be replaced. According to the invention, the bolted connections are easily accessible from above (see Figure 1), such that the replacement of the clamping bodies 14, 15 is quick and simple.

[0056] The deformation body 16 exerts a considerable force upon the projecting end portion of the metal rod element 2 in order to plastically deform that end portion into a thickened head 5. For driving of the deformation body 16, a drive device is provided, which drive device will be described in greater detail below with reference to Figures 4-7.

[0057] The drive device is provided with a linear drive unit 18, which in this illustrative embodiment is constructed as a pneumatic cylinder having a drive rod 19. The drive rod 19 is movable back and forth relative to the pneumatic cylinder 18. The pneumatic cylinder 18 together with the drive rod 19 are articulated about a hinge axis 29.

[0058] The end of the drive rod 19 which can be moved back and forth is hingeable about a hinge axis 20 connected to a transmission element 21. The transmission element 21 is pivotable about a pivot axis 22, which runs substantially parallel to the hinge axes 29, 20. The transmission element 21 comprises a cam track 23, which in this illustrative embodiment is configured as a curved track or curve path.

[0059] Supported against the curve path 23 is a supporting roller 26, which is placed rotatably about a rotational axis 30 on a bottom end 25 of a lever arm 24. The rotational axis 30 runs substantially parallel to the pivot axis 22. The lever arm 24 is fastened by means of a bolted connection (see Figure 6) to a U-shaped holder 28. The U-shaped holder 28 and the lever arm 24 are jointly articulated about a hinge axis 27 running substantially parallel to the pivot axis 22. To the top end of the lever arm 24 is fastened the deformation member 16.

[0060] The curve path 23 of the transmission element 21 comprises a path having a start point and an end point. This path does not run concentrically relative to the pivot axis 22. Each point of the path of the curve path 23 is determined by the distance between that point of the path and the pivot axis 22 and the angle between the connecting line from that point to the pivot axis 22 and the connecting line from the start point to the pivot axis 22. The

path of the curve path 23 is thus configured such that said distance is truly proportional to said angle.

[0061] In other words, each mm of travel of the drive rod 19 produces a proportional displacement of the supporting roller 26 of the lever arm 24. Hence the deformation body 16 exerts a substantially constant force upon the projecting end portion of the metal rod element 2, whilst the supporting roller 26 of the lever arm 24 follows the path of the curve path 23. The movement of the drive device is represented schematically in Figures 7a, 7b.

[0062] The movable clamping member 15 is drivable by a second drive device, which in this illustrative embodiment is configured in the same way as the drive device for driving the deformation member 16. The second drive device therefore comprises a second drive unit, a second lever arm 44 and a second transmission element, which latter is pivotably connected between the second drive unit and the second lever arm 44. The second drive unit is constructed as a pneumatic cylinder 38, having a drive rod which can be moved back and forth. The second lever arm 44 comprises on the top end the movable clamping body 15 and on the bottom end a rotatable supporting roller 46, which abuts against a curve path of the second transmission element.

[0063] The invention is not limited to the illustrative embodiment represented in the figures. The person skilled in the art can make various adaptations which lie within the scope of the invention.

[0064] The invention can also be described by the following clauses:

1. Device for forming a thickened head (5) on a head end of a metal rod element (2), which device is provided with:

- a clamping device for clamping the metal rod element (2), whilst leaving an end portion having the head end free,
- a deformation body (16) for the plastic deformation of the end portion of the metal rod element (2) in order to form the thickened head (5),
- a drive device for driving the deformation body (16),

characterized in that
the drive device is provided with:

- a drive unit (18),
- a transmission element (21) drivably connected to the drive unit (18), which transmission element (21) is pivotable about a pivot axis (22) and is provided with a cam track (23),
- a lever arm (24), which at one end abuts against the cam track (23) of the transmission element (21) and at an opposite end is provided with the deformation body (16), which lever arm (24) is hingeable about a hinge axis (27) running substantially parallel to the pivot axis (22).

2. Device according to clause 1, wherein the drive unit comprises a linear drive unit, such as a pneumatic cylinder (18).

3. Device according to clause 1 or 2, wherein the drive unit (18) is provided with a drive rod (19) which can be reciprocated and which is hingeably connected to the transmission element (21).

4. Device according to one of the preceding clauses, wherein the cam track (23) of the transmission element (21) comprises a curved track.

5. Device according to clause 4, wherein the curved track (23) is provided with a path having a start point, and wherein each point of the path is determined by the distance between that point of the path and the pivot axis (22) and the angle between the connecting line from that point to the pivot axis (22) and the connecting line from the start point to the pivot axis (22), and wherein said distance is directly proportional to said angle.

6. Device according to one of the preceding clauses, wherein the device is provided with a stop element (32) for the head end of the metal rod element (2) to be clamped, wherein the stop element (32) is adjustable in a direction parallel to the rod element (2) to be clamped.

7. Device according to one of the preceding clauses, wherein the clamping device is provided with a fixed clamping body (14) and a movable clamping body (15), wherein the movable clamping body (15) is movable between a first position, in which the metal rod element (2) can be brought between the clamping bodies (14, 15), and a second position, in which the metal rod element (2) can be laterally clamped between the clamping bodies (14, 15) whilst leaving the end portion having the head end free.

8. Device according to clause 7, wherein the device comprises a second drive device, which is configured to drive the movable clamping body (15), wherein the second drive device is provided with:

- a second drive unit (38),
- a second transmission element, which is drivably connected to the second drive unit (38), which second transmission element is pivotable about a pivot axis and is provided with a cam track,
- a second lever arm (44), which at one end abuts against the cam track of the second transmission element and at an opposite end is provided with the movable clamping member (15), which second lever arm (44) is hingeable about a hinge axis running substantially parallel to the pivot

axis of the second transmission element.

9. Device according to clause 7 or 8, wherein the fixed clamping body (14) and the movable clamping body (15) are each provided with respectively a clamping surface (50, 51) in which a longitudinal groove (53, 54) is made, and wherein, in the second position of the movable clamping body (15), the clamping surfaces (50, 51) of the clamping bodies (14, 15) are placed one against the other such that the longitudinal grooves (53, 54) form a receiving cavity for receiving a portion of the metal rod element (2), wherein the movable clamping body (15) is provided with a hook-shaped projection (56) projecting from the clamping surface (51) thereof, and the fixed clamping body (14) is provided with a recess (60) made in the clamping surface (50) thereof, and wherein, in the second position of the movable clamping body (15), the hook-shaped projection (56) of the movable clamping body (15) is received in the recess (60) of the fixed clamping body (14).

10. Device according to clause 9, wherein the hook-shaped projection (56) is configured to, when the clamping surfaces (50, 51) of the clamping bodies (14, 15) abut one against the other and a metal rod element (2) is accommodated in the receiving cavity, laterally engage on that metal rod element (2) when these mutually abutting clamping surfaces (50, 51) of the clamping bodies (14, 15) move away from each other.

11. Device according to clause 9 or 10, wherein the hook-shaped projection (56) is provided with a support part (57), which extends substantially transversely from the clamping surface (51) of the movable clamping body (15), and a hook part (58), which extends substantially transversely from the support part (57) at a distance from the longitudinal groove (54) in the clamping surface (51) of the movable clamping body (15).

12. Device according to one of clauses 9-11, wherein the support part (57) is provided with a support surface (59) for the depositing of the metal rod element (2) thereon, and wherein the support surface (59) is aligned relative to the longitudinal groove (54) of the movable clamping body (15).

13. Device according to one of clauses 9-12, wherein the longitudinal grooves (53, 54) of the clamping bodies (14, 15) are each provided with at least one clamping rib (61), wherein the clamping ribs (61) are configured to, when the clamping surfaces (50, 51) of the clamping bodies (14, 15) abut one against the other and a metal rod element (2) is accommodated in the receiving cavity, laterally clamp that metal rod element (2).

14. Device according to one of clauses 9-13, wherein the clamping bodies (14, 15) are each provided with a substantially flat stop face (62, 63), which extends substantially perpendicularly to the longitudinal groove (53, 54), wherein the stop faces (62, 63) of the clamping bodies (14, 15) are aligned in a common plane, and wherein the deformation body (16) is provided with a deformation surface which is configured to, when a metal rod element (2) having an end portion which is provided with the head end and projects relative to the stop faces (62, 63) is accommodated in the receiving cavity, plastically deform that end portion in order to form the thickened head (5).

15. Device according to clause 14, wherein the deformation body (16) is movable between a first position, in which the deformation body (16) is located at a distance from the head end of the metal rod element (2), and a second position, in which the deformation body (16) has been moved from the first position to the stop faces (62, 63) of the clamping bodies (14, 15) and the end portion having that head end has been plastically deformed by the deformation body (16).

16. Device according to one of clauses 9-15, wherein the deformation surface is provided with a deformation cavity which substantially corresponds to the thickened head (5) to be formed.

17. Device according to one of clauses 9-16, wherein the fixed clamping body (14) is releasably fastened to the device, and wherein the movable clamping body (15) is releasably fastened to the second lever arm (44).

18. Device for forming a metal handle for a bucket, comprising a device according to one of the preceding clauses.

19. Bucket handle fitting device for fitting a metal handle to a bucket, comprising a device according to clause 18.

20. In combination, at least a first clamping body (15) and a second clamping body (14), wherein each clamping body (14, 15) is provided with a clamping surface (50, 51) in which a longitudinal groove (53, 54) is made, and wherein the clamping surfaces (50, 51) of the clamping bodies (14, 15) can be placed one against the other such that the longitudinal grooves (53, 54) form a receiving cavity for receiving a portion of a metal rod element (2), **characterized in that** the first clamping body (15) is provided with a hook-shaped projection (56) projecting from the clamping surface (51) thereof, and the second clamping body (14) is provided with a recess (60)

made in the clamping surface (50) thereof, and the hook-shaped projection (56) of the first clamping body (15) can be received in the recess (60) of the second clamping body (14) when the clamping surfaces (50, 51) of the clamping bodies (14, 15) abut one against the other.

21. Combination according to clause 20, wherein the hook-shaped projection (56) is configured so as to, when the clamping surfaces (50, 51) of the clamping bodies (14, 15) abut one against the other and a metal rod element (2) is accommodated in the receiving cavity, laterally engage on that metal rod element (2) when these mutually abutting clamping surfaces (50, 51) of the clamping bodies (14, 15) move away from each other.

22. Combination according to clause 20 or 21, wherein the hook-shaped projection (56) is provided with a support part (57), which extends substantially transversely from the clamping surface (51) of the first clamping body (15), and a hook part (58), which extends substantially transversely from the support part (57) at a distance from the longitudinal groove (54) in the clamping surface of the first clamping body (15).

23. Combination according to clause 22, wherein the support part (57) is provided with a support surface (59) for the depositing of a metal rod element (2) thereon, and wherein the support surface (59) is aligned relative to the longitudinal groove (54) of the first clamping body (15).

24. Combination according to one of clauses 20-23, wherein the longitudinal grooves (53, 54) of the clamping bodies (14, 15) are each provided with at least one clamping rib (61), wherein the clamping ribs (61) are configured to, when the clamping surfaces (50, 51) of the clamping bodies (14, 15) abut one against the other and a metal rod element (2) is accommodated in the receiving cavity, laterally clamp that metal rod element (2).

25. Combination according to one of clauses 20-24, wherein the clamping bodies (14, 15) are each provided with a substantially flat stop face (62, 63), which extends substantially perpendicularly to the longitudinal groove (53, 54), wherein the stop faces (62, 63) of the clamping bodies (14, 15) can be aligned in a common plane when the clamping surfaces (50, 51) of the clamping bodies (14, 15) abut one against the other, and wherein the combination comprises a deformation body (16), which is provided with a deformation surface which is configured to, when the clamping surfaces (50, 51) of the clamping bodies (14, 15) abut one against the other and a metal rod element (2), having a head end which projects relative to the stop surfaces (50, 51), is accommodated in the receiving cavity, plastically deform that head end in order to form the thickened head (5).

26. Combination according to clause 25, wherein the deformation surface is provided with a deformation cavity which substantially corresponds to the thickened head (5) to be formed.

27. Combination according to one of clauses 20-26, wherein the first clamping body (15) and the second clamping body (14) are each provided with at least one fastening hole (64, 65) for the releasable fastening of that clamping body (14, 15).

28. Combination according to one of clauses 20-27, wherein the first clamping body (15) and/or the second clamping body (14) and/or the deformation body (16) are made of hardened steel.

29. Method for forming a thickened head (5) on the head ends of a metal rod element (2), which method is provided with:

- the clamping of the metal rod element (2), whilst leaving an end portion having a head end free,
- the plastic deformation, by a deformation body (16), of the end portion of the metal rod element (2) in order to form the thickened head (5),
- the driving, by a drive device, of the deformation body (16), wherein the drive device is provided with:
- a drive unit (18),
- a transmission element (21) drivably connected to the drive unit (18), which transmission element (21) is pivotable about a pivot axis (22) and is provided with a cam track (23),
- a lever arm (24), which at one end abuts against the cam track (23) of the transmission element (21) and at an opposite end is provided with the deformation body (16), which lever arm (24) is hingeable about a hinge axis (27) running substantially parallel to the pivot axis (22).

Claims

1. In combination, at least a first clamping body (15) and a second clamping body (14), wherein each clamping body (14, 15) is provided with a clamping surface (50, 51) in which a longitudinal groove (53, 54) is made, and wherein the clamping surfaces (50, 51) of the clamping bodies (14, 15) can be placed one against the other such that the longitudinal grooves (53, 54) form a receiving cavity for receiving a portion of a metal rod element (2), **characterized in that** the first clamping body (15) is provided with

a hook-shaped projection (56) projecting from the clamping surface (51) thereof, and the second clamping body (14) is provided with a recess (60) made in the clamping surface (50) thereof, and the hook-shaped projection (56) of the first clamping body (15) can be received in the recess (60) of the second clamping body (14) when the clamping surfaces (50, 51) of the clamping bodies (14, 15) abut one against the other.

2. Combination according to claim 1, wherein the hook-shaped projection (56) is configured so as to, when the clamping surfaces (50, 51) of the clamping bodies (14, 15) abut one against the other and a metal rod element (2) is accommodated in the receiving cavity, laterally engage on that metal rod element (2) when these mutually abutting clamping surfaces (50, 51) of the clamping bodies (14, 15) move away from each other.

3. Combination according to claim 1 or 2, wherein the hook-shaped projection (56) is provided with a support part (57), which extends substantially transversely from the clamping surface (51) of the first clamping body (15), and a hook part (58), which extends substantially transversely from the support part (57) at a distance from the longitudinal groove (54) in the clamping surface of the first clamping body (15).

4. Combination according to claim 3, wherein the support part (57) is provided with a support surface (59) for the depositing of a metal rod element (2) thereon, and wherein the support surface (59) is aligned relative to the longitudinal groove (54) of the first clamping body (15).

5. Combination according to one of claims 1-4, wherein the longitudinal grooves (53, 54) of the clamping bodies (14, 15) are each provided with at least one clamping rib (61), wherein the clamping ribs (61) are configured to, when the clamping surfaces (50, 51) of the clamping bodies (14, 15) abut one against the other and a metal rod element (2) is accommodated in the receiving cavity, laterally clamp that metal rod element (2).

6. Combination according to one of claims 1-5, wherein the clamping bodies (14, 15) are each provided with a substantially flat stop face (62, 63), which extends substantially perpendicularly to the longitudinal groove (53, 54), wherein the stop faces (62, 63) of the clamping bodies (14, 15) can be aligned in a common plane when the clamping surfaces (50, 51) of the clamping bodies (14, 15) abut one against the other, and wherein the combination comprises a deformation body (16), which is provided with a deformation surface which is configured to, when the clamping surfaces (50, 51) of the clamping bodies (14, 15) abut one against the other and a metal rod element (2), having a head end which projects relative to the stop surfaces (50, 51), is accommodated in the receiving cavity, plastically deform that head end in order to form the thickened head (5).

7. Combination according to claim 6, wherein the deformation surface is provided with a deformation cavity which substantially corresponds to the thickened head (5) to be formed.

8. Combination according to one of claims 1-7, wherein the first clamping body (15) and the second clamping body (14) are each provided with at least one fastening hole (64, 65) for the releasable fastening of that clamping body (14, 15).

9. Combination according to one of claims 1-8, wherein the first clamping body (15) and/or the second clamping body (14) and/or the deformation body (16) are made of hardened steel.

10. Clamping device for clamping a metal rod element, comprising a combination of clamping bodies according to one of claims 1-9.

11. Clamping device according to claim 10, wherein the first clamping device is movable, and the second clamping body is fixed.

12. Device for forming a thickened head on a head end of a metal rod element, comprising a combination of clamping bodies according to one of claims 1-9, and/or a clamping device according to claim 10 or 11.

13. Device for forming or manufacturing a metal handle for a bucket, comprising a combination of clamping bodies according to one of claims 1-9, and/or a device for forming a thickened head on a head end of a metal rod element according to claim 12.

14. Bucket handle fitting device for fitting a metal handle to a bucket, comprising a combination of clamping bodies according to one of claims 1-9.

15. Device for forming or manufacturing a metal handle for a bucket, comprising a combination of clamping bodies according to one of claims 1-9.

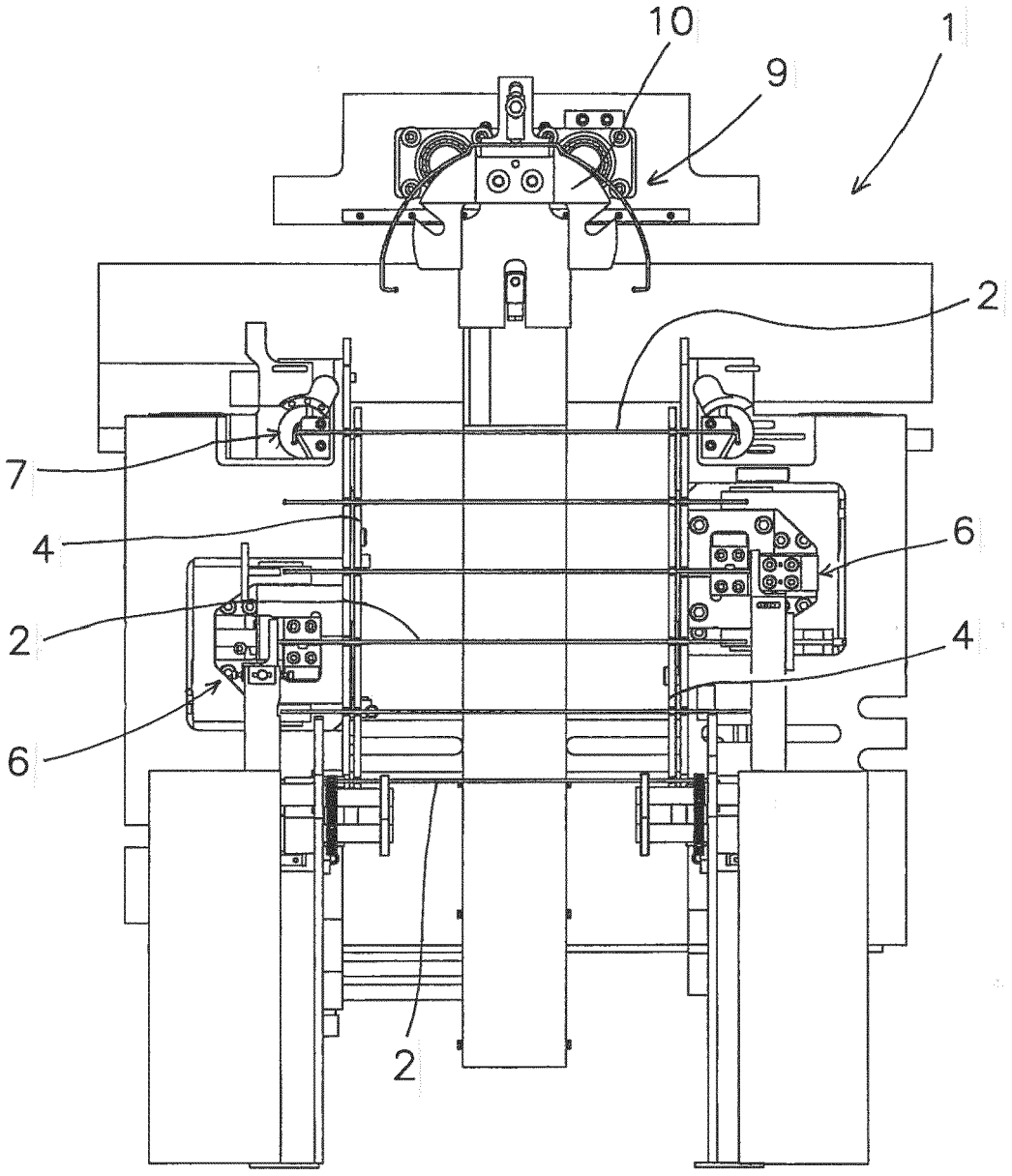

Fig 1

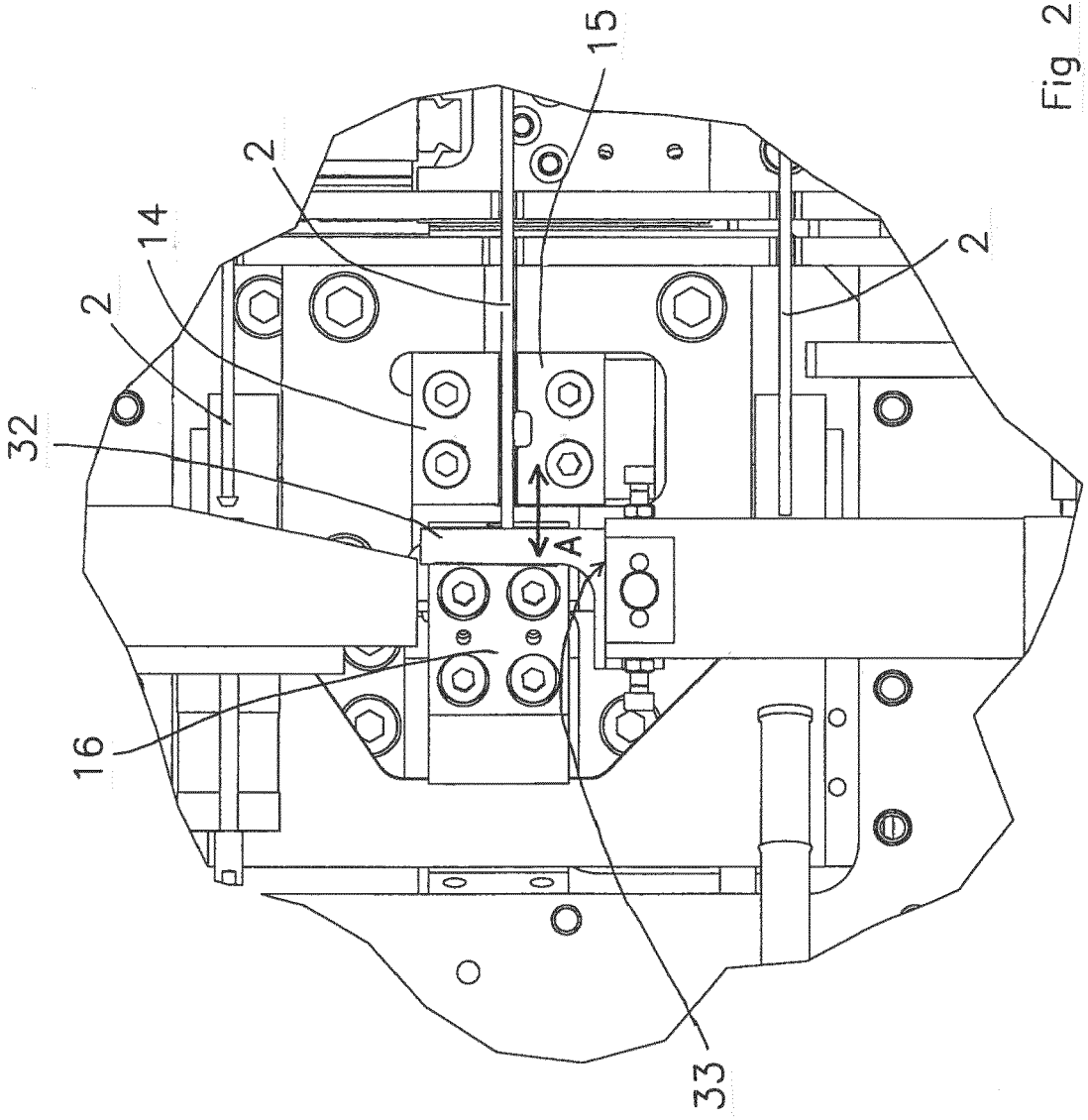

Fig 2a

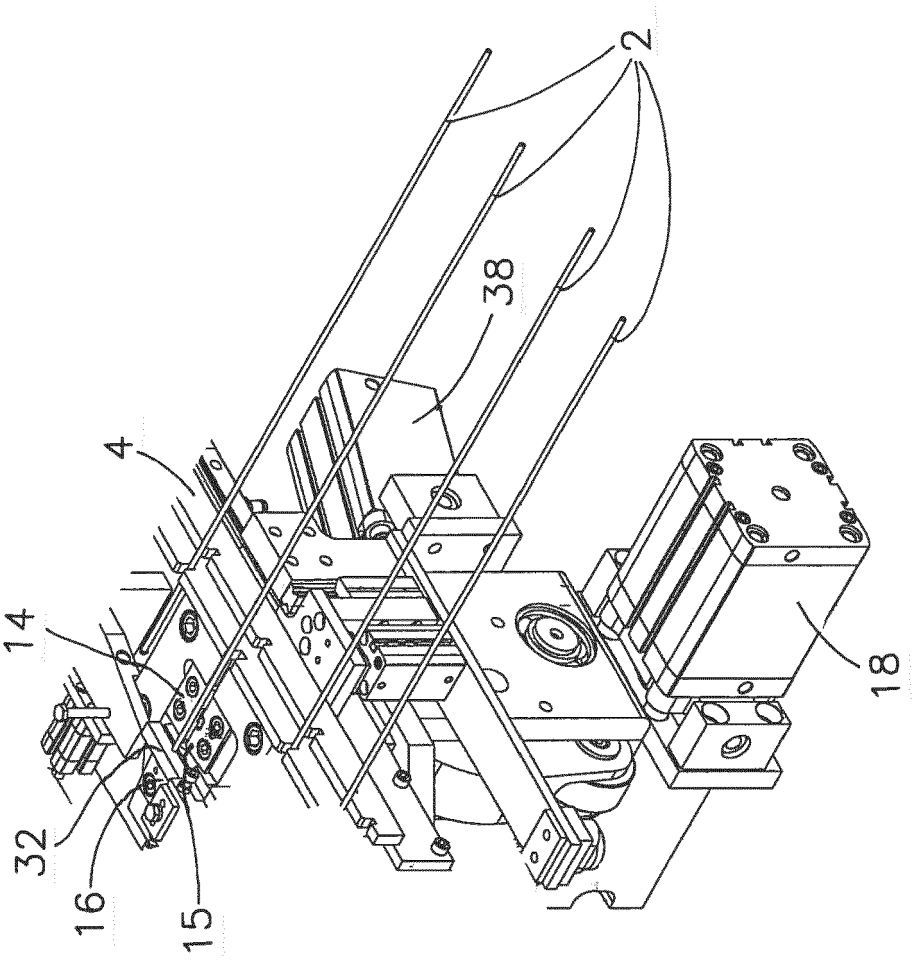

Fig 2b

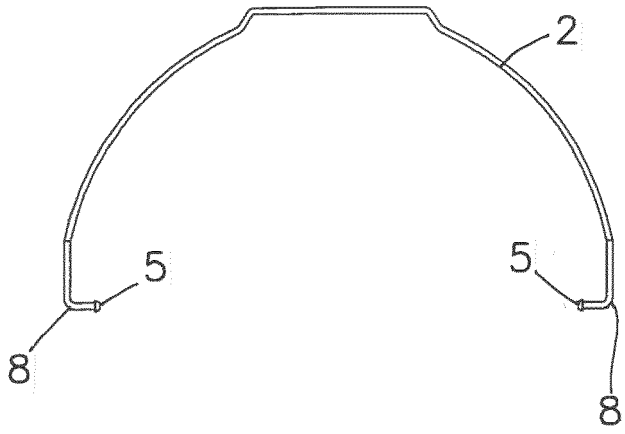

Fig 3g

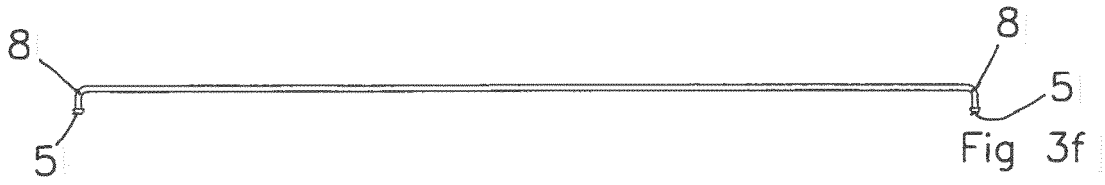

Fig 3f

Fig 3e

Fig 3d

Fig 3c

Fig 3b

Fig 3a

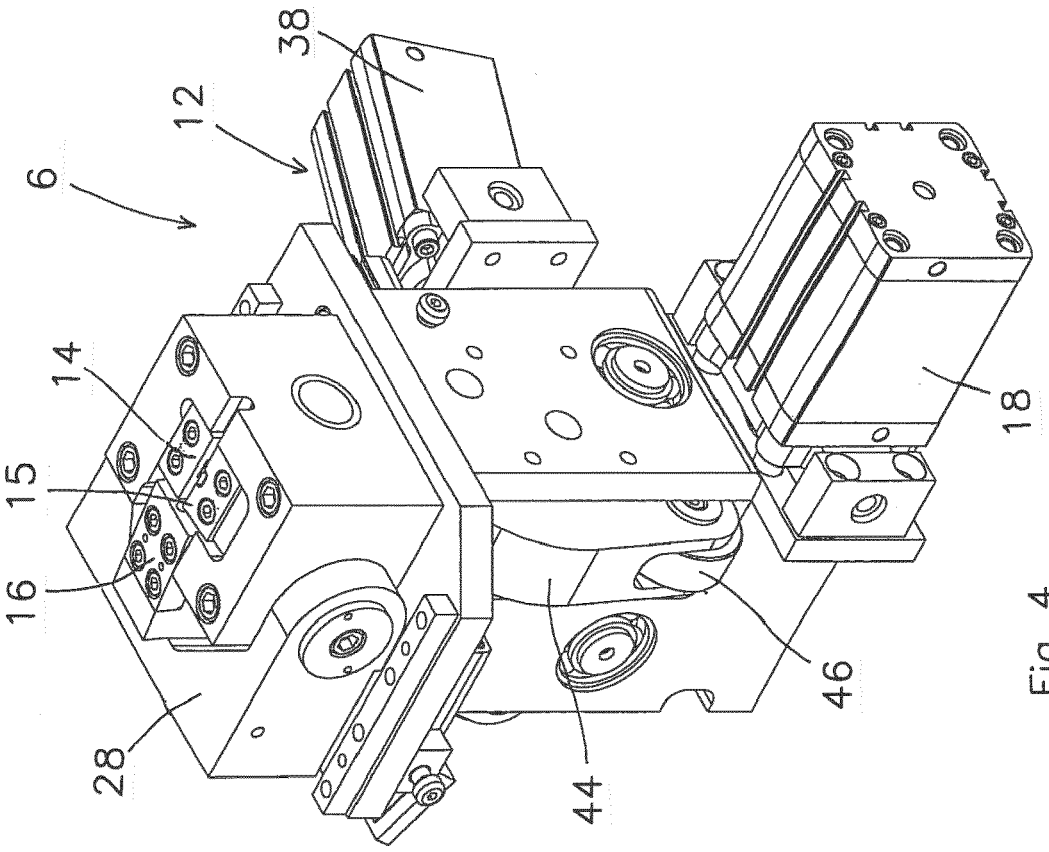

Fig 4

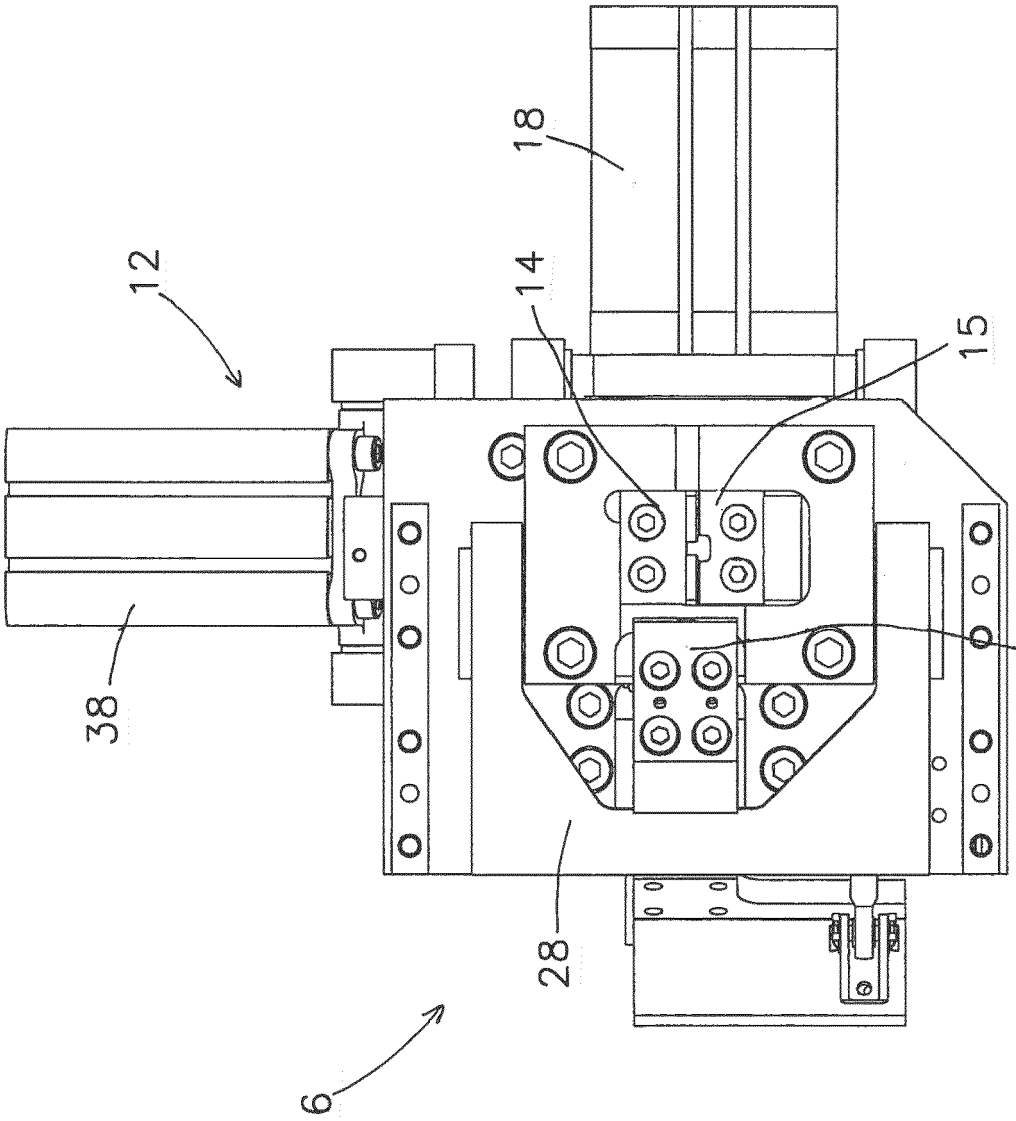

Fig 5

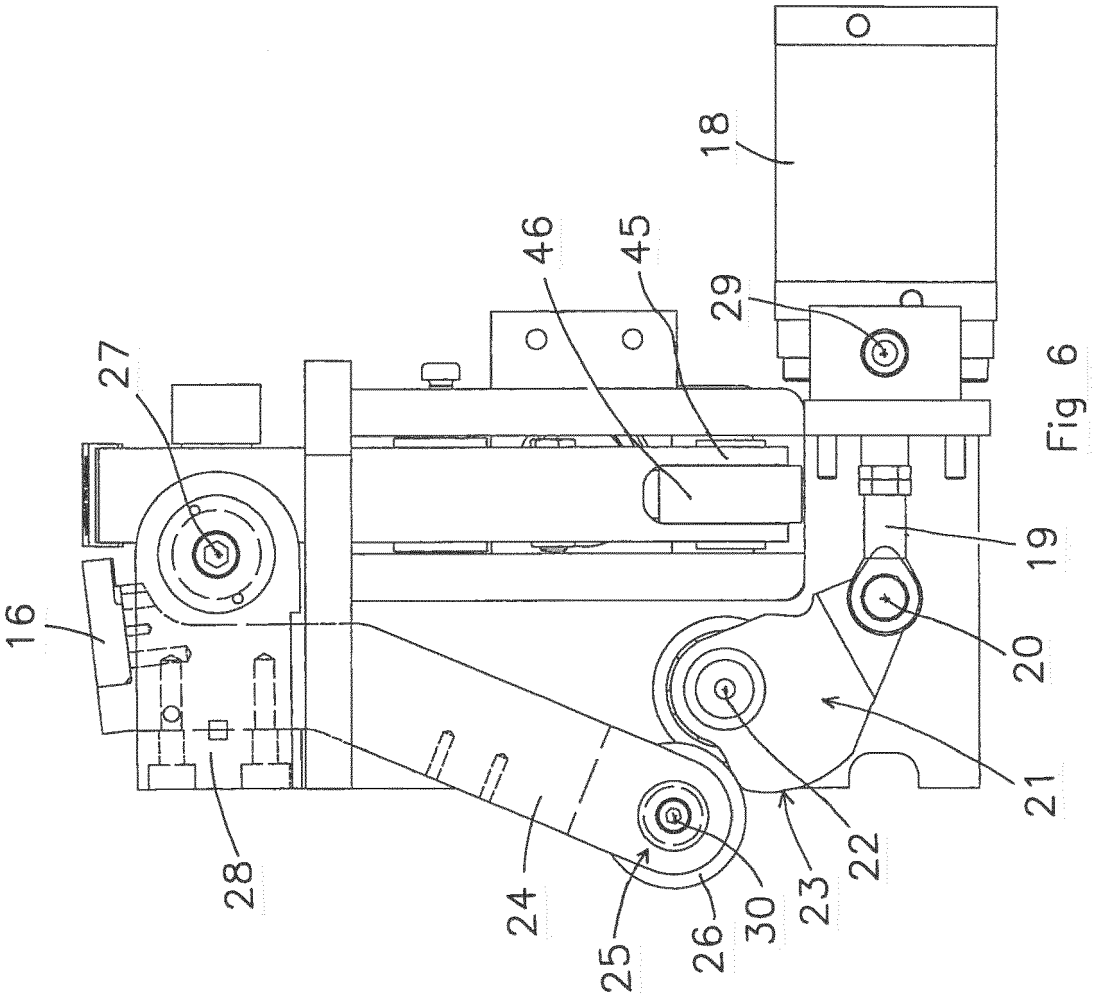

Fig 6

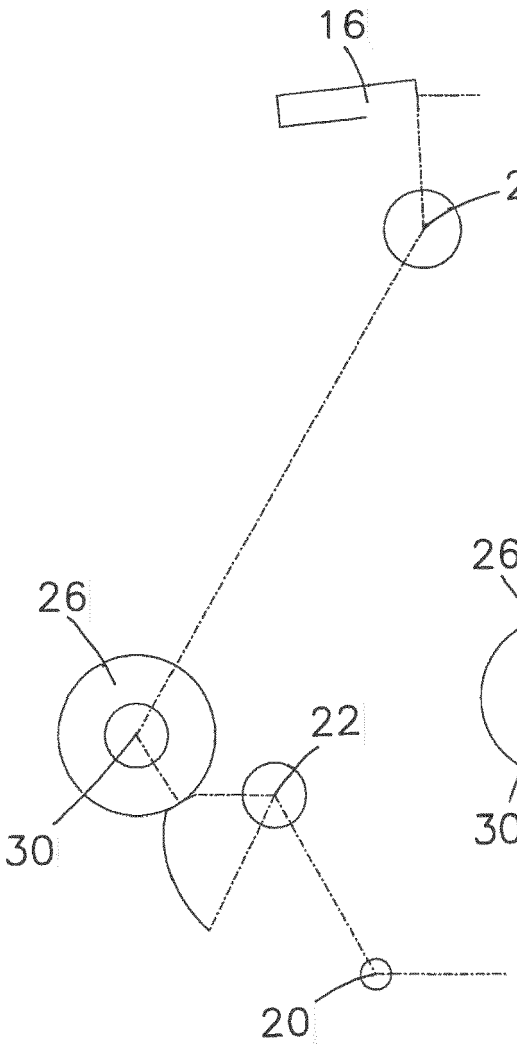

Fig 7a

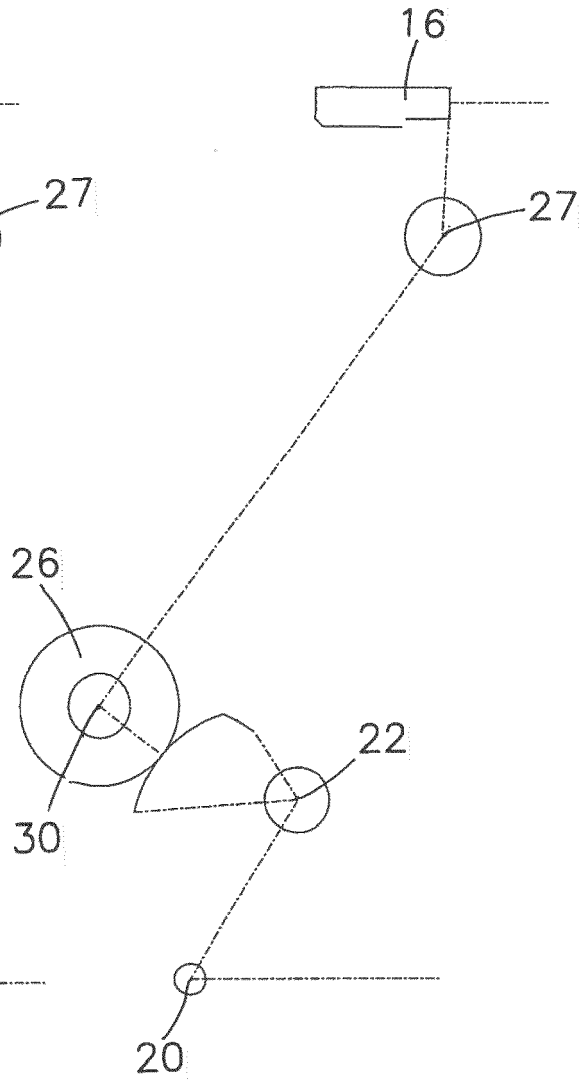

Fig 7b

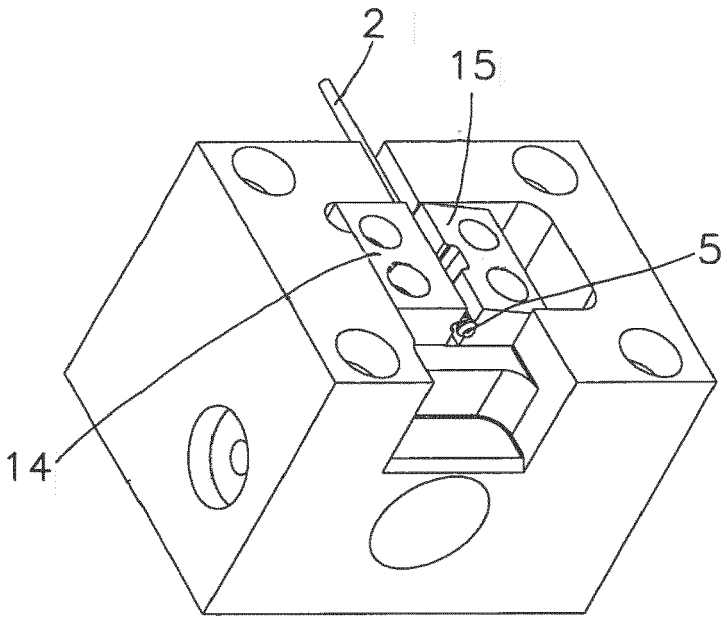

Fig 8a

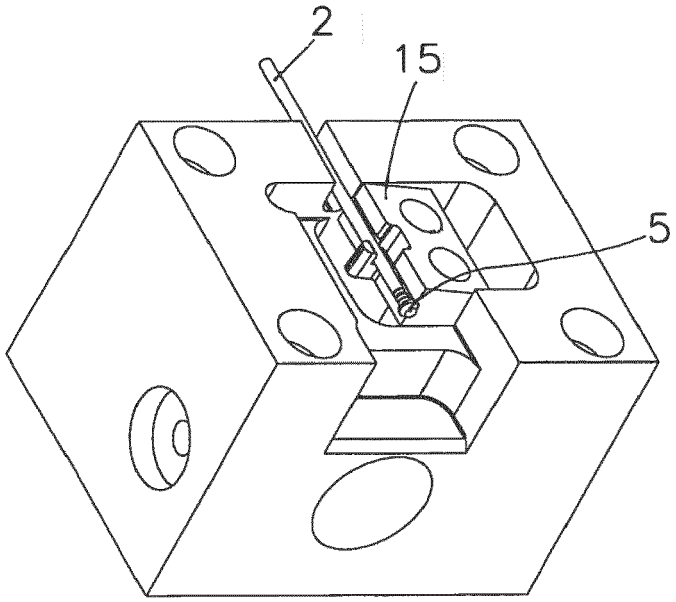

Fig 8b

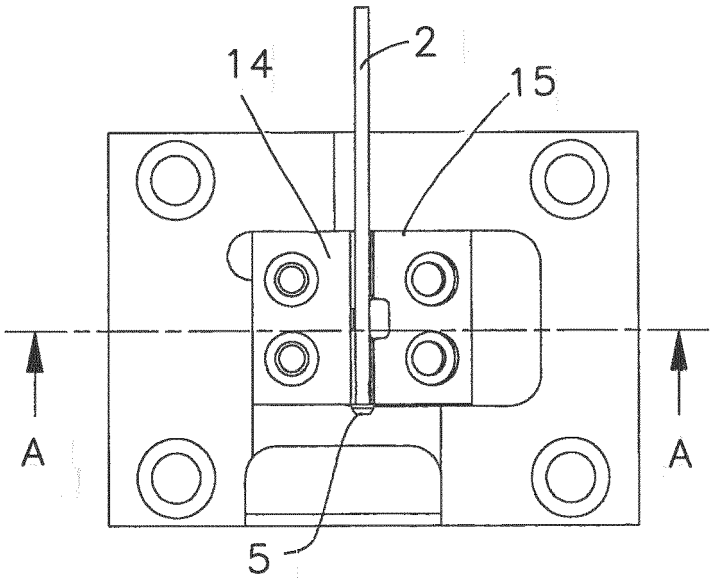

Fig 9

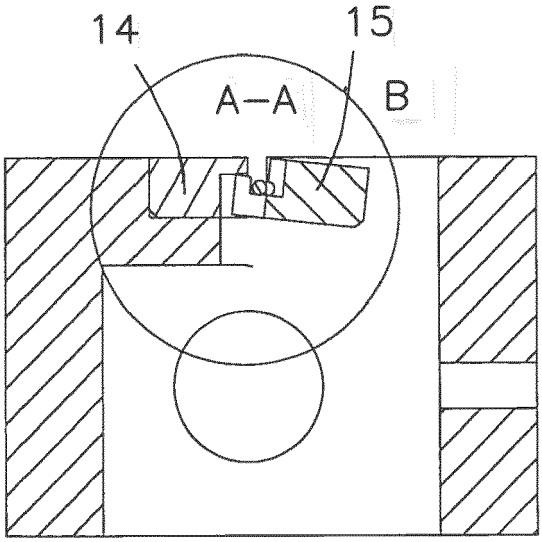

Fig 10

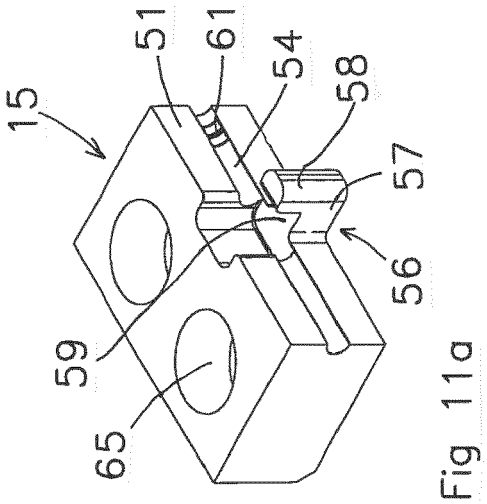

Fig 11a

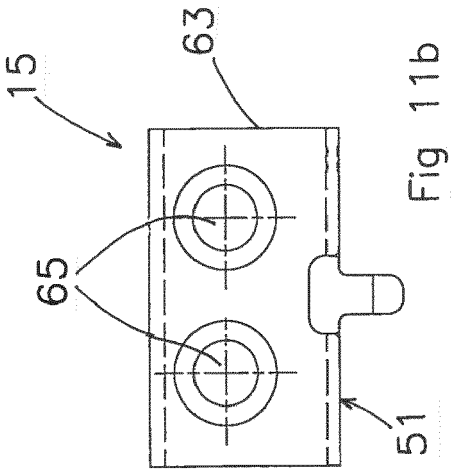

Fig 11b

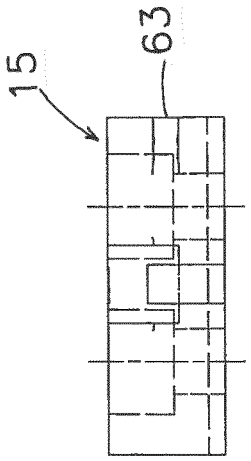

Fig 11c

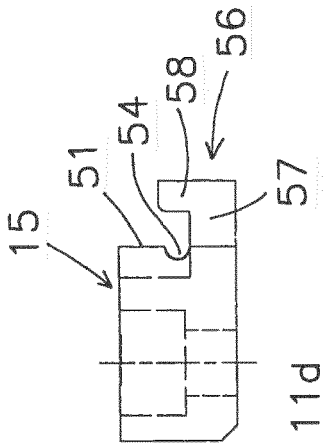

Fig 11d

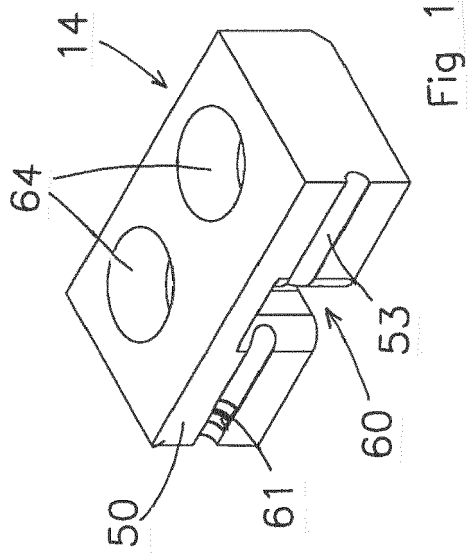

Fig 12a

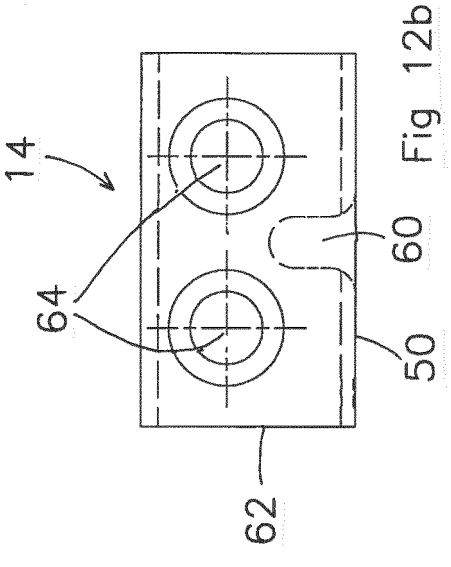

Fig 12b

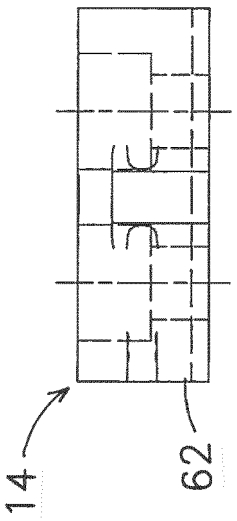

Fig 12c

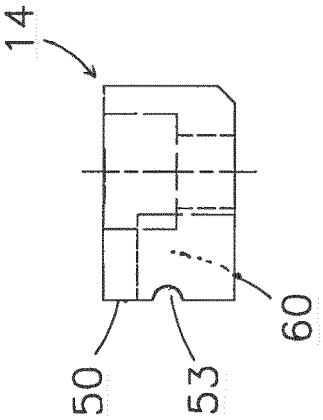

Fig 12d

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EUROPEAN SEARCH REPORT

Application Number
EP 19 19 3156

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 3 359 582 A (POWERS CHARLES W) 26 December 1967 (1967-12-26) * column 1, line 44 - column 2, line 14; figures 1-2 *	1-15	INV. B21F5/00 B21F45/00 B65D25/32 B25B5/00
A	US 5 154 670 A (SYGNATOR HENRY A [US] ET AL) 13 October 1992 (1992-10-13) * column 6, line 50 - column 7, line 43; figures 13-19 *	1-15	
A	WO 2009/052538 A1 (CERATIZIT AUSTRIA GMBH [AT]; DE MONTE MARKUS [AT]; TALON FABIANO [IT]) 30 April 2009 (2009-04-30) * page 4, line 18 - page 5, line 20; figures 1-2 *	1-15	
A	EP 1 002 733 A1 (DEN BRINK B V VAN [NL]) 24 May 2000 (2000-05-24) * paragraph [0009] * * paragraph [0014] - paragraph [0021]; figures 1-12 *	1-15	

TECHNICAL FIELDS SEARCHED (IPC)

B21F
B21G
B65D
B25B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	19 December 2019	De Backer, Tom

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 19 19 3156

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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19-12-2019

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 3359582 A	26-12-1967	NONE	
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