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(54) OPTIMIZED EFFICIENCY ACTUATING UNIT OF THE ARTICULATED LEVER TYPE

GELENKHEBELANTRIEB MIT OPTIMIERTEM WIRKUNGSGRAD

UNITÉ D'ACTIONNEMENT D'EFFICACITÉ OPTIMISÉE DU TYPE DE LEVIER ARTICULÉ

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(73) Proprietor: **Pneumax S.p.A.**
20129 Milan (IT)

(72) Inventor: **BOTTACINI, Roberto**
deceased (IT)

(74) Representative: **Mati, Silvia et al**
Thinx S.r.l.
P.le Luigi Cadorna, 10
20123 Milano (IT)

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Description

[0001] The present invention relates to an articulated lever actuation unit with optimized efficiency. In particular, the present invention relates to an actuation unit of the above optimized efficiency type in terms of energy consumption and overall dimensions.

[0002] Articulated lever actuation units, such as locking unit and pivot units, are typically used for handling and/or clamping elements during sheet metal processing. For example, within the scope of making motor vehicle bodies, it is known to use clamping units for keeping the metal sheets into position during mechanical processes (such as welding, crimping or other technique for joining metal sheets).

[0003] Such mechanical processes require extremely accurate positioning of the elements to be machined and that such a positioning is kept over time. To this end, clamping units comprise a closing device able to cause the rotation of a clamping arm, connected to such a closing device, up to an exact operating angular position of closure and, once achieved, keep it in such a position, triggering an irreversibility mechanism able to guarantee the position even in the absence of control (for example, in the absence of air in the case of pneumatic control).

[0004] The stroke of the closing device, which generally corresponds to a rotation of 135° of the clamping arm, is usually controlled through a pneumatic or electrical actuation, depending on the specific embodiment. In both cases, the closing device comprises a piston which acts on a toggle mechanism to which the clamping arm is in turn constrained. In particular, the toggle mechanism consists of a connecting rod and a crank rod, where the connecting rod is pivoted at the ends thereof to the piston rod and to the crank rod, respectively, and the crank rod sets the clamping arm in rotation. The connecting rod and the crank rod are typically made of multiple parts or as a single part, for example by means of a fork.

[0005] In case of pneumatic actuation of the piston, feeding of pressurized fluid, usually compressed air, is required for generating the thrust force required. The generation of compressed air has a very low yield, typically less than 3%. Moreover, pneumatic actuations are generally characterized by high losses which lead to an increase in the consumption of compressed air, in addition to that strictly necessary for control. This source of energy is therefore particularly inefficient and expensive.

[0006] Considering that normally, 3500 to 4000 clamping units plus about 60-80 pneumatic control pivot units are used in production lines of motor vehicle bodies, it goes without saying that in the field of articulated lever actuation units for use in such production lines there is a high interest in an optimization of the efficiency in terms of energy consumption, for example to reduce the amount of compressed air required for the actuation. Clearly, the optimization of energy consumption must be subject to the conditions dictated by the already existing production lines which require other operating parameters, such as the overall dimensions of the actuation units and the output clamping moment provided by the same, to be kept unchanged. Furthermore, these physical characteristics are determined by industrial standards and cannot be varied.

[0007] Actuation units designed to optimize air consumption are known in the art. They use complex pneumatic circuits that allow a partial air recovery. In this way, keeping the other features of the actuation unit unchanged, the pneumatic cylinder is able to operate and produce the same thrust force on the piston through a reduced supply of compressed air. An example of a clamping unit that uses such a solution is described in patent EP 2016290.

[0008] The Applicant started from the observation that, to date, the actuation units available on the market are made according to predetermined and by the industrial standards specifically defined "models" in terms of both clamping moment and actuation, which in the specific case of pneumatic actuation translates into "sizes" of the actuation cylinders. For example, a known model of clamping unit currently widespread on the market is actuated by means of a Ø 50 mm pneumatic cylinder, offering a clamping moment of a value comprised between 180 N m and 230 N m. Likewise, a further widespread model of clamping unit is actuated by means of a Ø 63 mm pneumatic cylinder, offering a clamping moment of a value comprised between 375 N m and 425 N m. Such pneumatic cylinders, when supplied at a pressure of 5 bar, generate a thrust force equal to 981.75 N and 1558.62 N, respectively, consuming a volume of compressed air at each cycle substantially proportional to the respective thrust force.

[0009] Analogously, another known model of clamping unit currently widespread on the market is actuated by means of a Ø 40 mm pneumatic cylinder, offering a clamping moment of a value comprised between 115 N m and 145 N m. Not least, a still further widespread model of clamping unit is actuated by means of a Ø 80 mm pneumatic cylinder, offering a clamping moment of a value comprised between 830 N m and 880 N m. Such pneumatic cylinders, when supplied at a pressure of 5 bar, generate a thrust force equal to 628,32 N and 2513,27 N, respectively, consuming a volume of compressed air at each cycle substantially proportional to the respective thrust force.

[0010] In the present description and in the following claims, where reference is made to a pneumatic cylinder with "standardized size" it is meant a cylinder having features according to what defined in the international standard ISO 15552 - *Pneumatic fluid power - Cylinders with detachable mountings* as regards each specific size.

[0011] In order to obtain energy saving, the Applicant has therefore identified a need to operate the articulated lever actuation unit through a lower thrust force, while keeping the clamping moment and the overall dimensions substantially unchanged in order to satisfy the industrial standards of the field.

[0012] In the field of the articulated lever actuating units, such as clamping and pivot units for use in the automotive sector, there are indeed industrial standards which define the physical characteristics of such units based on the cylinder sizes. In detail, such industrial standards define the dimensions of the units in terms of volumes and position of the unit axis (which coincides with the axis along which the rod translates inside the unit) with respect to the rotating axis given at the output of the unit.

[0013] In theoretical terms, torque M is defined by a relationship of direct proportionality with both the thrust force P and with the length of the second rod $\overline{AO}$ (also known as crank) according to the following variability law (with respect to a configuration of the articulated lever system other than the closed position in which the system has reached the condition of irreversibility):

$$M = k * P * \overline{AO}$$

with k = const.

where k is calculated with respect to a position of the pivotable arm other than the closed position and has to be considered invariable with respect to the plurality of physical characteristics which determine the geometry of the actuating unit defined by the industrial standards since, in turn, these physical characteristics are considered to be predefined by the standards. Such factor k has furthermore to be considered substantially invariable also with respect to the first rod length $\overline{BA}$ (also known as connecting rod) which just negligibly contributes to the generation of clamping moment at the output, by substantially working along the horizontal.

[0014] Starting from this theoretical law, the Applicant has first noted that, in order to keep the clamping moment unchanged while reducing the thrust force P exerted on the piston by the (either pneumatic or electric) actuator to achieve energy saving, the length of the second rod needs to be increased.

[0015] Applying this theoretical law, the Applicant has noted that in order to reduce the size of the pneumatic cylinders currently used in the known articulated lever actuation units to obtain a significant reduction of the thrust force exerted on the piston and a consequent energy saving, it is necessary to increase the crank length not compatible with the need of keeping the current overall dimensions substantially unchanged.

[0016] Still according to the theoretical law of variability, the Applicant has also noted that reductions in the volume of the cylinder such as to result in an increase of the crank length compatible with keeping the overall dimensions unchanged would lead to a negligible energy saving, in particular well below 10%.

[0017] The Applicant has surprisingly found that, contrary to what the theoretical laws lead to conclude, the relation between torque, thrust force and length of the second rod is not bound by a constant proportionality factor but conversely, such a proportionality factor varies as a function of the thrust force exerted. Such different relation between torque, thrust force and length of the second rod particularly applies when the articulated lever system is approaching or has substantially reached its irreversibility condition.

[0018] The Applicant has, in fact, found that, near to such condition, such a proportionality factor is strongly influenced by the energy typically dissipated by the system, releasing the thrust force exerted on the articulated lever mechanism on contrast elements. The contrast elements for example are the walls of the body against which the articulated lever mechanism rests during the movement caused by the translation of the piston rod, rather than the rods (connecting rod and crank) themselves. These elements are able, by deforming, to absorb part of the thrust force exerted on the same.

[0019] The Applicant has found that, advantageously, the dissipation incurred by the system is considerably lower in proportion for lower thrust forces, thereby allowing a same clamping moment to be obtained with crank lengths well lower than those theoretically calculated. This at the same time allows a considerable energy saving to be obtained while keeping the current overall dimensions unchanged.

[0020] Specifically, the Applicant has unexpectedly found that the proportionality factor k that binds the clamping moment to the product between thrust force and length of the second lever is comprised between 6.8 and 10.0 for clamping moments comprised between 180 N m and 230 N m, allowing energy saving to be obtained while keeping the length of the second rod $\overline{AO}$ equal to or less than 32 mm and therefore not changing the current overall dimensions of the corresponding clamping units known to date, able to offer the same clamping moments.

[0021] Likewise, the Applicant has surprisingly found that the proportionality factor k that binds the clamping moment to the product between thrust force and length of the second lever is comprised between 8.0 and 12.2 for a clamping moment comprised between 375 N m and 425 N m, allowing energy saving to be obtained while keeping the length of the second rod $\overline{AO}$ equal to or less than 35.5 mm and therefore not changing the current overall dimensions of the corresponding clamping units known to date, able to offer the same clamping moments.

[0022] Similarly, the Applicant has surprisingly found that the proportionality factor k that binds the clamping moment to the product between thrust force and length of the second lever is comprised between 6.8 and 11.4 for a clamping moment comprised between 830 N m and 880 N m, allowing energy saving to be obtained while keeping the length of the second rod $\overline{AO}$ equal to or less than 56.5 mm and therefore not changing the current overall dimensions of the corresponding clamping units known to date, able to offer the same clamping moments.

[0023] Again, the Applicant has surprisingly found that the proportionality factor k that binds the clamping moment to the product between thrust force and length of the second lever is comprised between 8.0 and 13.8 for a clamping moment comprised between 115 N m and 145 N m, allowing energy saving to be obtained while keeping the length of the second rod $\overline{AO}$ equal to or less than 30.5 mm and therefore not changing the current overall dimensions of the corresponding clamping units known to date, able to offer the same clamping moments.

[0024] By selecting the crank length and the thrust force according to the above parameters, the Applicant has surprisingly succeeded in obtaining articulated lever actuation units able to provide, for equal overall dimensions, same clamping moments with an optimization of the energy saving of up to about 46%.

[0025] Moreover, the optimization of the geometry of the articulated lever mechanism of the actuation unit with reference to the thrust force applied, in accordance with the parameters defined above, allows energy saving to be obtained also in the presence of an electric or combined pneumatic-manual or electric-manual actuation, it being possible to significantly reduce the thrust force required to generate the desired clamping moment without it being necessary to modify the current overall dimensions.

[0026] Last but not least, the possibility of using cylinders of a smaller size also positively affects the sizing of the valves and of the fittings of the pneumatic circuit, allowing an additional cost saving to be obtained.

[0027] Preferred embodiments of the present invention are defined in the dependent claims.

[0028] Further features and advantages of the present invention will appear more clearly from the following detailed description of some preferred embodiments thereof, made with reference to the accompanying drawings.

[0029] The different features in the single configurations may be combined with one another as desired according to the description above, to make use of the advantages resulting in a specific way from a particular combination.

[0030] In such drawings,

- figures 1a and 1b are schematic side sectional views of a clamping unit according to the present invention in the non-operating open position and in the operating closed position, respectively.

- figure 2 is a schematic representation of an articulated lever mechanism included in an actuation unit according to the present invention in a configuration other than the irreversibility condition.

[0031] With reference to figures 1a and 1b, an articulated lever actuation unit is shown according to the present invention, indicated overall with reference numeral 10, in particular a clamping unit.

[0032] The clamping unit 10 comprises a body 11 within which a control piston 12 is arranged, comprising a rod 12a which can slide within body 11 along a sliding axis A.

[0033] Rod 12a of piston 12 is connected to an articulated lever mechanism 13, specifically comprising a toggle mechanism consisting of a pair of rods 13a, 13b. A first rod 13a, also called connecting rod, is pivoted at the ends thereof to the piston rod 12a and to the second rod 13b, called crank rod 13b, respectively. The crank rod 13b is rotatably connected to body 11 and, at the axis of revolution B thereof, it sets a clamping arm 14 in rotation.

[0034] The control piston 12 is coupled to a pneumatic cylinder 15 able to exert a thrust force P on the control piston when supplied with compressed air.

[0035] Figure 2 schematically shows the articulated lever mechanism 13 in a different configuration compared to the irreversibility condition shown in figure 1b. In particular, rod AO corresponds to the crank rod 13b, rod AB corresponds to the connecting rod 13a and the third rod schematizes rod 12a of piston 12.

[0036] In such a configuration, the clamping moment M measurable at the output (i.e. at the axis of rotation B coincident at point O in figure 2) is obtainable through the equilibrium equations of the kinematics shown in figure 2, leading to the following equation:

$$M = (\frac{P}{\tan\beta} * \overline{AO *} \cos\alpha) + (P * \overline{AO} * \sin\alpha)$$

[0037] It is therefore possible to deduce a substantial proportionality between torque M and the product of the thrust force P with the length of the crank rod $\overline{AO}$ according to the following variability law:

$$M = k * P * \overline{AO}$$

with k = const.

[0038] The following is a comparative example to illustrate the present invention. The scope of protection defined by the appended claims, however, is not to be considered limited only to the specific example.

COMPARATIVE EXAMPLE 1:

[0039] A known clamping unit was considered, characterized by the following parameters:

- length of the crank arm equal to 28 mm;
- piston stroke equal to 78 mm;
- size of the pneumatic cylinder equal to Ø 50 mm operated at 5 bar; and
- output clamping moment equal to 186 N m.

[0040] It was measured that such a clamping unit requires an air consumption equal to about 306.31 cm^3 for each cycle defined as a forward and backward stroke of the cylinder.

[0041] In particular, the cylinder having section Ø equal to 50 mm, when operated with compressed air at 5 bar, generates a thrust force P equal to about 981.75 N. From the proportionality relation discussed above it is therefore inferred that the proportionality constant of such a clamping unit is about k = 6.77.

[0042] Theoretically, this means that, in order to scale the size of the cylinder, using one having section Ø equal to 40 mm, therefore able to develop a thrust force at 5 bar equal to about P = 628.32 N, it would be necessary to bring the length of the crank rod to about AO = 44 mm. However, such an increase in length is not compatible with the requirement of keeping the overall dimensions of the starting clamping unit unchanged.

EXAMPLE 1:

[0043] According to the present invention, a clamping unit was implemented characterized by the following parameters:

- length of the crank arm equal to 32 mm;
- piston stroke equal to 84.8 mm;
- size of the pneumatic cylinder equal to Ø 40 mm operated at 5 bar,

obtaining the same output clamping moment equal to 186 N m as the clamping unit of the prior art described in the comparative Example 1.

[0044] In particular, the increase in the piston stroke was selected based on the fact that it is proportional to the increase in the length of the crank rod according to the following law $\Delta corsa = \Delta\overline{AO} * (1 + \sin 45°)$, applicable in the operating range of the device suitable for ensuring an opening angle equal to 135° (opening angle characteristic of the applications on production lines of motor vehicle bodies).

[0045] The energy consumption of the clamping unit according to the embodiment of the present example in line with the invention therefore was 213.13 cm^3, i.e. more than 30% lower than the consumption of the clamping unit of the prior art described in the comparative Example 1.

[0046] In practice, it was sufficient to extend the crank rod by only 4 mm, obtaining the same torque equal to 186 N m with a pneumatic actuation carried out with a cylinder having section Ø equal to 40 mm.

[0047] Such a configuration led to a reduced energy dissipation and therefore to an increase in the proportionality constant. Specifically, in the configuration described, the proportionality constant surprisingly reached a value of about k = 9.25.

COMPARATIVE EXAMPLE 2:

[0048] With a known clamping unit, characterized by the following parameters:

- length of the crank arm equal to 31.5 mm;
- piston stroke equal to 85.8 mm;

- size of the pneumatic cylinder equal to Ø 63 mm operated at 5 bar; and
- output clamping moment equal to 390 N m.

[0049] It was measured that such a clamping unit requires an air consumption equal to about 534.92 cm^3 for each cycle defined as a forward and backward stroke of the cylinder.
[0050] In particular, the cylinder having section Ø equal to 63 mm, when operated with compressed air at 5 bar, generates a thrust force P equal to about 1558.62 N. From the proportionality relation discussed above it is therefore inferred that the proportionality constant of such a clamping unit is about k = 7.94.
[0051] Theoretically, this for example means that, in order to scale the size of the cylinder, using one having section Ø equal to 50 mm, therefore able to develop a thrust force at 5 bar equal to about P = 981.75 N, it would be necessary to bring the length of the crank rod to about AO = 50 mm. However, such an increase in length is not compatible with the requirement of keeping the overall dimensions of the starting clamping unit unchanged.

EXAMPLE 2:

[0052] According to the present invention, a clamping unit was implemented characterized by the following parameters:

- length of the crank arm equal to 35 mm;
- piston stroke equal to 91.77 mm;
- size of the pneumatic cylinder equal to Ø 50 mm operated at 5 bar,

obtaining the same output clamping moment equal to 390 N m as the clamping unit of the prior art described in the comparative Example 2.
[0053] In particular, the increase in the piston stroke was selected based on the fact that it is proportional to the increase in the length of the crank rod according to the following law $\Delta corsa = \Delta\overline{AO} * (1 + \sin 45°)$, applicable in the operating range of the device suitable for ensuring an opening angle equal to 135° (opening angle characteristic of the applications on production lines of motor vehicle bodies).
[0054] The energy consumption of the clamping unit according to the embodiment of the present example in line with the invention therefore was 360.39 cm^3, i.e. more than 32% lower than the consumption of the clamping unit of the prior art described in the comparative Example 2.
[0055] In practice, it was sufficient to extend the crank rod by only 3.5 mm, obtaining the same torque equal to 390 N m with a pneumatic actuation carried out with a cylinder having section Ø equal to 50 mm.
[0056] Such a configuration led to a reduced energy dissipation and therefore to an increase in the proportionality constant. Specifically, in the configuration described, the proportionality constant surprisingly reached a value of about k = 11.28.

COMPARATIVE EXAMPLE 3:

[0057] With a known clamping unit, characterized by the following parameters:

- length of the crank arm equal to 26 mm;
- piston stroke equal to 71.22 mm;
- size of the pneumatic cylinder equal to Ø 40 mm operated at 5 bar; and
- output clamping moment equal to 130 N m.

[0058] It was measured that such a clamping unit requires an air consumption equal to about 178.99 cm^3 for each cycle defined as a forward and backward stroke of the cylinder.
[0059] In particular, the cylinder having section Ø equal to 40 mm, when operated with compressed air at 5 bar, generates a thrust force P equal to about 628.32 N. From the proportionality relation discussed above it is therefore inferred that the proportionality constant of such a clamping unit is about k = 7.95.
[0060] Theoretically, this for example means that, in order to scale the size of the cylinder, using one having section Ø equal to 32 mm, therefore able to develop a thrust force at 5 bar equal to about P = 402.12 N, it would be necessary

to bring the length of the crank rod to about AO = 40 mm. However, such an increase in length is not compatible with the requirement of keeping the overall dimensions of the starting clamping unit unchanged.

EXAMPLE 3:

[0061] According to the present invention, a clamping unit was implemented characterized by the following parameters:

- length of the crank arm equal to 29 mm;
- piston stroke equal to 77 mm;
- size of the pneumatic cylinder equal to Ø 32 mm operated at 5 bar,

obtaining the same output clamping moment equal to 130 N m as the clamping unit of the prior art described in the comparative Example 3.

[0062] In particular, the increase in the piston stroke was selected based on the fact that it is proportional to the increase in the length of the crank rod according to the following law $\Delta corsa = \Delta\overline{AO} * (1 + \sin 45°)$, applicable in the operating range of the device suitable for ensuring an opening angle equal to 135° (opening angle characteristic of the applications on production lines of motor vehicle bodies).

[0063] The energy consumption of the clamping unit according to the embodiment of the present example in line with the invention therefore was 123.85 cm^3, i.e. more than 30% lower than the consumption of the clamping unit of the prior art described in the comparative Example 3.

[0064] In practice, it was sufficient to extend the crank rod by only 3 mm, obtaining the same torque equal to 130 N m with a pneumatic actuation carried out with a cylinder having section Ø equal to 32 mm.

[0065] Such a configuration led to a reduced energy dissipation and therefore to an increase in the proportionality constant. Specifically, in the configuration described, the proportionality constant surprisingly reached a value of about k = 11.15.

COMPARATIVE EXAMPLE 4:

[0066] With a known clamping unit, characterized by the following parameters:

- length of the crank arm equal to 50 mm;
- piston stroke equal to 135.2 mm;
- size of the pneumatic cylinder equal to Ø 80 mm operated at 5 bar; and
- output clamping moment equal to 850 N m.

[0067] It was measured that such a clamping unit requires an air consumption equal to about 1359.17 cm^3 for each cycle defined as a forward and backward stroke of the cylinder.

[0068] In particular, the cylinder having section Ø equal to 80 mm, when operated with compressed air at 5 bar, generates a thrust force P equal to about 2513.27 N. From the proportionality relation discussed above it is therefore inferred that the proportionality constant of such a clamping unit is about k = 6.76.

[0069] Theoretically, this for example means that, in order to scale the size of the cylinder, using one having section Ø equal to 63 mm, therefore able to develop a thrust force at 5 bar equal to about P = 1558.62 N, it would be necessary to bring the length of the crank rod to about AO = 80 mm. However, such an increase in length is not compatible with the requirement of keeping the overall dimensions of the starting clamping unit unchanged.

EXAMPLE 4:

[0070] According to the present invention, a clamping unit was implemented characterized by the following parameters:

- length of the crank arm equal to 55 mm;
- piston stroke equal to 144.7 mm;

- size of the pneumatic cylinder equal to Ø 63 mm operated at 5 bar,

obtaining the same output clamping moment equal to 850 N m as the clamping unit of the prior art described in the comparative Example 4.

[0071] In particular, the increase in the piston stroke was selected based on the fact that it is proportional to the increase in the length of the crank rod according to the following law $\Delta corsa = \Delta\overline{AO} * (1 + \sin 45°)$, applicable in the operating range of the device suitable for ensuring an opening angle equal to 135° (opening angle characteristic of the applications on production lines of motor vehicle bodies).

[0072] The energy consumption of the clamping unit according to the embodiment of the present example in line with the invention therefore was 902.13 cm^3, i.e. more than 33% lower than the consumption of the clamping unit of the prior art described in the comparative Example 4.

[0073] In practice, it was sufficient to extend the crank rod by only 5 mm, obtaining the same torque equal to 850 N m with a pneumatic actuation carried out with a cylinder having section Ø equal to 63 mm.

[0074] Such a configuration led to a reduced energy dissipation and therefore to an increase in the proportionality constant. Specifically, in the configuration described, the proportionality constant surprisingly reached a value of about k = 9.92.

[0075] The Applicant has in fact found that, in clamping units according to the industrial standards that provide an output clamping moment comprised between 180 N m and 230 N m, the length of the crank rod, amounting today to 28 mm, can be incremented by nevertheless remaining under or equal to 32.8 mm so as to keep unchanged the current overall dimensions deriving from the standards.

[0076] Likewise, the Applicant has also found that, in clamping units according to the industrial standards that provide an output clamping moment comprised between 375 N m and 425 N m, the length of the crank rod, amounting today to 31.5 mm, can be incremented by nevertheless remaining under or equal to 35.5 mm so as to keep the current overall dimensions unchanged.

[0077] Similarly, the Applicant has also found that, in clamping units according to the industrial standards that provide an output clamping moment comprised between 115 N m and 145 N m, the length of the crank rod, amounting today to 26 mm, can be incremented by nevertheless remaining under or equal to 30.5 mm so as to keep the current overall dimensions unchanged.

[0078] Not least, the Applicant has also found that, in clamping units according to the industrial standards that provide an output clamping moment comprised between 830 N m and 880 N m, the length of the crank rod, amounting today to 50 mm, can be incremented by nevertheless remaining under or equal to 56.5 mm so as to keep the current overall dimensions unchanged.

[0079] The configuration of maximum optimization of the energy saving is carried at said crank lengths identified by the Applicant as the maximum allowable.

[0080] Accordingly, in case of clamping units with a clamping moment comprised between 180 N m and 230 N m, it is possible to bring the energy saving up to 36.2%, while in case of clamping units with a clamping moment comprised between 375 N m and 425 N m, it is possible to bring the energy saving of up to 37.3%.

[0081] Furthermore, in case of clamping units with a clamping moment comprised between 115 N m and 145 N m, it is possible to bring the energy saving up to 45.7%, while in case of clamping units with a clamping moment comprised between 830 N m and 880 N m, it is possible to bring the energy saving of up to 43.3%.

[0082] The features of the articulated lever actuation unit object of the present invention as well as the relevant advantages are clear from the above description.

[0083] Additional variations of the embodiments described above are possible without departing from the teaching of the invention as defined by the claims.

[0084] Finally, it is clear that several changes and variations may be made to the articulated lever actuation unit thus conceived, all falling within the invention; moreover, all details can be replaced with technically equivalent elements. In the practice, the materials used can be any according to the technical requirements.

Claims

1. An articulated lever actuation unit (10) for handling and/or clamping elements during metal sheet processing for making motor vehicle bodies comprising a body (11), inside of which a control piston (12) is slidably associated to the body (11) along a sliding axis (A), the control piston (12) being connected or coupled to actuation means (15) able to exert a thrust force (P) on the control piston (12), wherein

- the control piston (12) is operatively coupled to a pivotable arm (14) with the interposition of an articulated lever mechanism (13) in order to induce a rotational movement to the pivotable arm (14) about an axis of rotation

(B) perpendicular to the sliding axis (A) following a sliding motion of the control piston (12), the pivotable arm (14) being moved between an open or non-operating position and a closed or operating position,
- the articulated lever mechanism (13) comprises a first (13a) and a second (13b) rod, the first rod (13a) being pivoted to a rod (12a) of the control piston (12) and to the second rod (13b), respectively, and the second rod (13b) being pivoted to the body (11) and setting the pivotable arm (14) in rotation,
- for each position of the pivotable arm other than the closed position, the thrust force (P) exerted by the control piston (12) determines a clamping moment (M) at the axis of rotation (B),
wherein the actuation means are of the pneumatic type, comprising a pneumatic cylinder (15), and
wherein the actuating unit is a clamping unit or a pivot unit,
characterized in that
said clamping moment (M) at the axis of rotation (B) is variable according to law $M = k * P * \overline{AO}$ where $\overline{AO}$ is the length of the second rod and k is a proportionality factor which is variable as a function of the thrust force (P), and wherein:

- the pneumatic cylinder is of the standard size type having section Ø equal to 40 mm as defined in international standard ISO 15552, the length of the second rod (*AO*) is equal to about 32 mm, wherein the piston stroke is equal to about 84.8 mm, and wherein the proportionality factor (k) is a value of about 9.25 and the clamping moment is comprised between 185 Nm and 190 Nm when the pneumatic cylinder is operated at about 5 bar; or
- the pneumatic cylinder is of the standard size type having section Ø equal to 50 mm as defined in international standard ISO 15552, the length of the second rod (*AO*) is equal to about 35 mm, wherein the piston stroke is equal to about 91.77 mm, and wherein the proportionality factor is a value of about 11.28 and the clamping moment is comprised between 380 Nm and 400 Nm when the pneumatic cylinder is operated at about 5 bar; or
- the pneumatic cylinder is of the standard size type having section Ø equal to 32 mm as defined in international standard ISO 15552, the length of the second rod *(AO)* is equal to about 29 mm, wherein the piston stroke is equal to about 77 mm, and wherein the proportionality factor (k) is a value of about 11.15 and the clamping moment is comprised between 125 Nm and 132 Nm when the pneumatic cylinder is operated at about 5 bar; or
- the pneumatic cylinder is of the standard size type having section Ø equal to 63 mm as defined in international standard ISO 15552, the length of the second rod (*AO*) is equal to about 55 mm, wherein the piston stroke is equal to about 144.7 mm, and wherein the proportionality factor is a value of about 9.92 and the clamping moment is comprised between 845 Nm and 855 Nm when the pneumatic cylinder is operated at about 5 bar.

2. Actuation unit (10) according to claim 1, wherein for pneumatic cylinder of the standard size type having section Ø equal to 40 mm as defined in international standard ISO 15552 and operated at about 5 bar, the clamping moment (M) is substantially equal to 186 N m.

3. Actuation unit (10) according to claim any one of the preceding claims, wherein for pneumatic cylinder of the standard size type having section Ø equal to 50 mm as defined in international standard ISO 15552 and operated at about 5 bar, the clamping moment (M) is substantially equal to 390 N m.

4. Actuation unit (10) according to claim any one of the preceding claims, wherein for pneumatic cylinder of the standard size type having section Ø equal to 63 mm as defined in international standard ISO 15552 and operated at about 5 bar the clamping moment (M) is substantially equal to 850 N m.

5. Actuation unit (10) according to claim any one of the preceding claims, wherein for pneumatic cylinder of the standard size type having section Ø equal to 32 mm as defined in international standard ISO 15552 and operated at about 5 bar, the clamping moment (M) is substantially equal to 130 N m.

Patentansprüche

1. Gelenkhebelantrieb (10) zum Handhaben und/oder Klemmen von Elementen während der Metallblechverarbeitung zur Herstellung von Kraftfahrzeugkarosserien, umfassend einen Körper (11), in dem ein Steuerkolben (12) gleitend mit dem Körper (11) entlang einer Gleitachse (A) verbunden ist, wobei der Steuerkolben (12) mit Betätigungsmitteln (15) verbunden oder gekoppelt ist, die eine Schubkraft (P) auf den Steuerkolben (12) ausüben können, wobei

- der Steuerkolben (12) operativ mit einem drehbar gelagerten Arm (14) unter Zwischenschaltung eines Gelenkhebelmechanismus (13) gekoppelt ist, um eine Drehbewegung des drehbar gelagerten Arms (14) um eine zur Gleitachse (A) senkrechte Drehachse (B) im Anschluss an eine Gleitbewegung des Steuerkolbens (12) zu induzieren, wobei der drehbar gelagerte Arm (14) zwischen einer offenen oder Nicht-Betriebsstellung und einer geschlossenen oder Betriebsstellung bewegt wird,
- der Gelenkhebelmechanismus (13) eine erste (13a) und eine zweite (13b) Stange umfasst, wobei die erste Stange (13a) an einer Stange (12a) des Steuerkolbens (12) bzw. an der zweiten Stange (13b) drehbar gelagert ist und die zweite Stange (13b) an dem Körper (11) drehbar gelagert ist und den drehbar gelagerten Arm (14) in Drehung versetzt,
- für jede Stellung des drehbar gelagerten Arms anders als die Schließstellung, die vom Steuerkolben (12) ausgeübte Schubkraft (P) ein Klemmmoment (M) an der Drehachse (B) bestimmt, wobei die Betätigungsmittel vom pneumatischen Typ sind, umfassend einen Pneumatikzylinder (15), und
wobei die Betätigungseinheit eine Klemmeinheit oder eine drehbar gelagerte Einheit ist, **dadurch gekennzeichnet, dass**
dieses Klemmmoment (M) an der Drehachse (B) variabel nach dem Gesetz $M = k * P * \overline{AO}$ ist, wobei $\overline{AO}$ die Länge der zweiten Stange ist und kein Proportionalitätsfaktor ist, der in Abhängigkeit von der Schubkraft (P) variabel ist,
und wobei:

- der Pneumatikzylinder vom Typ mit Standardgröße ist und einen Querschnitt Ø von 40 mm aufweist, wie in der internationalen Norm ISO 15552 definiert, die Länge der zweiten Stange (*AO*) gleich etwa 32 mm ist, wobei der Kolbenhub etwa 84,8 mm beträgt, und wobei der Proportionalitätsfaktor (K) einen Wert von etwa 9,25 aufweist und das Klemmmoment zwischen 185 Nm und 190 Nm umfasst, wenn der Pneumatikzylinder mit etwa 5 bar betrieben wird; oder
- der Pneumatikzylinder vom Typ mit Standardgröße ist und einen Querschnitt Ø von 50 mm aufweist, wie in der internationalen Norm ISO 15552 definiert, die Länge der zweiten Stange (*AO*) gleich etwa 35 mm ist, wobei der Kolbenhub etwa 91,77 mm beträgt, und wobei der Proportionalitätsfaktor (K) einen Wert von etwa 11,28 aufweist und das Klemmmoment zwischen 380 Nm und 400 Nm umfasst, wenn der Pneumatikzylinder mit etwa 5 bar betrieben wird; oder
- der Pneumatikzylinder vom Typ mit Standardgröße ist und einen Querschnitt Ø von 32 mm aufweist, wie in der internationalen Norm ISO 15552 definiert, die Länge der zweiten Stange (*AO*) gleich etwa 29 mm ist, wobei der Kolbenhub etwa 77 mm beträgt, und wobei der Proportionalitätsfaktor (K) einen Wert von etwa 11,15 aufweist und das Klemmmoment zwischen 125 Nm und 132 Nm umfasst, wenn der Pneumatikzylinder mit etwa 5 bar betrieben wird; oder
- der Pneumatikzylinder vom Typ mit Standardgröße ist und einen Querschnitt Ø von 63 mm aufweist, wie in der internationalen Norm ISO 15552 definiert, die Länge der zweiten Stange (*AO*) gleich etwa 55 mm ist, wobei der Kolbenhub etwa 144,7 mm beträgt, und wobei der Proportionalitätsfaktor (K) einen Wert von etwa 9,92 aufweist und das Klemmmoment zwischen 845 Nm und 855 Nm umfasst, wenn der Pneumatikzylinder mit etwa 5 bar betrieben wird.

2. Antrieb (10) gemäß Anspruch 1, wobei bei einem Pneumatikzylinder vom Typ mit Standardgröße, der einen Querschnitt Ø von 40 mm aufweist, wie in der internationalen Norm ISO 15552 definiert, und der mit etwa 5 bar betrieben wird, das Klemmmoment (M) im Wesentlichen gleich 186 Nm ist.

3. Antrieb (10) gemäß einem der vorhergehenden Ansprüche, wobei bei einem Pneumatikzylinder vom Typ mit Standardgröße, der einen Querschnitt Ø von 50 mm aufweist, wie in der internationalen Norm ISO 15552 definiert, und der mit etwa 5 bar betrieben wird, das Klemmmoment (M) im Wesentlichen gleich 390 Nm ist.

4. Antrieb (10) gemäß einem der vorhergehenden Ansprüche, wobei bei einem Pneumatikzylinder vom Typ mit Standardgröße, der einen Querschnitt Ø von 63 mm aufweist, wie in der internationalen Norm ISO 15552 definiert, und der mit etwa 5 bar betrieben wird, das Klemmmoment (M) im Wesentlichen gleich 850 Nm ist.

5. Antrieb (10) gemäß einem der vorhergehenden Ansprüche, wobei bei einem Pneumatikzylinder vom Typ mit Standardgröße, der einen Querschnitt Ø von 32 mm aufweist, wie in der internationalen Norm ISO 15552 definiert, und der mit etwa 5 bar betrieben wird, das Klemmmoment (M) im Wesentlichen gleich 130 Nm ist.

Revendications

1. - Unité d'actionnement à levier articulé (10) pour la manipulation et/ou le serrage d'éléments pendant le traitement de tôles pour la fabrication de carrosseries de véhicule automobile, comprenant un corps (11) à l'intérieur duquel un piston de commande (12) est associé de manière coulissante au corps (11) le long d'un axe de coulissement (A), le piston de commande (12) étant relié ou couplé à des moyens d'actionnement (15) aptes à exercer une force de poussée (P) sur le piston de commande (12), dans laquelle

    - le piston de commande (12) est couplé de manière fonctionnelle à un bras pivotant (14) avec l'interposition d'un mécanisme de levier articulé (13) afin d'induire un mouvement de rotation du bras pivotant (14) autour d'un axe de rotation (B) perpendiculaire à l'axe de coulissement (A) suite à un mouvement de coulissement du piston de commande (12), le bras pivotant (14) étant déplacé entre une position ouverte ou de non-fonctionnement et une position fermée ou de fonctionnement,
    - le mécanisme de levier articulé (13) comprend des première (13a) et seconde (13b) tiges, la première tige (13a) étant articulée à pivotement à une tige (12a) du piston de commande (12) et à la seconde tige (13b), respectivement, et la seconde tige (13b) étant articulée à pivotement au corps (11) et mettant le bras pivotant (14) en rotation,
    - pour chaque position du bras pivotant autre que la position fermée, la force de poussée (P) exercée par le piston de commande (12) détermine un moment de serrage (M) sur l'axe de rotation (B),

    les moyens d'actionnement étant du type pneumatique, comprenant un vérin pneumatique (15), et
    l'unité d'actionnement étant une unité de serrage ou une unité de pivotement,
    caractérisée par le fait que
    ledit moment de serrage (M) sur l'axe de rotation (B) est variable selon la loi $M = k * P * \overline{AO}$, où $\overline{AO}$ est la longueur de la seconde tige et k est un facteur de proportionnalité qui est variable en fonction de la force de poussée (P),
    et dans laquelle :

        - le vérin pneumatique est du type de taille standard ayant une section Ø égale à 40 mm, telle que définie dans la norme internationale ISO 15552, la longueur de la seconde tige (AO) est égale à environ 32 mm, la course de piston est égale à environ 84,8 mm, et le facteur de proportionnalité (k) est une valeur d'environ 9,25 et le moment de serrage est compris entre 185 Nm et 190 Nm lorsque le vérin pneumatique fonctionne à environ 5 bars ; ou
        - le vérin pneumatique est du type de taille standard ayant une section Ø égale à 50 mm, telle que définie dans la norme internationale ISO 15552, la longueur de la seconde tige (AO) est égale à environ 35 mm, la course de piston est égale à environ 91,77 mm, et le facteur de proportionnalité est une valeur d'environ 11,28 et le moment de serrage est compris entre 380 Nm et 400 Nm lorsque le vérin pneumatique fonctionne à environ 5 bars ; ou
        - le vérin pneumatique est du type de taille standard ayant une section Ø égale à 32 mm, telle que définie dans la norme internationale ISO 15552, la longueur de la seconde tige (AO) est égale à environ 29 mm, la course de piston est égale à environ 77 mm, et le facteur de proportionnalité (k) est une valeur d'environ 11,15 et le moment de serrage est compris entre 125 Nm et 132 Nm lorsque le vérin pneumatique fonctionne à environ 5 bars ; ou
        - le vérin pneumatique est du type de taille standard ayant une section Ø égale à 63 mm, telle que définie dans la norme internationale ISO 15552, la longueur de la seconde tige (AO) est égale à environ 55 mm, la course de piston est égale à environ 144,7 mm, et le facteur de proportionnalité est une valeur d'environ 9,92 et le moment de serrage est compris entre 845 Nm et 855 Nm lorsque le vérin pneumatique fonctionne à environ 5 bars.

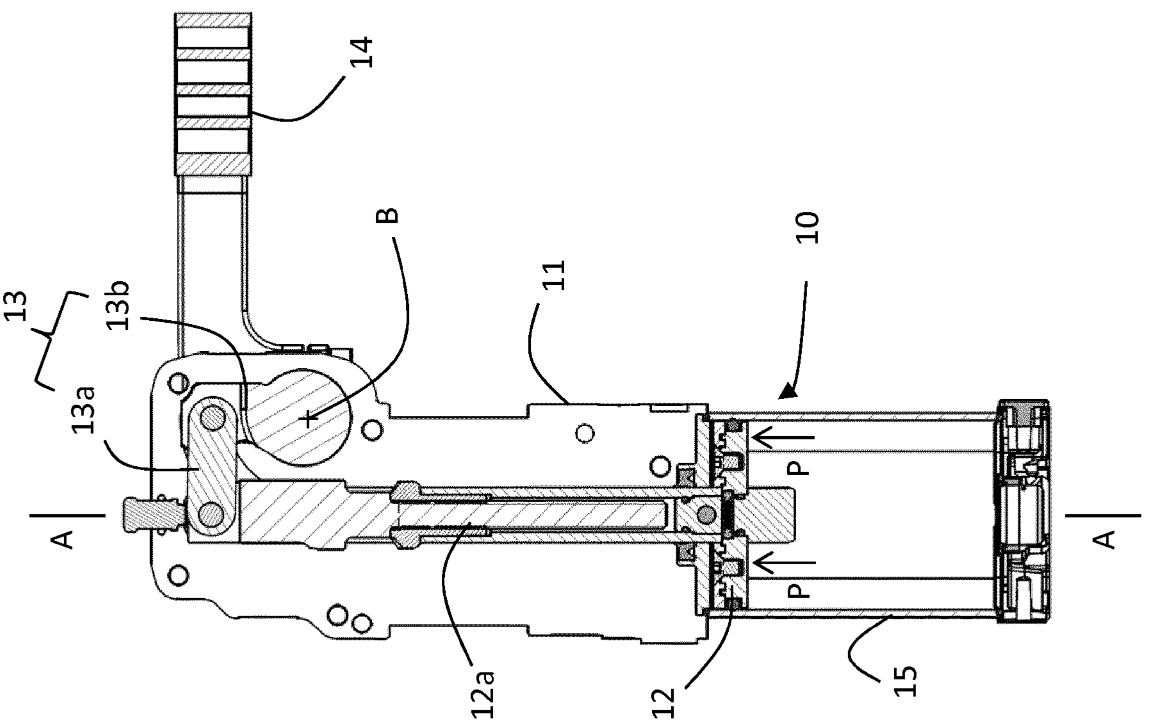
2. - Unité d'actionnement (10) selon la revendication 1, dans laquelle, pour un vérin pneumatique du type de taille standard ayant une section Ø égale à 40 mm telle que définie dans la norme internationale ISO 15552 et fonctionnant à environ 5 bars, le moment de serrage (M) est sensiblement égal à 186 Nm.

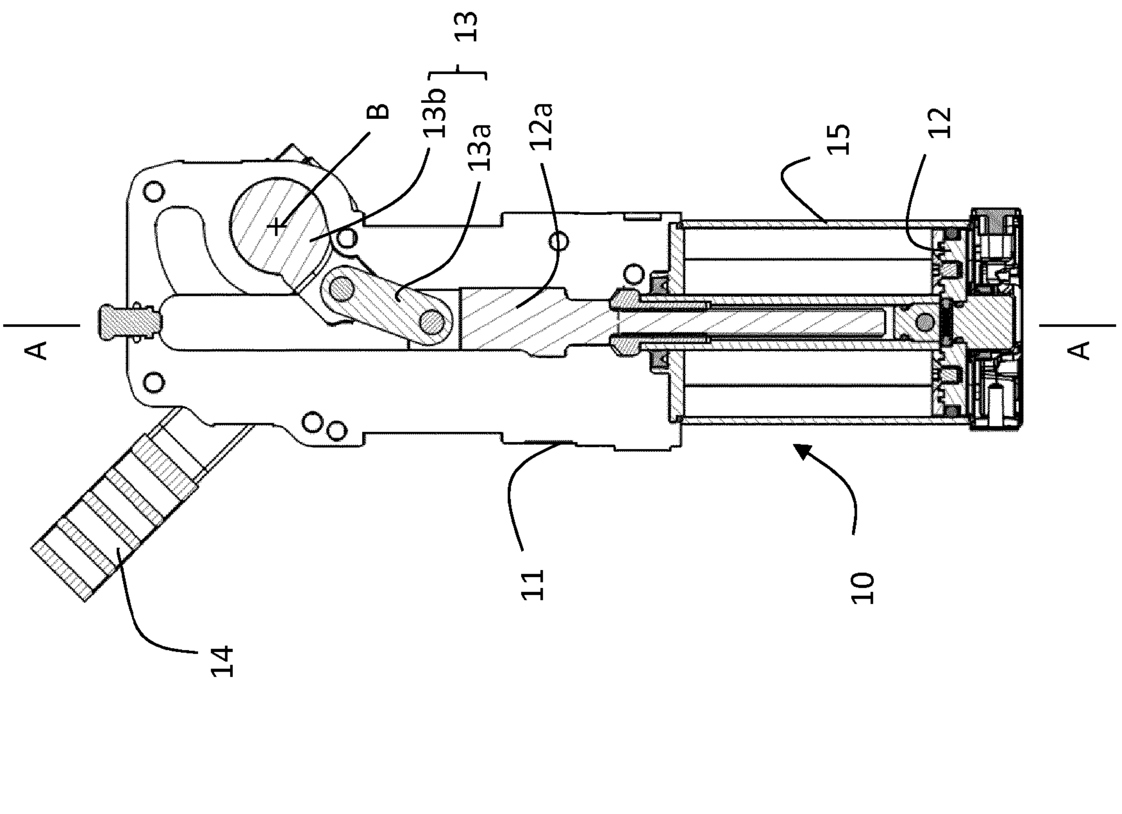
3. - Unité d'actionnement (10) selon l'une quelconque des revendications précédentes, dans laquelle, pour un vérin pneumatique du type de taille standard ayant une section Ø égale à 50 mm telle que définie dans la norme internationale ISO 15552 et fonctionnant à environ 5 bars, le moment de serrage (M) est sensiblement égal à 390 Nm.

4. - Unité d'actionnement (10) selon l'une quelconque des revendications précédentes, dans laquelle, pour un vérin pneumatique de type de taille standard ayant une section Ø égale à 63 mm telle que définie dans la norme inter-

nationale ISO 15552 et fonctionnant à environ 5 bars, le moment de serrage (M) est sensiblement égal à 850 Nm.

5. - Unité d'actionnement (10) selon l'une quelconque des revendications précédentes, dans laquelle, pour un vérin pneumatique du type de taille standard ayant une section Ø égale à 32 mm telle que définie dans la norme internationale ISO 15552 et fonctionnant à environ 5 bars, le moment de serrage (M) est sensiblement égal à 130 Nm.


14
13
13b
13a
B
11
10
A
P
P
A
12a
12
15
FIG. 1b


13
B
13b
13a
12a
15
12
A
A
11
10
14
FIG. 1a

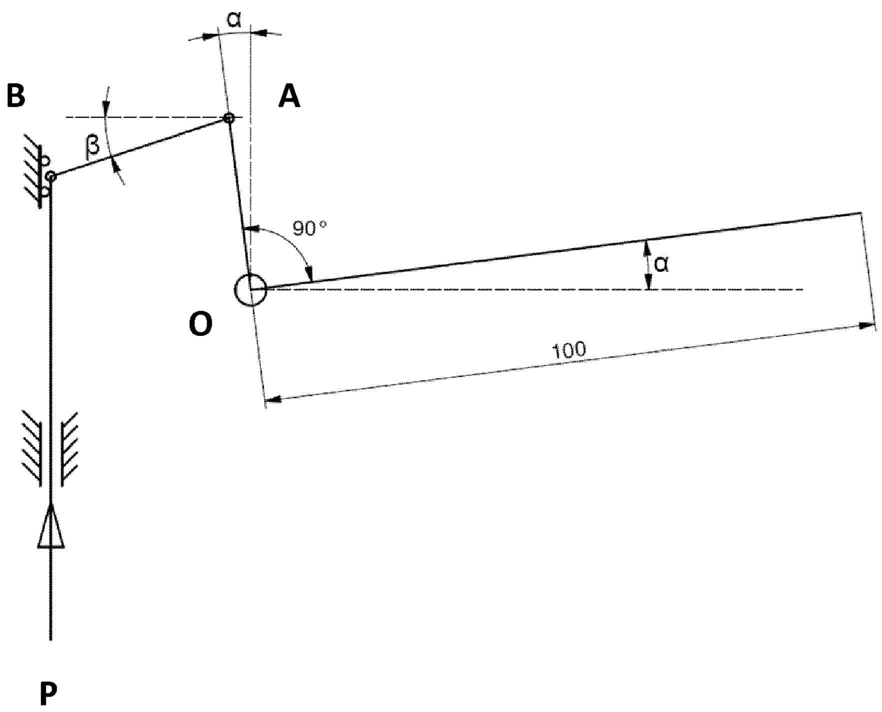


FIG. 2

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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