US 20050224664A1

(19) **United States**
(12) **Patent Application Publication**
Metelski

(10) **Pub. No.: US 2005/0224664 A1**
(43) **Pub. Date: Oct. 13, 2005**

(54) **STAND, IN PARTICULAR FOR SURGICAL MICROSCOPES, HAVING AN ENERGY STORAGE ELEMENT**

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(21) Appl. No.: **11/102,248**

(22) Filed: **Apr. 8, 2005**

(30) **Foreign Application Priority Data**

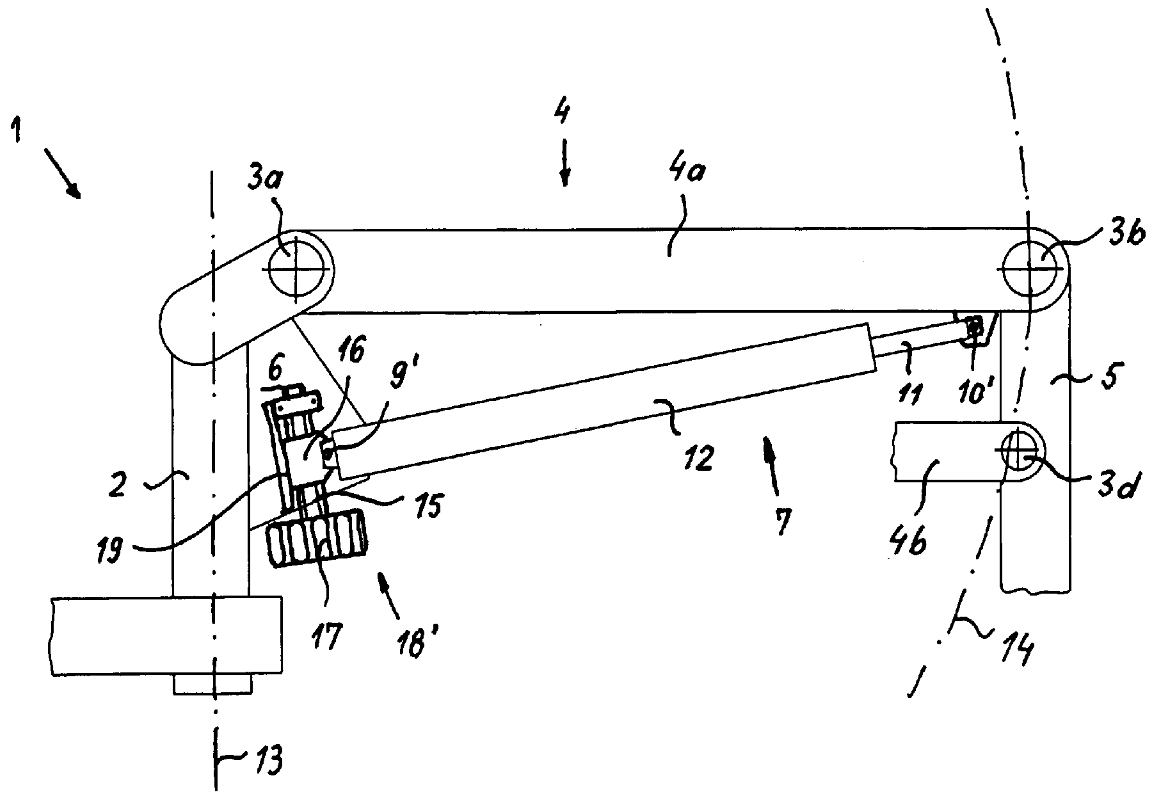
Apr. 12, 2004 (DE) 10 2004 017 971.9

Publication Classification

(51) **Int. Cl.**[7] **A47F 5/00**
(52) **U.S. Cl.** **248/123.11**

(57) **ABSTRACT**

The invention concerns a stand arrangement **(1)** having a particularly arranged energy storage element **(7)** with specific parameters, in particular a low spring progression. The static friction is thereby reduced to a minimum.



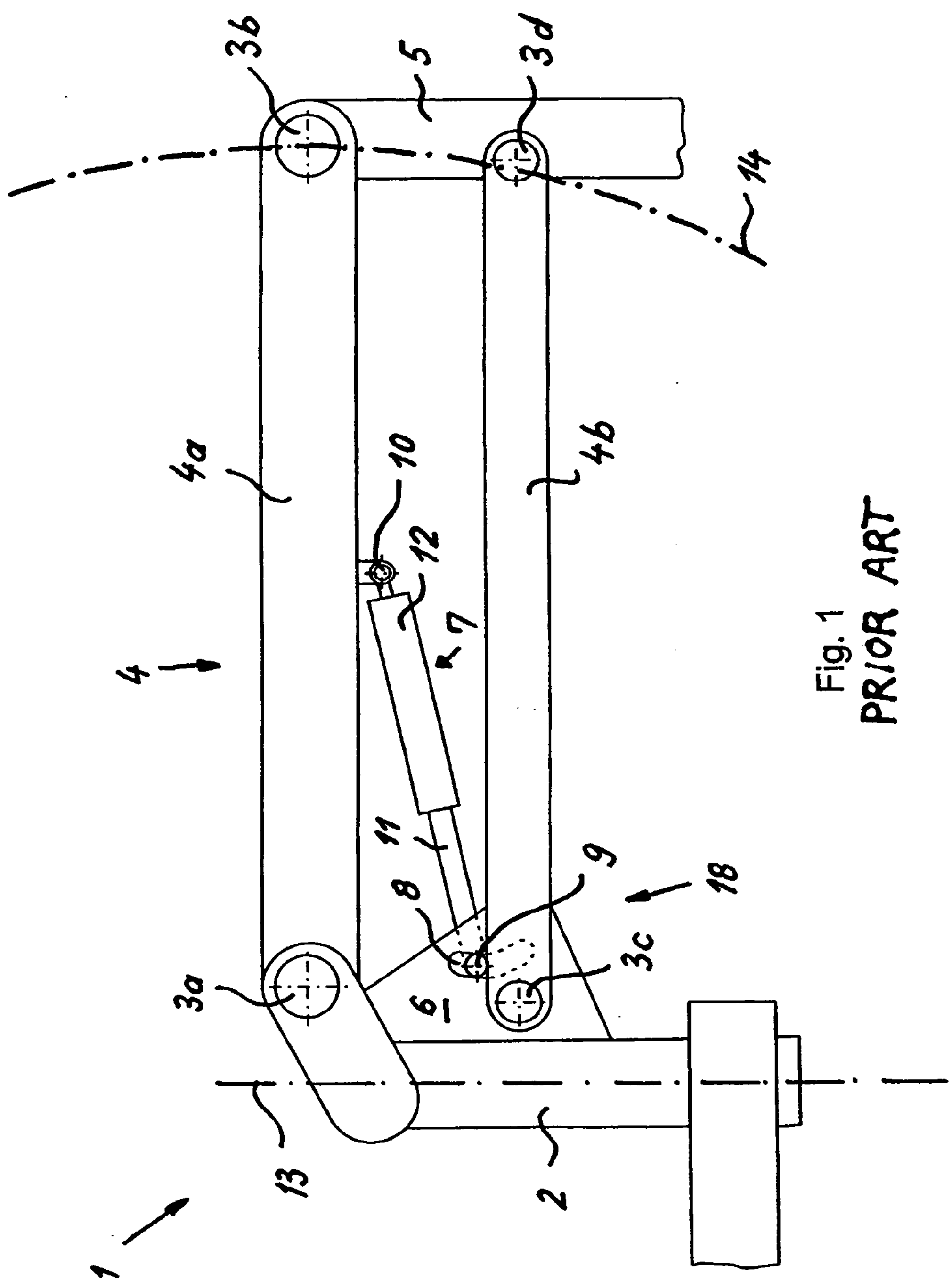


Fig. 1
PRIOR ART

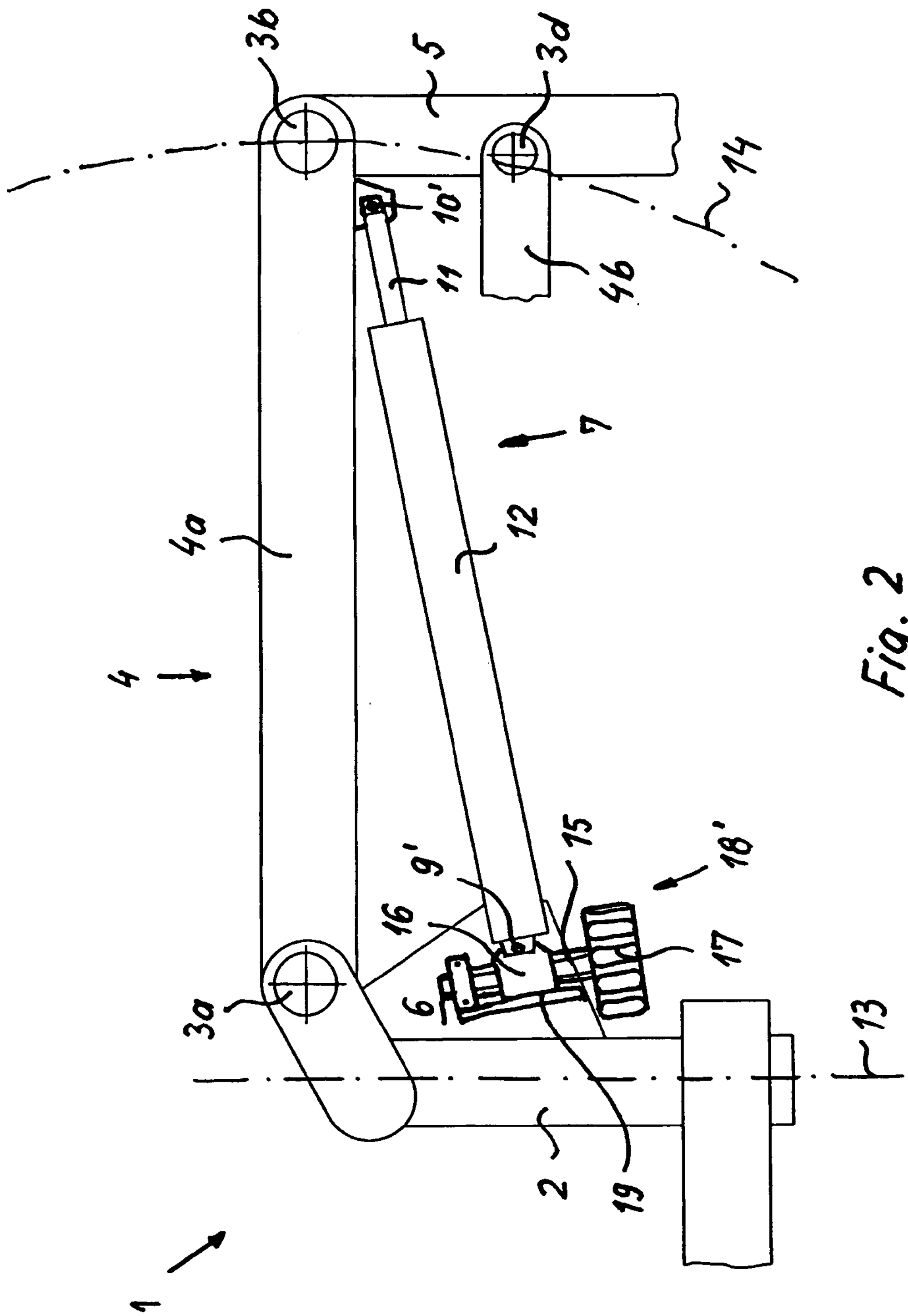


Fig. 2

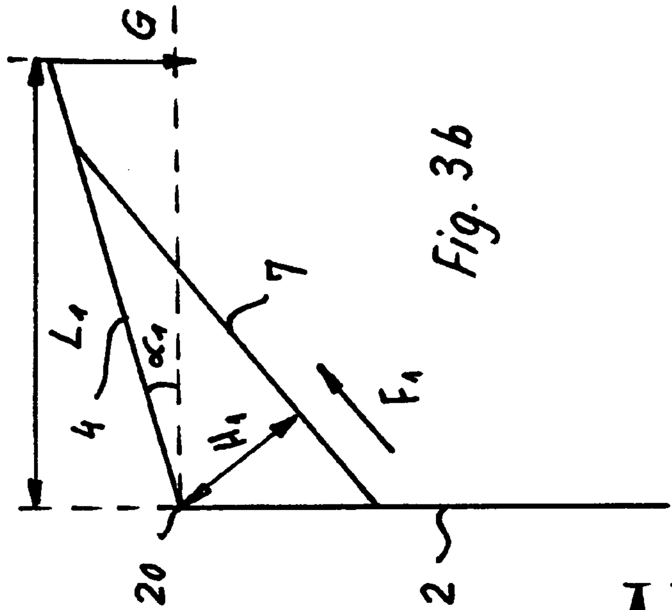


Fig. 3b

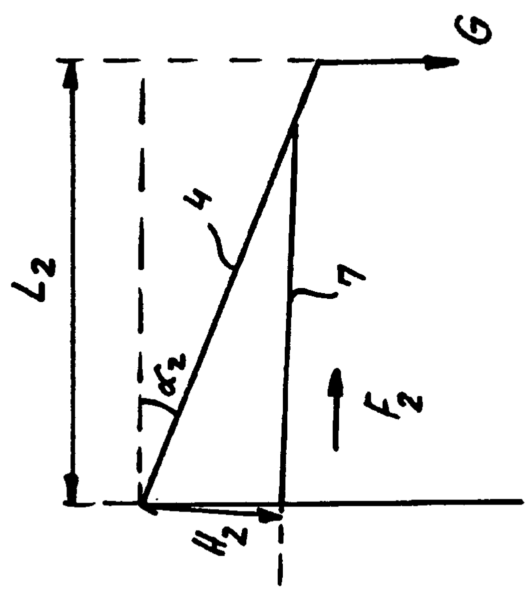


Fig. 3c

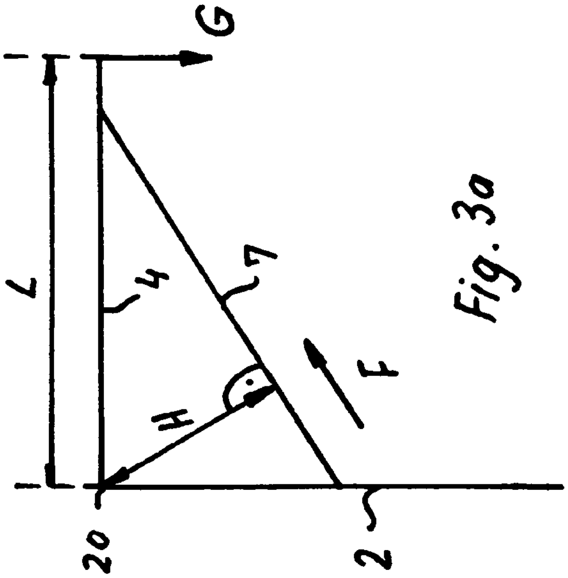


Fig. 3a

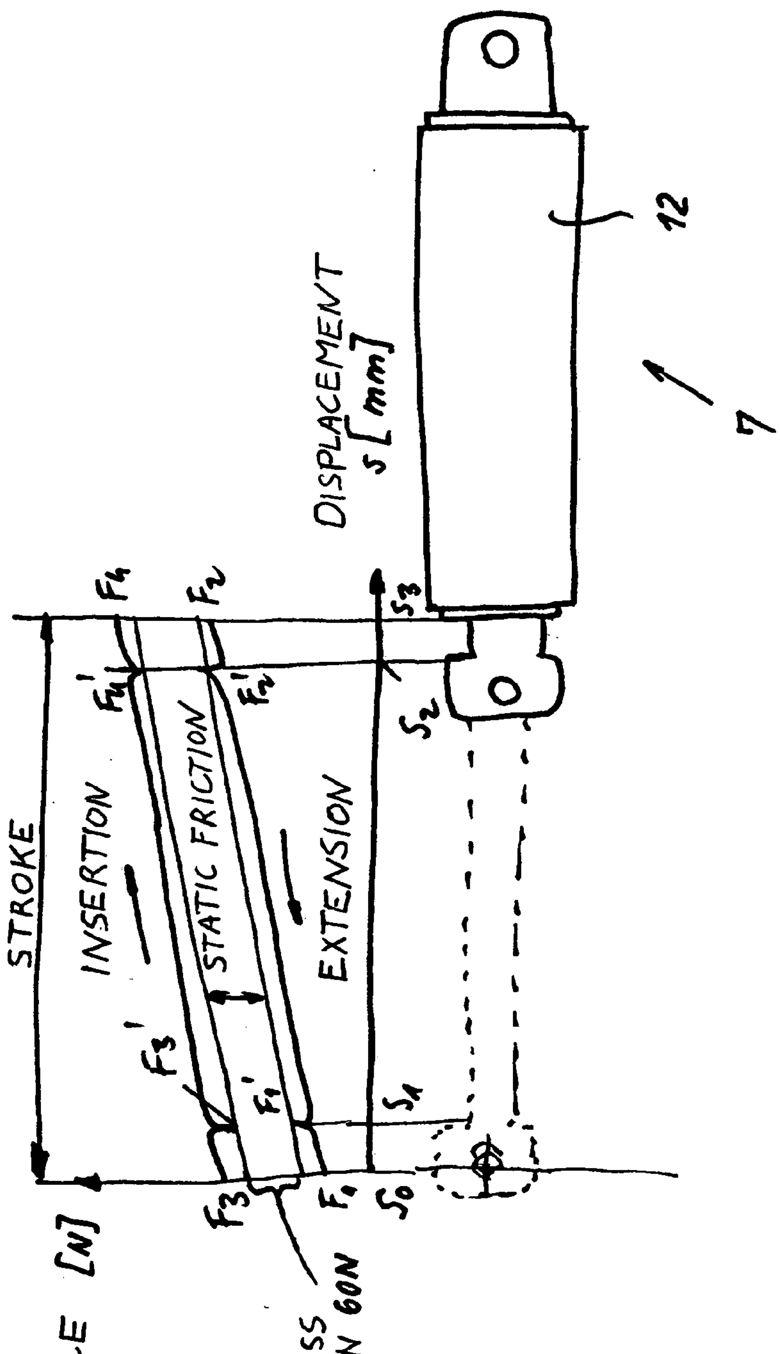

DISPLACEMENT
s [mm]
STROKE
INSERTION
STATIC FRICTION
EXTENSION
FORCE [N]
LESS THAN 60N
F4
F2
F4'
F2'
F3'
F1'
F3
F1
S0
S1
S2
S3
12
7

Fig. 4

STAND, IN PARTICULAR FOR SURGICAL MICROSCOPES, HAVING AN ENERGY STORAGE ELEMENT

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority of the German patent application 10 2004 017 971.9 filed Apr. 12, 2004, which application is incorporated by reference herein.

FIELD OF THE INVENTION

[0002] The invention concerns a stand, in particular a stand for a surgical microscope, having one or more energy storage elements. "Energy storage elements" are understood in general to be elements that are suitable for absorbing an energy or force and delivering it again, or converting it into a different form of energy, in defined fashion. Relevant in this context are springs of mechanical, pneumatic, or hydraulic type or a combination of such types, or shock absorbers. Gas springs are primarily used in stand construction, in particular for surgical microscopes, but springs of the other aforementioned types are also implemented.

BACKGROUND OF THE INVENTION

[0003] In order to achieve a maximally space-saving stand configuration, stands having energy storage elements dispense with a counterbalancing arm configured as a counterweight, or even a counterweight that is located opposite the horizontal support, but instead make use of the energy storage element, which takes over the lever function of the horizontal support, in particular under the load of the microscope. Gas springs used for this purpose as energy storage elements comprise a cylinder that is internally hollow and is divided by a piston into two pressure chambers. The piston is equipped with small holes (nozzles) through which pressure equalization can take place only in delayed ("cushioned") fashion. Because the cylinder represents a closed pressure system, pressure equalization takes place until the pressures in the two pressure chambers are the same.

[0004] Conventional stands with gas-spring bracing have proven successful, but are used only in stands that exhibit moderately homogeneous movement. Different types of bracing, for example the balance-like weight/counterweight system, are used for stands that need to be used over a larger movement space and/or with more convenient movement guidance.

[0005] Conventional gas-spring support systems in stands are interchangeable depending on the load that is to be used, i.e. different gas springs are used for different loads. This is necessary because the working range of conventional gas springs has insufficient bandwidth. The bandwidth of the various weights of the surgical microscope, depending e.g. on accessories, must be distributed over gas springs of different strengths so that a balanced-out state of the stand can always be guaranteed. In other words: assuming, for example, a gas spring having a conventionally narrow working range, if the surgical microscope hung on the stand were one equipped with more accessories than provided for, and if it balanced out in a certain position and then departed from that balanced position, the horizontal support would then move automatically into different positions.

[0006] Conventional gas-spring-braced stands have the disadvantage that because of the so-called "cosine function" of the load lever effect of the microscope along its vertical movement arc, the bracing effect that is present differs as a function of the angular position of the horizontal support with respect to the vertical support. The (lever) force on the gas spring acting as the supporting lever is also greatest with the stand in the pivot position in which the load is located farthest away from the vertical support (the horizontal support and vertical support form a right angle).

[0007] EP-B1-433 426 describes a compensating apparatus, having a gas spring as the energy storage element, that encompasses an arc-shaped or kidney-shaped elongated guidance hole on the vertical support in which the proximal end of a piston rod is guided, while the cylinder constituting the distal end of the gas spring is secured pivotably on the horizontal support. (In the remainder of this Application, "proximal" means "toward the vertical support" and "distal" means "away from the vertical support, toward the unattached end of the horizontal support".) This construction with an arc-shaped elongated guidance hole is theoretically intended to prevent the hysteresis of the gas spring from becoming disadvantageously perceptible. "Hysteresis" is understood in general to mean the dependence of the physical state of an object on previous states, based on a residual effect (remanence) after removal of the applied physical magnitude or force.

[0008] It has been found in practical use, however, that this configuration is disadvantageous in that the proximal end of the piston rod does not move continuously in the arc-shaped elongated guidance hole but instead, when used, jumps from one extreme position to the other in the manner of a toggle lever; for a user, this requires an additional movement across the jumping point in order to achieve readjustment of the support conditions in the arc-shaped elongated guidance hole.

SUMMARY OF THE INVENTION

[0009] It is thus the object of the invention to arrive at an improved system having energy-storage-element bracing, in particular gas-spring bracing, that is adjustable to different loads on the one hand so as thereby to eliminate the interchanging of different gas springs for different loads, and on the other hand in order to eliminate the disadvantageous cosine effect of the horizontal support under the load of the microscope, or reduce it sufficiently that it is no longer an annoyance. The toggle-lever jump effect is also to be eliminated. At the same time, the energy storage element must meet the typical requirements for a surgical microscope stand, i.e. the energy storage element must be capable of absorbing a counterbalancing force of approximately 2000 N. Conventionally, however, such high-rated energy storage elements exhibit a spring progression of approximately 18%.

[0010] These objects are achieved by the selection of an energy storage element having a defined and selected spring progression of, in novel fashion, less than 10%, preferably less than 9% (conventional gas springs have, on average, 11-60%), preferably accompanied by the highest possible energy absorption. The latter is preferably approximately 2000 N. The lowest possible spring progression value also guarantees a low hysteresis, which has an annoying effect specifically in the small movement ranges that are typical of a surgical application. In other words, according to the present invention the static friction, which plays a substantial role in the context of small movements of the horizontal support, is kept as low as possible (less than 60 N), while the dynamic friction, which plays a role in the context of larger movements of the horizontal support, can assume any arbitrary and relatively larger value. The reason is that the dynamic friction is of subordinate significance because large movements of the horizontal support are necessary only in the context of prepositioning operations, but not in the context of fine manipulation movements during surgical use.

[0011] Simultaneously or alternatively, these objects can be achieved by the fact that in novel fashion, instead of the conventional installation of the gas spring piston rod on the vertical support and of the gas spring cylinder on the horizontal support, it is the gas spring cylinder and not the gas spring piston rod that is articulated at the displaceable mounting point of the vertical support. The gas spring piston rod is thus, in novel fashion, preferably articulated as far out as possible at the distal end of the horizontal support. On the one hand this reduces the disadvantageous effect of the cosine function of the load, since the weight of the cylinder is shifted from the distal end of the horizontal support closer to the vertical support. An additional result is that a smaller annoying variable magnitude is present, which in novel fashion is no longer determined by a larger shiftable cylinder mass but instead by a smaller shiftable piston-rod mass. On the other hand, a gas spring of the greatest possible length exhibits better hysteresis properties (because of larger pressure chambers and, associated therewith, a lower potential pressure in the gas spring).

[0012] It is also preferred, for the sake of larger pressure chambers (so that the spring progression value is lower) and better hysteresis properties associated therewith, to select gas springs having the largest possible cylinder diameters.

[0013] A further preferred embodiment of a gas spring designed specifically for the desired applications has the smallest possible outside diameter for the piston rod. This design feature once again makes it possible to improve the hysteresis properties and, most of all, to lower the static friction, in particular the necessary "breakaway" force, at the cost of an increase in dynamic friction.

[0014] A further action that, according to the present invention, improves the gas spring is to bore out the nozzles in the piston. In conventional gas springs the diameter of these nozzles is in the range of tenths of a millimeter; in novel fashion, however, it is increased to no less than 2 mm, preferably 4 mm. Static friction is thereby minimized.

[0015] It is furthermore preferred for the horizontal support to have a longer protrusion than in the case of conventional stands (900 mm instead of 700 mm). Assuming pivot angles at the articulation point of the support gas spring that are kept small or at the same magnitude, this feature, results not only in a larger pivot range for the load (surgical microscope) in the vertical, but also a larger radius of action.

[0016] A preferred embodiment of a stand according to the present invention additionally comprises a displacement apparatus for the articulation point of the gas spring. This displacement apparatus can be, as known from the existing art, a threaded spindle having a carriage with a guide and a joint, which spindle is driven manually or in motorized fashion. Reference is explicitly made to the possibility of combining this Application with an invention filed simultaneously by the same Applicant, in which a bidirectionally acting displacement apparatus is disclosed that can also be utilized in the context of the stand disclosed here.

[0017] The horizontal support of a stand such as the one used for surgical microscopes is usually configured as a parallelogram support. Horizontal supports of single configuration are also, however, within the scope of the invention.

[0018] As already mentioned, the energy storage element can be a gas spring. Also conceivable in general, however, are pneumatic or hydraulic or even mechanical springs, or combinations thereof.

[0019] The invention is moreover not limited to a stand having only one energy storage element; stand solutions having two or more energy storage elements are also intended to fall within the scope of the disclosure of this Application, especially with regard to an improvement in hysteresis properties.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] Further embodiments of the invention are shown in the Figures. The invention will be explained in more detail, symbolically and by way of example, with reference to the Figures. The Figures are described continuously and in overlapping fashion. Identical reference characters denote identical components; reference characters having different indices indicate similar or functionally identical components. In the drawings:

[0021] **FIG. 1** shows a stand configuration according to the existing art;

[0022] **FIG. 2** shows a stand arrangement according to the present invention;

[0023] **FIGS. 3*a*-3*c*** schematically depict the so-called "cosine effect" in three different positions; and

[0024] **FIG. 4** shows the spring force diagram of an energy storage element according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0025] **FIG. 1** schematically depicts a stand arrangement **1** according to the existing art. Stand **1** comprises a vertical support **2** and a horizontal support **4** that is implemented as a parallelogram support having an upper horizontal support arm **4*a*** and a lower horizontal support arm **4*b***. A gas spring is arranged, as a supporting energy storage element **7**, at an articulation point **10** on upper horizontal support arm **4*a*** of horizontal support **4** and at an articulation point **9** in a plate **6**. Stand **1** has, as a means for positively influencing hysteresis properties, a displacement apparatus **18** that does not act linearly but instead permits, by way of an arc-shaped elongated guide hole **8**, a radial displacement of articulation point **9**.

[0026] Gas spring **7** is arranged with a cylinder **12** at distal articulation point **10** and with a piston rod **11** at articulation point **9**.

[0027] This stand arrangement furthermore comprises joints **3***a-d* and a microscope carrier **5**. Horizontal support **4** pivots about pivot axis **13**, and in turn describes a movement arc **14** in the context of vertical pivoting movements.

[0028] **FIG. 2** shows a stand arrangement **1** according to the present invention that, like the embodiment according to the existing art depicted in **FIG. 1**, comprises a vertical support **2** and a horizontal support **4** implemented as a parallelogram support. In addition, this stand arrangement **1** also comprises a displacement apparatus **18**' having a threaded spindle **15** which is manually rotatable by rotating a hand knob **17** to cause linear movement of a threadably mated carriage **16** on which proximal articulation point **9** is arranged. A guide **19** prevents rotation of carriage **16** so that it moves along tspindle **15** when the spindle is rotated. Rotation of spindle **15** may also be controlled by a motor (not shown). As is evident from this Figure, energy storage element **7** is attached with piston rod **11** at an articulation point **10**' that is located at the outermost possible distal attachment point of upper horizontal support arm **4***a* of horizontal support **4**. It is also apparent that energy storage element **7** not only is longer but also has a larger cylinder diameter, and is attached at proximal articulation point **9**' not with its piston rod **11**, but with cylinder **12**. Cylinder **12** has an outside diameter preferably within a range from 10 mm to 100 mm, and most preferably the outside diameter of cylinder **12** is about 40 mm. The outside diameter of piston rod **11** is kept small, preferably within a range from 5 mm to 50 mm, and most preferably the outside diameter of piston rod **11** is about 14 mm.

[0029] **FIGS. 3***a-c* schematically depict the lever effect as a function of various angles of the horizontal support with respect to the vertical support (the so-called "cosine effect"). **FIG. 3***a* shows horizontal arm **4** in a horizontal position (angle between vertical support **2** and horizontal arm **4**=90 degrees). Horizontal arm **4** carries load G at the distal end and corresponds in this position to lever arm L, and the force F with which energy storage element **7** braces lever arm L is located at a (virtual) distance H from articulation point **20** of horizontal support **4** on vertical support **2**. In this position, L*G=H*F. **FIG. 3***b* shows horizontal arm **4** in a position pivoted up through an angle α_1. Lever arm L_1 now corresponds to L/cos α_1, and L_1*G is now equal to H_1*F_1. **FIG. 3***c* shows horizontal arm **4** in a position pivoted downward through an angle α_2. Lever arm L_2 now corresponds to L/cos α_2, and the applicable equation is L_2*G=H_2*F_2.

[0030] **FIG. 4** shows the spring force diagram of an energy storage element according to the present invention. The dynamic hysteresis is the difference F_3–F_1 or F_4–F_2. The difference in static breakaway force (static hysteresis) at a travel point s_1 between insertion force F_3' and extension force F_1', or between F_4' and F_2', is less than 60 N according to the present invention, as can be read off on the force axis. The parameters of energy storage element **7** are selected, according to the present invention, in such a way that the spring progression is less than 10%, preferably 9%. The spring progression is represented on the spring force diagram as the slope from F_1 to F_2 and from F_3 to F_4.

PARTS LIST

[0031] The Parts List is a constituent of the disclosure.

[0032] **1** Stand

[0033] **2** Vertical support

[0034] **3***a-d* Joint

[0035] **4** Horizontal support

[0036] **4***a* Upper horizontal support arm

[0037] **4***b* Lower horizontal support arm

[0038] **5** Microscope carrier

[0039] **6** Plate

[0040] **7** Energy storage element

[0041] **8** Arc-shaped elongated guidance hole

[0042] **9** Proximal articulation point

[0043] **10** Distal articulation point

[0044] **11** Piston rod

[0045] **12** Cylinder

[0046] **13** Pivot axis of 4

[0047] **14** Movement arc of load

[0048] **15** Threaded spindle

[0049] **16** Carriage

[0050] **17** Hand knob

[0051] **18** Displacement apparatus

[0052] **18**' Displacement apparatus

[0053] **19** Guide of 16

[0054] **20** Articulation point of 4 on 2

[0055] $\alpha_{1,\,2}$ Angle between 4 and $L_{1,\,2}$

[0056] L Lever arm

[0057] G Load; weight

[0058] F Force

[0059] H Height; distance of 7 from 20

[0060] s_0 Maximum linear stroke of 11

[0061] $s_{1,\,2}$ Travel point of 11 at which measurement occurs

[0062] s_3 End point

[0063] F_1 Extension force at s_0

[0064] F_2 Extension force at s_3

[0065] F_3 Insertion force at s_0

[0066] F_4 Insertion force at s_3

[0067] F_1' Extension force at s_1

[0068] F_2' Extension force at s_2

[0069] F_3' Insertion force at s_1

[0070] F_4' Insertion force at s_2

What is claimed is:

1. A stand for a surgical microscope, the stand comprising:

a vertical support;

a horizontal support articulated on the vertical support; and an energy storage element articulated at a proximal articulation point on the vertical support and at a distal articulation point on the horizontal support, wherein the energy storage element has a spring progression of less than 10% and is arranged such that the static friction associated with movement of the horizontal support is less than 60 N.

2. The stand as defined in claim 1, wherein the spring progression is less than 9%.

3. The stand as defined in claim 1, further comprising a displacement apparatus mounted on the vertical support for changing the position of the proximal articulation point.

4. The stand as defined in claim 3, wherein the displacement apparatus includes a threaded spindle and a carriage threadably mated with the spindle to move along the spindle upon rotation of the spindle, and wherein the proximal articulation point is located on the carriage to move therewith.

5. The stand as defined in claim 1, wherein the horizontal support is configured as a parallelogram support.

6. The stand as defined in claim 1, wherein the horizontal support has a protrusion distance from the vertical support within a range from 500 mm to 1500 mm.

7. The stand as defined in claim 6, wherein the protrusion distance is approximately 900 mm.

8. The stand as defined in claim 1, wherein the distal articulation point is located near a distal end of the horizontal support.

9. The stand as defined in claim 1, wherein the energy storage element includes a gas spring apparatus.

10. The stand as defined in claim 9, wherein the gas spring apparatus is a pneumatic spring apparatus.

11. The stand as defined in claim 1, wherein the energy storage element includes a hydraulic spring apparatus.

12. The stand as defined in claim 1, wherein the energy storage element includes a mechanical spring.

13. The stand as defined in claim 1, wherein the energy storage element includes a cylinder articulated on the vertical support and a piston rod articulated on the horizontal support.

14. The stand as defined in claim 1, wherein the energy storage element is a gas spring including a cylinder having an outside diameter within a range from 10 mm to 100 mm.

15. The stand as defined in claim 14, wherein the outside diameter of the cylinder is approximately 40 mm.

16. The stand as defined in claim 1, wherein the energy storage element is a gas spring including a piston rod having an outside diameter within a range from 5 mm to 50 mm.

17. The stand as defined in claim 16, wherein the outside diameter of the piston rod is approximately 14 mm.

18. The stand as defined in claim 1, wherein the energy storage element is a gas spring having a cylinder and a piston within the cylinder, wherein the piston includes nozzle orifices having a diameter of at least 2 mm.

19. The stand as defined in claim 18, wherein the piston includes nozzle orifices having a diameter of approximately 4 mm.

* * * * *