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(54) Title: A LIFTING DEVICE

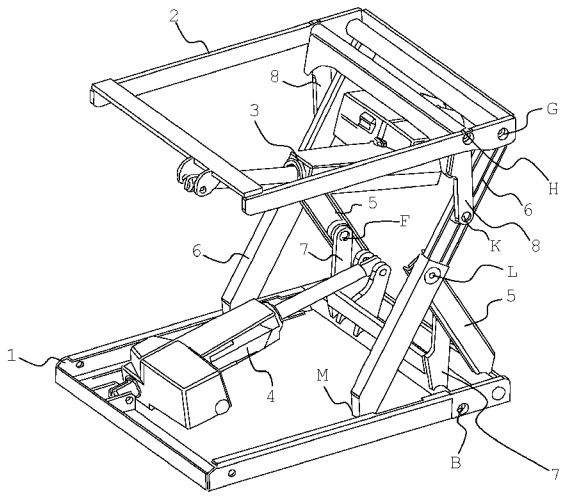



Fig. 5

(57) Abstract: A lifting device comprising a lower frame (1) and an upper frame (2) which are connected by a lever arm (6), the lower frame comprising a lower pivoting arm (5) which with a first end is pivotally connected to the lower frame and with a 5 second end is pivotally connected to the lever arm, a lower tilting arm (7) is with a first end pivotally connected with the lower frame and with a second end slidably connected with the lower pivoting arm, said lower tilting arm being adapted to tilt by the action of a first actuator (4) and thereby cause a movement of the lower pivoting arm, wherein that the upper frame comprises an 10 upper tilting arm (8) which with a first end is pivotally connected to the upper frame and with a second end is slidably connected with the lever arm.

A lifting device

The present invention relates to a lifting device comprising a lower frame, an upper frame and a lever arm which lever arm with a first end is pivotally connected to the upper frame in a fixed point and with a second end is slidably connected to the lower frame by a first sliding connection, the lower frame comprising a lower pivoting arm which with a first end is pivotally connected to the lower frame in a fixed point and with a second end is pivotally connected to the lever arm in a fixed point, a lower tilting arm is with a first end pivotally connected to the lower frame in a fixed point and with a second end is slidably connected to the lower pivoting arm by a second sliding connection, said lower tilting arm being adapted to tilt by the action of a first actuator and thereby cause a movement of the lower pivoting arm.

Lifting devices for use for tables, chairs, beds etc. are well known. The majority of these known lifting devices operates according to the so-called "scissor principle", where two lever arms are pivotally connected in a configuration that corresponds to the way the two arms in a scissor are connected. At their top and bottom the lever arms are connected to a frame or a platform and by moving the end points of the lever arms together the frame or platform at the top can be lifted. If the end points of the two lever arms are moved away from each other, the frame or the platform can be lowered. The movements of the lever arms can be affected by an actuator, such as a linear actuator, which e.g. may be hydraulic or electric.

This principle is basically well-known and lifting that utilizes the principle can e.g. be found disclosed in the documents GB 915556, GB 2172875, US 2,874,805 A and US 2,706,102 A.

Although the "scissor principle" functions very well and provides many good solutions for lifting devices, the principle is not capable of fully utilizing the forces provided by an actuator in respect of energy consumption and, normally, an actuator used in a scissor lifting device has to be somewhat oversized to deliver the required power. In particular, the problem arises when the lifting device using the scissor principle is in extreme positions, which may cause undesired load on the system. Consequently, there is a need for lifting systems that are

able to utilize the power from an actuator in a more even way and with lesser load on the system.

The object of the present invention is to provide a lifting device that has better properties in respect of utilizing energy applied for the lifting process.

The inventive lifting device is characterised in that the upper frame comprises an upper tilting arm which with a first end is pivotally connected to the upper frame in a fixed point and with a second end is slidably connected with the lever arm by a third sliding connection.

Moreover, the present invention provides a lifting device that has a more even consumption of energy during the lifting process, and where there is lesser load on the parts in the lifting device than in the hitherto known devices.

Consequently, the present invention relates to a lifting device comprising a lower frame and an upper frame connected by a lever arm, wherein the lever arm is pivotally connected at a fixed point in the upper frame and slidably connected in the lower frame, the lower frame comprises a lower pivoting arm pivotally connected in a fixed point to the lower frame at a first end and pivotally connected in a fixed point of the lever arm at a second end, where a lower tilting arm is pivotally connected with the lower frame in a fixed point at a first end and slidably connected with the lower pivoting arm at a second end, said lower tilting arm being adapted to tilt by the action of a first actuator and thereby cause a movement of the lower pivoting arm.

The lifting device according to the invention can be incorporated in a table, a chair, a bed and other utility items where a lifting device can facilitate the use. In case the utility item is a table, the lower frame may be located on the floor and form the basis for the table and the upper frame may carry the table top.

The lifting device requires only one lever arm connecting the lower and upper frame to function. The lever arm is pivotally connected with the upper frame at one point on the upper frame. In the lower frame the lever arm is connected in such a way that it is able to slide in the lower frame. The sliding properties can e.g. be achieved by mounting one or more rollers on the lever arm which can roll in a U-shaped profile in the lower frame. The sliding movement of the lever arm

in the lower frame can be affected by a lower pivoting arm that at one end is pivotally connected with the lower frame in a fixed point and at the other end is pivotally connected in a fixed point to the lever arm.

However, to move the lower pivoting arm, this is slidably connected with a lower tilting arm which is pivotally connected at one end with the lower frame in a fixed point. The sliding connection can be designed by using one or more rollers that can roll in e.g. a U-shaped profile. This corresponds to the solution described for the lever arm and the lower frame.

The lower tilting arm is adapted to tilt by the action of a first actuator which will cause the other end of the tilting arm to slide in the lower pivoting arm which again will affect the lever arm to slide in the lower frame. The first actuator is preferably connected with one part to the tilting arm in such a way that it easily can tilt the tilting arm. One other part of the first actuator is preferably mounted to the lower frame.

When the tilting arm affects the lower pivoting arm this again affects the lever arm to perform a sliding movement in the lower frame. If the sliding movement of the lever arm is towards the point in the lower frame where the lower pivoting arm is fixed, the lever arm will raise the upper frame. If the sliding movement of the lever arm, however, is away from the point in the lower frame where the lower pivoting arm is fixed, the lever arm will lower the upper frame.

In this respect, the lower frame and the upper frame may be different or substantially identical, depending on the intended use of the lifting device according to the invention.

For the purpose of adjusting the upper frame in a desired position, e.g. horizontal position, it is preferred that the upper frame comprises an upper tilting arm pivotally connected in a fixed point to the upper frame at a first end and slidably connected with the lever arm at a second end and where the upper tilting arm is adapted to tilt by the action of a second actuator and thereby cause a movement of the upper frame. The sliding properties can be achieved in a manner as described above. The second actuator is preferably connected with one part to the upper tilting arm and one other part of the second actuator is preferably mounted to the upper frame.

Although the design and thereby the length of the lever arm, the length of the lower pivoting arm and the lengths of the tilting arms and the displacement of the actuators may vary in respect of each other, it is, however, preferred that the mentioned lengths and displacements are within the ratios mentioned below.

A first preferred ratio is a ratio where the lever arm has a first length and the lower pivoting arm has a second length where the second length is substantially half the first length.

A second preferred ratio is a ratio where the first actuator has a maximum displacement and the lower tilting arm has a length allowing the lower tilting arm to tilt between a first and a second position, where the distance between the first and the second position corresponds substantially to the maximum displacement of the first actuator.

Moreover, for some specific embodiment a ratio where the lever arm has a first length and the lower tilting arm has a third length, where the third length is substantially one quarter of the first length, may be desirable.

For similar specific embodiments a ratio where the lower pivoting arm has a second length and the lower tilting arm has a third length, where the third length is substantially half the second length, may also be suitable.

A third preferred ratio is a ratio where the second actuator has a maximum displacement and the upper tilting arm has a length allowing the upper tilting arm to tilt between a first and a second position, where the distance between the first and the second position corresponds substantially to the maximum displacement of the second actuator.

Some specific embodiments may comprise a ratio where the lever arm has a first length and the upper tilting arm has a fourth length, where the fourth length is substantially one quarter of the first length.

The above mentioned preferred ratios ensure that the lifting device according to the invention is able to provide a stable lift, where the lower and upper frame is

kept parallel during the lift if desired and where extreme load on the parts of the lifting device can be avoided.

Moreover, to obtain the best possible properties of the lifting device according to the invention, it is preferred that the lower tilting arm can slide in the lower pivoting arm substantially from the point where the lower pivoting arm is pivotally connected to the lower frame to the point where the lower pivoting arm is pivotally connected to the lever arm.

Furthermore, to utilize the full potential and to obtain the best possible properties of the lifting device, it is also preferred that the upper tilting arm can slide in the lever arm substantially from the point where the lever arm is pivotally connected to the upper frame to the point where the lever arm is pivotally connected with the lower pivoting arm.

Although one lever arm is sufficient for the lifting device to function properly, a preferred embodiment is, however, an embodiment where the lifting device comprises two parallel lever arms connecting the lower frame and the upper frame. Such an embodiment is easy to incorporate in the design of a table, a chair such as a wheel chair, a bed etc.

The material for constructing the lifting device may be plastic or metal. Plastic material may be chosen for smaller constructions which are not intended for high loads. Metal, such as steel, stainless steel and aluminum may be preferred for larger constructions intended for higher loads. Optional roller wheels may be made from synthetic rubber.

The first and the second actuator may be any suitable actuators. They may be identical or different. In a preferred embodiment, the first and the second actuator are linear actuators which may be operated by hydraulic, electric or mechanical power.

The invention will now be described in further details with reference to drawings where

Fig. 1 depicts schematically an embodiment of a lifting device according to the invention in a first position;
Fig. 2 depicts the embodiment of figure 1 in a second position;
Fig. 3 depicts the embodiment of figure 1 in a third position;
Fig. 4 depicts the embodiment of figure 1 in a fourth position; and
Fig. 5 shows a three-dimensional illustration of an embodiment of the lifting device according to the invention.

Figure 1 depicts schematically a possible embodiment of the invention. Figure 1 shows a lower frame 1 and an upper frame 2. In the upper frame 2 an upper, second actuator 3 is mounted which is attached to the upper frame in a fixed point J. The second actuator 3 is pivotally connected in a fixed point I to an upper tilting arm 8 which is pivotally connected with the upper frame 2 in a fixed point H.

A lower, first actuator 4 is with its first end attached to the lower frame 1 in a fixed point D and its second end is pivotally connected to a lower tilting arm 7 in a fixed point C. The lower tilting arm 7 is pivotally connected with the lower frame 1 in a fixed point B.

A lower pivoting arm 5 is with a first end pivotally connected to the lower frame 1 in a fixed point A and the lower pivoting arm 5 is with a second end pivotally connected with a lever arm 6 in a fixed point L.

The lever arm 6 is pivotally connected to the upper frame 2 in a fixed point G. The lever arm 6 is slidably connected to the lower frame 1 in a fixed point M by a first sliding connection 11. The first sliding connection 11 between the lower frame 1 and the lever arm 6 is accomplished by e.g. a roller or a wheel 11.

The lower tilting arm 7 is pivotally connected with the lower frame 1 in a fixed point B and with the first actuator 4 in a fixed point C. The lower tilting arm 7 is also slidably connected with the lower pivoting arm 5 in a fixed point F by a second sliding connection 10. The second sliding connection 10 between the lower pivoting arm 5 and the tilting arm 7 in the fixed point F is accomplished by e.g. a roller or a wheel 10.

In figure 1 the lifting device can be said to be in a rested, lower position. In the following figures 2-4 the lifting device is shown in other positions. The reference numbers used in figure 1 refer to the same parts in the figures 2-4.

Figure 2 shows the lifting device in an activated, upper position, where the upper frame 2 is raised in respect of the lower frame 1.

In figure 2 the lower tilting arm 7 has been affected by the actuator 4 to make a tilting movement in the fixed point B, thereby affecting the lower pivoting arm 5 via the second sliding connection 10. This causes the lower pivoting arm 5 to affect the lever arm 6 in the fixed point L, causing the lever arm 6 to slide in the lower frame 1 by means of the first sliding connection 11.

The sliding movement of the lever arm 6 in the lower frame 1 has the consequence that the upper frame 2 is raised in respect of the lower frame 1.

To maintain the upper frame 2 horizontal in respect of the ground level or the lower frame 1, the second actuator 3 is activated to affect the upper tilting arm 8 in the fixed point I. The upper tilting arm 8 is pivotally attached to the upper frame 2 in the fixed point H and slidably connected with the lever arm 6 in a fixed point K by a third sliding connection 9. The third sliding connection 9 between the upper tilting arm 8 and the lever arm 6 is accomplished by e.g. a roller or a wheel 9. The tilting of the upper tilting arm 8 caused by the actuator 3 has the effect that the roller 9 in the fixed point K moves towards the fixed point G, which affects the position of the upper frame 2 via the upper tilting arm 8 which is pivotally connected to the upper frame 2 in the fixed point H.

In this way it is possible to achieve a desired position, e.g. a horizontal position, of the upper frame 2 when the lever arm 6 raises the upper frame 2.

Figure 3 depicts the lifting device according to the invention in a third position, where the upper frame 2 is tilting.

This situation can be achieved during the raise of the lever arm 6 and the upper frame 2 as described above. However, when a tilt of the frame 2 is desired, the second actuator 3 should only affect the upper tilting arm 8 in a degree in such a

way that the upper frame 2 does not reach a horizontal level or the level where the upper frame 2 is parallel with the lower frame 1.

Figure 3 illustrates the situation with maximum tilt of the upper frame 2 in respect of the lower frame 1. This situation is achieved when the second actuator 3 is not activated and, consequently, not affects the upper tilting arm 8.

Figure 4 depicts the possibility of a negative tilt of the lifting device according to the invention. A negative tilt can be achieved when the second actuator 3 is activated to affect the upper tilting arm 8 more than the lower tilting arm 7 is affected by the first actuator 4.

The maximum negative tilt of the upper frame 2 can be achieved when the second actuator 3 is activated to provide maximum effect on the upper tilting arm 8, while at same time the first actuator 4 is not activated. Figure 4 illustrates the situation with maximum negative tilt.

Figure 5 shows a preferred embodiment of a three-dimensional illustration of the lifting device according to the invention. This particular embodiment comprises the lower frame 1 and the upper frame 2. The upper frame 2 is connected with the upper actuator 3 and the lower frame 1 is connected with the lower actuator 4.

The lower frame 1 is, furthermore, connected with the two lower pivoting arms 5 which, respectively, are pivotally connected with the two lever arms 6 in the fixed points L. The lever arms 6 are parallel and pivotally connected with the upper frame 2 in the fixed points G. The lever arms 6 are slidably connected with the lower frame 1 in the fixed points M.

The lifting device further comprises the two lower tilting arms 7 and the two upper tilting arms 8. The lower tilting arms 7 are connected with the first actuator 4 and pivotally connected with the lower frame 1 in the fixed point B. Moreover, the lower tilting arms 7 are slidably connected with the lower pivoting arms 5 in the fixed point F.

In a similar manner the upper tilting arms 8 are connected with the second actuator 3 and with the upper frame 2 in the fixed point H. Additionally, the

upper tilting arms 8 are slidably connected with the lever arms 6 in the fixed point K.

In figure 5 the lifting device is in the activated position, where the upper frame 2 is raised in respect of the lower frame 1. The actuator 3 has been activated to affect the upper tilting arms 8 to keep the upper frame 2 parallel with the lower frame 1.

Figure 5 shows tubular members, arms and other devices which are not specifically referred to in the above text. However, these features are not necessary for the basic function of the lifting device, i.e. the lifting device according to the invention can be constructed without them and, therefore, they are not mentioned. Their functions are, however, clear from the disclosure of the figure.

Although the present invention has been described with reference to only a few embodiments, it will easily be envisaged by a skilled person that several other embodiments and variations are possible within the scope of the claims. The length of the lever arm, lower tilting arm, lower and upper tilting arms may be changed and other types of actuators can be used.

# C L A I M S

1. A lifting device comprising a lower frame (1), an upper frame (2) and a lever arm (6) which lever arm (6) with a first end is pivotally connected to the upper frame (2) in a fixed point (G) and with a second end is slidably connected to the lower frame (1) by a first sliding connection (11), the lower frame (1) comprising a lower pivoting arm (5) which with a first end is pivotally connected to the lower frame (1) in a fixed point (A) and with a second end is pivotally connected to the lever arm (6) in a fixed point (L), a lower tilting arm (7) is with a first end pivotally connected to the lower frame (1) in a fixed point (B) and with a second end is slidably connected to the lower pivoting arm (5) by a second sliding connection (10), said lower tilting arm (7) being adapted to tilt by the action of a first actuator (4) and thereby cause a movement of the lower pivoting arm (5), **characterised in** that the upper frame (2) comprises an upper tilting arm (8) which with a first end is pivotally connected to the upper frame (2) in a fixed point (H) and with a second end is slidably connected with the lever arm (6) by a third sliding connection (9).

2. A lifting device according to claim 1, **characterised in** that the upper tilting arm (8) is adapted to tilt by the action of a second actuator (3) and thereby cause a movement of the upper frame (2).

3. A lifting device according to any of the preceding claims, **characterised in** that the lever arm (6) has a first length and the lower pivoting arm (5) has a second length, where the second length is substantially half the first length.

4. A lifting device according to any of the preceding claims, **characterised in** that the first actuator (4) has a maximum displacement and the lower tilting arm (7) has a length allowing the lower tilting arm (7) to tilt between a first and a second position, where the distance between the first and the second position corresponds substantially to the maximum displacement of the first actuator (4).

5. A lifting device according to any of the preceding claims, **characterised in** that the lower pivoting arm (5) has a second length and the lower tilting arm (7) has a third length, where the third length is substantially half the second length.

6. A lifting device according to any of the preceding claims 1-5, **characterised in** that the second actuator (3) has a maximum displacement and the upper tilting arm (8) has a length allowing the upper tilting arm (8) to tilt between a first and a second position, where the distance between the first and the second position corresponds substantially to the maximum displacement of the second actuator (3).

7. A lifting device according to any of the preceding claims, **characterised in** that the lower tilting arm (7) can slide in the lower pivoting arm (5) substantially from the fixed point (A) where the lower pivoting arm (5) is pivotally connected to the lower frame (1) to the fixed point (L) where the lower pivoting arm (5) is pivotally connected to the lever arm (6).

8. A lifting device according to any of the preceding claims 1-7, **characterised in** that the upper tilting arm (8) can slide in the lever arm (6) substantially from the fixed point (G) where the lever arm (6) is pivotally connected to the upper frame (2) to the fixed point (L) where the lever arm (6) is pivotally connected with the lower pivoting arm (5).

9. A lifting device according to any of the preceding claims, **characterised in** that the lifting device comprises two parallel lever arms (6) connecting the lower frame (1) and the upper frame (2).

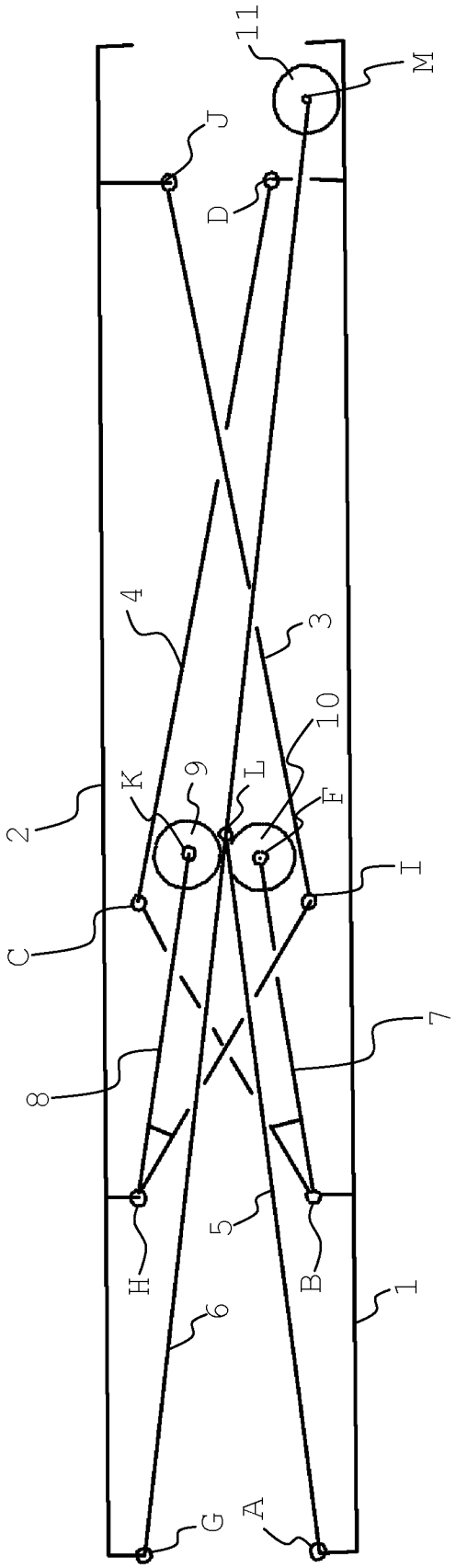



Fig. 1

Fig. 2

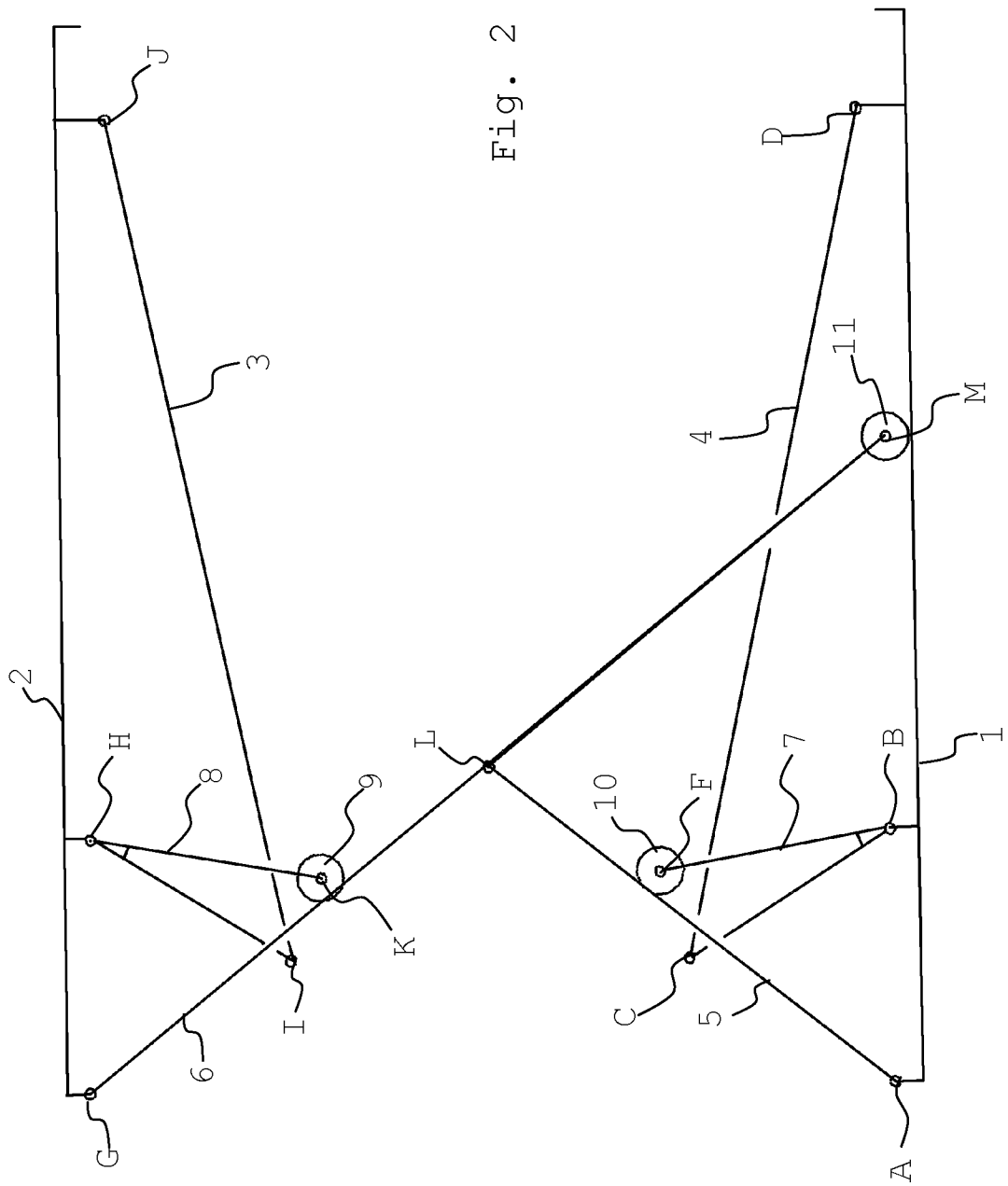


Fig. 3

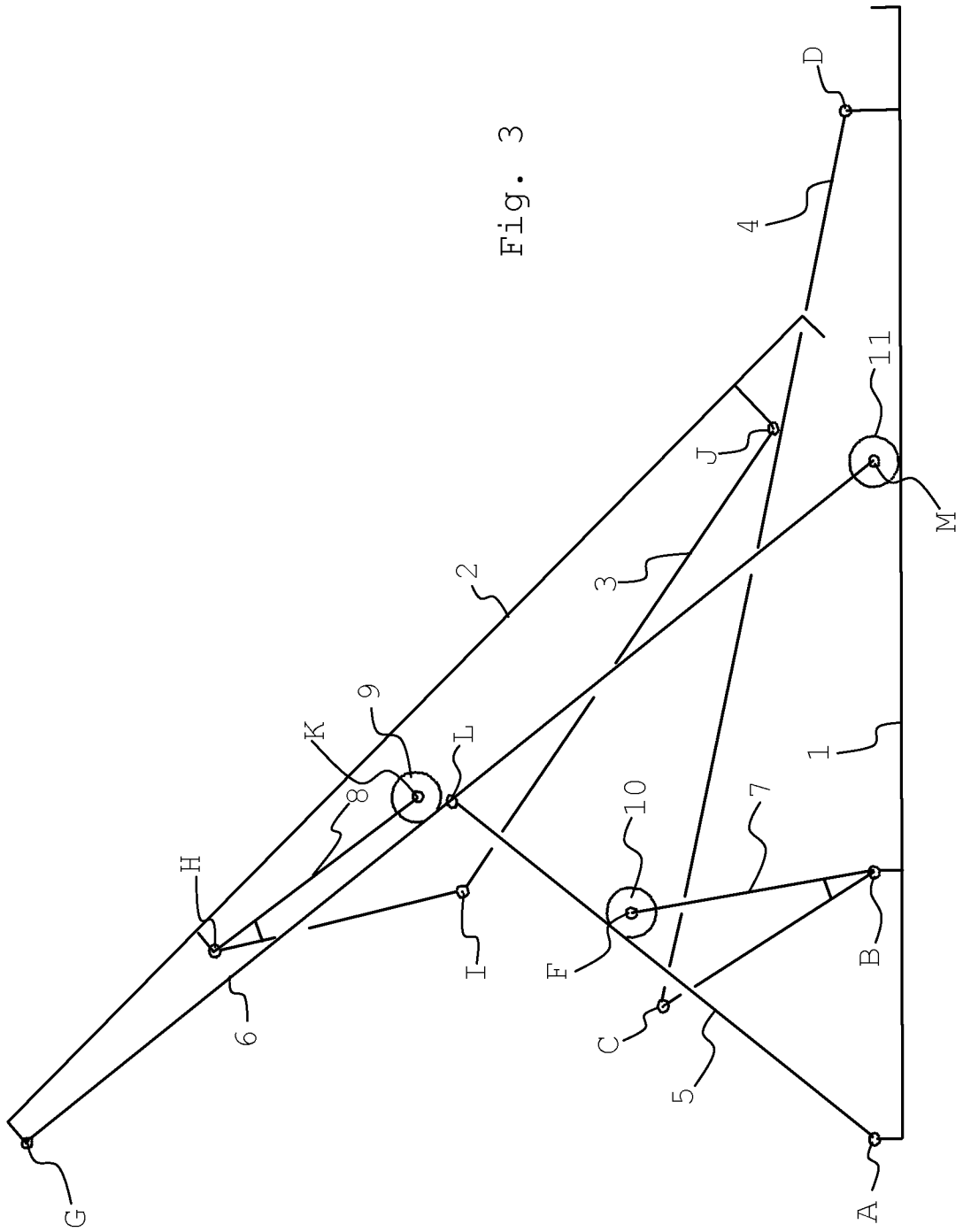
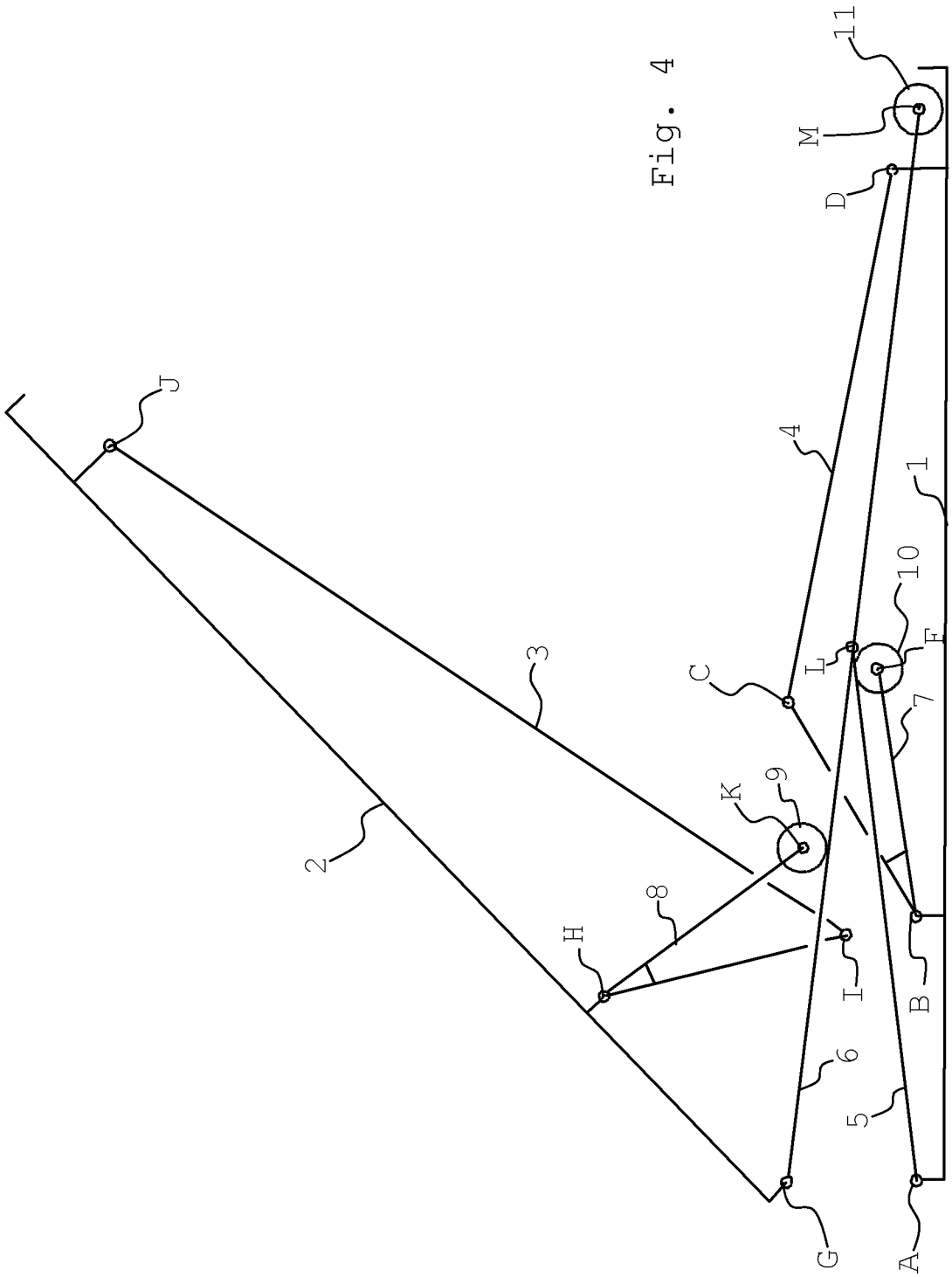


Fig. 4



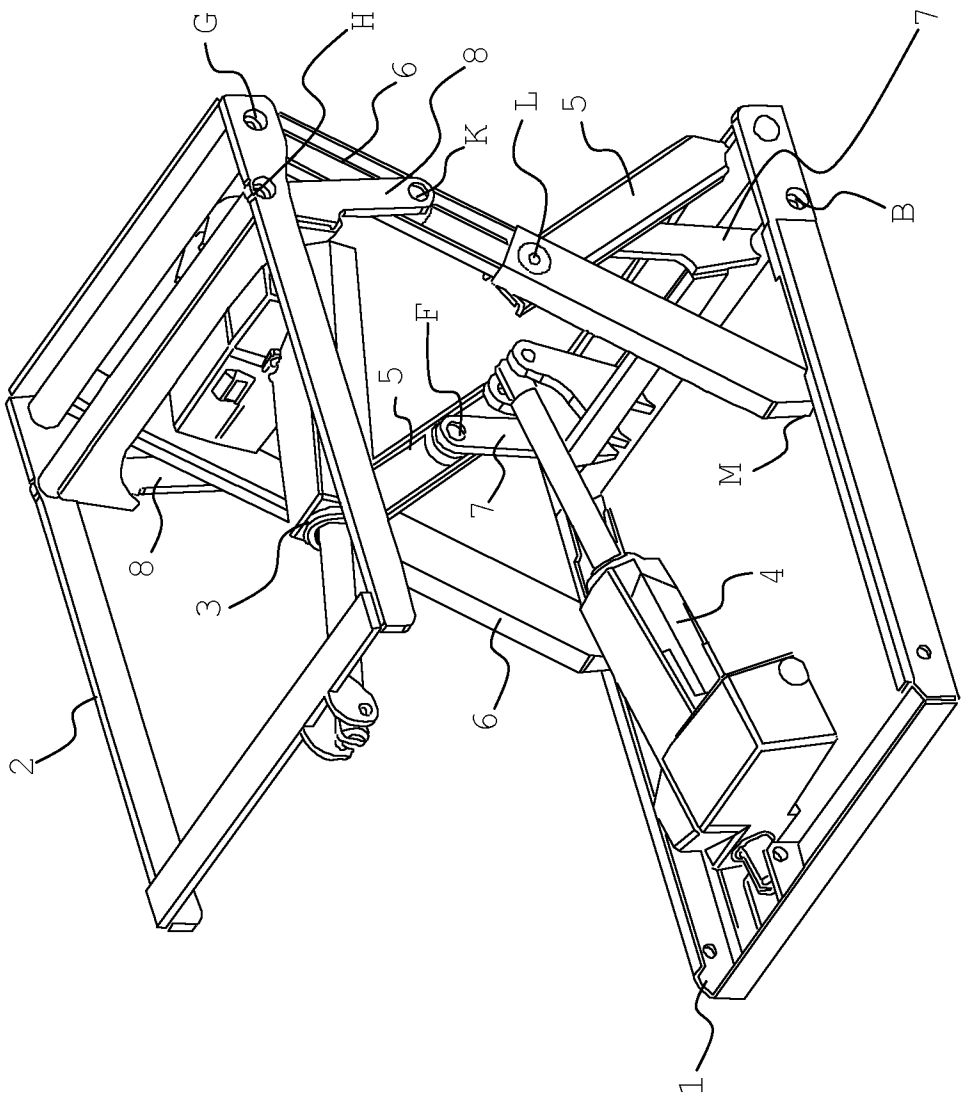



Fig. 5

**INTERNATIONAL SEARCH REPORT**

International application No.
PCT/SE2012/050226

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: A47B, A61G, B25H, B66F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE, DK, FI, NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, PAJ, WPI data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
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☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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**INTERNATIONAL SEARCH REPORT**

International application No.
PCT/SE2012/050226

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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**Continuation of:** second sheet

**International Patent Classification (IPC)**

***B66F 7/06*** (2006.01)
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Cited literature, if any, will be enclosed in paper form.

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