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(54) **Mechanical latch unit for a main drive unit**

(57) The invention is related to a mechanical latch unit (1) for a main drive (120) unit with a permanently coupled four bar latch mechanism within a housing (9),
- with a first link (20) with a base end connected with the housing (9) via a first joint (25) and with a top end connected with the first end of a second link (40) via a second joint (35),
- with a third joint (45) to connect the second end of the second link (40) with the second end of a third link (50),

- whereby the first end of the third link (50) interconnects with a trip unit and a pivot centre of the third link (50) is connected with the housing (9) via a fourth joint (55),
- whereby the second joint (35), the third joint (45) and the fourth joint (55) approximately are lying in one line and
- whereby the load (F) of the traction link (121) of the main drive unit (120) is applied to the top end of the first link (20) next to the second joint (35) with defined deviation (d1) rectangular to this line in direction to the first joint (25).

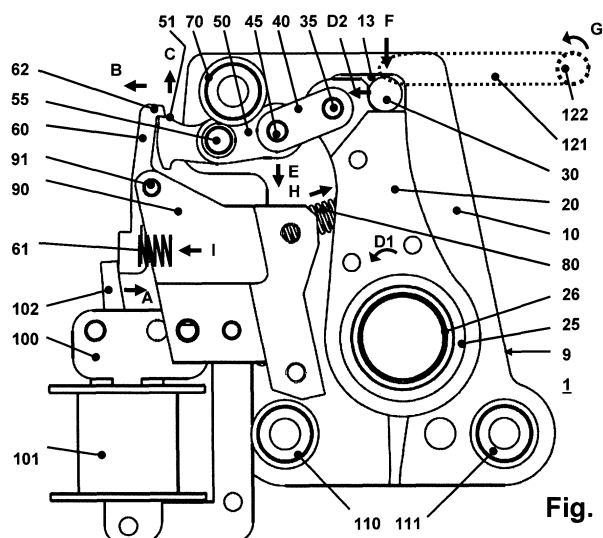


Fig. 1

Description

[0001] The invention relates to a mechanical latch unit for a main drive unit.

[0002] A mechanical latch unit is used to lock/release a mechanical system especially a mechanism formed by links and joints in a defined position or operating stage.

[0003] A typical application of latch units can be found in electromechanical main drive units for contact systems of electric circuit breakers. Technical areas are low voltage, medium voltage and high voltage. Requirements for these latch units especially in the mentioned application areas are:

- high reliability,
- high robustness towards shock and overload conditions,
- large temperature ranges,
- high repeatability with lowest possible response time scatter,
- shortest and adjustable reaction time and total mechanical operation time.

[0004] Typically these requirements and operating conditions imply a complex and high quality and therefore costly system design mainly based on electromechanical subsystems. If these latch units are designed to meet low cost targets usually there have to be compromises in quality and/or performance.

[0005] Therefore it is an objective of this invention to provide a mechanical latch unit for a main drive unit with high reliability, high repeatability with lowest possible scatter in movement time and shortest/adjustable reaction time and total mechanical operation time.

[0006] This problem is solved by a mechanical latch unit for a main drive unit with a permanently coupled four bar latch mechanism within a housing,

- with a first link with a base end connected with the housing via a first joint and with a top end connected with the first end of a second link via a second joint,
- with a third joint to connect the second end of the second link with the second end of a third link,
- whereby the first end of the third link interconnects with a trip unit and a pivot centre of the third link is connected with the housing via a fourth joint,
- whereby the second joint, the third joint and the fourth joint approximately are lying in one line and
- whereby the load of the traction link of the main drive unit is applied to the top end of the first link next to the second joint with defined deviation rectangular to this line in direction to the first joint.

[0007] It is an advantage of the proposed mechanical latch unit for a main drive unit that the proposed design allows fulfilling tough performance requirements based on standard parts replacing the typically used special parts in the state of the art designs. The use of less parts

and standard parts enables to improve the ratio cost to performance of latch designs. A reset in a defined repeatable initial condition after one operation sequence is guaranteed.

[0008] Further advantageous embodiments of the invention are mentioned in the dependent claims.

[0009] The invention will now be further explained by means of an exemplary embodiment and with reference to the accompanying drawings, in which:

Figure 1 shows a side view of a latch unit (sectional view),

Figure 2 shows a three-dimensional view of an opened latch unit,

Figure 3 shows a three-dimensional view of the latch unit,

Figure 4 shows in a side view the frontal area of the latch unit,

Figure 5 shows the relevant links and joints of the latch unit,

Figure 6 shows the relevant links and joints of the latch unit in the form of a line drawing.

[0010] Figure 1 shows a side view of a latch unit (sectional view). The main components of the latch unit 1 are:

- a housing 9 with two housing plates 10,
- a main lever (= first link) 20 within this housing 9, with base end and top end,
- a main bearing 25 (= first joint) at the base end of the main lever 20 fastened to the housing 9, with axle 26,
- a catch (contact) main roller 30 contacting the (free) top end of the main lever 20, whereby this catch main roller 30 is able to move (loosely coupled) within slots 13 implemented (for instance milled) in the housing plates 10,
- a release link 50 (= third link) with first end, pivot centre and second end, whereby the pivot centre is fastened to the housing 9 via a bearing 55 (= fourth joint),
- a release link 40 (= second link) with first end and second end, whereby the first end is fixed to the top end of the main lever 20 via a joint 35 (= second joint) and the second end is fixed to the second end of the release link 50 via a joint 45 (= third joint),
- an end stop bolt 70 fastened to the housing 9, limiting the freedom of movement of the release link 50 and being a stop for a neutral position,
- two external interface bolts 110, 111, representing components of the housing 9 and linking units to fasten with the main drive unit,
- an actuator unit 100 with an actuator coil 101 and a

swivel anchor 102, whereby an integration block 90 acts as linking unit between the actuator unit 100 and the housing 9,

- a main lever return spring 80 which pushes the main lever 20 in a neutral position at which the release link 50 pushes towards the end stop bolt 70,
- an actuator trip lever 60 with first end, pivot centre and second end, whereby the pivot centre is fastened to the integration block 90 via a trip lever bearing 91, the first end contacts the swivel anchor 102, the second end contacts the release link 50 and a trip lever return spring 61 pushes the actuator trip lever 60 in a neutral position, in which a locking latch 62 at the second end of the actuator trip lever 60 locks a locking latch 51 at the first end of the release link 50.

[0011] During locking state (= neutral position) a traction link 121 of a main drive unit 120 (especially an electromechanical drive unit for contact system of electrical circuit breaker) pushes towards the catch main roller 30, see pivot centre 122 of this traction link 121 and direction arrow F which shows the load F respectively the force of the traction link 121 of the main drive unit 120 carried out in direction to the main bearing 25. Fig. 1 shows the neutral position of the latch unit 1 whereby rotation of traction link 121 is blocked by the permanently coupled four bar latch mechanism (together with the catch main roller 30 and releasable locking unit). To operate the main drive unit 120 the following steps occur:

- 1) First a control signal is applied to actuator unit 100 and accordingly swivel anchor 102 moves in direction of arrow A, contacting/pushing first end of the actuator trip lever 60.
- 2) Accordingly the actuator trip lever 60 turns round about trip lever bearing 91 (pivot centre) and this deactivates the releasable locking unit respectively the interlock performed by locking latches 51, 62 - see movement of second end of actuator trip lever 60, expressed by arrow B.
- 3) The release link 50 turns round about bearing 55 (pivot centre) - see movement of the first end of the release link 50 expressed by arrow C and movement of the joint 45 with the second ends of the release links 50 and 40 expressed by arrow E (joint 45 moves downwards and removes from end stop bolt 70) - with simultaneous rotation of main lever 20 round about main bearing 25 - see rotary movement expressed by arrow D1.
- 4) Accordingly catch main roller 30 moves sideways - see movement expressed by arrow D2 - and this releases traction link 121 which turns round about pivot centre 122 of the main drive unit 120 - see rotary movement expressed by arrow G. Thus the desired operation sequence (switching breaking process) will be performed.

[0012] After cessation of control signal to actuator unit 100 the trip lever return spring 61 pushes actuator trip lever 60 back to the neutral position - see movement of the first end of the actuator trip lever 60 expressed by arrow I. After release of traction link 121 the main lever return spring 80 pushes the main lever 20 back to the neutral position - see movement expressed by arrow H.

[0013] After a 360°-rotation the traction link 121 returns to the catch main roller 30 (for instance with the help of an electrical motor of the main drive) and will be blocked. Accordingly the latch unit 1 is prepared for the next operation sequence, for instance the following desired switching breaking process.

[0014] Figure 2 shows a three-dimensional view of an opened latch unit 1. It is shown that the housing plate 10, the main lever 20 and both release links 40, 50 too consist of several sheet metal components, see for instance two sheet metal components 11, 12 of a housing plate 10. The two external interface bolts 110, 111 and the end stop bolt 70 are essential constructional components of the housing 9. Further main bearing 25 with axle 26, catch main roller 30 (movable lateral loosely coupled by slots 13), joints 35, 45 and bearing 55 are shown as well as integration block 90, actuator unit 100 with actuator coil 101, swivel anchor 102 and a part of the actuator trip lever 60.

[0015] Figure 3 shows a three-dimensional view of the latch unit 1. Unlike Figure 2 this Figure 3 shows a closed housing 9 with both housing plates 10 (consisting of sheet metal components 11, 12). Further the external interface bolts 110, 111, the end stop bolt 70, the main lever 20 with the axle 26, and the catch main roller 30 are shown as well as a slot 13, the release links 40, 50, the integration block 90, the actuator unit 100 with the actuator coil 101 and the swivel anchor 102.

[0016] Figure 4 shows in a side view the frontal area of the latch unit 1. The housing 9 with the housing plates 10, the external interface bolts 110, 111 and the end stop bolt 70 are shown as well as the main lever 20 with the axle 26 and the catch main roller 30, the release links 40, 50 with the joints 35, 45 and the bearing 55 just as the actuator unit 100 with the actuator coil 101, the swivel anchor 102 and the actuator trip lever 60.

[0017] Figure 5 shows the relevant links and joints respectively the permanently coupled four bar latch mechanism of the latch unit 1 with

- the main lever 20 respectively the first link with the main bearing 25 respectively the first joint at its base end just as the second joint 35 and the catch main roller 30 at its top end,
- the release link 40 respectively the second link with its first end connected with the second joint 35 and its second end connected with the third joint 45,
- the release link 50 respectively the third link with its free first end interacting as releasable locking unit with the actuator trip lever 60, with its second end connected with the third joint 45 and with its pivot

centre designed as bearing 55 respectively fourth joint.

[0018] The actuator trip lever 60 serves (together with the swivel anchor 102) as trip unit for the permanently coupled four bar latch mechanism, whereby the swivel anchor 102 is applied to the first end of the actuator trip lever 60, the pivot centre is designed as trip lever bearing 91 and the second end interacts as releasable locking unit with the first end of the release link 50.

[0019] Figure 6 shows the relevant links and joints of the latch unit in the form of a line drawing. Again the relevant components of the permanently coupled four bar latch mechanism of the latch unit 1 are shown:

- first link = main lever 20
- second link = release link 40
- third link = release link 50
- first joint = main bearing 25
- second joint = joint 35
- third joint = joint 45
- fourth joint = bearing 55

[0020] Further you can see the load respectively force F carried out to the catch main roller 30 by the traction link 121 of the main drive unit 120 with the pivot centre 122. On the basis of the x/y-coordinate system it is shown that the load respectively force F does not exactly press in direction to the first joint respectively main bearing 25 but there has to be a defined (small) deviation $x = d1$ in order to cause the rotary movement $D1$ and all other movements $D2$, E , C and ultimately rotary movement G after interlock deactivation.

[0021] The described design allows fulfilling tough performance requirements based on a permanently coupled four bar latch mechanism: 25 - 20 - 35 - 40 - 45 - 50 - 55. State of the art latch designs typically use a mixture of only temporary and permanently coupled subsystems which are hard to set and reset in a defined repeatable initial condition after one operation sequence. The permanent coupling of the described four bar latch mechanism instead allows not only for repeatable initial conditions but also for repeatable operation sequence. This is because the four bar latch mechanism constrains each part and its dynamics during the operation at any time.

[0022] The performance versus cost ratio of the four bar design can be easily scaled so the joint units can either be realized with roller or less costly friction bearings. Therefore for applications where the performance requirements in reaction time can be reduced or higher peak load or overload conditions can be expected cheaper but more robust friction bearings can be used. For joint axles standard pins and bolts can be used which integrate high precision and material quality at comparable low cost.

[0023] For the links of the mechanism and the main housing components sheet metal combinations can be used. The sheet metal components can be produced by

stamping (fine blanking), laser cutting or other energy beam technology based manufacturing methods. The sheet metal design has several advantages:

- Easy incremental scaling of the design by adding more or reducing sheet metal layers in order to adapt to different application specific loads.
- Functional integration since the sheet metal production process enables to integrate complex geometry elements. So secondary functional elements can be directly integrated into these sheet metal parts so that the total number of parts in the design can be reduced.
- By use of the right manufacturing process for the sheet metal parts no additional finishing processes like grinding are necessary.

[0024] The sheet metal layers are combined by screwing, riveting, gluing, stamping, welding especially spot welding, friction stir welding, brazing, stamping or a combination of these methods.

[0025] As an alternative housing 9 and link components can be casted or machined (cutted). The housing design can be realized by use of sheet metal concept also. In the preferred embodiment the housing 9 comprises two main parts (housing plates 10), a left and a right housing unit which are fixed and positioned by screws and support sleeves. The support sleeves are connected with screws to the interface of the main drive unit 120 - see the external interface bolts 110, 111. As an option by use of casting the housing 9 can be made out of one single part in case the number of parts needs to be further minimized.

[0026] The four bar latch mechanism in the described latch design can be set in a highly repeatable initial condition by only one pin or bolt - see end stop bolt 70 - which limits the mobility of the mechanism in one direction so that the mechanism can rest in this position. This special position is defined the initial position. The four bar latch mechanism ideally will be placed close to singular position where three joints - 35, 45, 55 - are laying in one line because the holding force of the releasable locking unit F_N required from the tripping actuator unit 100 will be a minimum. For the real design the mechanism will be placed close to the singularity and not in or beyond the singularity by adjusting the bolt position and to guarantee for the required performance. In case the mechanism is placed beyond or too close to the singularity the tripping force or the sensitivity won't be optimal resulting in a too high reaction time and/or less robustness. In order to adjust the pin position and therefore the initial position of the latch mechanism the pin (end stop bolt 70) can be designed as an eccentric pin which enables a tuning functionality and to compensate the effect of manufacturing tolerances. Summing up these features ensure ability for tuning and highly repeatable initial conditions.

[0027] With respect to the initial position of the latch mechanism two different initial positions have to be dis-

tinguished during the functional sequence:

- At the beginning of the resetting movement the mechanism will be moved as far as release link 50 lies close to end stop bolt 70 (which is caused by main lever return spring 80). The locking latches 62 and 51 do not come into contact. The width of the gap between these locking latches 62, 51 can be adjusted by setting-up of an eccentric designed end stop bolt 70.
- As soon as load F is applied to main lever 20 the locking latches 62 and 51 come into contact whereas release link 50 does not contact end stop bolt 70 any more. This initial position is important for the power transmission and the function of the mechanism.

[0028] The mechanism is reset by spring force applied to one or more mechanism link components. For this one or more springs (tension, compression, torsion or complex geometry springs) can be used. In the preferred embodiment one spring - see spring 80 - will act on the main lever 20 and another - see spring 61 - on the trip lever 60. The trip lever 60 will be driven by the trip actuator unit 100 for the release operation but reset by the spring 61 to catch the four bar latch mechanism in the initial position.

[0029] The contact main roller 30 catches load and distributes it within main lever 20 which is made out of sheet metal layers. The main portion of the load is directly transferred into the housing 9 via the main lever 20 (also called catch link) and the main bearing 25. In order to improve the load distribution an additional load sleeve can be introduced between main lever 20 and main bearing 25. The main bearing 25 transfers the load via a standard precision parallel bolt forming the main axles into the housing 9. Throughout the whole linkage chain either roller bearings or friction sleeve bearings can be introduced.

[0030] The integration block 90 which can also be made from sheet metal layers, integrates joint axles and interfaces of several parts in one single part saves parts and reduces tuning effort during assembly due to functional integration. Alternatively to sheet metal layers it can be also made from bended and formed sheet metal parts, machine cutted part or a casted part.

[0031] List of reference signs

1	latch unit	
9	housing	
10	housing plates	
11	sheet metal component	50
12	sheet metal component	
13	slots in housing plates	
20	main lever (catch link) = first link with base end and top end	
25	main bearing = first joint	55
26	axle	
30	catch (contact) main roller	
35	second joint	

40	release link = second link with first end and second end	
45	third joint	
50	release link = third link with first end, pivot centre and second end	
51	locking latch	
55	bearing = fourth joint	
60	actuator trip lever with first end, pivot centre and second end	
61	trip lever return spring	10
62	locking latch	
70	end stop bolt	
80	main lever return spring	
90	integration block	
91	trip lever bearing	15
100	actuator unit	
101	actuator coil	
102	swivel anchor	
110	external interface bolt	
111	external interface bolt	20
120	main drive unit (electromechanical drive unit for contact system of electrical circuit breaker)	
121	traction link	
122	pivot centre	
A	movement of the swivel anchor 102	25
B	movement of the second end of the actuator trip lever 60	
C	movement of the first end of the release link 50	
D1	rotary movement of the main lever 20	
D2	movement of the catch main roller 30	30
E	movement of the joint 45 with the second ends of the links 40, 50	
F	load, force of the traction link 121	
F _N	holding force of the releasable locking unit	
G	rotary movement of the traction link 121	35
H	movement of the main lever 20	
I	movement of the first end of the actuator trip lever 60	

Claims

1. Mechanical latch unit (1) for a main drive unit (120) with a permanently coupled four bar latch mechanism within a housing (9),

- with a first link (20) with a base end connected with the housing (9) via a first joint (25) and with a top end connected with the first end of a second link (40) via a second joint (35),
- with a third joint (45) to connect the second end of the second link (40) with the second end of a third link (50),
- whereby the first end of the third link (50) interconnects with a trip unit and a pivot centre of the third link (50) is connected with the housing (9) via a fourth joint (55),
- whereby the second joint (35), the third joint

(45) and the fourth joint (55) approximately are lying in one line and

- whereby the load (F) of the traction link (121) of the main drive unit (120) is applied to the top end of the first link (20) next to the second joint (35) with defined deviation (d1) rectangular to this line in direction to the first joint (25). 5

2. Mechanical latch unit according to claim 1, **characterized in that** a catch main roller (30) is inserted between the traction link (121) of the main drive unit (120) and the top end of the first link (20). 10
3. Mechanical latch unit according to claim 2, **characterized in that** the catch main roller (30) is guided/loosely coupled by slots (13) implemented in the housing plates (10). 15
4. Mechanical latch unit according to any of the preceding claims, **characterized in that** an end stop bolt (70) limits the freedom of movement of the third link (50) and being a stop for a neutral position. 20
5. Mechanical latch unit according to any of the preceding claims, **characterized in that** a locking latch (62) at the second end of an actuator trip lever (60) locks a locking latch (51) at the first end of the third link (50). 25
6. Mechanical latch unit according to claim 5, **characterized in that** a trip lever return spring (61) pushes the actuator trip lever (60) in a neutral position. 30
7. Mechanical latch unit according to any of the preceding claims, **characterized in that** a main lever return spring (80) pushes the first link (20) in a neutral position. 35

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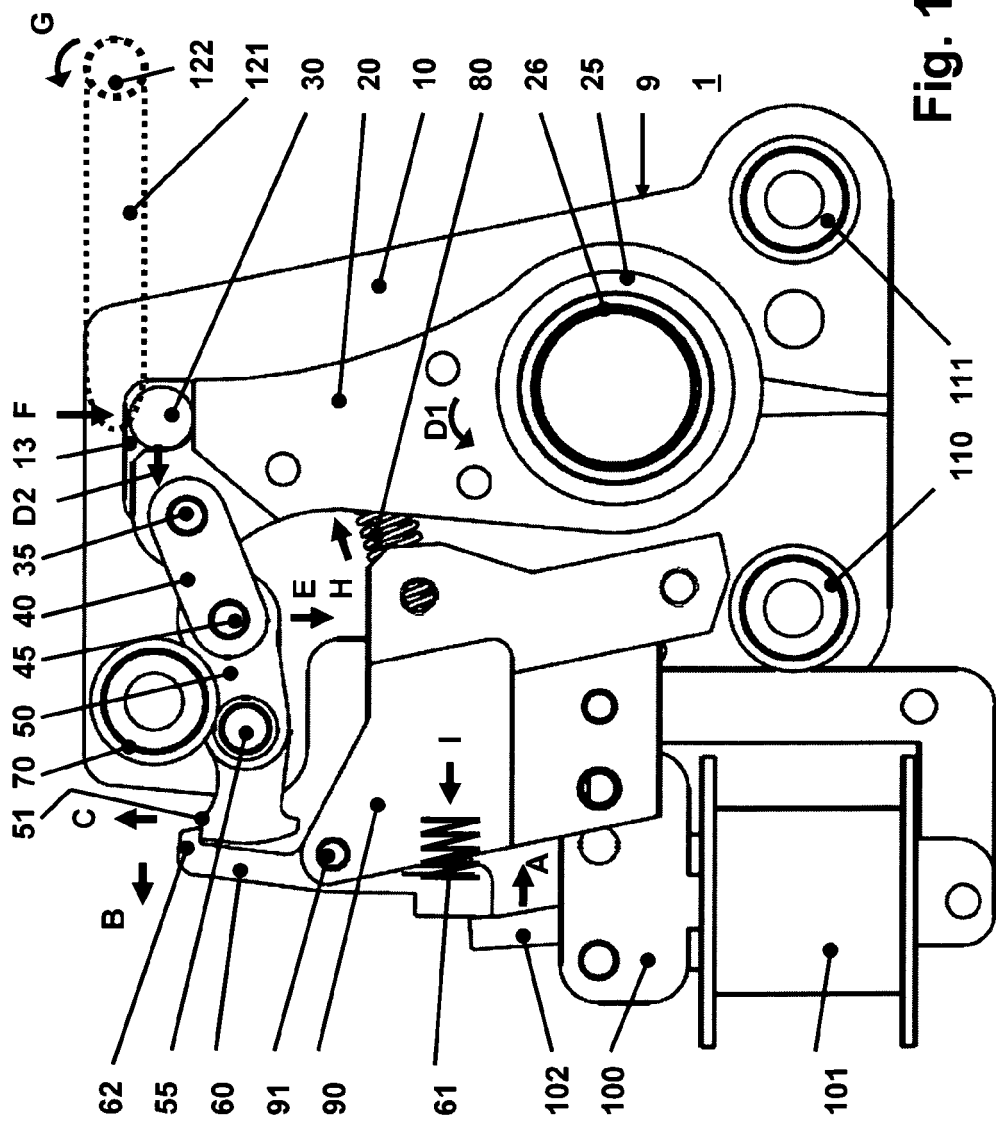


Fig. 1

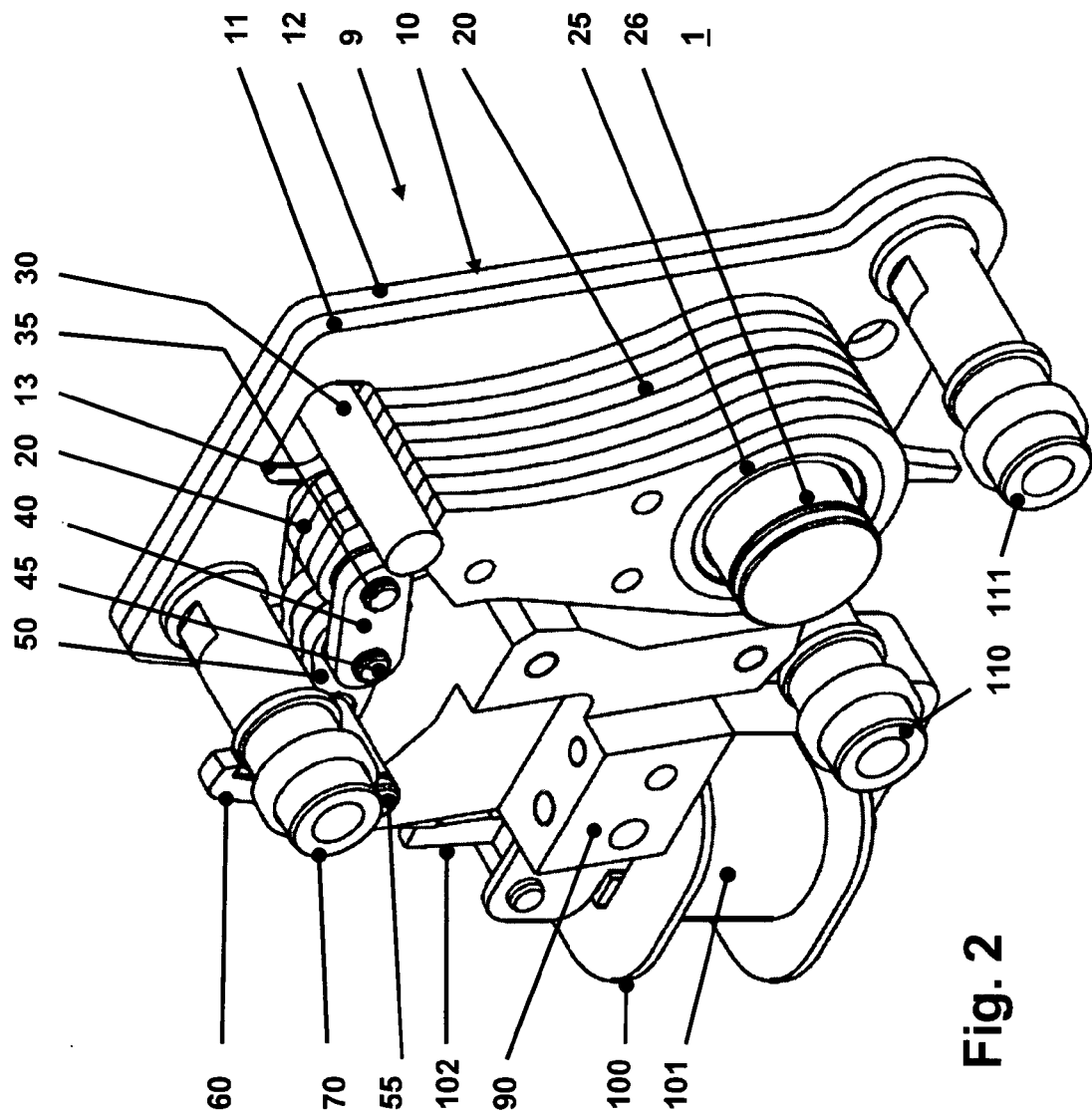


Fig. 2

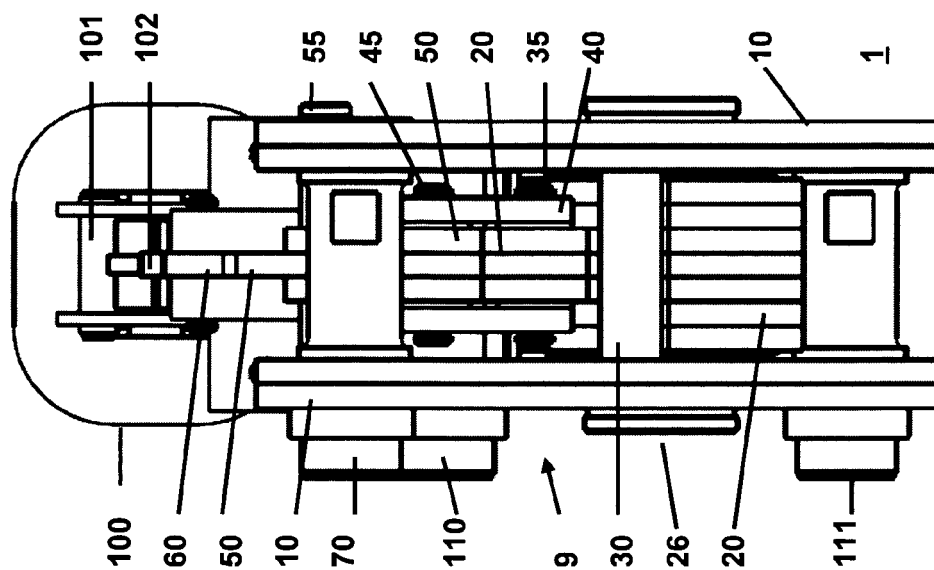


Fig. 4

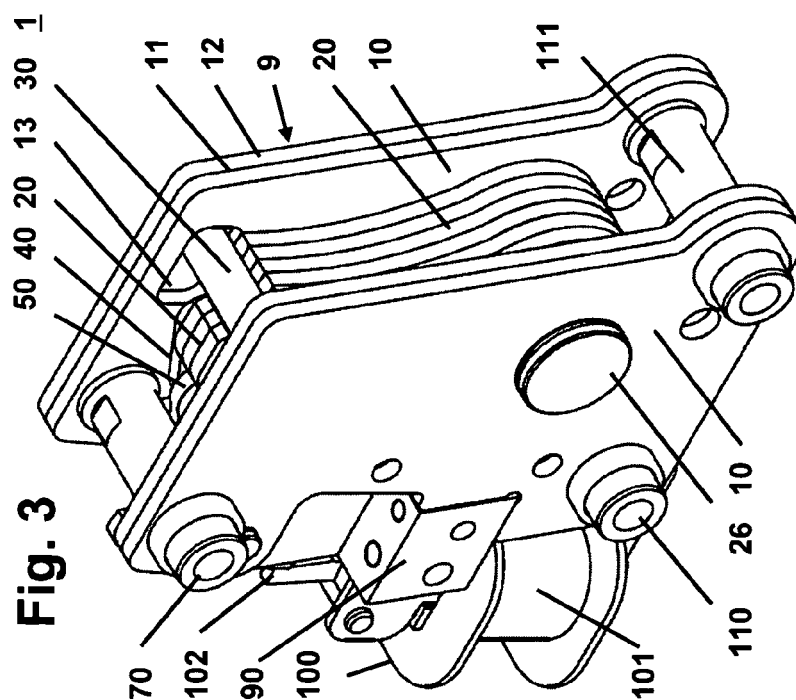


Fig. 3

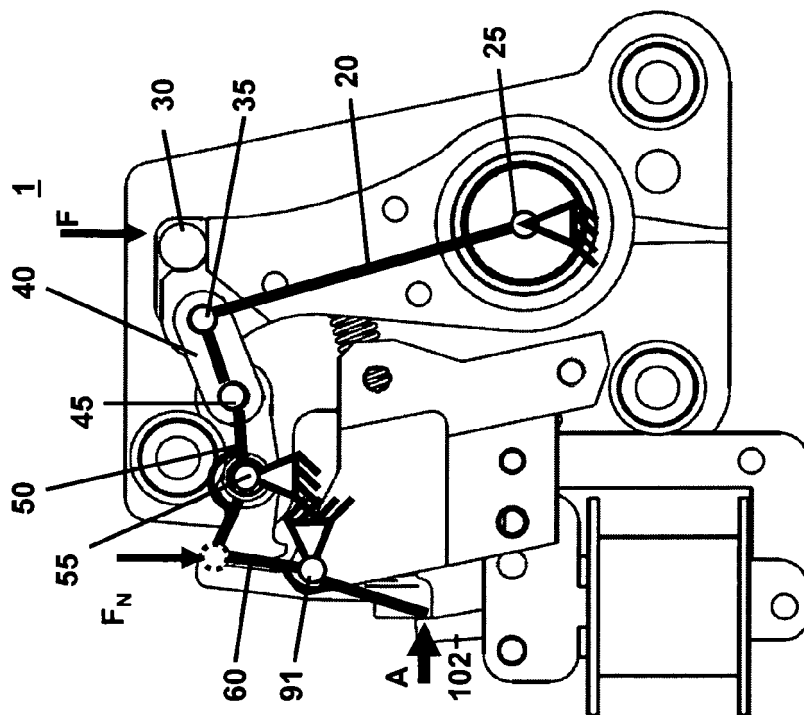


Fig. 5

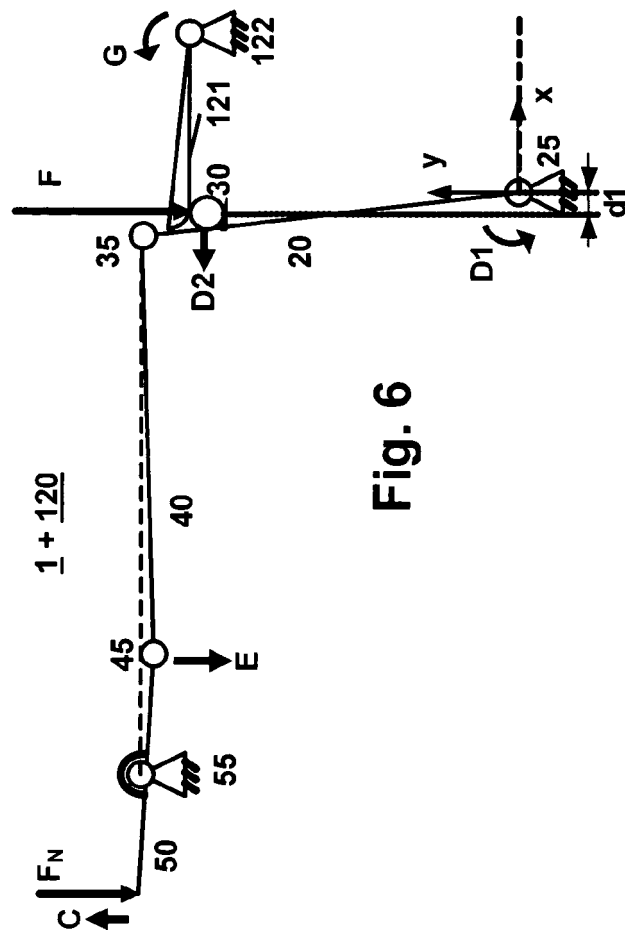


Fig. 6



EUROPEAN SEARCH REPORT

Application Number
EP 09 00 5973

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 2008/271982 A1 (GIBSON PERRY R [US] ET AL) 6 November 2008 (2008-11-06) * paragraphs [0039], [0042] - [0044], [0050] - [0052] * * figures 3-5 *	1	INV. H01H71/50
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			H01H
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 16 September 2009	Examiner Glaman, C
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			

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EPO FORM 1503 03.02 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 09 00 5973

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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16-09-2009

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