(19) Octrooicentrum Nederland

(11) **2009202**

(12)C **OCTROOI**

(21) Aanvraagnummer: **2009202**

(22) Aanvraag ingediend: **17.07.2012**

(51) Int.Cl.:
A61B 17/29 (2006.01)

(43) Aanvraag gepubliceerd:
-

(47) Octrooi verleend:
20.01.2014

(45) Octrooischrift uitgegeven:
29.01.2014

(73) Octrooihouder(s):
Technische Universiteit Delft te Delft.
Stichting voor de Technische Wetenschappen te Utrecht.

(72) Uitvinder(s):
Nima Tolou te DELFT.
Johannes Lassooij te Delft.
Justus Laurens Herder te DELFT.

(74) Gemachtigde:
mr. ir. J. van Breda c.s. te Amsterdam.

(54) **Grasper embodied with a bi-stable element.**

(57) Grasper embodied with a bi-stable element and grasper legs, which legs have a stable first position and a stable second position, wherein converting between the first position and the second position and vice versa is supported by the bi-stable element, wherein when the legs are disconnected from the bi-stable element the grasper legs are preferably in the first position and exhibit positive stiffness when converting from the first position to the second position, and that with the bi-stable element connected to the grasper legs and converting the legs from the first position to the second position, the bi-stable element is arranged with negative stiffness that is higher in magnitude and counteracts the positive stiffness of the grasper legs.

NL C 2009202

Dit octrooi is verleend ongeacht het bijgevoegde resultaat van het onderzoek naar de stand van de techniek en schriftelijke opinie. Het octrooischrift komt overeen met de oorspronkelijk ingediende stukken.

Grasper embodied with a bi-stable element

The invention relates to a grasper embodied with a bi-stable element and grasper legs, which legs have a stable first position and a stable second position, wherein converting between the first position and the second position and vice versa is supported by the bi-stable element.

An elastic yet not bi-stable grasper is proposed on the Internet on July 9, 2010 on the website **www.*compliant*mechanisms.3me.tudelft.nl/.../MSc_*Bi-stable element.*** According to this website conventional graspers transfer force and motion by utilizing multiple rigid links and kinematic joints. A compliant grasper on the other hand is a mechanism that gains some or all of its motion from the relative flexibility of its members rather than from rigid-body joints, which provides numerous advantages such as single-piece production, absence of coulomb friction, no need for lubrication, compactness, etc. Further, bi-stability has been an important topic in compliant mechanisms such as MEMS. These mechanisms only have two stable positions and the energy which is needed to achieve the same displacement compared to conventional compliant mechanisms is less. The website proposes to develop a high performance compliant grasper which is bi-stable. The design according to his research proposal should provide a fully compliant grasper which has two stable positions, i.e. "open" and "close". The bi-stability should allow the grasper to work in a wider range of displacement with less input energy (force) required than available designs and grasp all size of subject-matter within the legs of the grasper.

The invention is not limited to a compliant grasper but may also relate to the grasper that is embodied with rigid parts that are connected through joints.

One of the problems with conventional graspers is that when the grasper holds something between the legs, a continuous grasping force is required to maintain the grabbed subject matter between the legs of the grasper. Specifically with surgical graspers, this may cause fatigue in the sur-

geons muscles which is detrimental, particularly when the grasper is used in laparoscopic surgery.

Another problem with graspers, specifically with surgical graspers, is that generally speaking there is insufficient force feedback which is detrimental for the accuracy of the operation that is performed with the grasper.

The invention aims to provide a solution to the above mentioned problems and to provide an alternative for existing solutions known from the prior art.

The grasper of the invention is to that end provided with the features of one or more of the appended claims. It is expressly pointed out that the features that are provided in any one of the appended claims may be applied independent from the features of any of the other claims. This applies also when such features are mentioned in a claim that is dependent from one or more other claims.

In a first aspect, the grasper of the invention that is embodied with a bi-stable element and grasper legs, wherein the legs have a stable first position (the first position being preferably although not necessarily the open position) and a stable second position (the second position being preferably although not necessarily the closed position), and wherein conversion between the first position and the second position and vice versa is supported by the bi-stable element, has the features that when the legs are disconnected from the bi-stable element, said legs are preferably in the first position and exhibit positive stiffness when converting from the first position to the second position, and that with the bi-stable element connected to the grasper legs and converting the legs from the first position to the second position, the bi-stable element is arranged with negative stiffness that is higher in magnitude and counteracts the positive stiffness of the grasper legs. This arranges that the single or mere combination of the grasper legs with the bi-stable element exhibits negative stiffness and bi-stable behavior and provides an effective solution to avoid the situation that continuously a force must be applied to the grasper in order to hold subject matter that is grabbed with the legs of

the grasper. The bi-stable element provides a prestressed grasper, which alters the total amount of its potential energy. This enables the (surgical) grasper to provide the necessary force to hold for instance tissue or a needle for an endured period of time and without effort by the surgeon.

Preferably the grasper legs are embodied with flexible beams that merge between the legs into an actuation part. The actuation part can then be used for manipulation of the grasper legs. Beneficially then the actuation part is connectable to the bi-stable element.

There are of course many variations feasible to the grasper of the invention with the above mentioned features. One of the possible embodiments that is preferred for effectively linking the actuation part and the bi-stable element, has the features that the actuation part is embodied with a screw threaded protrusion extending from the actuation part through a hole in the bi-stable element. Preferably the screw threaded protrusion is provided with fixing means that are movable along the screw threaded protrusion to enable adjusting the location where the bi-stable element connects to the screw threaded protrusion. This enables preloading of the bi-stable element so as to cause that there is a well-defined first position of the grasper legs.

In another aspect of the invention the grasper is embodied with a bi-stable element and grasper legs, which legs have a stable first position and a stable second position, wherein converting between the first position and the second position and vice versa is supported by the bi-stable element, wherein when the grasper legs are disconnected from the bi-stable element said legs have preference for the first position and exhibit positive stiffness when converting from the first position to the second position, and that the bi-stable element is arranged with negative stiffness so as to arrange that with the bi-stable element connected to the grasper legs and converting the legs from the first position to the second position, the negative stiffness of the bi-stable element compensates the grasper's positive stiffness so as to provide that the legs are statically balanced. By

this arrangement it is possible not only to merely improve the grasper but to provide effective force feedback to a user of the grasper, and make working with the grasper of the invention a pleasure.

It is further possible to implement the grasper of the invention such that the actuation part is spring-loaded to provide additional positive stiffness to the positive stiffness of the grasper legs in order to substantially match the negative stiffness of the bi-stable element when the legs convert between the first position and the second position. This effectively enables fine-tuning of the static balancing of the grasper of the invention.

Another embodiment of the grasper of the invention which can be applied independent from the other features as discussed herein or in addition thereto, has the features that the grasper is embodied with a bi-stable element and grasper legs, which legs have a stable first position and a stable second position, wherein converting between the first position and the second position and vice versa is supported by the bi-stable element, and wherein when the grasper legs are disconnected from the bi-stable element said legs have preference for the first position and exhibit positive stiffness when converting from the first position to the second position, and that the bi-stable element is arranged with negative stiffness, and that further an actuation part connects to the grasper legs which is spring-loaded to provide additional positive stiffness to the positive stiffness of the grasper legs in order to substantially match the negative stiffness of the bi-stable element when the legs convert between the first position and the second position, and that said actuation part is convertible between said spring-loaded condition and a non-spring-loaded condition so as to arrange that in the non-spring-loaded condition the grasper legs with the connected bi-stable element exhibit negative stiffness when the legs convert between the first position and the second position, and that in the spring-loaded condition the grasper legs with the connected bi-stable element exhibit zero or near to zero stiffness when the legs convert

between the first position and the second position. In this manner the grasper becomes switchable between a bi-stable operation in the non-spring-loaded condition, and a statically balanced operation in the spring-loaded condition. This can be effectively arranged when a screw threaded protrusion extends from an actuation part of the grasper legs, and by mounting a spring on said screw threaded protrusion wherein the simultaneous movement of the spring with the screw threaded protrusion is selectable between a limited range and an unlimited range. Suitably therefore a movable stop is provided which can be placed in a position to limit the excursion of the spring when said spring moves together with the screw threaded protrusion.

The invention will hereinafter be further elucidated with reference to the drawing.

In the drawing:

-figure 1 shows a first exemplary embodiment of a grasper in accordance with the invention;

-figure 2 shows an exploded view of a second exemplary embodiment of a grasper in accordance with the invention;

-figure 3 shows in detail the connection between a bi-stable element and an actuation rod that form part of the grasper shown in figure 2;

-figure 4 shows a schematic drawing of the grasper of figure 1, having an actuation rod that is switchable between the spring-loaded and non-spring-loaded condition.

Whenever in the figures the same reference numerals are applied, these numerals refer to the same parts.

Figure 1 shows in accordance with the invention a typical example of a grasper 1 embodied with a bi-stable element 2 and grasper legs 3. The legs 3 have a stable first position and a stable second position, and converting between the first position and the second position or vice versa is supported by the bi-stable element 2. When disconnected from the bi-stable element 2 the grasper legs 3 are structured to have preference for the first position, for instance the open position. The grasper legs 3 further exhibit positive stiffness when converting from the first (preferably open) posi-

tion to the second (preferably closed) position. When the bi-stable element 2 is connected to the grasper legs 3, as is shown in figure 1, during converting the legs 3 from the first position to the second position, the bi-stable element exhibits negative stiffness that is higher in magnitude and counteracts the positive stiffness of the grasper legs 3. The combination of the grasper legs 3 with the bi-stable element 2 thus Exhibits negative stiffness and bi-stable behavior.

As is shown in the typical grasper 1 of figure 1, yet also present in the grasper 1 shown in figure 2 and figure 4, the grasper legs 3 are embodied with flexible beams 4 that merge between the legs 3 into an actuation part 5. The actuation part 5 is connected to the bi-stable element 2.

With reference to figure 4 is shown that the actuation part 5 has a protrusion 6 which is preferably screw threaded and extends from the actuation part 5. This (preferably screw threaded) protrusion 6 extends through a hole 7 in the bi-stable element 2 (see the exploded view of figure 2). The protrusion 6 is provided with fixing means, for instance nuts 8, that are movable along the screw threaded protrusion 6 to enable adjusting the location where the bi-stable element 2 connects to the protrusion 6. Thus when the legs 3 convert between the first position and the second position the negative stiffness of the bi-stable element 2 is capable to compensate the positive stiffness of the legs 3 so as to provide that the legs 3 are statically balanced.

With reference further to figure 4 it is shown that the actuation part 5 can be implemented as spring-loaded by spring 9 to provide additional positive stiffness to the positive stiffness of the grasper legs 3 in order to substantially match the negative stiffness of the bi-stable element 2 when the legs 3 convert between the first position and the second position. This figure 4 also shows that the actuation part 5 can be arranged to be convertible between a spring-loaded condition and a non-spring-loaded condition. For this purpose the spring 9 can be switched between loading and not loading the actuation part 5. In the non-spring-loaded condition the grasper legs 3 with the connected bi-stable element

2 exhibit negative stiffness when the legs 3 convert between the first position and the second position, whereas in the spring-loaded condition the grasper legs 3 with the connected bi-stable element 2 can be arranged to exhibit zero or near to zero stiffness when the legs 3 convert between the first position and the second position.

For the purpose of switching the spring 9 and arranging the changeover between the spring-loaded condition and the non-spring-loaded condition of the actuation part 5 of the grasper 1 of the invention, the spring 9 can be suitably mounted on the screw threaded protrusion 6. It can then be arranged that simultaneous movement of the spring 9 with the screw threaded protrusion 6 is possible in the non-spring-loaded condition by selecting an unlimited excursion range of the spring 9. If on the other hand the excursion range of the spring 9 is limited, the actuation part 5 connected to the screw threaded protrusion 6 is placed in the spring-loaded condition. This can be effectively implemented by arranging that a movable stop 10 is provided which can be placed in a position to limit the excursion of the spring 9 by engaging it when said spring 9 moves together with the screw threaded protrusion 6. This condition is shown in figure 4. Movement of the stop 10 in accordance with the arrows arranges for the switchover between the spring-loaded condition and the non-spring-loaded condition of the actuation part 5 of the grasper 1 of the invention. In this non-spring-loaded condition the grasper number 1 of the invention exhibits bi-stable behavior of its legs 3.

It is specifically pointed out that the foregoing description with reference to examples of graspers in accordance with the invention serves to explain the principles of the invention, without intent to limit the appended claims to what is shown in the drawings. On the contrary, the scope of protection that merits the invention is solely determined by the appended claims.

CONCLUSIES - III

1. Grijper (1) uitgevoerd met een bistabiel element (2) en grijperbenen (3), welke benen een stabiele eerste positie en een stabiele tweede positie bezitten, waarin de overgang tussen de eerste positie en de tweede positie en vice versa ondersteund wordt door het bistabiele element (2), **met het kenmerk**, dat wanneer deze losgenomen zijn van het bistabiele element (2) de grijperbenen (3) voorkeur bezitten voor de eerste positie en positieve stijfheid bezitten wanneer deze overgaan van de eerste positie naar de tweede positie, en dat het bistabiele element (2) is ingericht met negatieve stijfheid, waarbij verder een actueringsdeel (5) verbonden is met de grijperbenen (3) en genoemd actueringsdeel (5) veerbelast is voor het verschaffen van additionele positieve stijfheid aan de positieve stijfheid van de grijperbenen (3), teneinde in hoofdzaak de negatieve stijfheid van het bistabiele element (2) te evenaren wanneer de benen (3) converteren tussen de eerste positie en de tweede positie, en dat genoemd actueringsdeel (5) converteerbaar is tussen genoemde veerbelaste conditie en een niet-veerbelaste conditie, teneinde te bewerkstelligen dat in de niet-veerbelaste conditie de grijperbenen (3) met het verbonden bistabiele element (2) negatieve stijfheid bezitten wanneer de benen (3) converteren tussen de eerste positie en de tweede positie, en dat in de veerbelaste conditie de grijperbenen (3) met het verbonden bistabiele element (2) nul-stijfheid of bijna nul-stijfheid bezitten wanneer de benen (3) converteren tussen de eerste positie en de tweede positie.

2. Grijper (1) volgens conclusie 1, waarin een van schroefdraad voorzien uitsteeksel (6) reikt vanaf een actueringsdeel (5) van de grijperbenen (3), **met het kenmerk**, dat een veer (9) gemonteerd is op genoemde van schroefdraad voorziene uitsteeksel (6) en de gelijktijdige beweging van de veer (9) met het van schroefdraad voorziene uitsteeksel (6) selecteerbaar is tussen een beperkt verplaatsingsbereik en een onbeperkt verplaatsingsbereik.

3. Grijper (1) volgens conclusie 2, **met het kenmerk**,

dat een beweegbare stop (10) is voorzien welke geplaatst kan worden in een positie om in te grijpen op de veer (9) wanneer genoemde veer (9) tegelijk beweegt met het van schroefdraad voorziene uitsteeksel (6).

4. Grijper (1) volgens een der voorgaande conclusies, **met het kenmerk**, dat de grijperbenen (3) uitgevoerd zijn met flexibele balken (4) die tussen de benen (3) overgaan in een actueringsdeel (5), en dat het actueringsdeel (5) verbindbaar is met het bistabiele element (2).

5. Grijper (1) volgens een der voorgaande conclusies, **met het kenmerk**, dat het actueringsdeel (5) een met schroefdraad uitgevoerd uitsteeksel (6) bezit dat reikt vanaf het actueringsdeel (5) door een gat (7) in het bistabiele element (2), waarbij het van schroefdraad voorziene uitsteeksel (6) is voorzien van fixeermiddelen (8) die beweegbaar zijn langs het van schroefdraad voorziene uitsteeksel (6) teneinde mogelijk te maken om de locatie in te stellen waar het bistabiele element (2) in verbinding staat met het van schroefdraad voorziene uitsteeksel (6).

6. Grijper (1) volgens een der voorgaande conclusies, **met het kenmerk**, dat de negatieve stijfheid van het bistabiele element (2) hoger in omvang is en tegenwerkt aan de positieve stijfheid van de grijperbenen (3), teneinde te bewerkstelligen dat de enkele combinatie van de grijperbenen (3) met het bistabiele element (2) negatieve stijfheid bezit en bistabiel gedrag vertoont.

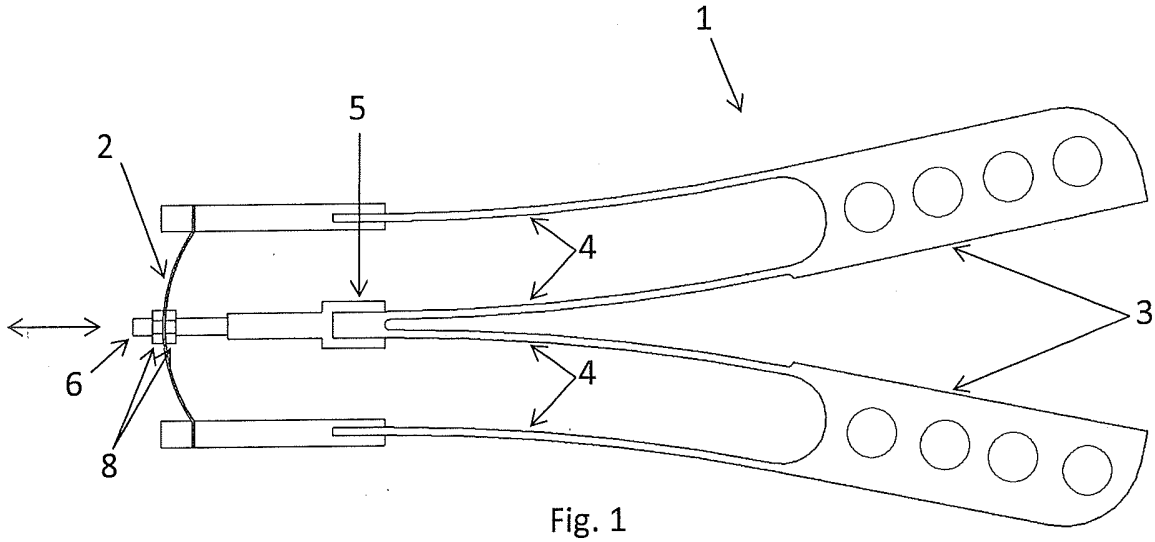


Fig. 1

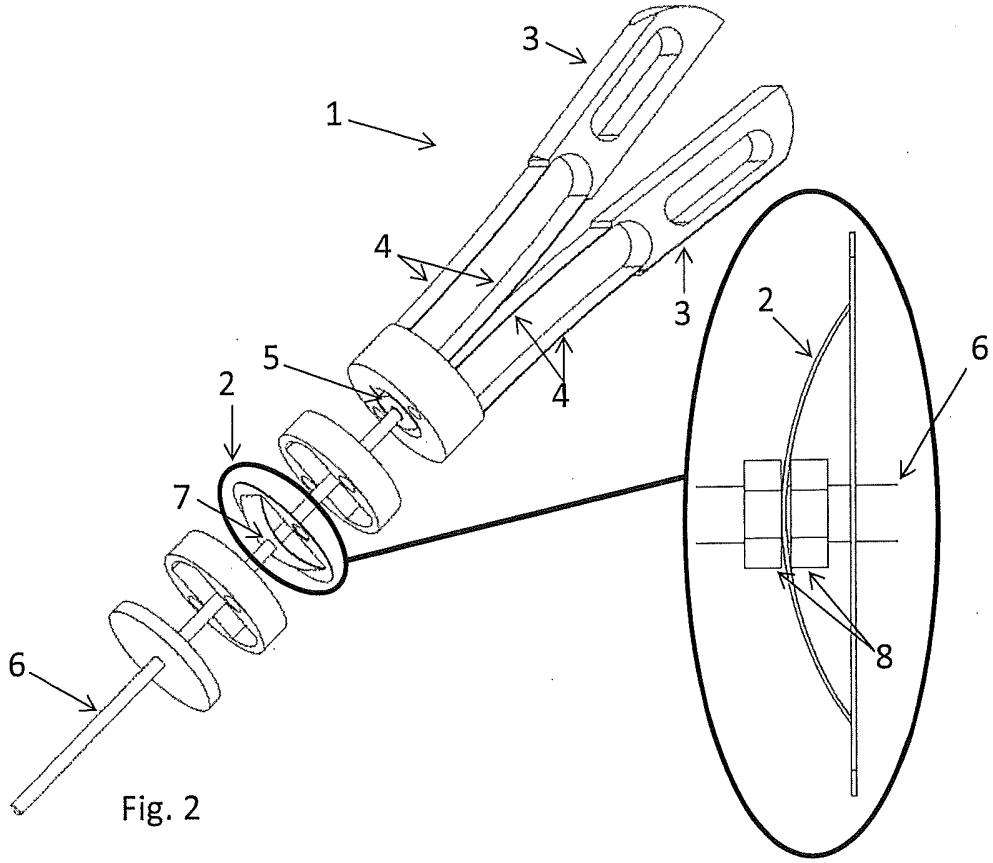


Fig. 2

Fig. 3

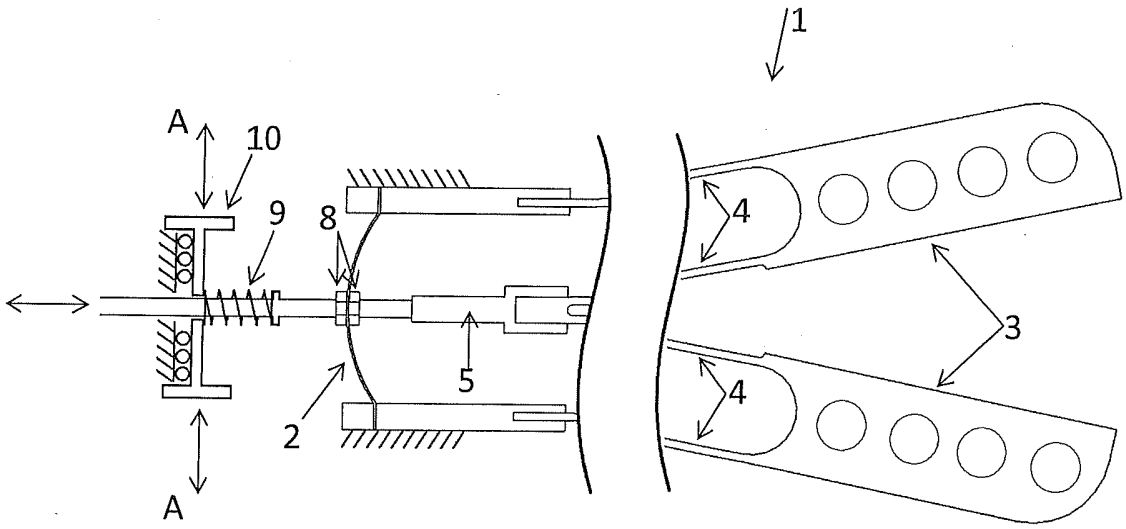


Fig. 4

SAMENWERKINGSVERDRAG (PCT)

RAPPORT BETREFFENDE NIEUWHEIDSONDERZOEK VAN INTERNATIONAAL TYPE

IDENTIFICATIE VAN DE NATIONALE AANVRAGE	KENMERK VAN DE AANVRAGER OF VAN DE GEMACHTIGDE
	NL 48814 III-VB
Nederlands aanvraag nr. **2009202**	Indieningsdatum **17-07-2012**
	Ingeroepen voorrangsdatum
Aanvrager (Naam) **Technische Universiteit Delft, et al**	
Datum van het verzoek voor een onderzoek van internationaal type **01-09-2012**	Door de Instantie voor Internationaal Onderzoek aan het verzoek voor een onderzoek van internationaal type toegekend nr. **SN 58781**

I. CLASSIFICATIE VAN HET ONDERWERP (bij toepassing van verschillende classificaties, alle classificatiesymbolen opgeven)

Volgens de internationale classificatie (IPC)

A61B17/29

II. ONDERZOCHTE GEBIEDEN VAN DE TECHNIEK

Onderzochte minimumdocumentatie

Classificatiesysteem	Classificatiesymbolen
IPC8	**A61B**

Onderzochte andere documentatie dan de minimum documentatie, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen

III.	☐ **GEEN ONDERZOEK MOGELIJK VOOR BEPAALDE CONCLUSIES**	(opmerkingen op aanvullingsblad)
IV.	☐ **GEBREK AAN EENHEID**	(opmerkingen op aanvullingsblad)

ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Nummer van het verzoek om een onderzoek naar de stand van de techniek
NL 2009202

A. CLASSIFICATIE VAN HET ONDERWERP
INV. A61B17/29
ADD.

Volgens de Internationale Classificatie van octrooien (IPC) of zowel volgens de nationale classificatie als volgens de IPC.

B. ONDERZOCHTE GEBIEDEN VAN DE TECHNIEK

Onderzochte miminum documentatie (classificatie gevolgd door classificatiesymbolen)
A61B

Onderzochte andere documentatie dan de mimimum documentatie, voor dergelijke documenten, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen

Tijdens het onderzoek geraadpleegde elektronische gegevensbestanden (naam van de gegevensbestanden en, waar uitvoerbaar, gebruikte trefwoorden)
EPO-Internal, WPI Data

C. VAN BELANG GEACHTE DOCUMENTEN

Categorie °	Geciteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages	Van belang voor conclusie nr.
A	WO 2012/058611 A2 (PARE SURGICAL INC [US]; FLEENOR RICHARD P [US]; BROMLEY ROBERT L [US]) 3 mei 2012 (2012-05-03) * bladzijden 19-20; figuren 4a,4b,4c,1,3a,3b *	1
A	US 2010/292724 A1 (RAVIKUMAR SUNDARAM [US] ET AL) 18 november 2010 (2010-11-18) * alinea [0059] - alinea [0061]; figuren 8a,8b,8c,8d *	1
A	DE 100 31 773 A1 (ERBE ELEKTROMEDIZIN [DE]) 15 november 2001 (2001-11-15) * figuren 5-9 *	1
A	EP 1 757 235 A1 (MICROLINE PENTAX INC [US]) 28 februari 2007 (2007-02-28) * alineas [0051], [0044], [0055], [0054]; figuur 14 *	1

☐ Verdere documenten worden vermeld in het vervolg van vak C.

☒ Leden van dezelfde octrooifamilie zijn vermeld in een bijlage

° Speciale categorieën van aangehaalde documenten

"A" niet tot de categorie X of Y behorende literatuur die de stand van de techniek beschrijft

"D" in de octrooiaanvrage vermeld

"E" eerdere octrooi(aanvrage), gepubliceerd op of na de indieningsdatum, waarin dezelfde uitvinding wordt beschreven

"L" om andere redenen vermelde literatuur

"O" niet-schriftelijke stand van de techniek

"P" tussen de voorrangsdatum en de indieningsdatum gepubliceerde literatuur

"T" na de indieningsdatum of de voorrangsdatum gepubliceerde literatuur die niet bezwarend is voor de octrooiaanvrage, maar wordt vermeld ter verheldering van de theorie of het principe dat ten grondslag ligt aan de uitvinding

"X" de conclusie wordt als niet nieuw of niet inventief beschouwd ten opzichte van deze literatuur

"Y" de conclusie wordt als niet inventief beschouwd ten opzichte van de combinatie van deze literatuur met andere geciteerde literatuur van dezelfde categorie, waarbij de combinatie voor de vakman voor de hand liggend wordt geacht

"&" lid van dezelfde octrooifamilie of overeenkomstige octrooipublicatie

Datum waarop het onderzoek naar de stand van de techniek van internationaal type werd voltooid	Verzenddatum van het rapport van het onderzoek naar de stand van de techniek van internationaal type
12 maart 2013	

Naam en adres van de instantie	De bevoegde ambtenaar
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Hausmann, Alexander

1

ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Informatie over leden van dezelfde octrooifamilie

Nummer van het verzoek om een onderzoek naar de stand van de techniek
NL 2009202

In het rapport genoemd octrooigeschrift	Datum van publicatie	Overeenkomend(e) geschrift(en)	Datum van publicatie
WO 2012058611	A2 03-05-2012	US 2012109185 A1	03-05-2012
		WO 2012058611 A2	03-05-2012
US 2010292724	A1 18-11-2010	GEEN	
DE 10031773	A1 15-11-2001	GEEN	
EP 1757235	A1 28-02-2007	EP 1757235 A1	28-02-2007
		JP 2007054632 A	08-03-2007
		US 2007049947 A1	01-03-2007

WRITTEN OPINION

File No.	Filing date *(day/month/year)*	Priority date *(day/month/year)*	Application No.
SN58781	17.07.2012		NL2009202

International Patent Classification (IPC)
INV. A61B17/29

Applicant
Technische Universiteit Delft, et al

This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the application
- ☒ Box No. VIII Certain observations on the application

	Examiner
	Hausmann, Alexander

Application number

WRITTEN OPINION

NL2009202

Box No. I Basis of this opinion

1. This opinion has been established on the basis of the latest set of claims filed before the start of the search.

2. With regard to any **nucleotide and/or amino acid sequence** disclosed in the application and necessary to the claimed invention, this opinion has been established on the basis of:

   a. type of material:

   ☐ a sequence listing

   ☐ table(s) related to the sequence listing

   b. format of material:

   ☐ on paper

   ☐ in electronic form

   c. time of filing/furnishing:

   ☐ contained in the application as filed.

   ☐ filed together with the application in electronic form.

   ☐ furnished subsequently for the purposes of search.

3. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

4. Additional comments:

Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty	Yes:	Claims	1-6
	No:	Claims	
Inventive step	Yes:	Claims	1-6
	No:	Claims	
Industrial applicability	Yes:	Claims	1-6
	No:	Claims	

2. Citations and explanations

see separate sheet

WRITTEN OPINION

Box No. VIII Certain observations on the application

see separate sheet

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1 Reference is made to the following document:

D1 WO 2012/058611 A2 (PARE SURGICAL INC [US]; FLEENOR RICHARD P [US]; BROMLEY ROBERT L [US]) 3 mei 2012 (2012-05-03)

2 D1 is regarded as being the prior art closest to the subject-matter of claim 1, and discloses
Gripper (fig 4A-4C) equipped with a bistable element (the bistable element in this case is the shaft of the instrument forcing the jaw members together, both positions of fig 4A and 4B are stable).
and gripper legs (fig 4A, no 82, no 84), which legs a stable first position and a stable second position possess (both positions, fig 4A and fig 4B are stable), in which the transition between the first position and the second position and vice versa, is supported by the bistable element (shaft), wherein when disconnected from the bistable element of the gripper legs are preferred for the first position (open position of fig 4A) and positive stiffness when they pass from the first position to the second position, and that the bistable element is equipped with negative-stiffness (shaft exerts force in opposite direction of the force of the biased gripper legs).

2.1 The subject-matter of claim 1 therefore differs from this known D1 in that it further comprises an actuation part that is connected to the gripper legs and said actuation part is spring-loaded for providing additional positive stiffness of the positive stiffness of the gripper legs, in order substantially to the negative-stiffness of the bistable element to be equal when the legs to convert between the first position and the second position, and in that said actuation part is convertible between said spring-loaded condition, and a non-spring-loaded condition, in order to ensure that in the non-spring-loaded condition the gripper legs with the associated bistable element negative stiffness when the legs to convert between the first position and the second position, and that, in the spring-loaded condition of the gripper legs with the associated bistable element is zero stiffness or nearly zero-stiffness when the legs to convert between the first position and the second position.

2.2 Claim 1 is therefore new.

2.3 The problem to be solved by the present invention may be regarded as providing a gripper which is switchable between a bi-stable operation in the non-spring-loaded condition, and a balanced operation in the spring-loaded condition.

2.4 The solution to this problem proposed in claim 1 of the present application is considered as involving an inventive step as this is not suggested by the prior art and the person skilled in the art would not find the solution without the exercise of inventive skill.

3 Claims 2-6 are dependent on one or more independent claims whose subject-matter is considered as being new and inventive, as discussed above, and as such said dependent claims also meet the requirements of novelty and inventive step.

Re Item VIII

4 Claims 1 and 6 are not clear:
"positive", "negative stiffness" and "zero stiffness" is not clear: The stiffness, of a body is a measure of the resistance offered by an elastic body to deformation. It is not clear how this can be positive, negative or zero.