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STAND FOR OPTICAL DEVICES

Field of the Invention

This invention relates to a stand in which heavy medical optical devices such as operating microscope and its auxiliary devices are supported with a retaining link mechanism utilizing a parallel link and are balanced with a counterweight, and above described operating microscope etc. can be retained or kept at the desired spatial positions during microsurgery.

Description of Prior Art

In the fields of encephalotomy and cardiosurgery, a technique of so-called microsurgery is employed, in which surgeries are performed under observation of the focuses using operating microscopes as "medical optical devices". Various types of stand apparatuses, for retaining heavy operating microscope and its auxiliary devices at any desired spatial positions, to be utilized in such microsurgeries have been proposed (e.g. Japanese Patent Publication before Examination No. 32110/1981). These stands generally are of a balancing structure, in which a retaining link mechanism employing a parallel link is pivotally (tiltably) supported at an intermediary portion on a frame, and an operating microscope is supported at one end portion of the retaining link mechanism with a counterweight for countervailing the weight of the operating microscope being supported on the other end portion of the retaining link mechanism relative to the pivot thereof.

As a position where the balancing type stand is set up, an optimum position in an operating room is selected depending on the content of the surgery to be carried out, and balance is adjusted at the selected position. In other

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words, while the optimum position around the operating table is specified by a doctor prior to surgery, the doctor himself is in a sterilized region, so that moving the stand to the position to set up is carried out by an assistant such as a nurse who does not participate in the surgery. Since auxiliary devices such as a side microscope for assistant doctors and a video camera are attached to the operating microscope, the position of the counterweight is changed corresponding to the weight of these devices to adjust the entire balance of the stand so that the operating microscopes with auxiliary devices and a counterweight are well balanced.

However, moving such heavy counterweight is a tremendous task and is also dangerous for the nurse who is in most cases a woman. Further, the balance adjusting operation takes too much time to be advantageously rendered for emergent surgery and the like.

What is most serious in the prior art stand is that the balance adjustment between the operating microscope and the counterweight is very difficult due to the structure of the stand itself. More specifically, in order to stop the operating microscope and the auxiliary devices at the desired spatial positions, the operating microscope must be perfectly balanced in the horizontal and vertical directions. However, the prior art stand does not always have a structure which facilitates secured balance adjustment in the horizontal and vertical directions in accordance with the weight on the operating microscope side which changes depending on the presence or absence of various auxiliary devices.

This invention has been accomplished noting such prior art technique and is

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directed to provide a stand for optical devices which enables easy and secured balance adjustment in accordance with the weight change on the operating microscope side.

Disclosure of the Invention

In the stand for optical devices according to the present invention, the intermediary portion of the retaining link mechanism essentially consisting of first and second parallel links which interlock each other is supported at a rotational fulcrum of a frame, a part of the above described first parallel link is laterally extended to form a supporting arm at which extremity medical optical device and/or its auxiliary devices are retained, a connecting point which is farthest from the rotational fulcrum of the above described second parallel link is positioned on a straight line connecting the extremity of the supporting arm and the rotational fulcrum, a counterweight is provided at the connecting point, and the length of the second parallel link is retractable both vertically and laterally so that the counterweight is moveable on the above described straight line.

The counterweight which is moveable on the straight line connecting the extremity of the supporting arm and the rotational fulcrum enables easy and secured balance adjustment of the weight of the above described operating microscope side both in horizontal and vertical directions by the movement of the counterweight along the straight line even when the weight of the operating microscope side changes because of the presence or absence of the auxiliary devices.

Alternatively, a displacement detecting means which detects unbalace of the

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retaining link mechanism may be provided at a part of the retaining link mechanism so that the counterweight can be moved manually in response to the signal from the displacement detecting means.

Furthermore, a drive means which moves the counterweight by means of a motor may be provided to control the drive means in response to the signal from the displacement detecting means, thereby the counterweight can be automatically moved to positions where the counterweight and the operating microscope side are balanced.

Brief Description of the Drawings

Fig. 1 is an entire side view showing a stand for optical devices according to this invention;

Fig. 2 shows a pinion and moving bevel teeth;

Fig. 3 shows a universal joint;

Fig. 4 is a schematic view showing a stand in which both the vertical length of a second parallel link and the lateral length of a weight-retaining arm are in a retracted state;

Fig. 5 is a schematic view showing a stand in which both the vertical length of the second parallel link and the lateral length of the weight-retaining arm are in a extended state;

Fig. 6 is a schematic view showing a vertical displacement in the stand in

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Fig. 4;

Fig. 7 is a schematic view showing a horizontal displacement in the stand in Fig. 4;

Fig. 8 is a schematic view showing vertical and horizontal displacement in the stand in Fig. 4;

Fig. 9 is a perspective view showing a displacement detecting means.

Fig. 10 is a side view showing a detection lever which is shifted to one side;

Fig. 11 is a side view showing a detection lever which is shifted to the other side;

Fig. 12 is a cross-sectional view showing an electromagnetic clutch is in an unlocked state; and

Fig. 13 is a cross-sectional view showing an electromagnetic clutch is in a locked state.

Best Mode for Carrying out the Invention

A preferred embodiment of this invention will be described below referring to the attached drawings. It should be noted here that the following description is made assuming that the arrow A and the arrow B shown in Fig. 1 mean the front side and the rear side, respectively.

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The stand according to the preferred embodiment of the invention has a basic structure wherein a retaining link mechanism 4 essentially consisting of a first parallel link 2 and a second parallel link 3 is supported at a part (intermediary portion 4a) on a rotational fulcrum S on a frame 1, and an operating microscope 5 and other devices are supported at one end portion (connecting point β_1) of a supporting arm 9 which is an extended portion of the first parallel link 2, while a counterweight W_4 is provided on the connecting point β_6 of the second parallel link 3 positioned on a straight line X.

The base affixed with the reference number 5 has on the bottom a plurality of casters 6 with locking mechanisms, thus the entire stand is allowed to run on the floor. A frame 1 having a substantially rectangular U-shaped side profile is mounted on the base 5. The frame 1 is designed to be pivotable on the vertical axis α_1 and also to be unpivotably locked by an electromagnetic clutch C_1 provided on the axis α_1.

A first parallel link 2 is pivotably supported on the rotational fulcrum S assumed on the upper front end side of the frame 1. The first parallel link 2 is formed by combining a pair of first parallel vertical arms 7a,7b and a pair of first parallel horizontal arms 8a,8b. The front first vertical arm 7a of the first parallel link 2 is supported at the intermediary portion 4a on the rotational fulcrum S, as described above. An electromagnetic clutch C_2 is provided on the rotational fulcrum S, so that the front first vertical arm 7a can be locked at a desired pivoted position (i.e. the displaced state of the first horizontal link 2). The upper portion of the front first vertical arm 7a supported on the rotational axis S is bulged backward so as not to

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interfere with the body of a doctor who performs the surgery.

The upper first horizontal arm 8a of the first parallel link 2 extends forward to form a supporting arm 9 integrally therewith, and a vertical front arm 10 is pivotably attached to the connecting point β_1 at the front end portion thereof. The supporting arm 9 is also bulged upward so as not to interfere with the head of the doctor.

A supporting parallel link 11 consisting of two parallel links which interlock with each other is provided below the front arm 10 to be pivotable on the vertical axis α_2. An electromagnetic clutch C_3 is provided at the upper end of the supporting parallel link 11, and an operating microscope (medical optical device) W_1 which is pivotable on the axis α_3 is attached via another electromagnetic clutch C_4 to the lowermost portion of the supporting parallel link 11. The supporting parallel link 11 as a whole presents a curved shape, so that the doctor can operate the operating microscope W_1 easily. The view angle of the operating microscope W_1 can be changed by transforming the supporting parallel link 11. Incidentally, the transformed state of the supporting parallel link 11 can be locked by an electromagnetic clutch C_5. " Auxiliary devices" such as a side microscope W_2 for assistant doctors and a video camera W_3 for recording are attached to the operating microscope W_1. The weight on the operating microscope (W_1) side changes by attaching or detaching these auxiliary devices.

A bell crank 12 is pivotably supported on the connecting point β_3 which is the origin of the supporting arm 9, and the rear end portion 12a of the bell crank 12 is connected via a vertical subarm 13 to the connecting point β_4 of

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the frame 1, while the upper end 12b of the bell crank 12 is connected via a horizontal subarm 14 to the upper end portion 10a of the front arm 10. In other words, on the connecting point β_3 which is the origin of the supporting arm 9 is supported the bell crank 12, having the rear end portion 12a on the horizontal line including the connecting point β_3 and the upper end portion 12b on the perpendicular line including the connecting point β_3; the rear end portion 12a of the bell crank 12 and the connecting point β_4 of the frame 1 are connected by the vertical subarm 13, which is parallel with the front first vertical arm 7a and has a length which is equal to the linear distance from the connecting point β_3 of the front first vertical arm 7a to the rotational fulcrum S; and the upper end portion 12b of the bell crank 12 and the upper end portion 10a of the front link 10 are connected by the horizontal subarm 14 which is parallel with the supporting arm 9 and has a length which is equal to that of the supporting arm 9.

With the aid of the vertical subarm 13 and the horizontal subarm 14 additionally provided, a "parallel link" is formed by the rotational fulcrum S ⇨ connecting point β_3 ⇨ rear end portion 12a ⇨ connecting point β_4; while another "parallel link" is formed by the connecting point β_3 ⇨ connecting point β_1 ⇨ upper end portion 10a⇨ upper end portion 12b. Accordingly, since the bell crank 12 cannot be turned no matter how the first parallel link 2 is transformed, the front arm 10 is constantly maintained in the vertical posture, and consequently the axis α_2 of the supporting parallel link 11 is prevented from tilting to maintain constantly the vertical posture.

Next, there provided below the first parallel link 2 the second parallel link 3 which deforms interlockedly with the first parallel link 2. The second

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parallel link 3 comprises an upper second horizontal arm 17a as formed with a lower first horizontal arm 8b backwardly extended, a lower second horizontal arm 17b as parallel and equal in length with the upper second horizontal arm 17a, a front second vertical arm 16a as formed with a rear first vertical arm 7b downwardly extended, and a rear second vertical arm 16b as parallel and equal in length with the front second vertical arm 16a. The arms 16a, 16b, 17a, and 17b which form the second parallel link 3, individually have therein an expandable structure with an inner cylinder which is slidably inserted in an outer cylinder, and a screw bar 18 provided to the outer cylinder is screwed to a female thread 19 on the inner cylinder to allow the whole length to retract.

Each screw bar 18 is rotated by a motor M of which revolving effect is transmitted to each screw bar 18 to retract each arm 16a, 16b, 17a, and 17b. First, the motor M, at the front side, rotates the screw bar 18 of lower second horizontal arm 17b via two spur teeth 20, and simultaneously rotates the front second vertical arm 16a via two bevel teeth 21. On the other hand, the motor M is provided with a backwardly-extended spline 22 at the rear side thereof, and via moving bevel teeth 23 and other bevel teeth 21 both engaged with the spline 22, the screw bar 18 in the rear second vertical arm 16b is rotated. Furthermore, at the root of screw bar 18 in the rear second vertical arm 16b, there provided a spline 22 which is rotated by a pair of spur teeth 20, and via moving bevel teeth 23 and other bevel teeth 21 both engaged with the spline 22, the screw bar 18 in the upper second horizontal arm 17a is rotated. On the each fulcrum portion of the second parallel link 3, at the root of each screw bar 18, a universal joint 24 is interposed. Thereby, even if the second parallel link 3 is deformed, the revolving effect

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of the motor M is securely transmitted to the screw bar 18. The revolving effect transmitted via the spline 22 and moving bevel teeth 23 secures the revolving effect of the motor M if the lengths of the arms 16a, 16b, 17a, and 17b change. The gear ratio of the spur teeth 20 themselves, the bevel teeth 21 themselves, and the bevel teeth 21 and moving bevel teeth 23 are set so that the second horizontal arms 17a, 17b and the second vertical arms 16a, 16b retract with the length ratio between the second horizontal arms 17a, 17b and the second vertical arms 16a, 16b are maintained. Thus, the second parallel link 3 enlarges or reduces while maintaining its similar figures. The motor M is controlled by a later-described control section 24, and the motor M and control section 24 provide a "drive means".

A connecting point β_6 as the farthest connecting point from the rotational fulcrum S of the second parallel link is positioned on a straight line X which connects the connecting point β_1 on the extremity of the supporting arm 9 and the rotational fulcrum S, and the connecting point β_6 is always positioned on the straight line X whatever the second parallel link 3 may be deformed. To the connecting point β_6, a counterweight W_4 is mounted.

Next, a detection lever 25 is provided on the left side (reverse side of the front first vertical arm 7a in Fig. 1) of the connecting point β_6 where the front first vertical arm 7a and the lower first horizontal arm 8b are connected. While a conventional electromagnetic clutch C_6 is disposed on the right side of the connecting point β_5, the detection lever 25 is attached to another electromagnetic clutch C_7 disposed to a connecting shaft 26 penetrating the lower first horizontal lever 8b ("which is a counterpart member") through the front first vertical arm 7a. More specifically, a disc-

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shaped flange 26a is formed at one end of the connecting shaft 26, and the electromagnetic clutch C_7 is provided with a fixed flange 27 and a moveable flange 28. The flange 26a is grasped and locked between the fixed flange 27 and the moveable flange 28. The moveable flange 28 side is provided with an electromagnetic coil 29 on which the moveable flange 28 is magnetically adsorbed and a spring 30 which urges the moveable flange 28 toward the fixed flange 27. Accordingly, the electromagnetic coil 29 attracts the moveable flange 28 overcoming the force of the spring 30 during energization, so that the detection lever 25 assumes a state of free rotation with respect to the connecting shaft 26 (see Fig. 12). However, the attraction by the electromagnetic coil 29 is not exerted during de-energization, so that the moveable flange 28 is pushed toward the fixed flange 27 to hold the flange 26a of the connecting shaft 26 between the fixed flange 27 and the moveable flange 28, and thus the detection lever 25 can be turned integrally with the connecting shaft 26 (see Fig. 13).

A metal shaft 31 is disposed to protrude from the front first vertical arm 7a at a position opposing to the detection lever 25, and the outer end portion of the shaft 31 is resiliently supported by a resilient bushing 32 disposed in the middle of the detection lever 25. An irradiation section 33 for irradiating a beam f is provided on the front first vertical arm 7a at a position opposing to the upper end portion of the detection lever 25. The irradiation section 33 contains a light-emitting diode 34 therein, and the beam f from the light-emitting diode 34 is designed to pass through a slit 35 and impinge upon the upper end portion of the detection lever 25. The upper end portion of the detection lever 25 to be irradiated with the beam f is provided with a two-piece photo-location section 36 having two sensors

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36a,36b. Accordingly, so long as the detection lever 25 is maintaining a vertical neutral position relative to the front first vertical arm 7a, the beam f transmitted through the slit 35 impinges at the middle of the two sensors 36a,36b, and thus the sensors 36a,36b receive the beam f on the same area, producing no output difference. However, if the detection lever 25 is pivoted to either side and deviated from the neutral position, the photo-detecting area in the sensor 36a or 36b locating on the side opposite to the side the detection lever 25 is shifted is increased to generate an output difference, thus enabling detection of the shift. The photo-location section 36 is electrically connected to the control section 24, and the control section 24 allows the motor M to be driven based on the signal from the photo-location section 36, whereby the counterweight W_4 can be moved in a direction such that the detection lever 25 can resume the neutral position. The detection lever 25, the irradiation section 33, the photo-location section 36, etc. constitute the "displacement detection means".

In the meantime, the operational procedures of the stand will now be described. First, the entire stand is carried to a position near the operating table specified by a doctor. A specified side microscope W_2 and a video camera W_3 are attached to the operating microscope W_1. At this point, the weight of the counterweights W_1 and the weight on the operating microscope (W_1) side including the side microscope W_2 and the video camera W_3 (hereinafter referred to as "operating microscope, etc. W_{1-3}") are not necessarily balanced. Incidentally, the retaining link mechanism 4 itself from which the counterweight W_4 and the operating microscope, etc. W_{1-3} are detached is balanced on the rotational fulcrum S.

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Subsequently, the retaining link mechanism 4 is once allowed to resume the standard posture as shown in Fig. 1, and the electromagnetic clutch C_7 is actuated to immobilize the detection lever 25 onto the connecting shaft 26 of the lower first horizontal arm 8b. If the weight of the operating microscope, etc. W_{1-3} and that of the counterweight W_4 in this state is not balanced, the angle of the front first vertical arm 7a is inevitably changed with respect to the lower first horizontal arm 8b which is a "counterpart member", so that the detection lever 25 locked integrally with the connecting shaft 26 of the lower first horizontal arm 8b is pivoted or shifted relative to the vertical arm 7a.

Since the detection lever 25 and the front first vertical arm 7a constitute via the resilient bushing 32 a resilient supporting structure, the detection lever 25 has an allowance of being shifted within the maximum elastic deformation range of the resilient bushing 32. When the detection lever 25 is shifted relative to the front first vertical arm 7a, the light receiving area receiving the beam f from the irradiation section 33 in the sensor 36a or 36b locating on the side opposite to the direction the detection lever 25 is shifted is increased to cause an output difference in the photo-location section 36, and thus the direction that the detection lever 25 is shifted, i.e. the change in the angle of the front first vertical arm 7a with respect to the lower first horizontal arm 8b which is a "counterpart member" at the connecting point β_5 can be found.

Accordingly, the control section 24, upon receipt of a signal from the photo-location section 36, rotates the motor M in the direction to correct the displacement of the detection lever 25, whereby the counterweight W_4 is moved

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in directions along the straight line X. In other words, if the weight of the operating microscope, etc. W_{1-3} is small, the counterweight W_4 is moved in a direction towards the operating microscope, etc. W_{1-3} (see Fig.4); whereas if the weight of the counterweight W_4 side is large, the counterweight W_4 is moved in a direction away from the operating microscope, etc. W_{1-3} (see Fig.5)

Thus, the reason why the weight of the operating microscope W_1 side can be balanced only by moving the counterweight W_4 in directions along the straight line X will be described below. In such type of stand, the weight of the operating microscope, etc. W_{1-3} and that of the counterweight W_4 must be balanced in the horizontal and vertical directions on the rotational fulcrum S. Namely, to describe referring to Fig. 1, while the weight of the operating microscope, etc. W_{1-3} and the weight of the counterweight W_4 must satisfy the following relationship:

* Balance in the vertical direction:

$$W_{1-3} \times Z_2 = W_4 \times Z_1$$

* Balance in the horizontal direction:

$$W_{1-3} \times L_2 = W_4 \times L_1$$

In this invention, all the connecting point β_1, rotational fulcrum S, and counterweight W_4 are on the straight line X and the counterweight W_4 moves only along the straight line X, so that the weight of the operating microscope W_1 side and the counterweight W_4 are well balanced both in the vertical and horizontal directions only by moving the counterweight W_4 along the straight line X even when the weight of the operating microscope, etc. W_{1-3} side

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changes.

That is to say, the operating microscope, etc. W_{1-3} which are positioned Z_2 : L_2 with respect to the rotational fulcrum S necessitate the counterweight W_4 to be moved at a ratio of Z_2 : L_2 in accordance with the weight change of the operating microscope, etc. W_{1-3} if any. However in this invention, since the position of the counterweight W_4 to the rotational fulcrum S, i.e. Z_1 : L_1 is equal to the above described Z_2 : L_2 as seen from the positional relationship according to the straight line X as a reference, the weights of the operating microscope, etc. W_{1-3} and the counterweight W_4 can be balanced only by moving the counterweight W_4 along the straight line X even when the weight of the operating microscope, etc. W_{1-3} changes because of the presence or absence of the auxiliary devices.

Therefore, when the counterweight W_4 is moved to a balancing point, the displacement of the detection lever 25 is corrected to allow the detection lever 25 to resume the neutral position, so that the photo-location section 36 detects the state of the neutral position, and the control section 24 stops driving of the motor M to allow the counterweight W_4 to stop at the balancing point. Now that the weight of the operating microscope, etc. W_{1-3} and that of the counterweight W_4 is balanced, the electromagnetic clutch C_7 of the detection lever 25 is deactuated to provide a free joint at the connecting point β_5 connecting the front first vertical arm 7a and the lower first horizontal arm 8b. In the balanced stand, when the operating microscope, etc. W_{1-3} are vertically moved as shown in Fig. 6, horizontally moved as shown in Fig. 7, or in a vertically-and-horizontally-combined direction as shown in Fig. 8, the balance between the operating microscope,

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etc. W_{1-3} and the counterweight W_4 is maintained, thereby the operating microscope, etc. W_{1-3} can be positioned at any desired spatial position.

Meanwhile, the bell crank 12, the vertical subarm 13, the horizontal subarm 14 and the front arm 10 disposed in the embodiment described above constitute a structure where the supporting parallel link 11 for supporting the operating microscope, etc. W_{1-3} can constantly maintain the vertical posture, even if the operating microscope, etc. W_{1-3} are moved in the horizontal and vertical directions. In this regard also, the structure of the embodiment facilitates the balancing operation.

Further, while the frame 1 described in the above embodiment is of a floor type which is set on the floor, the frame 1 may be of a ceiling type which is suspended from the ceiling of the operating room.

Meanwhile, the technique of detecting displacement of the retaining link mechanism 4 may not be limited to the embodiment utilizing the detection lever 25 as described above, and other means such as rotary encoders can be utilized. Further, the position where the displacement is detected may not be limited to the connecting point β_5.

In addition, the "auxiliary devices" may not be limited to the side microscope W_2 and video camera W_2, and other devices can be attached.

Industrial Applicability

As described above, in the stand for optical devices according to this invention, the changes in both vertical and lateral length of the second

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parallel link and movements of the counterweight along a predetermined straight line allow easy and secured balance adjustment between the weight of the operating microscope and auxiliary devices and that of the counterweight both vertically and horizontally, so that the stand is particularly suitable for retaining optical devices for medical use which require a short-time balance adjustment in an operation room.

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What is claimed is:

1. A stand for optical devices, comprising:

a retaining link mechanism essentially consisting of first and second parallel links which interlock each other, said retaining link mechanism being supported at the intermediary portion thereof on a rotational fulcrum of a frame;

a medical optical device and/or its auxiliary devices being retained at the extremity of a supporting arm, said supporting arm being formed by extending a part of said first parallel link laterally; and

a counterweight mounted on a connecting point, said connecting point as the farthest connecting point from the rotational fulcrum of said second parallel link being positioned on a straight line connecting the extremity of said supporting arm and said rotational fulcrum;

characterized in that the lengths of said second parallel link is retractable both vertically and laterally so that the counterweight is moveable along said straight line.

2. The stand for optical devices according to Claim 1, wherein said first parallel link is supported at the intermediary portion of a first vertical arm thereof on said rotational fulcrum of said frame, said first parallel link being formed by combining a pair of first vertical arms and a pair of first horizontal arms, said pairs of first vertical arms and first horizontal arms being parallel, respectively; a medical optical device and/or its auxiliary devices are retained at the extremity of said supporting arm, said supporting arm being formed by extending said upper first horizontal arm in one direction; and said second parallel link is formed by a retractable upper

second horizontal arm formed by extending a lower first horizontal arm of said first parallel link toward the opposite direction to said direction, a lower second horizontal arm being parallel with said upper second horizontal arm, a retractable second vertical arm formed by extending the other first vertical arm downwardly, and the other retractable second vertical arm being parallel with said second vertical arm.

3. The stand for optical devices according to Claim 1 or 2, wherein a supporting parallel link having a vertical arm is provided on the lower end of a front arm to support a medical optical device and/or its auxiliary devices on a lowest horizontal arm of said supporting parallel link.

4. The stand for optical devices according to any of Claims 1 to 3, wherein at a connecting point of said first or second vertical arm and a counterpart member pivotably supported by said first or second vertical arm, a displacement detection means is provided for detecting the pivoted displacement of a detection lever with respect to said first or second vertical arm based on the signal output from a photo-location section, said displacement detection means being locked on said counterpart member, said displacement detection means comprising a detection lever pivotably supported on said counterpart member via an electromagnetic clutch in a locked or unlocked state, a shaft connecting said detection lever and said first or second vertical arm and being resiliently supported at one end portion thereof by a resilient bushing, a beam irradiation section provided on one of said detection lever or said first or second vertical arm, and a photo-location section provided on the other of said detection lever or said first or second vertical arm.

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5. The stand for optical devices according to any of Claims 1 to 4, wherein a drive means is provided, said drive means comprising a motor for retracting each arm of a second parallel link to allow said counterweight to move along said straight line, and a control section for controlling said motor in accordance with the output from said photo-location device to allow said counterweight to move in a direction that said detection lever returns to the neutral position.

6. The stand for optical devices according to any of Claims 1 to 5, wherein on the connecting point which is the origin of said supporting arm is pivotablly supported a bell crank having both a rear end portion on the horizontal line including the connecting point and an upper end portion on the vertical line including the connecting point, further on the extremity of said supporting arm is provided a front link for retaining medical optical device and/or its auxiliary devices, said rear end portion of said bell crank and a portion on said frame are connected by a vertical subarm which is parallel with one first vertical arm of a first parallel link and has a length which is equal to the distance from the connecting point to the rotational fulcrum of said first vertical arm, and said upper end portion of said bell crank and said upper end portion of a front link are connected by a horizontal subarm which is parallel with said supporting arm and has a length which is equal to the distance of said supporting arm.

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STAND FOR OPTICAL DEVICES

ABSTRACT

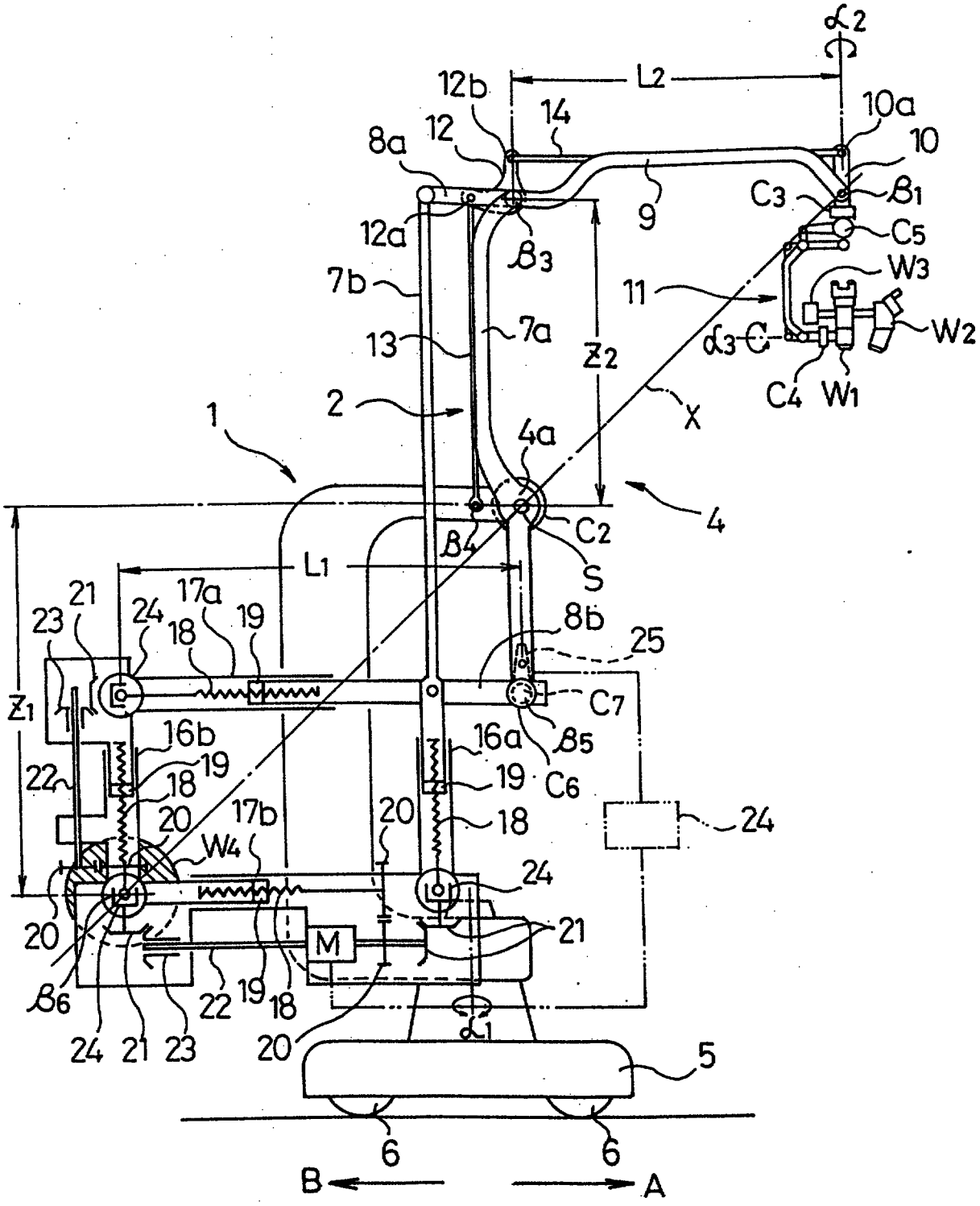
Disclosed is a stand for optical devices, wherein the lengths of a second parallel link 3 is retractable both vertically and laterally, so that a counterweight W_4 is moveable along a straight line X connecting a connecting point β_1 at the extremity of a supporting arm 9 and a rotational fulcrum S.

Moving the counterweight W_4 along the straight line X provides an easy and secured balance adjustment of the weight of operating microscope, etc. W_{1-3} both in horizontal and vertical directions.

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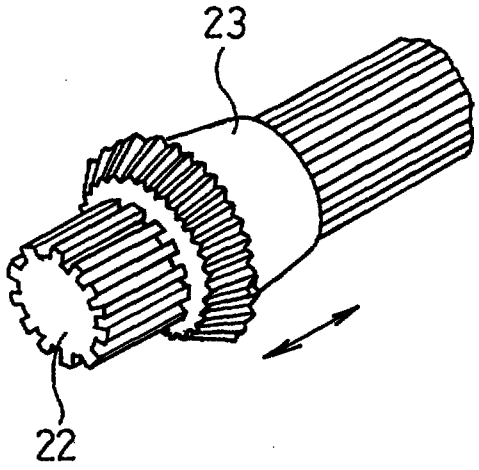


第 1 図

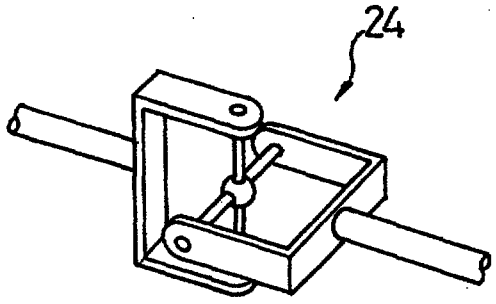


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第 2 図

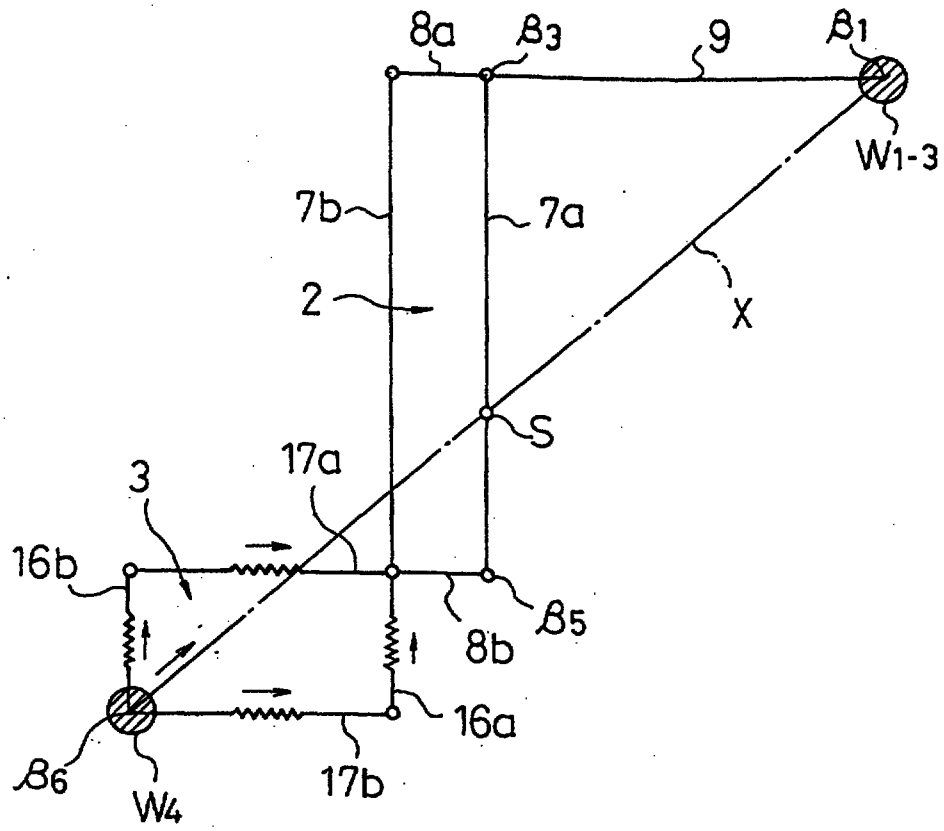


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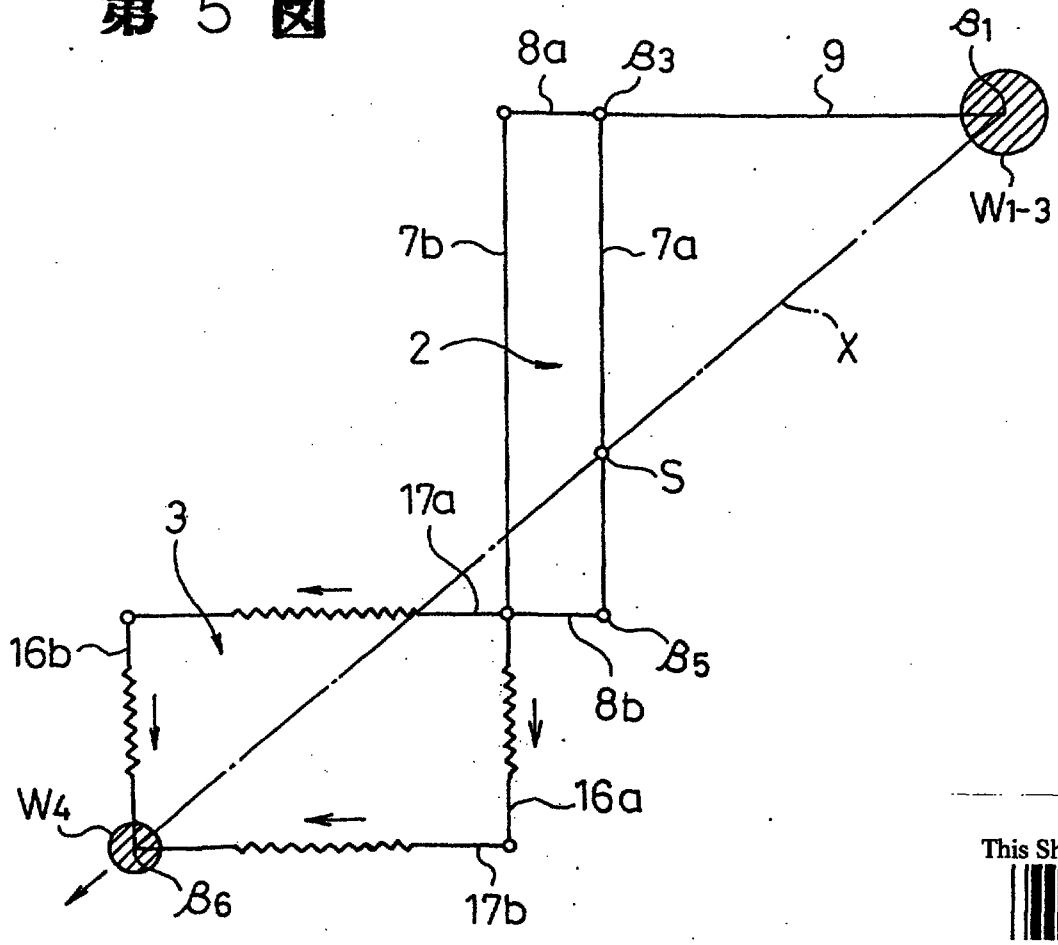


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第 4 図

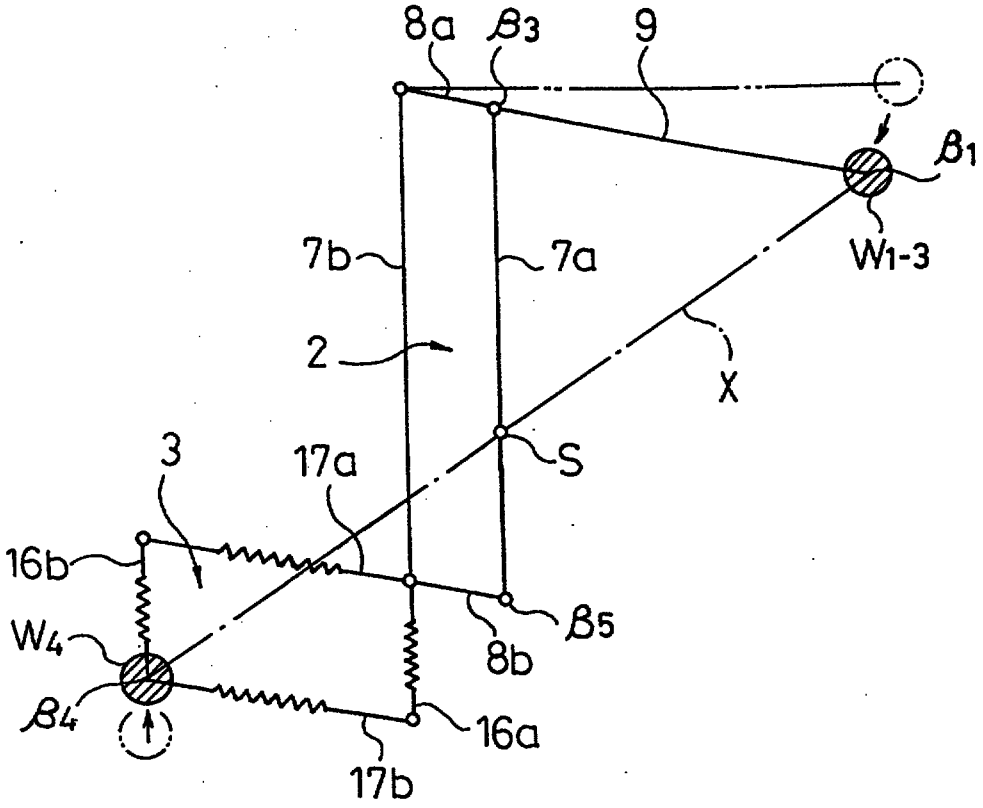


第 5 図

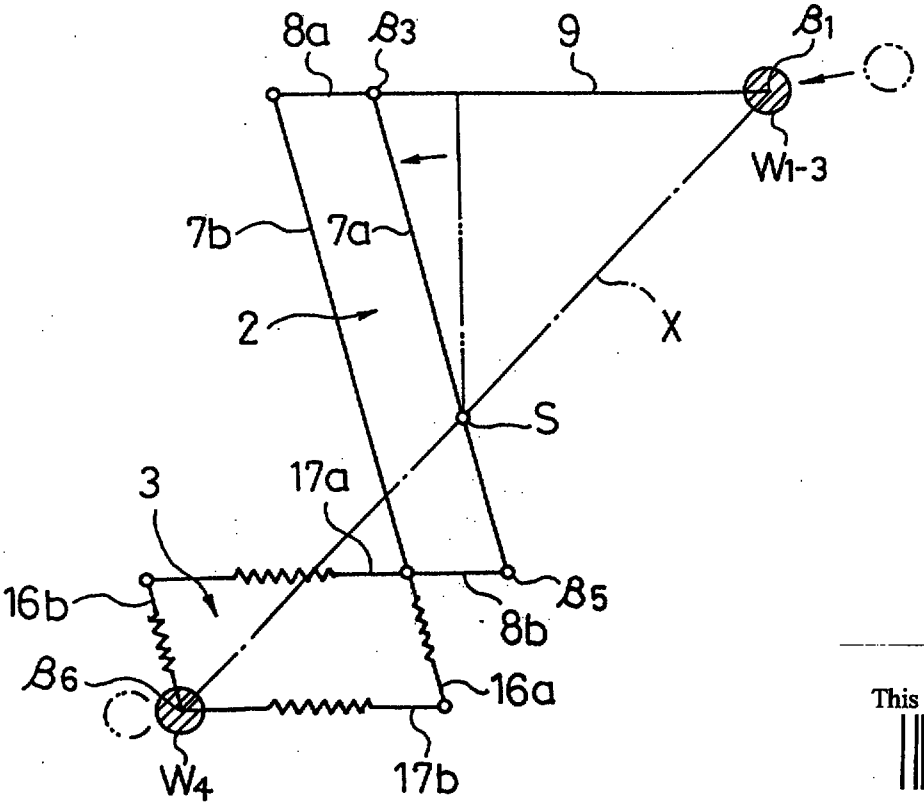


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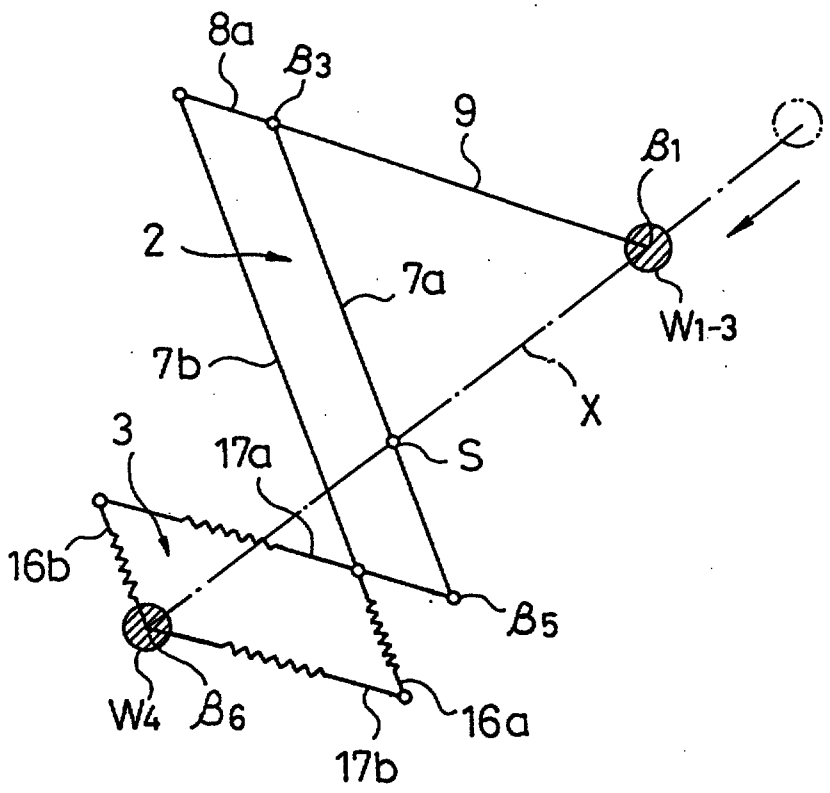


第 7 図



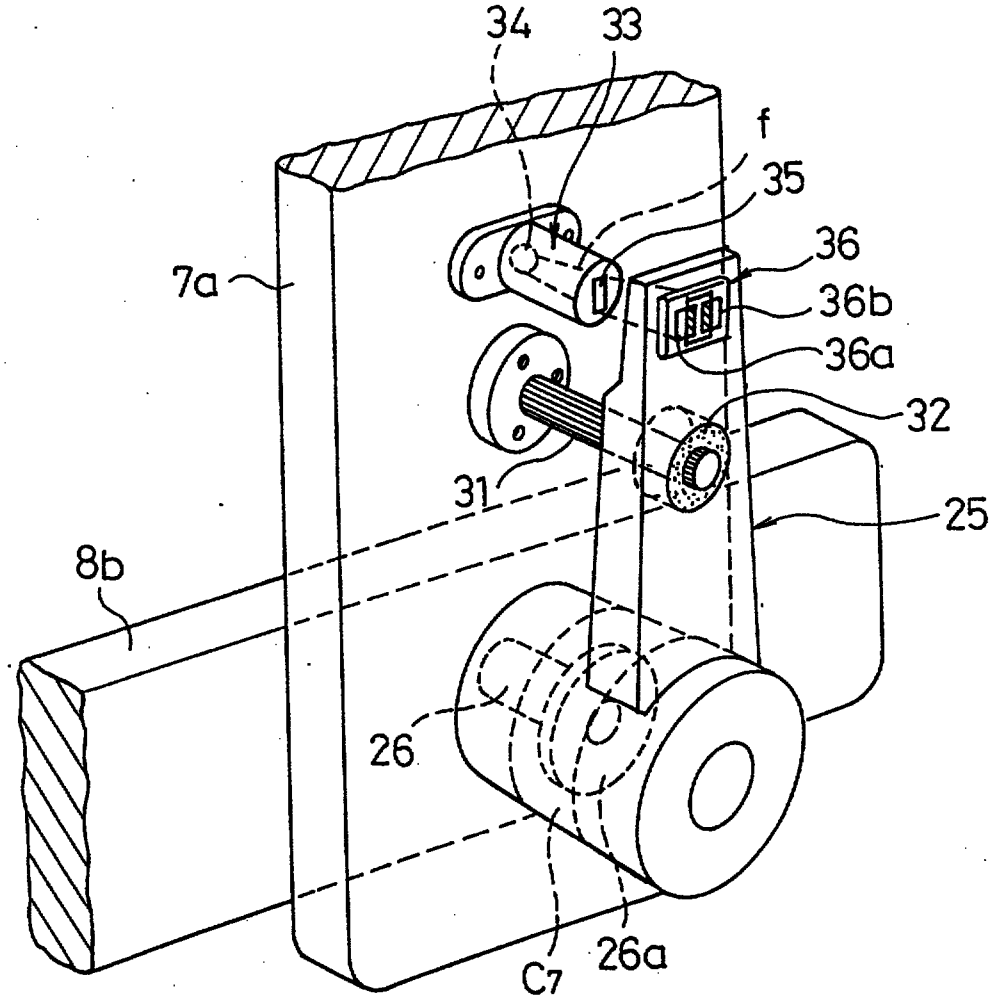
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第 8 図



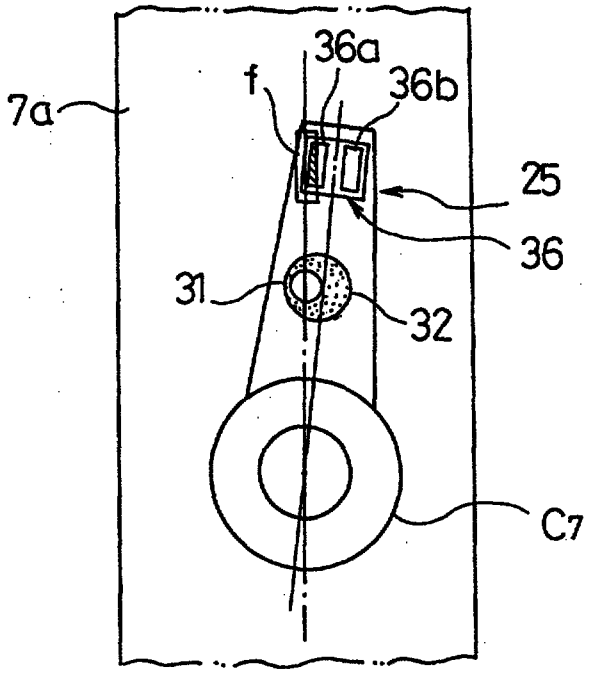
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第 9 図

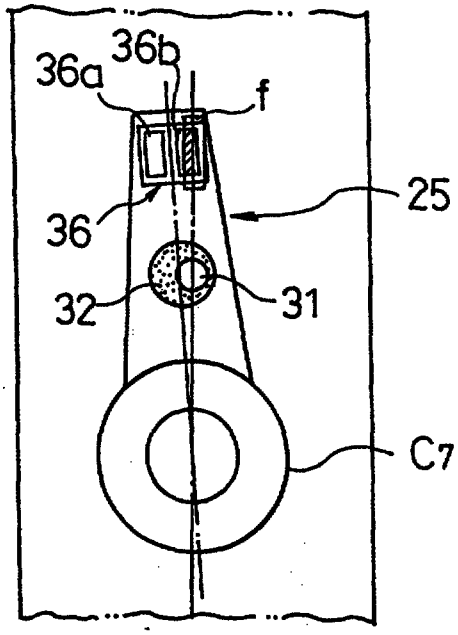


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第 10 図

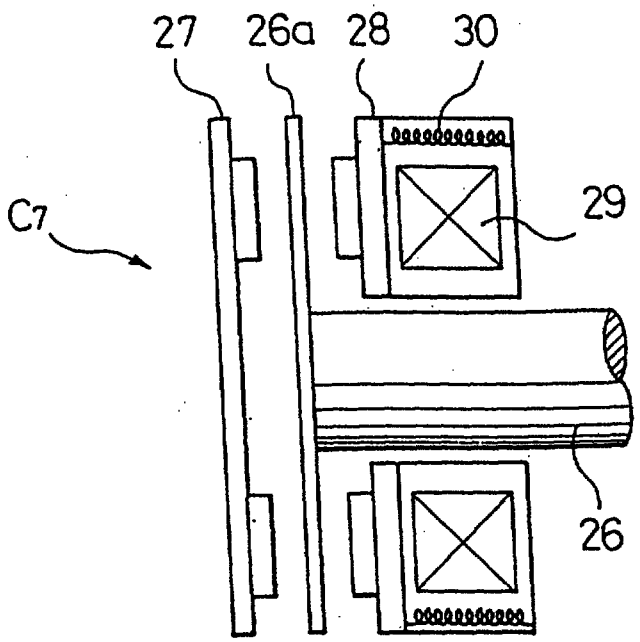


第 11 図

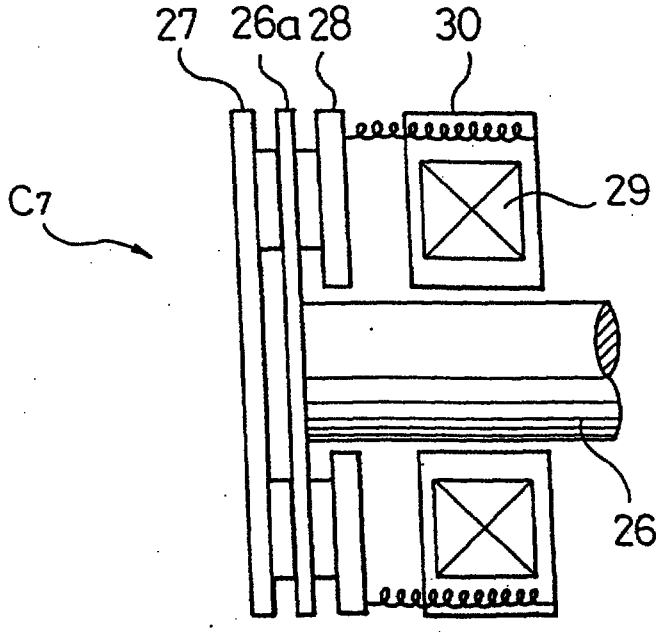


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第 12 図



第 13 図



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☑ Claim(s) : paged 18... to paged 20..
☑ Drawing(s) : paged 1/8. to paged 8/8.
☑ Abstract : paged 21. to paged ....
DATE OF RECEIPT 14/8/96

STAND FOR OPTICAL DEVICES

Field of the Invention

This invention relates to a stand in which heavy medical optical devices such as operating microscope and its auxiliary devices are supported with a retaining link mechanism utilizing a parallel link and are balanced with a counterweight, and above described operating microscope etc. can be retained or kept at the desired spatial positions during microsurgery.

Description of Prior Art

In the fields of encephalotomy and cardiosurgery, a technique of so-called microsurgery is employed, in which surgeries are performed under observation of the focuses using operating microscopes as "medical optical devices". Various types of stand apparatuses, for retaining heavy operating microscope and its auxiliary devices at any desired spatial positions, to be utilized in such microsurgeries have been proposed (e.g. Japanese Patent Publication before Examination No. 32110/1981). These stands generally are of a balancing structure, in which a retaining link mechanism employing a parallel link is pivotally (tiltably) supported at an intermediary portion on a frame, and an operating microscope is supported at one end portion of the retaining link mechanism with a counterweight for countervailing the weight of the operating microscope being supported on the other end portion of the retaining link mechanism relative to the pivot thereof.

As a position where the balancing type stand is set up, an optimum position in an operating room is selected depending on the content of the surgery to be carried out, and balance is adjusted at the selected position. In other

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words, while the optimum position around the operating table is specified by a doctor prior to surgery, the doctor himself is in a sterilized region, so that moving the stand to the position to set up is carried out by an assistant such as a nurse who does not participate in the surgery. Since auxiliary devices such as a side microscope for assistant doctors and a video camera are attached to the operating microscope, the position of the counterweight is changed corresponding to the weight of these devices to adjust the entire balance of the stand so that the operating microscopes with auxiliary devices and a counterweight are well balanced.

However, moving such heavy counterweight is a tremendous task and is also dangerous for the nurse who is in most cases a woman. Further, the balance adjusting operation takes too much time to be advantageously rendered for emergent surgery and the like.

What is most serious in the prior art stand is that the balance adjustment between the operating microscope and the counterweight is very difficult due to the structure of the stand itself. More specifically, in order to stop the operating microscope and the auxiliary devices at the desired spatial positions, the operating microscope must be perfectly balanced in the horizontal and vertical directions. However, the prior art stand does not always have a structure which facilitates secured balance adjustment in the horizontal and vertical directions in accordance with the weight on the operating microscope side which changes depending on the presence or absence of various auxiliary devices.

This invention has been accomplished noting such prior art technique and is

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directed to provide a stand for optical devices which enables easy and secured balance adjustment in accordance with the weight change on the operating microscope side.

Disclosure of the Invention

In the stand for optical devices according to the present invention, the intermediary portion of the retaining link mechanism essentially consisting of first and second parallel links which interlock each other is supported at a rotational fulcrum of a frame, a part of the above described first parallel link is laterally extended to form a supporting arm at which extremity medical optical device and/or its auxiliary devices are retained, a connecting point which is farthest from the rotational fulcrum of the above described second parallel link is positioned on a straight line connecting the extremity of the supporting arm and the rotational fulcrum, a counterweight is provided at the connecting point, and the length of the second parallel link is retractable both vertically and laterally so that the counterweight is moveable on the above described straight line.

The counterweight which is moveable on the straight line connecting the extremity of the supporting arm and the rotational fulcrum enables easy and secured balance adjustment of the weight of the above described operating microscope side both in horizontal and vertical directions by the movement of the counterweight along the straight line even when the weight of the operating microscope side changes because of the presence or absence of the auxiliary devices.

Alternatively, a displacement detecting means which detects unbalace of the

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retaining link mechanism may be provided at a part of the retaining link mechanism so that the counterweight can be moved manually in response to the signal from the displacement detecting means.

Furthermore, a drive means which moves the counterweight by means of a motor may be provided to control the drive means in response to the signal from the displacement detecting means, thereby the counterweight can be automatically moved to positions where the counterweight and the operating microscope side are balanced.

Brief Description of the Drawings

Fig. 1 is an entire side view showing a stand for optical devices according to this invention;

Fig. 2 shows a pinion and moving bevel teeth;

Fig. 3 shows a universal joint;

Fig. 4 is a schematic view showing a stand in which both the vertical length of a second parallel link and the lateral length of a weight-retaining arm are in a retracted state;

Fig. 5 is a schematic view showing a stand in which both the vertical length of the second parallel link and the lateral length of the weight-retaining arm are in a extended state;

Fig. 6 is a schematic view showing a vertical displacement in the stand in

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Fig. 4;

Fig. 7 is a schematic view showing a horizontal displacement in the stand in Fig. 4;

Fig. 8 is a schematic view showing vertical and horizontal displacement in the stand in Fig. 4;

Fig. 9 is a perspective view showing a displacement detecting means.

Fig. 10 is a side view showing a detection lever which is shifted to one side;

Fig. 11 is a side view showing a detection lever which is shifted to the other side;

Fig. 12 is a cross-sectional view showing an electromagnetic clutch is in an unlocked state; and

Fig. 13 is a cross-sectional view showing an electromagnetic clutch is in a locked state.

Best Mode for Carrying out the Invention

A preferred embodiment of this invention will be described below referring to the attached drawings. It should be noted here that the following description is made assuming that the arrow A and the arrow B shown in Fig. 1 mean the front side and the rear side, respectively.

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The stand according to the preferred embodiment of the invention has a basic structure wherein a retaining link mechanism 4 essentially consisting of a first parallel link 2 and a second parallel link 3 is supported at a part (intermediary portion 4a) on a rotational fulcrum S on a frame 1, and an operating microscope 5 and other devices are supported at one end portion (connecting point β_1) of a supporting arm 9 which is an extended portion of the first parallel link 2, while a counterweight W_4 is provided on the connecting point β_6 of the second parallel link 3 positioned on a straight line X.

The base affixed with the reference number 5 has on the bottom a plurality of casters 6 with locking mechanisms, thus the entire stand is allowed to run on the floor. A frame 1 having a substantially rectangular U-shaped side profile is mounted on the base 5. The frame 1 is designed to be pivotable on the vertical axis α_1 and also to be unpivotably locked by an electromagnetic clutch C_1 provided on the axis α_1.

A first parallel link 2 is pivotably supported on the rotational fulcrum S assumed on the upper front end side of the frame 1. The first parallel link 2 is formed by combining a pair of first parallel vertical arms 7a,7b and a pair of first parallel horizontal arms 8a,8b. The front first vertical arm 7a of the first parallel link 2 is supported at the intermediary portion 4a on the rotational fulcrum S, as described above. An electromagnetic clutch C_2 is provided on the rotational fulcrum S, so that the front first vertical arm 7a can be locked at a desired pivoted position (i.e. the displaced state of the first horizontal link 2). The upper portion of the front first vertical arm 7a supported on the rotational axis S is bulged backward so as not to

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interfere with the body of a doctor who performs the surgery.

The upper first horizontal arm 8a of the first parallel link 2 extends forward to form a supporting arm 9 integrally therewith, and a vertical front arm 10 is pivotably attached to the connecting point β_1 at the front end portion thereof. The supporting arm 9 is also bulged upward so as not to interfere with the head of the doctor.

A supporting parallel link 11 consisting of two parallel links which interlock with each other is provided below the front arm 10 to be pivotable on the vertical axis α_2. An electromagnetic clutch C_3 is provided at the upper end of the supporting parallel link 11, and an operating microscope (medical optical device) W_1 which is pivotable on the axis α_3 is attached via another electromagnetic clutch C_4 to the lowermost portion of the supporting parallel link 11. The supporting parallel link 11 as a whole presents a curved shape, so that the doctor can operate the operating microscope W_1 easily. The view angle of the operating microscope W_1 can be changed by transforming the supporting parallel link 11. Incidentally, the transformed state of the supporting parallel link 11 can be locked by an electromagnetic clutch C_5. " Auxiliary devices" such as a side microscope W_2 for assistant doctors and a video camera W_3 for recording are attached to the operating microscope W_1. The weight on the operating microscope (W_1) side changes by attaching or detaching these auxiliary devices.

A bell crank 12 is pivotably supported on the connecting point β_3 which is the origin of the supporting arm 9, and the rear end portion 12a of the bell crank 12 is connected via a vertical subarm 13 to the connecting point β_4 of

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the frame 1, while the upper end 12b of the bell crank 12 is connected via a horizontal subarm 14 to the upper end portion 10a of the front arm 10. In other words, on the connecting point β_3 which is the origin of the supporting arm 9 is supported the bell crank 12, having the rear end portion 12a on the horizontal line including the connecting point β_3 and the upper end portion 12b on the perpendicular line including the connecting point β_3; the rear end portion 12a of the bell crank 12 and the connecting point β_4 of the frame 1 are connected by the vertical subarm 13, which is parallel with the front first vertical arm 7a and has a length which is equal to the linear distance from the connecting point β_3 of the front first vertical arm 7a to the rotational fulcrum S; and the upper end portion 12b of the bell crank 12 and the upper end portion 10a of the front link 10 are connected by the horizontal subarm 14 which is parallel with the supporting arm 9 and has a length which is equal to that of the supporting arm 9.

With the aid of the vertical subarm 13 and the horizontal subarm 14 additionally provided, a "parallel link" is formed by the rotational fulcrum S ⇨ connecting point β_3 ⇨ rear end portion 12a ⇨ connecting point β_4; while another "parallel link" is formed by the connecting point β_3 ⇨ connecting point β_1 ⇨ upper end portion 10a⇨ upper end portion 12b. Accordingly, since the bell crank 12 cannot be turned no matter how the first parallel link 2 is transformed, the front arm 10 is constantly maintained in the vertical posture, and consequently the axis α_2 of the supporting parallel link 11 is prevented from tilting to maintain constantly the vertical posture.

Next, there provided below the first parallel link 2 the second parallel link 3 which deforms interlockedly with the first parallel link 2. The second

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parallel link 3 comprises an upper second horizontal arm 17a as formed with a lower first horizontal arm 8b backwardly extended, a lower second horizontal arm 17b as parallel and equal in length with the upper second horizontal arm 17a, a front second vertical arm 16a as formed with a rear first vertical arm 7b downwardly extended, and a rear second vertical arm 16b as parallel and equal in length with the front second vertical arm 16a. The arms 16a, 16b, 17a, and 17b which form the second parallel link 3, individually have therein an expandable structure with an inner cylinder which is slidably inserted in an outer cylinder, and a screw bar 18 provided to the outer cylinder is screwed to a female thread 19 on the inner cylinder to allow the whole length to retract.

Each screw bar 18 is rotated by a motor M of which revolving effect is transmitted to each screw bar 18 to retract each arm 16a, 16b, 17a, and 17b. First, the motor M, at the front side, rotates the screw bar 18 of lower second horizontal arm 17b via two spur teeth 20, and simultaneously rotates the front second vertical arm 16a via two bevel teeth 21. On the other hand, the motor M is provided with a backwardly-extended spline 22 at the rear side thereof, and via moving bevel teeth 23 and other bevel teeth 21 both engaged with the spline 22, the screw bar 18 in the rear second vertical arm 16b is rotated. Furthermore, at the root of screw bar 18 in the rear second vertical arm 16b, there provided a spline 22 which is rotated by a pair of spur teeth 20, and via moving bevel teeth 23 and other bevel teeth 21 both engaged with the spline 22, the screw bar 18 in the upper second horizontal arm 17a is rotated. On the each fulcrum portion of the second parallel link 3, at the root of each screw bar 18, a universal joint 24 is interposed. Thereby, even if the second parallel link 3 is deformed, the revolving effect

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of the motor M is securely transmitted to the screw bar 18. The revolving effect transmitted via the spline 22 and moving bevel teeth 23 secures the revolving effect of the motor M if the lengths of the arms 16a, 16b, 17a, and 17b change. The gear ratio of the spur teeth 20 themselves, the bevel teeth 21 themselves, and the bevel teeth 21 and moving bevel teeth 23 are set so that the second horizontal arms 17a, 17b and the second vertical arms 16a, 16b retract with the length ratio between the second horizontal arms 17a, 17b and the second vertical arms 16a, 16b are maintained. Thus, the second parallel link 3 enlarges or reduces while maintaining its similar figures. The motor M is controlled by a later-described control section 24, and the motor M and control section 24 provide a "drive means".

A connecting point β_4 as the farthest connecting point from the rotational fulcrum S of the second parallel link is positioned on a straight line X which connects the connecting point β_1 on the extremity of the supporting arm 9 and the rotational fulcrum S, and the connecting point β_4 is always positioned on the straight line X whatever the second parallel link 3 may be deformed. To the connecting point β_4, a counterweight W_4 is mounted.

Next, a detection lever 25 is provided on the left side (reverse side of the front first vertical arm 7a in Fig. 1) of the connecting point β_5 where the front first vertical arm 7a and the lower first horizontal arm 8b are connected. While a conventional electromagnetic clutch C_6 is disposed on the right side of the connecting point β_5, the detection lever 25 is attached to another electromagnetic clutch C_7 disposed to a connecting shaft 26 penetrating the lower first horizontal lever 8b ("which is a counterpart member") through the front first vertical arm 7a. More specifically, a disc-

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shaped flange 26a is formed at one end of the connecting shaft 26, and the electromagnetic clutch C_7 is provided with a fixed flange 27 and a moveable flange 28. The flange 26a is grasped and locked between the fixed flange 27 and the moveable flange 28. The moveable flange 28 side is provided with an electromagnetic coil 29 on which the moveable flange 28 is magnetically adsorbed and a spring 30 which urges the moveable flange 28 toward the fixed flange 27. Accordingly, the electromagnetic coil 29 attracts the moveable flange 28 overcoming the force of the spring 30 during energization, so that the detection lever 25 assumes a state of free rotation with respect to the connecting shaft 26 (see Fig. 12). However, the attraction by the electromagnetic coil 29 is not exerted during de-energization, so that the moveable flange 28 is pushed toward the fixed flange 27 to hold the flange 26a of the connecting shaft 26 between the fixed flange 27 and the moveable flange 28, and thus the detection lever 25 can be turned integrally with the connecting shaft 26 (see Fig. 13).

A metal shaft 31 is disposed to protrude from the front first vertical arm 7a at a position opposing to the detection lever 25, and the outer end portion of the shaft 31 is resiliently supported by a resilient bushing 32 disposed in the middle of the detection lever 25. An irradiation section 33 for irradiating a beam f is provided on the front first vertical arm 7a at a position opposing to the upper end portion of the detection lever 25. The irradiation section 33 contains a light-emitting diode 34 therein, and the beam f from the light-emitting diode 34 is designed to pass through a slit 35 and impinge upon the upper end portion of the detection lever 25. The upper end portion of the detection lever 25 to be irradiated with the beam f is provided with a two-piece photo-location section 36 having two sensors

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36a,36b. Accordingly, so long as the detection lever 25 is maintaining a vertical neutral position relative to the front first vertical arm 7a, the beam f transmitted through the slit 35 impinges at the middle of the two sensors 36a,36b, and thus the sensors 36a,36b receive the beam f on the same area, producing no output difference. However, if the detection lever 25 is pivoted to either side and deviated from the neutral position, the photo-detecting area in the sensor 36a or 36b locating on the side opposite to the side the detection lever 25 is shifted is increased to generate an output difference, thus enabling detection of the shift. The photo-location section 36 is electrically connected to the control section 24, and the control section 24 allows the motor M to be driven based on the signal from the photo-location section 36, whereby the counterweight W_4 can be moved in a direction such that the detection lever 25 can resume the neutral position. The detection lever 25, the irradiation section 33, the photo-location section 36, etc. constitute the "displacement detection means".

In the meantime, the operational procedures of the stand will now be described. First, the entire stand is carried to a position near the operating table specified by a doctor. A specified side microscope W_2 and a video camera W_3 are attached to the operating microscope W_1. At this point, the weight of the counterweights W_1 and the weight on the operating microscope (W_1) side including the side microscope W_2 and the video camera W_3 (hereinafter referred to as "operating microscope, etc. W_{1-3}") are not necessarily balanced. Incidentally, the retaining link mechanism 4 itself from which the counterweight W_4 and the operating microscope, etc. W_{1-3} are detached is balanced on the rotational fulcrum S.

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Subsequently, the retaining link mechanism 4 is once allowed to resume the standard posture as shown in Fig. 1, and the electromagnetic clutch C_7 is actuated to immobilize the detection lever 25 onto the connecting shaft 26 of the lower first horizontal arm 8b. If the weight of the operating microscope, etc. W_{1-3} and that of the counterweight W_4 in this state is not balanced, the angle of the front first vertical arm 7a is inevitably changed with respect to the lower first horizontal arm 8b which is a "counterpart member", so that the detection lever 25 locked integrally with the connecting shaft 26 of the lower first horizontal arm 8b is pivoted or shifted relative to the vertical arm 7a.

Since the detection lever 25 and the front first vertical arm 7a constitute via the resilient bushing 32 a resilient supporting structure, the detection lever 25 has an allowance of being shifted within the maximum elastic deformation range of the resilient bushing 32. When the detection lever 25 is shifted relative to the front first vertical arm 7a, the light receiving area receiving the beam f from the irradiation section 33 in the sensor 36a or 36b locating on the side opposite to the direction the detection lever 25 is shifted is increased to cause an output difference in the photo-location section 36, and thus the direction that the detection lever 25 is shifted, i.e. the change in the angle of the front first vertical arm 7a with respect to the lower first horizontal arm 8b which is a "counterpart member" at the connecting point β_6 can be found.

Accordingly, the control section 24, upon receipt of a signal from the photo-location section 36, rotates the motor M in the direction to correct the displacement of the detection lever 25, whereby the counterweight W_4 is moved

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in directions along the straight line X. In other words, if the weight of the operating microscope, etc. W_{1-3} is small, the counterweight W_4 is moved in a direction towards the operating microscope, etc. W_{1-3} (see Fig.4); whereas if the weight of the counterweight W_4 side is large, the counterweight W_4 is moved in a direction away from the operating microscope, etc. W_{1-3} (see Fig.5)

Thus, the reason why the weight of the operating microscope W_1 side can be balanced only by moving the counterweight W_4 in directions along the straight line X will be described below. In such type of stand, the weight of the operating microscope, etc. W_{1-3} and that of the counterweight W_4 must be balanced in the horizontal and vertical directions on the rotational fulcrum S. Namely, to describe referring to Fig. 1, while the weight of the operating microscope, etc. W_{1-3} and the weight of the counterweight W_4 must satisfy the following relationship:

* Balance in the vertical direction:

$$W_{1-3} \times Z_2 = W_4 \times Z_1$$

* Balance in the horizontal direction:

$$W_{1-3} \times L_2 = W_4 \times L_1$$

In this invention, all the connecting point β_1, rotational fulcrum S, and counterweight W_4 are on the straight line X and the counterweight W_4 moves only along the straight line X, so that the weight of the operating microscope W_1 side and the counterweight W_4 are well balanced both in the vertical and horizontal directions only by moving the counterweight W_4 along the straight line X even when the weight of the operating microscope, etc. W_{1-3} side

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changes.

That is to say, the operating microscope, etc. W_{1-3} which are positioned Z_2 : L_2 with respect to the rotational fulcrum S necessitate the counterweight W_4 to be moved at a ratio of Z_2 : L_2 in accordance with the weight change of the operating microscope, etc. W_{1-3} if any. However in this invention, since the position of the counterweight W_4 to the rotational fulcrum S, i.e. Z_1 : L_1 is equal to the above described Z_2 : L_2 as seen from the positional relationship according to the straight line X as a reference, the weights of the operating microscope, etc. W_{1-3} and the counterweight W_4 can be balanced only by moving the counterweight W_4 along the straight line X even when the weight of the operating microscope, etc. W_{1-3} changes because of the presence or absence of the auxiliary devices.

Therefore, when the counterweight W_4 is moved to a balancing point, the displacement of the detection lever 25 is corrected to allow the detection lever 25 to resume the neutral position, so that the photo-location section 36 detects the state of the neutral position, and the control section 24 stops driving of the motor M to allow the counterweight W_4 to stop at the balancing point. Now that the weight of the operating microscope, etc. W_{1-3} and that of the counterweight W_4 is balanced, the electromagnetic clutch C_7 of the detection lever 25 is deactuated to provide a free joint at the connecting point β_6 connecting the front first vertical arm 7a and the lower first horizontal arm 8b. In the balanced stand, when the operating microscope, etc. W_{1-3} are vertically moved as shown in Fig. 6, horizontally moved as shown in Fig. 7, or in a vertically-and-horizontally-combined direction as shown in Fig. 8, the balance between the operating microscope,

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etc. W_{1-3} and the counterweight W_4 is maintained, thereby the operating microscope, etc. W_{1-3} can be positioned at any desired spatial position.

Meanwhile, the bell crank 12, the vertical subarm 13, the horizontal subarm 14 and the front arm 10 disposed in the embodiment described above constitute a structure where the supporting parallel link 11 for supporting the operating microscope, etc. W_{1-3} can constantly maintain the vertical posture, even if the operating microscope, etc. W_{1-3} are moved in the horizontal and vertical directions. In this regard also, the structure of the embodiment facilitates the balancing operation.

Further, while the frame 1 described in the above embodiment is of a floor type which is set on the floor, the frame 1 may be of a ceiling type which is suspended from the ceiling of the operating room.

Meanwhile, the technique of detecting displacement of the retaining link mechanism 4 may not be limited to the embodiment utilizing the detection lever 25 as described above, and other means such as rotary encoders can be utilized. Further, the position where the displacement is detected may not be limited to the connecting point β_5.

In addition, the "auxiliary devices" may not be limited to the side microscope W_2 and video camera W_2, and other devices can be attached.

Industrial Applicability

As described above, in the stand for optical devices according to this invention, the changes in both vertical and lateral length of the second

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parallel link and movements of the counterweight along a predetermined straight line allow easy and secured balance adjustment between the weight of the operating microscope and auxiliary devices and that of the counterweight both vertically and horizontally, so that the stand is particularly suitable for retaining optical devices for medical use which require a short-time balance adjustment in an operation room.

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What is claimed is:

1. A stand for optical devices, comprising:

a retaining link mechanism essentially consisting of first and second parallel links which interlock each other, said retaining link mechanism being supported at the intermediary portion thereof on a rotational fulcrum of a frame;

a medical optical device and/or its auxiliary devices being retained at the extremity of a supporting arm, said supporting arm being formed by extending a part of said first parallel link laterally; and

a counterweight mounted on a connecting point, said connecting point as the farthest connecting point from the rotational fulcrum of said second parallel link being positioned on a straight line connecting the extremity of said supporting arm and said rotational fulcrum;

characterized in that the lengths of said second parallel link is retractable both vertically and laterally so that the counterweight is moveable along said straight line.

2. The stand for optical devices according to Claim 1, wherein said first parallel link is supported at the intermediary portion of a first vertical arm thereof on said rotational fulcrum of said frame, said first parallel link being formed by combining a pair of first vertical arms and a pair of first horizontal arms, said pairs of first vertical arms and first horizontal arms being parallel, respectively; a medical optical device and/or its auxiliary devices are retained at the extremity of said supporting arm, said supporting arm being formed by extending said upper first horizontal arm in one direction; and said second parallel link is formed by a retractable upper

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second horizontal arm formed by extending a lower first horizontal arm of said first parallel link toward the opposite direction to said direction, a lower second horizontal arm being parallel with said upper second horizontal arm, a retractable second vertical arm formed by extending the other first vertical arm downwardly, and the other retractable second vertical arm being parallel with said second vertical arm.

3. The stand for optical devices according to Claim 1 or 2, wherein a supporting parallel link having a vertical arm is provided on the lower end of a front arm to support a medical optical device and/or its auxiliary devices on a lowest horizontal arm of said supporting parallel link.

4. The stand for optical devices according to any of Claims 1 to 3, wherein at a connecting point of said first or second vertical arm and a counterpart member pivotably supported by said first or second vertical arm, a displacement detection means is provided for detecting the pivoted displacement of a detection lever with respect to said first or second vertical arm based on the signal output from a photo-location section, said displacement detection means being locked on said counterpart member, said displacement detection means comprising a detection lever pivotably supported on said counterpart member via an electromagnetic clutch in a locked or unlocked state, a shaft connecting said detection lever and said first or second vertical arm and being resiliently supported at one end portion thereof by a resilient bushing, a beam irradiation section provided on one of said detection lever or said first or second vertical arm, and a photo-location section provided on the other of said detection lever or said first or second vertical arm.

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5. The stand for optical devices according to any of Claims 1 to 4, wherein a drive means is provided, said drive means comprising a motor for retracting each arm of a second parallel link to allow said counterweight to move along said straight line, and a control section for controlling said motor in accordance with the output from said photo-location device to allow said counterweight to move in a direction that said detection lever returns to the neutral position.

6. The stand for optical devices according to any of Claims 1 to 5, wherein on the connecting point which is the origin of said supporting arm is pivotably supported a bell crank having both a rear end portion on the horizontal line including the connecting point and an upper end portion on the vertical line including the connecting point, further on the extremity of said supporting arm is provided a front link for retaining medical optical device and/or its auxiliary devices, said rear end portion of said bell crank and a portion on said frame are connected by a vertical subarm which is parallel with one first vertical arm of a first parallel link and has a length which is equal to the distance from the connecting point to the rotational fulcrum of said first vertical arm, and said upper end portion of said bell crank and said upper end portion of a front link are connected by a horizontal subarm which is parallel with said supporting arm and has a length which is equal to the distance of said supporting arm.

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STAND FOR OPTICAL DEVICES

ABSTRACT

Disclosed is a stand for optical devices, wherein the lengths of a second parallel link 3 is retractable both vertically and laterally, so that a counterweight W_4 is moveable along a straight line X connecting a connecting point β_1 at the extremity of a supporting arm 9 and a rotational fulcrum S.

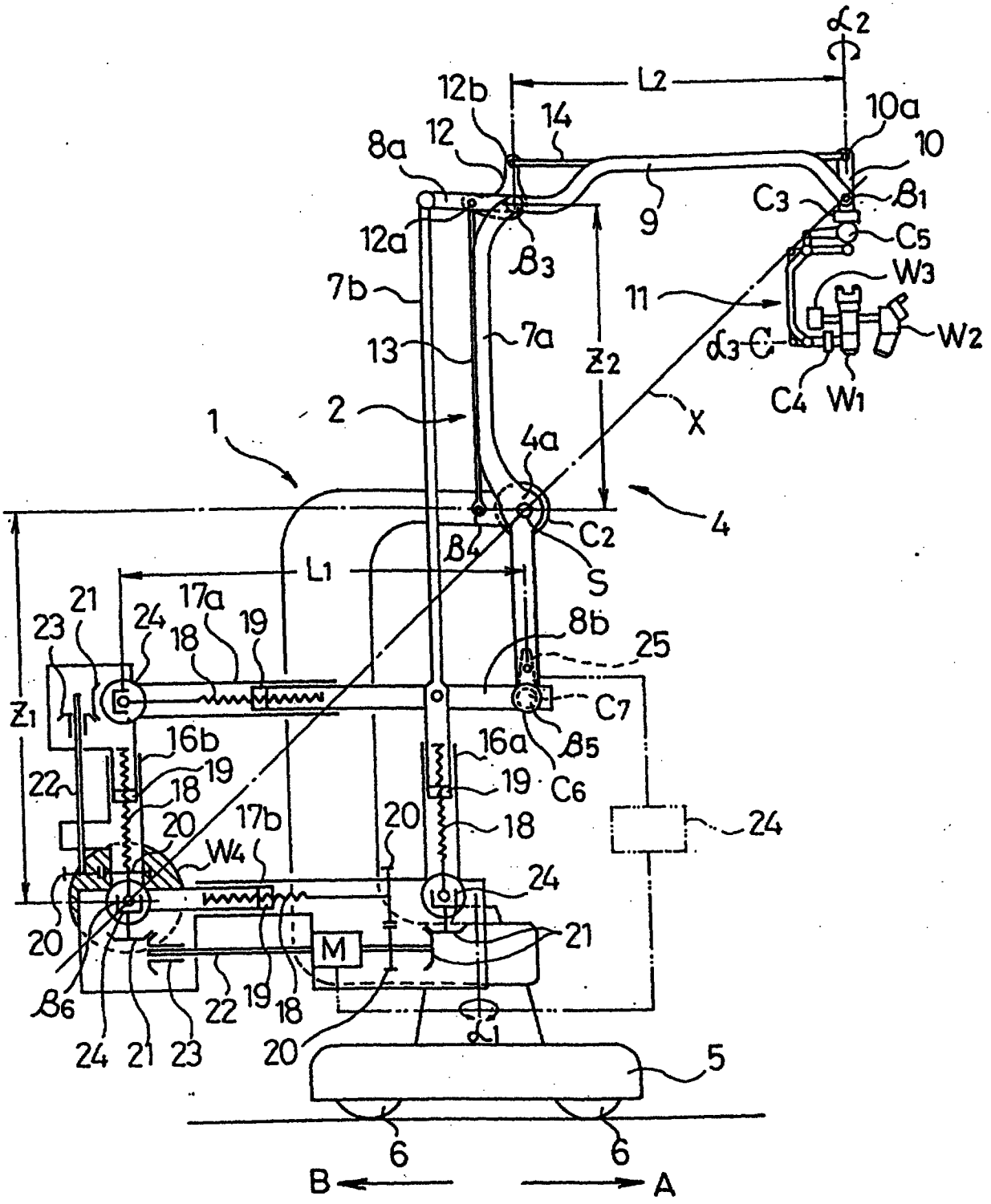
Moving the counterweight W_4 along the straight line X provides an easy and secured balance adjustment of the weight of operating microscope, etc. W_{1-3} both in horizontal and vertical directions.

FIGURE 1

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FIGURE 1



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FIGURE 2

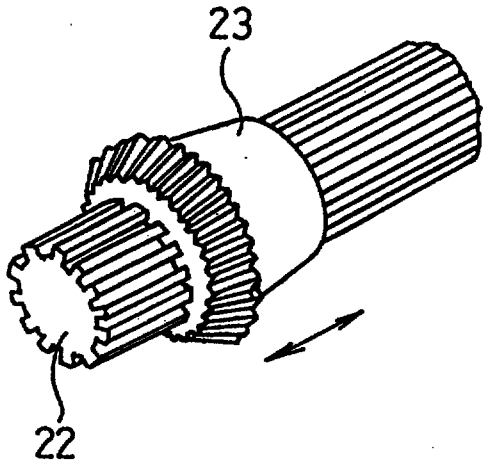
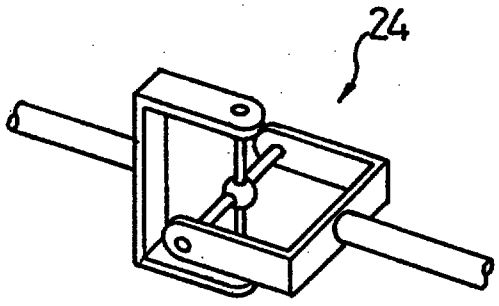


FIGURE 3



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FIGURE 4

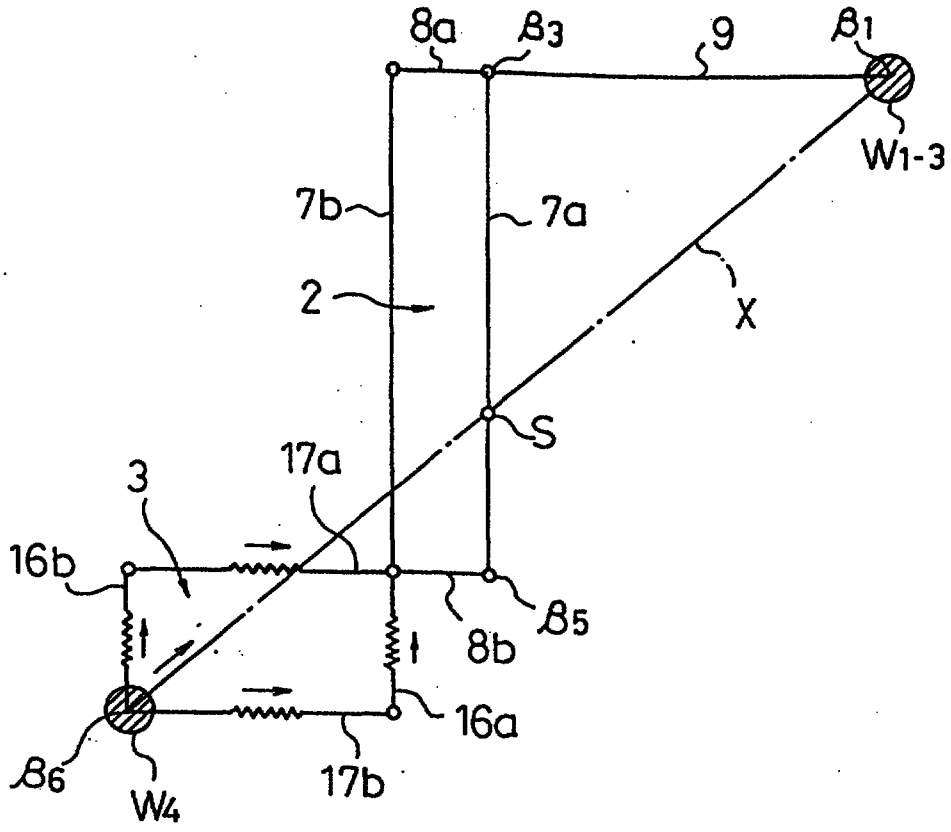
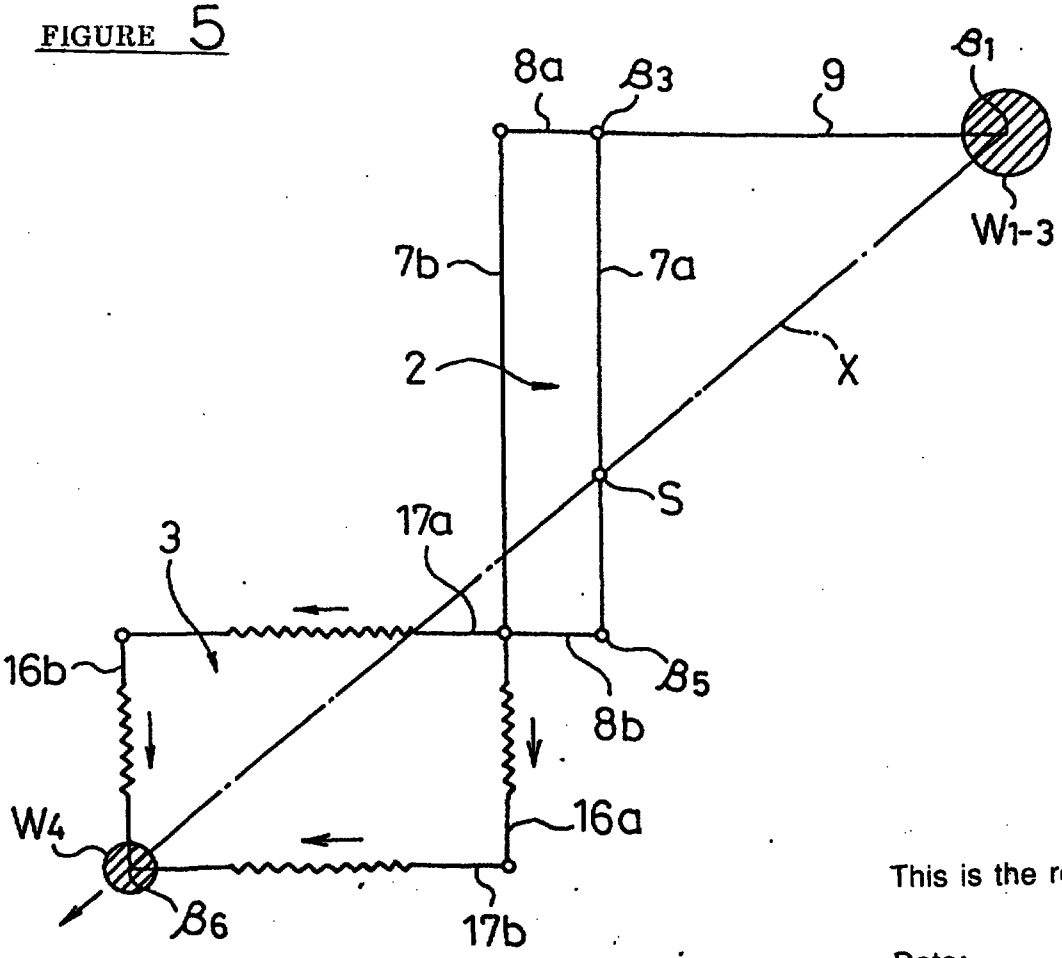


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FIGURE 6

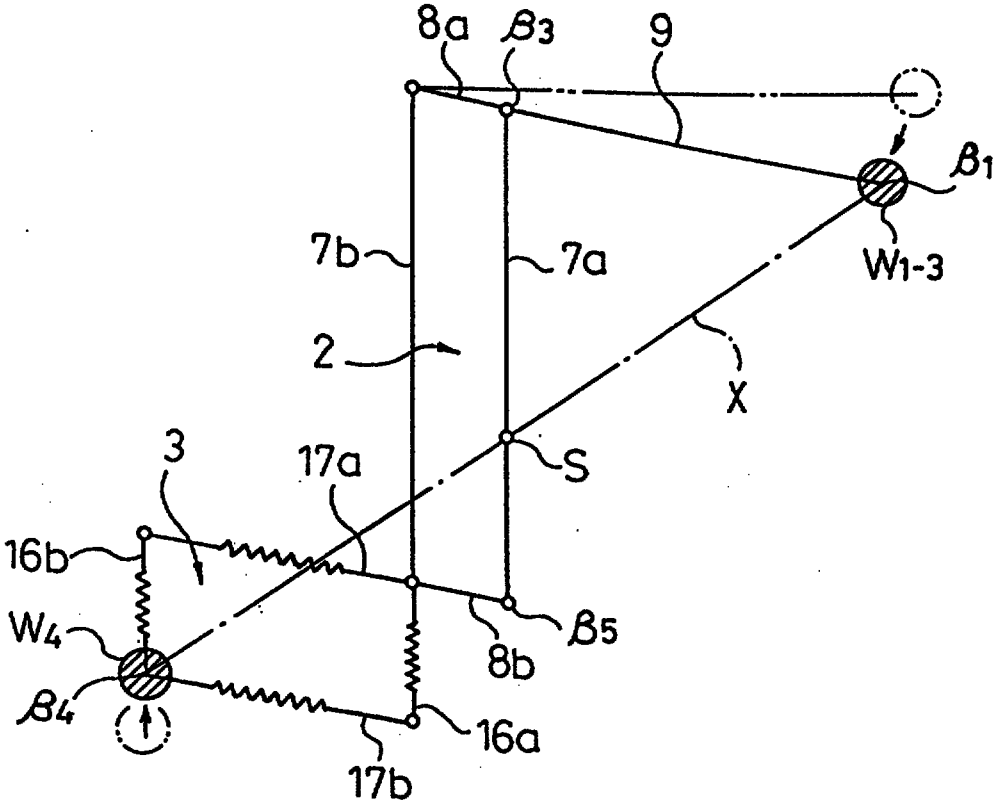
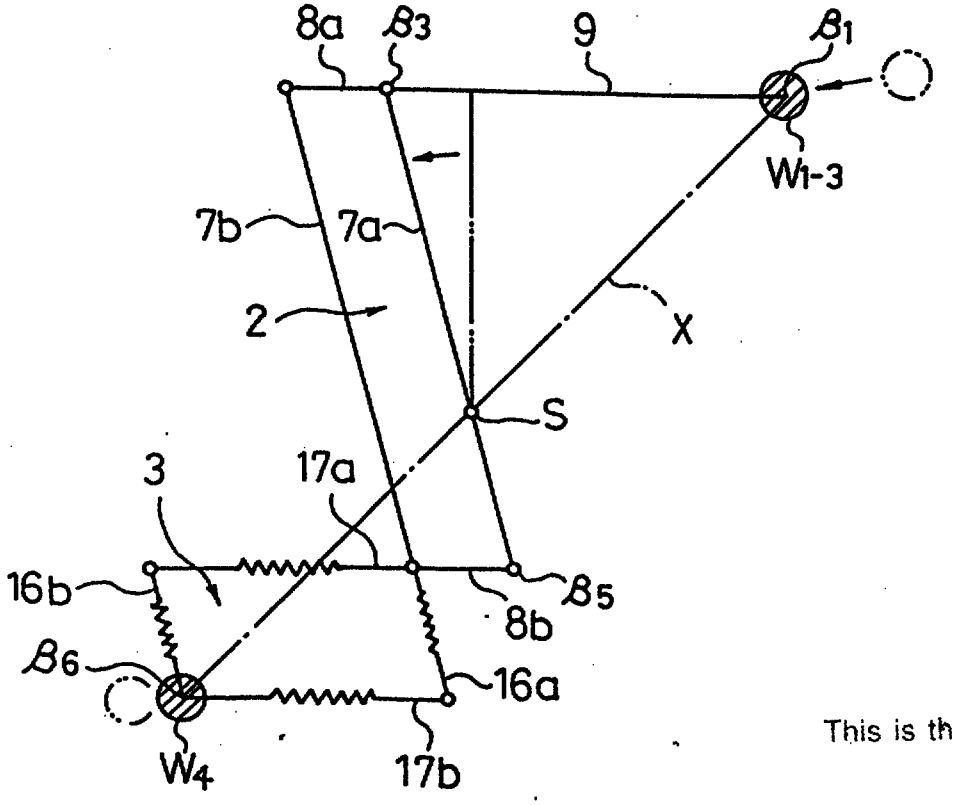


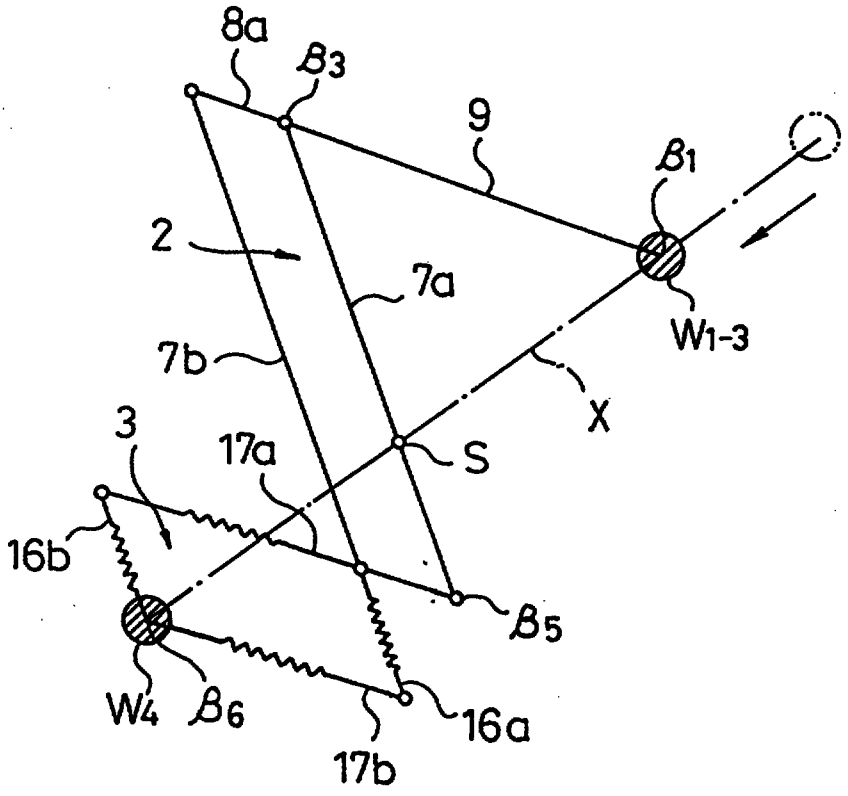
FIGURE 7



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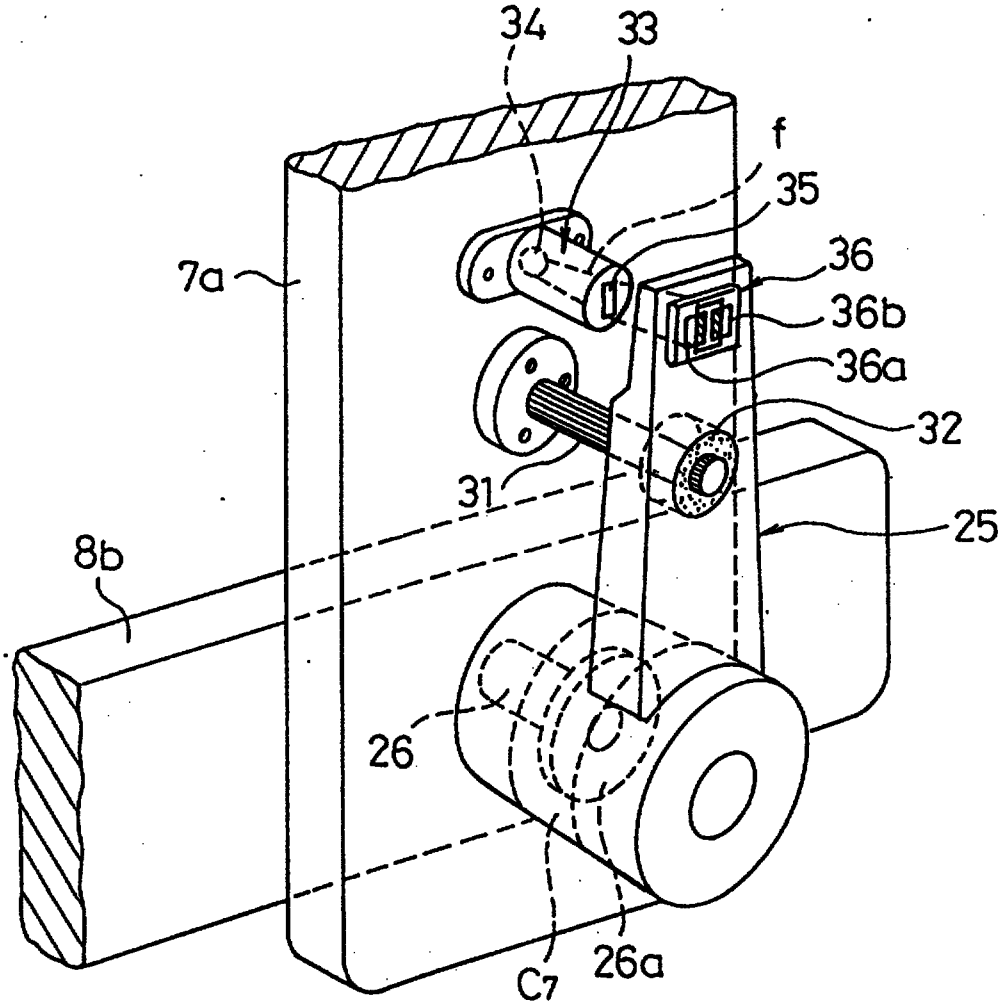
FIGURE 8



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FIGURE 9



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FIGURE 10

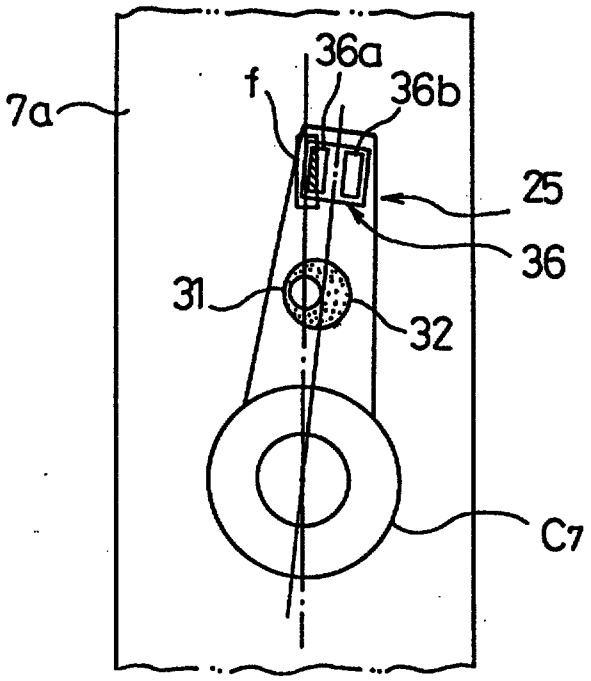
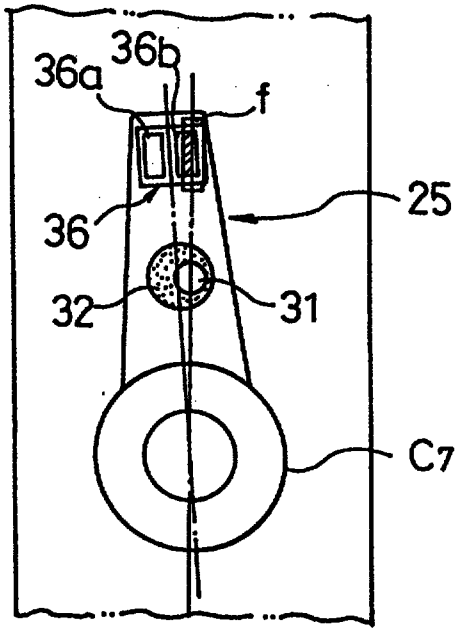


FIGURE 11



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FIGURE 12

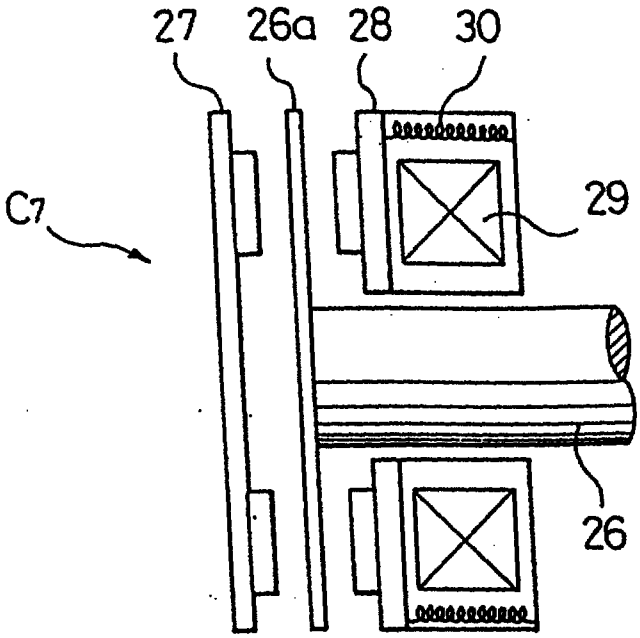
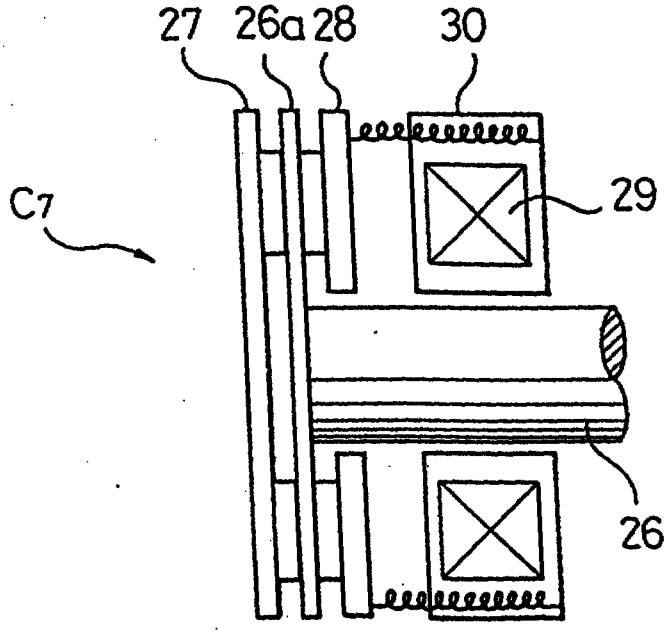


FIGURE 13



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