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(54) **HOOK APPARATUS FOR CENTERING AND CLAMPING WORKPIECES, PARTICULARLY SHEETS**

(57) A hook apparatus for centering and clamping workpieces, particularly metal sheets, comprises a main body (12) defining a resting zone (62) of a workpiece, a hooking member (19) movable between a resting position spaced from the resting zone (62) and at least one clamping position close to the resting zone (62), and members for controlling the movement of the hooking member (19) such as to allow workpieces of different thickness to be locked. The control means include a con-

trol rod (20) slidable with respect to the main body (12) between a lowered position and a raised position, at least one L-shaped member (32) articulated to a part (22) connected to the rod (20), and guide elements (36, 46, 48) to keep a predetermined orientation of the hooking member (19). The part connected to the rod (20) includes an auxiliary body (22) fixed to the rod (20), having a slit (24) in which a slidable pin (26) is engaged, which also engages a hole (30) of an arm of the L-shaped member (32).

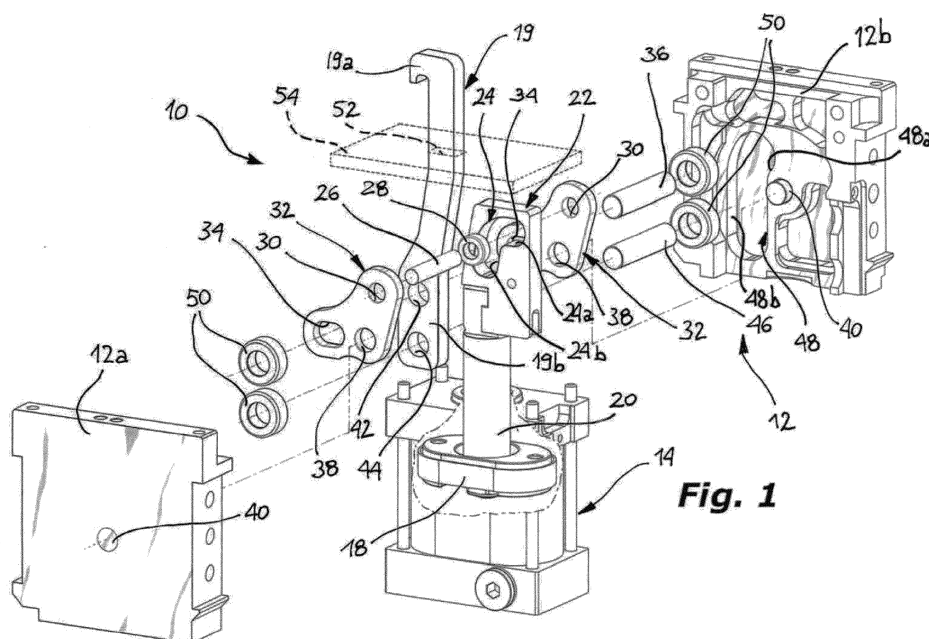


Fig. 1

Description

[0001] The present invention relates in general to apparatuses used in automatic processing lines for centering a workpiece, for example a metal sheet, and for locking it at a side edge thereof or at the edge of a hole formed therein, with the aim of holding the workpiece in a predetermined position to allow a processing to be executed, such as a welding, a bending or a similar operation.

[0002] An apparatus of such a type, which is known from DE-393 63 29 or from EP-1 393 861, allows a workpiece in the form of a metal sheet, having a single predetermined thickness, to be clamped.

[0003] In particular, the invention relates to an apparatus of the type defined in the preamble of appended claim 1.

[0004] An apparatus of the type defined above, which is known from EP-2 626 174, allows sheets the thickness of which is comprised in a predefined thickness range, to be clamped in a predetermined position. This apparatus, although satisfactory, takes up a large amount of space, which makes it unsuitable for use in some applications.

[0005] The object of the present invention is to provide an apparatus of the type mentioned above, which allows workpieces of different thickness to be centered and clamped and which, at the same time, takes up a minimal amount of space and has a relatively high clamping force, and the structure of which is particularly compact and light so as to allow it to be used in apparatuses in which reduced handling spaces are available and/or to be used by industrial robots.

[0006] This object is achieved by virtue of an apparatus having the features mentioned in the appended claims.

[0007] In particular, by virtue of the fact that the apparatus comprises a part connected to the control rod, which includes an auxiliary shaped body fixed to the rod at its side facing the hooking member, and has a slit in which a first transverse pin is slidably engaged, which pin also engages a hole of the first arm of said at least one L-shaped member, the apparatus of the invention has a very compact and light structure which allows a high clamping force to be developed.

[0008] According to a preferred feature of the invention, said slit is substantially arch-shaped and has a transverse section engageable by the first pin when the hooking member is in said resting position, and a section inclined with respect to the axis of said rod, which can be engaged by the first pin when the hooking member is in said clamping position, the inclination of said inclined section being such that the engagement of the first pin therein, in the absence of an axial displacement of the rod, causes the movement of said hooking member to be locked, in order to make irreversible the position of the hooking member. Thanks to these features, the movement of the coupling element of the apparatus is irreversible, and it allows the clamping action exerted on a workpiece to be deactivated only as a result of the dis-

placement of the control rod, which makes the apparatus safe in operation. Moreover, the structure of the apparatus is relatively simple, and therefore light and compact, while it allows workpieces of different thicknesses to be clamped.

[0009] According to another preferred feature of the invention, the apparatus comprises a second pin parallel to said first pin, which is slidably inserted into a slot of the second arm of said at least one L-shaped member and into a hole formed in a foot portion of the hooking member. This makes it possible to connect the movement of the hooking member with the movement of the first pin in the slit of the shaped body in a highly reliable manner, by means of said at least one L-shaped member.

[0010] According to still another preferred feature of the invention, the apparatus comprises a third pin parallel to said first pin, which engages a second hole formed in said foot portion of the hooking member, both said second and third pin engaging at least one substantially arch-shaped guide groove formed in the body of the apparatus and being part of said guide means. In this manner, the movement of the hooking member is guided reliably and precisely with respect to the main body of the apparatus.

[0011] Further characteristics and advantages of the invention will be made clearer by the following detailed description, provided purely by way of non-limiting example and referred to the appended drawings in which:

Figure 1 is an exploded perspective view of the main components of an apparatus according to the invention,

Figure 2 is a partially sectional side elevational view of the apparatus of Figure 1, in its resting condition in which the hooking member is spaced from a resting zone of a workpiece to be clamped,

Figure 3 is a view similar to that of Figure 1, in which the main body of the apparatus is in the open condition and is sectioned along a median plane,

Figures 4 and 5 are views similar to Figure 3, which illustrate positions of the apparatus that correspond to the locking of a workpiece of a maximum thickness and of a workpiece of a minimum thickness, respectively,

Figure 6 is a view similar to Figure 2, in which the hooking member of the apparatus is in the locking position of a workpiece of a minimum thickness, and Figure 7 is a side elevational view of the apparatus fully sectioned along a median plane, in its locking position shown in Figure 6.

[0012] With reference to the drawings, an apparatus according to the invention, which is intended for centering and clamping workpieces such as metal sheets, is indicated 10 as a whole.

[0013] The apparatus 10 comprises a main body 12 to which a driving unit is fixed in its lower part (with reference to the figures), which unit, in the embodiment shown, consists of an actuating cylinder 14, conveniently pneu-

matic and typically of the double-acting type, controlled by a pressurized fluid. The body 12 comprises a pair of half-shells 12a, 12b which delimit, in their coupled condition, an inner cavity of the body 12.

[0014] The cylinder 14 comprises a chamber 16 (Figure 7) in which a piston 18 is sealably and slidably mounted, which is fixed to the lower end of a control rod 20 that extends at least partially into the cavity defined by the half-shells 12a and 12b. The rod 20, as a result of sliding of the piston 18 in the chamber 16, can reach a series of axial positions with respect to the main body 12, in particular a completely lowered position and a plurality of raised positions, in order to control the displacement of a hooking member 19 that extends in part into the cavity defined between the half-shells 12a and 12b, the function of which is to clamp a workpiece (not shown), with respect to the apparatus 10.

[0015] The hooking member 19 has a general stem shape and comprises a typically hook-shaped upper end 19a, and an opposite foot portion 19b. It is movable between a resting position, corresponding to the completely lowered position of the rod 20, and a series of clamping positions, corresponding to the aforesaid plurality of raised positions, as a function of the thickness of a workpiece to be clamped.

[0016] The movement of the hooking member 19 is caused by control means described in greater detail below.

[0017] At the end of the rod 20 opposite to the piston 18, a shaped auxiliary body 22, having a substantially trapezoidal shape in a side view, is fixed, for example by means of a screw. A through slit 24 having an arched shape is provided in this auxiliary body 22, which comprises a first section 24a transverse to the rod 20, and a second section 24b inclined of a predetermined small angle with respect to the rod 20, the purpose of which will be further clarified in the following.

[0018] The slit 24 is slidably engaged by a first transverse pin 26, preferably with the interposition of a rolling bearing 28 between a central zone of the pin 26 and the surface of the slit 24. The presence of the shaped body 22 with its slit 24 engaged by the pin 26, allows the overall dimensions of the apparatus 10 to be made considerably smaller, and to reduce the weight in a sensitive manner, which are fundamental aspects for allowing the apparatus 10 to be used in applications in which it is moved by means of robotized devices or its operation occurs in limited spaces.

[0019] The opposite ends of the pin 26 are engaged in respective holes 30 formed in a first arm of a pair of equal L-shaped members 32, arranged at the opposite sides of the shaped body 22.

[0020] Each L-shaped member 32 has a second arm in which a slot 34 is formed. The two slots 34 of the two L-shaped members 32 are slidably engaged by a second transverse pin 36, parallel to the first pin 26.

[0021] In an intermediate zone of each L-shaped member 32, between its two arms, a hole 38 is formed in which

a half-pin 40 is inserted, which extends from a respective half-shell 12a, 12b. In the coupled condition of the half-shells 12a and 12b, the two half-pins 40 are coaxial, so as to define together a common articulation axis of the two L-shaped members 32, which are therefore swingably mounted within the body 12.

[0022] A pair of through holes, respectively indicated 42 and 44, are formed in the foot portion 19b of the hooking member 19. The hole 42, closer to the hook end 19a, is engaged by a central portion of the transverse pin 36, while the hole 44, farthest from the hook end 19a, is engaged by a central portion of a third transverse pin 46, parallel to the pin 36.

[0023] The opposite axial ends of the pins 36 and 46 extend up to the half-shells 12a and 12b to engage respective guide formations of the body 12 in order to keep the hooking member 19 in a predetermined configuration during the movement between its resting and clamping positions. In particular, when passing between one and the other of these positions, the hooking member 19 remains substantially parallel to itself, and its inclination varies by a small angle with respect to the axis of the rod 20. The aforesaid formations consist of a pair of symmetrical guide grooves 48, each formed by milling a respective half-shell 12a, 12b.

[0024] Each groove 48 has an overall arched shape defined by an upper arch-shaped portion 48a and by a lower rectilinear portion 48b (Figures 1 and 5). Conveniently, each axial end of the pins 36 and 46 engages a respective groove 48, with the interposition of a rolling bearing 50.

[0025] The intermediate part of the hooking member 19 projects above the half-shells 12a and 12b through an opening 52 formed in a shield plate 54 that is slidably mounted in the direction transverse to the axis of the rod 20. This plate 54 covers a widest opening facing the internal cavity of the body 12, in order to prevent foreign bodies from entering the body 12 during use of the apparatus 10, and interfering with the control means for controlling the movement of the hooking member 19. The opening 52 has a size substantially corresponding to the cross-section of the intermediate part of the hooking member 19, and has therefore a narrower width with respect to that of the widest opening facing the cavity of the body 12. The hooking member 19, during operation of the apparatus 10, undergoes a small transverse movement with respect to the body 12, and carries with it the shield plate 54.

[0026] Above the plate 54, a stationary covering plate 56 is fixed to the half-shells 12a and 12b, from which an axial centering pin 58 extends upwardly, on the side opposite the cylinder 14, to which a collar 62 is associated.

[0027] Preferably, the centering pin 58 has a slightly conical shape and it is intended to be inserted into a corresponding hole of a workpiece to be clamped by the apparatus 10. A recess 60 is formed inside the centering pin 58, within which the hook end 19a of the member 19 is received with a small clearance. In particular, when

the hooking member 19 is in its resting position, the hook end 19a is completely received into the recess 60.

[0028] The collar 62 that surrounds the pin 58 defines at its upper edge a resting zone for resting the workpiece to be clamped, which is arranged beneath the hook end 19a when the hooking member 19 is in one of the clamping positions thereof. Therefore, the support zone of the apparatus 10 cooperates with the hook end 19a, in the aforementioned clamping positions, to clamp a workpiece with respect to the apparatus 10.

[0029] Moreover, a removable side plate 64 is applied to the half-shells 12a and 12b, to which a pair of micro-switches 66a, 66b (Figures 4 and 7) are fixed, in order to detect the opposite end-of-travel positions of the rod 20 by means of a check element 68 that projects from the shaped body 22.

[0030] In the operation, a workpiece such as a metal sheet, for example provided with a hole of predetermined size, is approached to the apparatus 10 in such a manner to engage the centering pin 58 in the aforesaid hole, until the workpiece rests on the upper edge of the collar 62. In this condition, the hooking member 19 is in the resting position shown in Figures 2 and 3, with the hook end 19a thereof fully recovered inside the recess 60. Moreover, the rod 20 is in its fully lowered position, the first pin 26 engages the transverse section 24a of the slit 24 of the shaped body 22, and the opposite axial ends of the second pin 36 engage the upper arcuate portion 48a of the grooves 48 of the two half-shells 12a and 12b.

[0031] As a result of the application of a thrust on the lower surface of the piston 18 by the pressurized fluid of the cylinder 14, the rod 20 and the shaped body 22 undergo an upward displacement (with reference to the figures), such that the first pin 26 moves along the slit 24 until it engages the initial part of its inclined section 24b. This displacement causes an anti-clockwise rotation (with reference to the figures) of the L-shaped members 32 about the respective pins 40, as well as a corresponding displacement of the second and the third pins 36 and 46 towards the cylinder 14, along the grooves 48.

[0032] In particular, the second pin 36 moves from the upper arch-shaped portion 48a to the lower rectilinear portion 48b of the grooves 48, causing the hooking member 19 to undergo a small counter-clockwise rotation (with reference to the figures), and to move downward in the direction of the cylinder 14. In this manner, the hooking member 19 passes from its resting position, in which its hook end is received in the recess 60 and is substantially spaced from the edge of the collar 62, to a first clamping position in which its hook end 19a projects partially outside of the recess 60, and it is close to the edge of the collar 62, as shown in Figure 4.

[0033] In particular, the hook end 19a of the hooking member 19 is separated from the upper edge of the collar 62 by a distance indicated in Figure 4 by "X max", which corresponds to the maximum thickness of a workpiece to be clamped by means of the apparatus 10.

[0034] In this configuration, the pin 26 engages the in-

clined section 24b of the slit 24, which section is inclined of a small angle with respect to the axial direction identified by the rod 20, such that, in the absence of an axial displacement of the rod 20 and of the shaped body 22 consequent to a variation of the position of the piston 18 in the cylinder 14, a sliding of the pin 26 along the slit 24 is prevented by the position of the L-shaped members 32, and therefore an accidental displacement of the hooking member 19 from the reached clamping position is prevented, whereby its position is irreversible.

[0035] This feature is particularly useful in the case of an accidental interruption of the supply of pressurized fluid to the cylinder 14, for example as a result of an interruption of the power supply to the system that manages the operation of the apparatus 10. In fact, the hooking member 19 remains in the clamping position as long as the piston 18 undergoes a displacement controlled by the pressurized fluid in the cylinder 14.

[0036] If the workpiece to be clamped has a thickness smaller than "X max", a further thrust applied to the piston 18 causes an additional raising of the rod 20 and of the shaped body 22. This raising causes a displacement of the pin 26 towards the bottom of the inclined section 24b of the slit 24, which causes the L-shaped members 32 to undergo a further rotation in the anti-clockwise direction, and the second and the third pins 36 and 46 to undergo another displacement towards the lower rectilinear portion 48b of the grooves 48. Therefore, a further lowering of the hooking member 19 takes place, which allows its hook end 19a to be brought into a position closer to the upper edge of the collar 62 with respect to the aforementioned "X max" distance, which corresponds to the thickness of the workpiece to be clamped.

[0037] The minimum thickness of a workpiece to be clamped by the apparatus 10 corresponds to the distance "X min" (see figures 5 to 7) between the edge of the collar 62 and the hook end 19a, which is reached when the pin 26 is arranged at the bottom of the inclined section 24b of the slit 24. In this configuration, the third pin 46 is generally arranged at the bottom, or in a position adjacent thereto, of the rectilinear portion 48b of the grooves 48 (see in particular Figure 6).

[0038] More specifically, the apparatus 10 of the invention automatically adapts to clamp workpieces or sheets having a thickness included in the "X max"/"X min" range, which can usually correspond to 0.5 mm or more, while maintaining a high clamping force.

[0039] In particular, the length of the inclined section 24b of the slit 24, and also of the rectilinear lower portions 48b of the grooves 48, allows the width of the thickness range "X max"/"X min" of the workpieces that can be locked through the apparatus 10, to be determined, by preserving the irreversibility of the device for any position of the pin 26 with respect to this inclined section.

Claims

1. Hook apparatus for centering and clamping workpieces, particularly metal sheets, comprising a main body (12) that defines a support zone (62) for supporting a workpiece to be clamped, a hooking member (19) movable between a resting position spaced from said support zone (62) and at least one clamping position close to said support zone (62), and control means for controlling the movement of the hooking member (19) between the said positions, adapted to allow workpieces of different thickness to be clamped, which control means include:
 - a control rod (20) axially slidable with respect to the main body (12) between a lowered position and at least one raised position, said positions corresponding to said resting and clamping positions of the hooking member (19), respectively,
 - at least one L-shaped member (32) swingably mounted with respect to the main body (12), which comprises a first arm articulated to a part (22) connected to said rod (20), and a second arm articulated to the hooking member (19), and
 - guide means (36, 46, 48) for keeping a predetermined orientation of the hooking member (19) with respect to the main body (12),

characterized in that said part connected to the control rod includes an auxiliary shaped body (22) fixed to the rod (20) at its side facing the hooking member (19), and having a slit (24) in which a first transverse pin (26) is slidably engaged, which pin also engages a hole (30) of the first arm of said at least one L-shaped member (32).
2. Apparatus according to claim 1, **characterized in that** said slit (24) is substantially arch-shaped and has a transverse section (24a) engageable by the first pin (26) when the hooking member (19) is in said resting position, and a section (24b) inclined with respect to the axis of said rod (20), which can be engaged by the first pin (26) when the hooking member (19) is in said clamping position, the inclination of said inclined section (24b) being such that the engagement of the first pin (26) therein, in the absence of an axial displacement of the rod (20), causes the movement of said hooking member (19) to be locked in order to make irreversible the position of the hooking member (19).
3. Apparatus according to claim 2, **characterized in that** positioning of the first pin (26) in the inclined section (24b) of said slit (24), in a section thereof spaced from the bottom of such a section (24b) or at the bottom of such a section (24b), causes a workpiece of a maximum or a minimum thickness, respectively, to be clamped by the hooking member (19).
4. Apparatus according to any one of claims 1 to 3, **characterized in that** it comprises a second pin (36) parallel to said first pin (26), which is slidably inserted into a slot (34) of the second arm of said at least one L-shaped member (32) and into a hole (42) formed in a foot portion (19b) of the hooking member (19).
5. Apparatus according to claim 4, **characterized in that** it comprises a third pin (46) parallel to said first pin (26), which engages a second hole (44) formed in said foot portion (19b) of the hooking member (19), both said second (36) and third pin (46) engaging at least one substantially arch-shaped guide groove (48) formed in the body (12) of the apparatus (10) and being part of said guide means.
6. Apparatus according to claim 5, **characterized in that** said at least one guide groove (48) has an arched upper portion (48a) and a rectilinear lower portion (48b).
7. Apparatus according to any one of claims 1 to 6, **characterized in that** it comprises a pair of equal L-shaped members (32) which are mounted on opposite sides with respect to said rod (20) and to said shaped body (22), and **in that** the main body (12) comprises a pair of complementary half-shells (12a, 12b) coupled to each other, from each of which a half-pin (40) of articulation of a respective L-shaped member (32) projects toward said rod (20), each half-pin (40) engaging a hole (38) formed in the respective L-shaped member (32) in an intermediate portion between the arms thereof, a respective substantially arch-shaped guide groove (48) being formed in each half-shell (12a, 12b) to be slidably engaged by the respective ends of said second and third pins (36, 46).
8. Apparatus according to claim 7, **characterized in that** respective rolling bearings (30, 50) are interposed between the first pin (26) and the slit (24) of the shaped body (22), as well as between each end of the second and the third pin (36, 46) and the respective guide groove (48) of the main body (12).
9. Apparatus according to any one of claims 1 to 8, **characterized in that** the main body (12), close to said support zone (62), comprises an axial centering pin (58) for centering a workpiece to be clamped, in which centering pin (58) a recess (60) is formed for accommodating entirely a hook portion (19a) of the hooking member (19) in its resting position.
10. Apparatus according to any one of claims 1 to 9, **characterized in that** the main body (12) has a gen-

erally wide opening through which a portion of the hooking member (19) projects beyond the main body (12) on the side opposite to said rod (20), and **in that** it comprises a guard plate (54) slidable along a direction transverse to said rod (20), which guard plate (54) has a narrow opening (52) the size of which substantially corresponds to the cross-section of the hooking member (19), through which the hooking member (19) extends beyond the main body (12) on the side opposite to said rod (20).

11. Apparatus according to any one of claims 1 to 10, **characterized in that** the end of said rod (20) on its side opposite to the hooking member (19) is connected to a piston (18) slidably mounted in a driving cylinder (14) operated by a pressurized fluid, conveniently by a pneumatic actuating cylinder.

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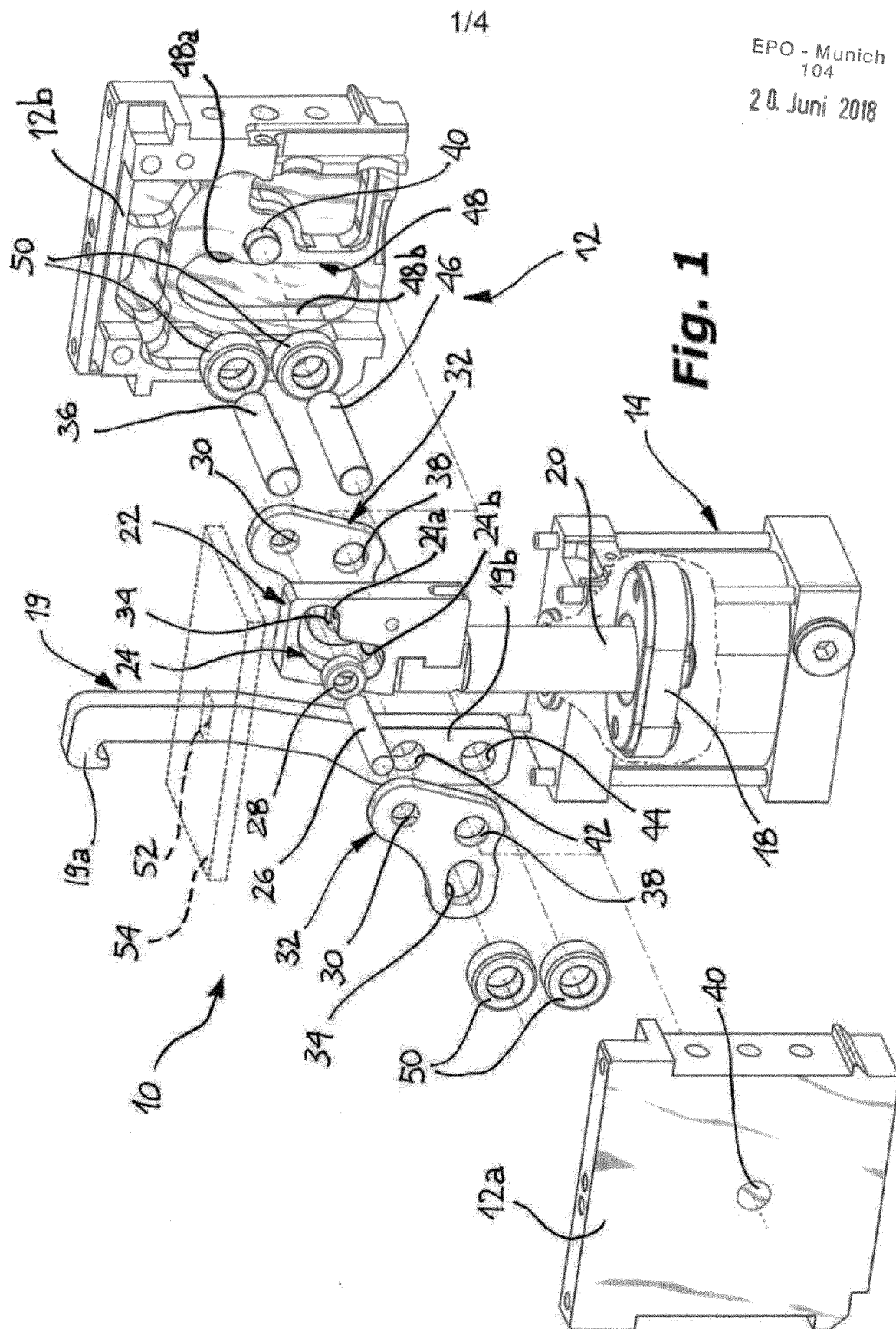
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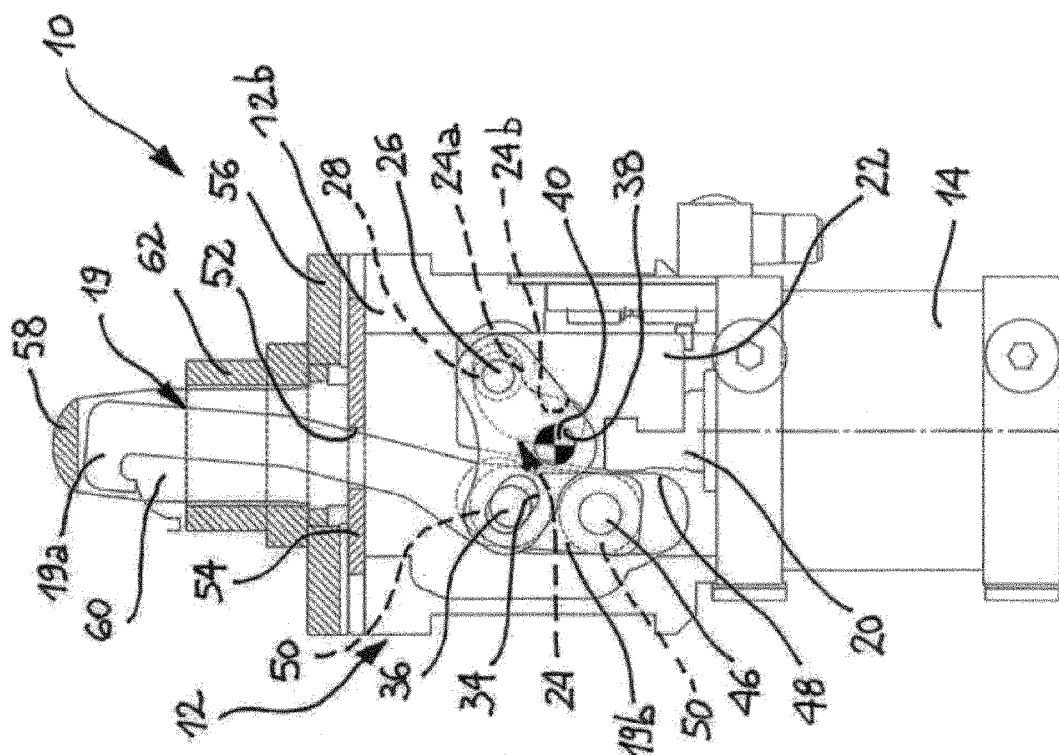


Fig. 2

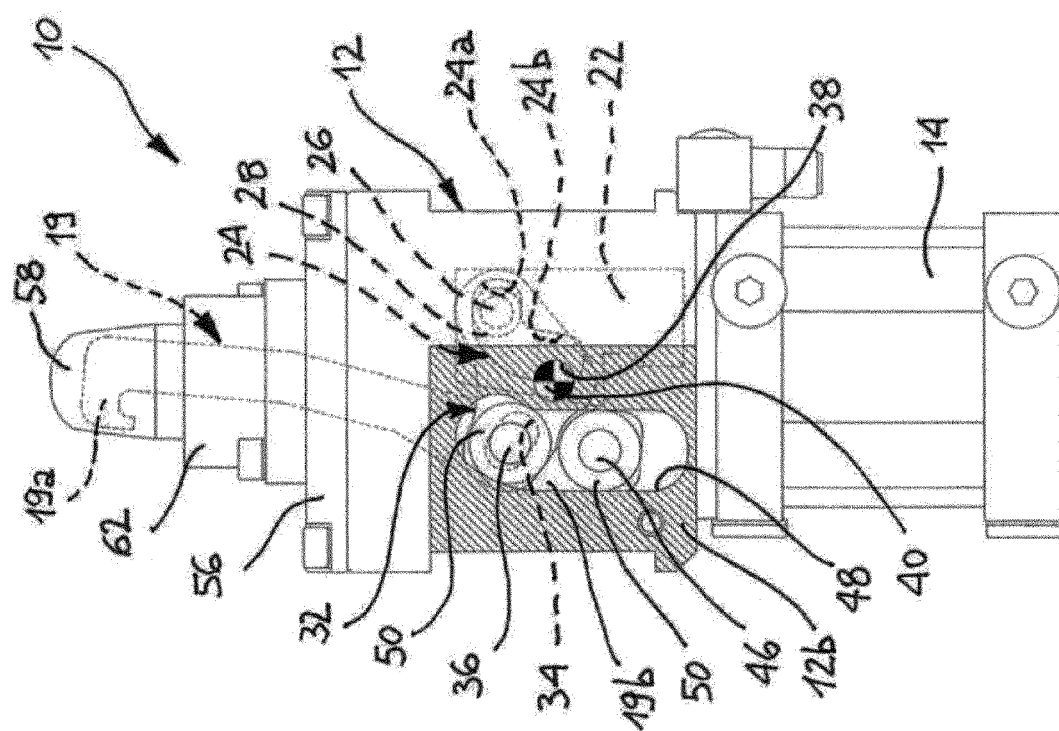


Fig. 3

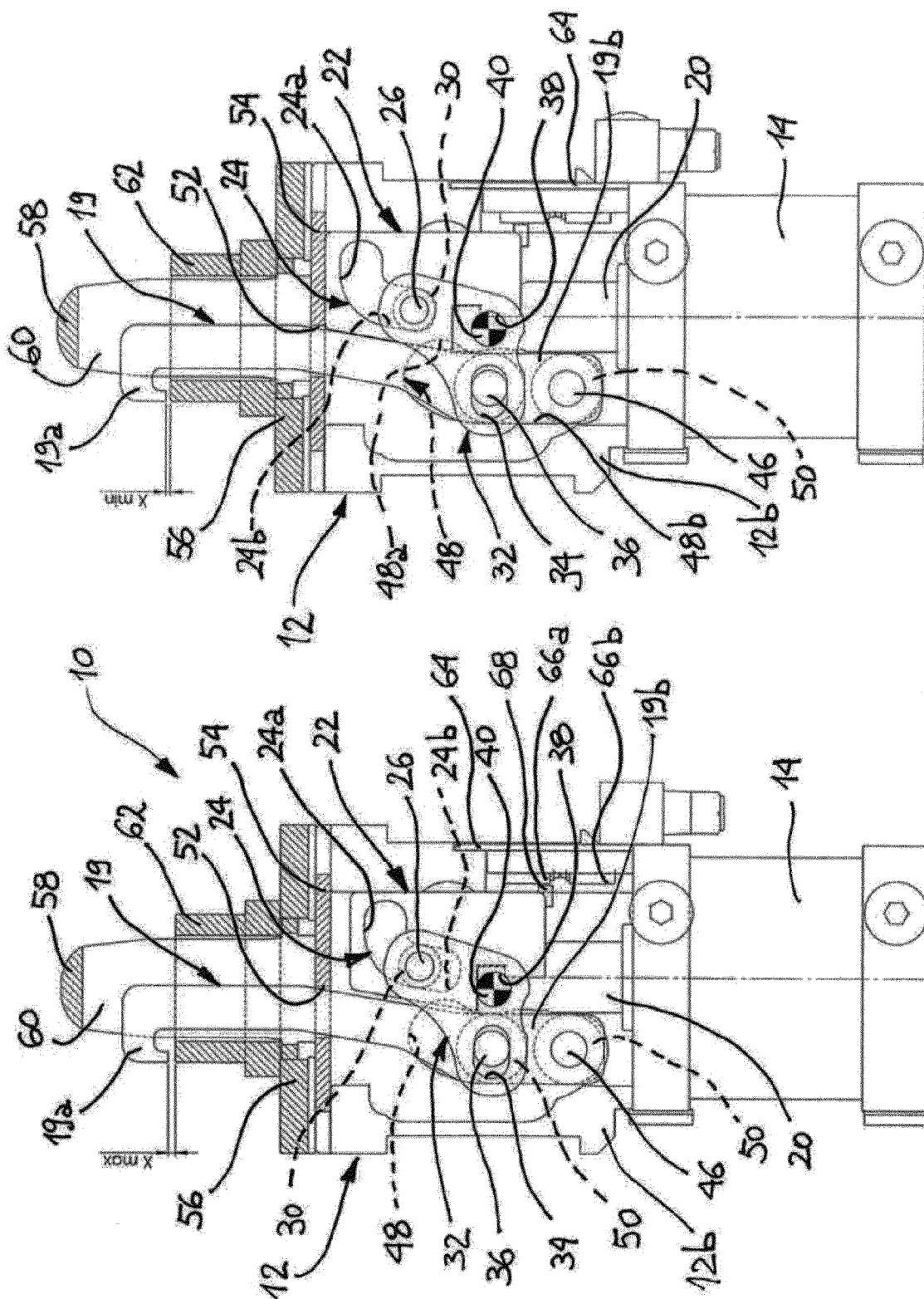


Fig. 5

Fig. 4

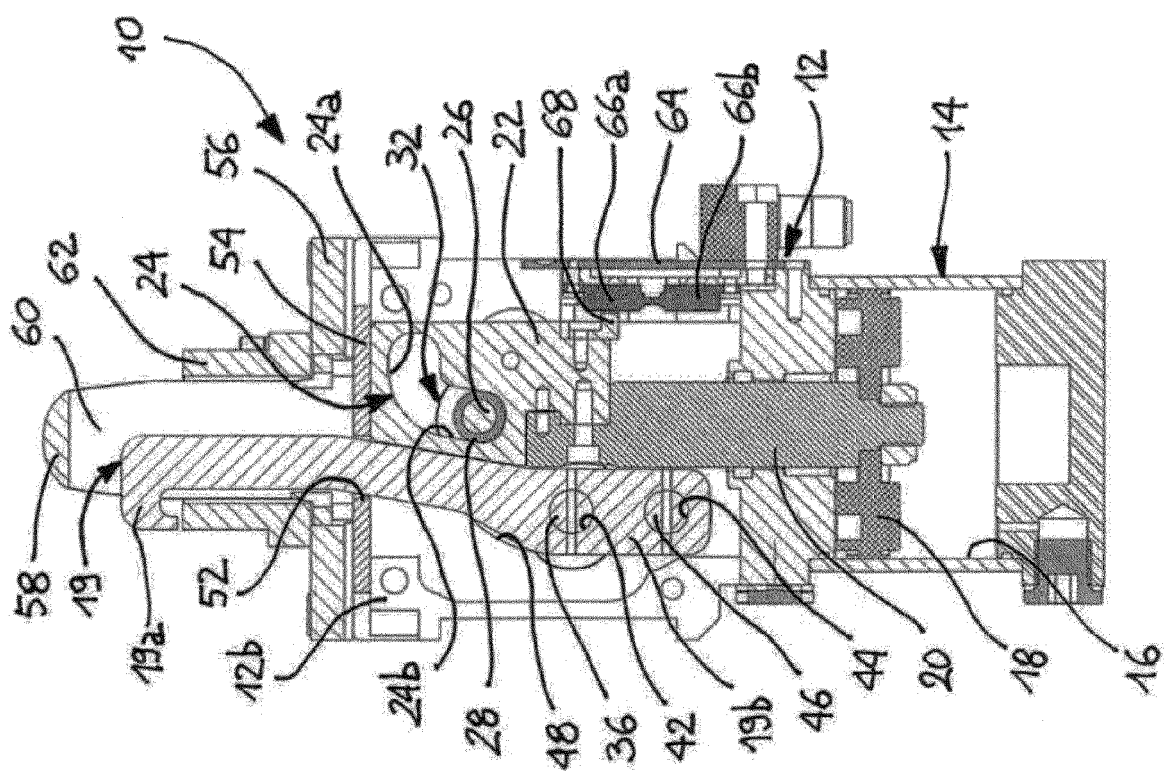


Fig. 7

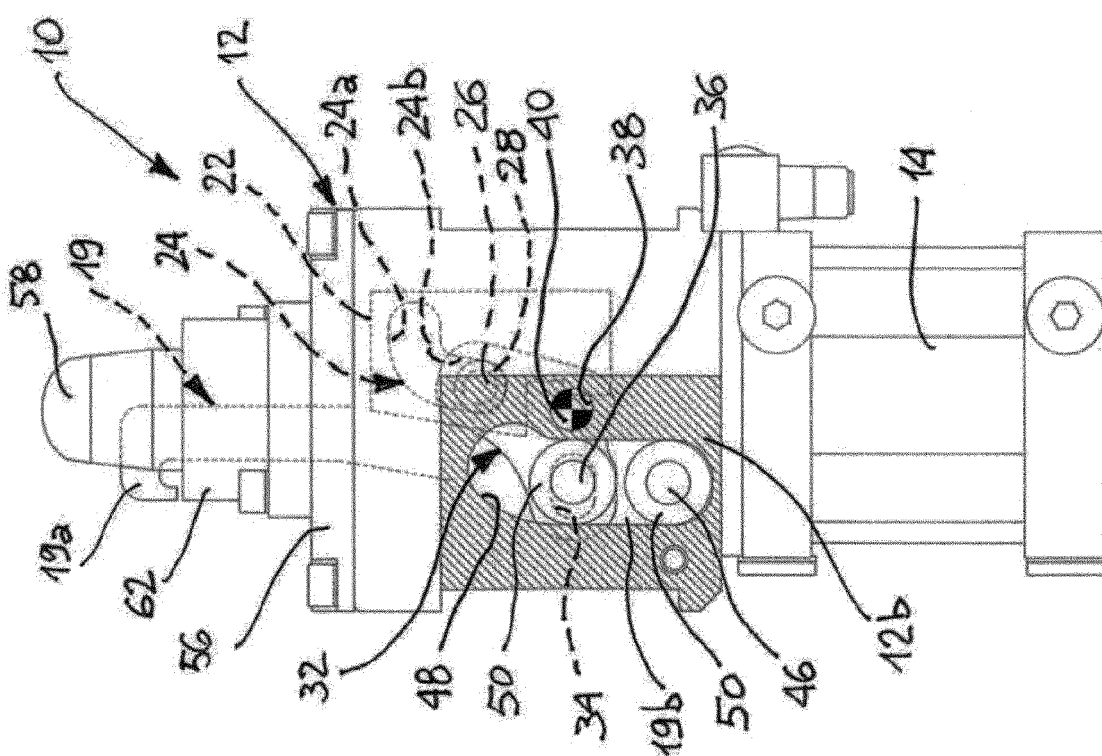


Fig. 6



EUROPEAN SEARCH REPORT

Application Number
EP 18 00 0503

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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 5 November 2018	Examiner Pothmann, Johannes
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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 18 00 0503

5 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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REFERENCES CITED IN THE DESCRIPTION

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