United States Patent

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[15] **3,683,744**

[45] **Aug. 15, 1972**

[54] **DEVICE FOR COMPENSATING THE HEAD WEIGHT ON PORTAL OR CANTILEVER TYPE MACHINE TOOLS**

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[22] Filed: **Jan. 27, 1971**

[21] Appl. No.: **110,040**

[30] **Foreign Application Priority Data**

Feb. 6, 1970 Germany.....P 20 05 554.3

[52] **U.S. Cl.** .....**90/11 F**, 408/235

[51] **Int. Cl.** **B23b 47/26**

[58] **Field of Search**.....90/11 R, 11 F, DIG. 28; 408/235; 82/2 D

[56] **References Cited**

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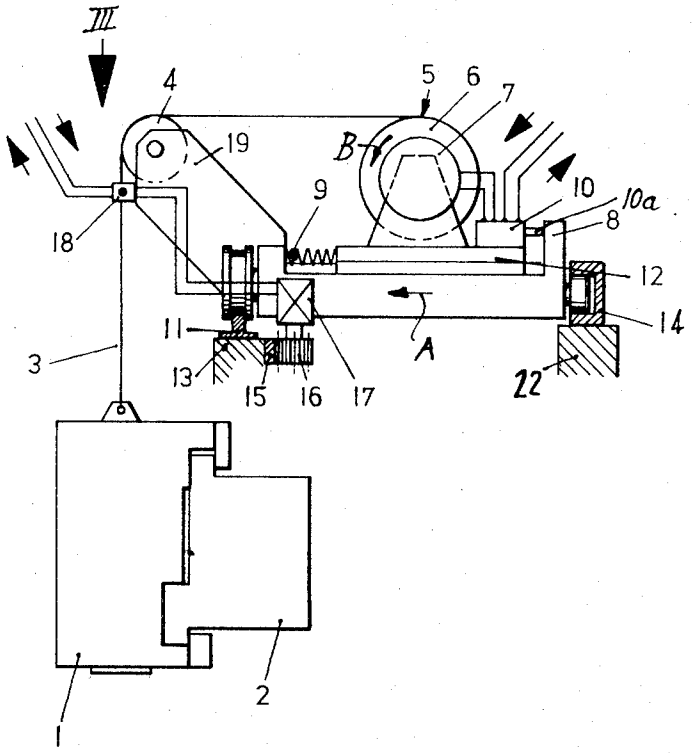
[57] **ABSTRACT**

A device for counterbalancing a head slidably mounted on a crossrail in which a cable is secured at one end to the head and the other end of which cable is secured to a cable winch exerting a constant pull on the cable and the head, the winch is resiliently, slidably mounted in the direction of cable pull on a carriage which carriage travels parallel to the direction of travel of the head on the cross rail, means including a feeler sensing the sliding movement of the winch in the cable pull direction is provided for controlling the direction of rotation of the cable winch so as to maintain the winch in a predetermined position of rest, means is also provided for maintaining the carriage travel in alinement with the head travel.

8 Claims, 3 Drawing Figures



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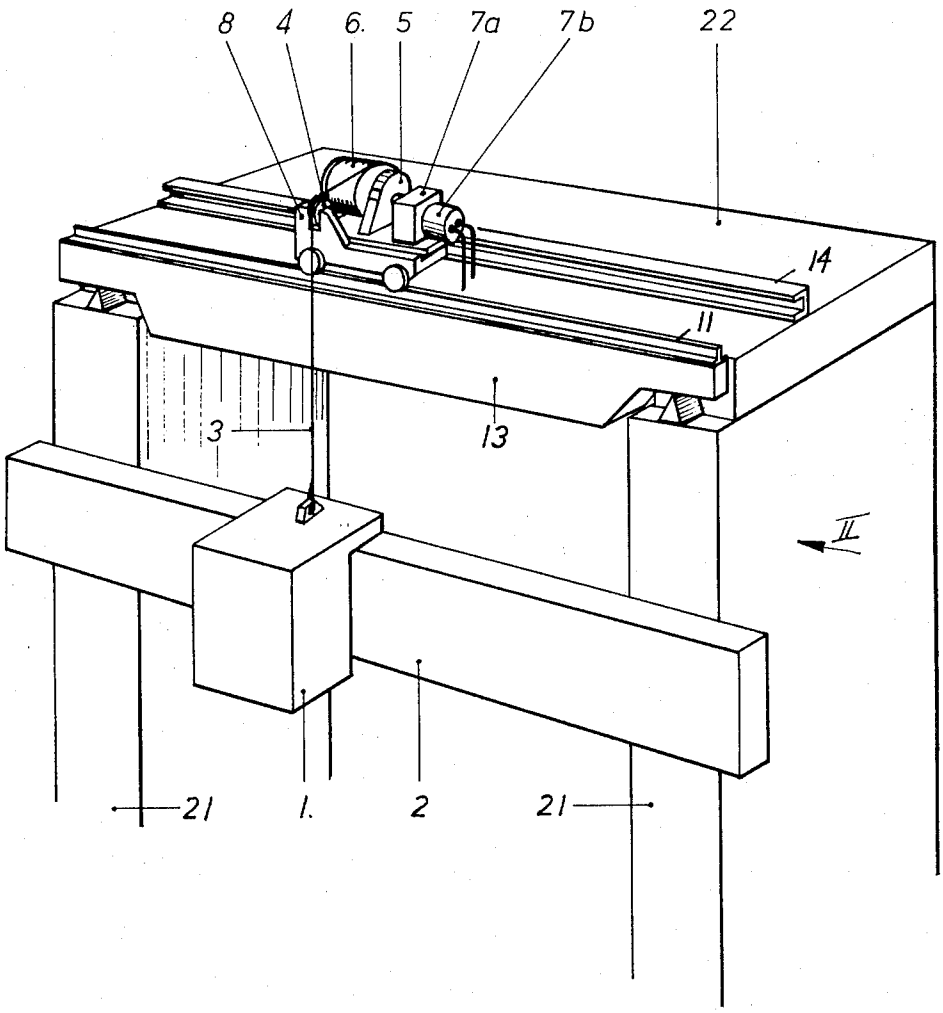

Fig. 1

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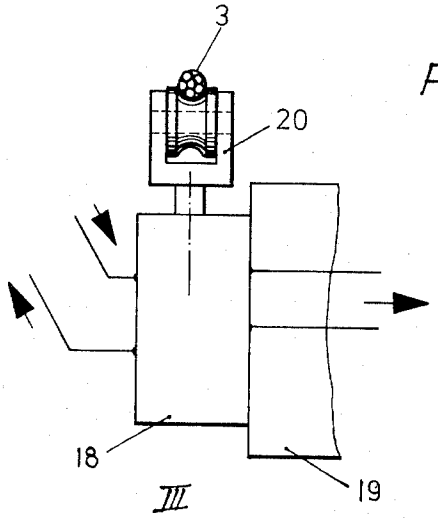
Fig.3



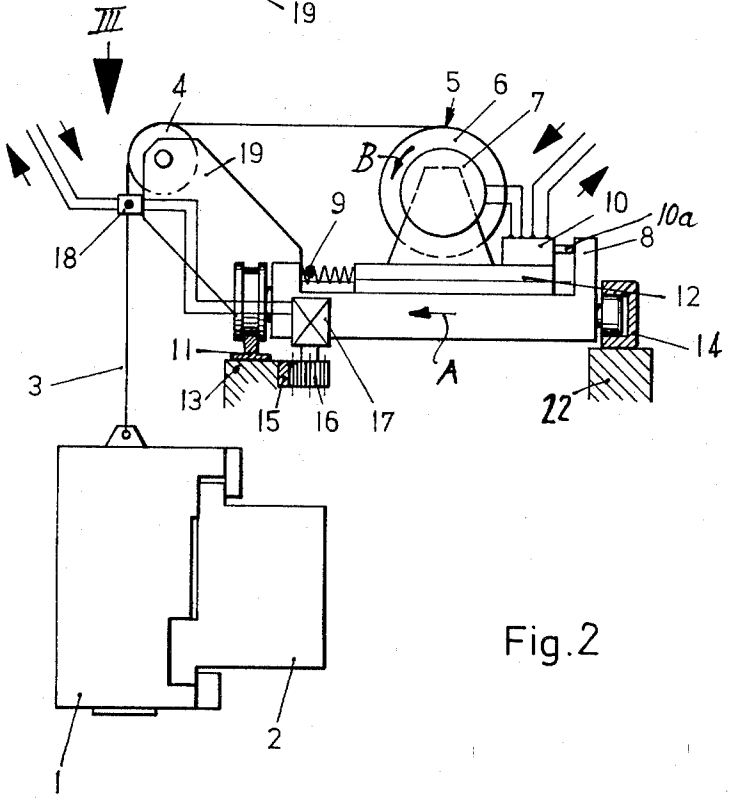


Fig.2

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DEVICE FOR COMPENSATING THE HEAD WEIGHT ON PORTAL OR CANTILEVER TYPE MACHINE TOOLS

The invention relates to a device for compensating the head weight on portal or cantilever type machine tools, in which the head is suspended on a cable leading to a carriage slidable above the cross rail on a stationary cross beam, for example the cross head, parallel with the cross rail, which carriage is driven in synchronism with the head, the cable being under constant pull.

Owing to the weight of the head or heads, the cross rail of a machine tool is deflected by different amounts depending on the position of the head. It is therefore necessary to compensate the weight of the heads by vertically upward pull.

In order to achieve this, in a device of the type mentioned above, the cable is passed over stationary rollers and over movable rollers situated on the carriage, and counterweights are provided on the end of the cable. For constructional reasons, however, the cable cannot run in one plane, so that many guide rollers are necessary. If there are two or more heads, this results in considerable accommodation difficulties, particularly if it is considered that in the case of heads of considerable weight, the counterweights must be of large and heavy construction.

Another device is therefore also known, in which the carriage is carried on an auxiliary girder supported by both ends in the vicinity of the ends of the cross rail. Tension springs are provided between the carriage and the head. This solution also has various disadvantages. If the cross rail is adjusted vertically by means of elevating screws, there are different loads on the screws, depending on the position of the head. Elongation of the screws is not compensated. The elevating screws have also to be of particularly robust construction and are subjected to heavy wear because in addition to the weight of the cross rail and heads, they have also to carry the weight of the auxiliary girder which must also be of particularly robust and therefore heavy construction for preventing deflections.

The invention is based on the problem of providing a device of the type mentioned in the foregoing which permits the most accurate compensation possible of the head weight and at the same time is of the most space-saving construction possible.

This is achieved according to the invention in that a cable winch, resiliently supported in the pulling direction of the cable, is provided on the carriage, which winch is driven by a motor continuously exerting a constant torque on the winch drum, a feeler, movable in the direction of pull of the cable and connected to a regulator controlling the power supply to the motor, being provided between the cable winch and carriage for controlling the motor, such that on a change in position of the cable winch owing to variation in the cable load, the power supply to the motor is released in one or the other direction of rotation until the cable winch has returned to its position of rest. This arrangement eliminates any counterweights. The entire device can be accommodated on a comparatively small carriage so that also the compensation of a number of heads does not give rise to any difficulties, since a number of carriages may be arranged side by side. The feeler with the regulator and motor together form a regulating circuit which ensures that the cable winch is always returned

to its position of rest in which the motor exerts a constant torque on the cable winch and hence a constant pull on the cable.

A particularly advantageous embodiment of the subject of the invention is that an auxiliary girder mounted freely at both ends on the uprights and independent of the cross-head is provided as cross-girder for the carriage, only the front carriage guide rail situated nearer to the head being preferably mounted on the auxiliary girder, while the more remotely situated guide rail is fixed to the cross head. The auxiliary girder then receives the principal supporting load. This obviates the transmission of bending forces to the uprights, which could affect the accuracy of the machine tool. Any deflections of the auxiliary girder in the device according to the invention are without effect on the compensation of the weight of the head. Independently of the length of the pull cable at the time, the device according to the invention ensures that the same pull is always exerted on the cable.

Further advantages and details of the invention are explained more particularly in the following with reference to an embodiment example illustrated in the drawings, in which:

FIG. **1** shows a diagrammatic perspective view of the subject of the invention,

FIG. **2** shows a side view in the direction II of FIG. **1**,

FIG. **3** shows a part plan in the direction III of FIG. **2**.

In the drawings, **1** denotes a head slidable on the cross rail **2**. For relieving the weight load, a cable **3** is fixed to the head **1** in the axis of its center of gravity. The cable is passed over a guide roller **4** to the cable drum **6** of a cable winch **5**, which advantageously is driven by a hydraulic motor **7**, possibly with the interposition of a suitable reduction gear **7a**. The cable winch **5** is mounted on a slide **12** slidable horizontally on the carriage **8** in the direction of the cable pull. The slide is supported on the carriage **8** by compression springs **9**. The carriage itself is slidably guided, parallel to the cross rail by means of the rail **11**, mounted on the auxiliary girder **13**, and the rail **14** secured to the cross head **22**. The carriage is driven by a hydraulic motor **17** which engages the rack **15** by means of the pinion **16**. Advantageously, the power supply to this hydraulic motor is controlled by means of a regulator **18** which co-operates with a feeler **20** exploring the deflection of the cable **3**, as is described more particularly below.

To bring about compensation of the head weight, it is necessary for the cable **3** to be under a constant pull. For this purpose, the hydraulic motor **7** is under constant pressure and exerts a constant torque on the cable drum **6**. By the pull of the cable winch on the one hand and the force of the springs **9**, a certain position of rest of the slide **12** occurs. This position of rest is monitored by a regulator **10** which controls the power supply to the motor **7** and is connected to a feeler **10*a***. The feeler **10*a*** is movable in the direction of pull of the cable and explores a part of the carriage **8**.

If the cross rail is moved downward, the cable winch **5** is at first moved to the left in the direction A, the springs **9** being compressed. This movement is detected by the feeler **10*a*** and hydraulic fluid is supplied to the hydraulic motor **7** by the regulator **10**, whereby the cable winch **6** is rotated in the direction B. The pull cable **3** is thereby lengthened until the pull on the cable

has reached its original value again, and the springs **9** force the cable winch **5** to the right into its position of rest. If, on the contrary, the cross rail **2** moves upward, the springs **9** force the cable winch **5** to the right. The feeler **10***a* then adjusts the regulator **10** such that the motor **7** is actuated in the reverse direction of rotation and thus the cable drum is driven opposite to the direction of the arrow B. Here again, supply to the motor **7** continues until the slide **12** has returned to its position of rest again. In the position of rest, the regulator **10** still allows so much pressure to occur in the hydraulic motor **7** that the equilibrium of forces between cable force and spring force is re-established, i.e., the hydraulic motor then exerts a corresponding torque. This condition of the hydraulic motor of the regulator will be referred to in what follows as the position or situation of rest.

A hydraulic motor is advantageously used for driving the cable drum **6** since it can be regulated particularly simply and in its position of rest develops the torque necessary for weight compensation. Instead of a hydraulic motor a suitable electric motor, which develops a holding torque when stationary, could possibly also be provided.

The regulating circuit of the motor is advantageously adjusted such that the constant pull exerted by the cable winch is greater than the weight of the head. The head is thereby pressed from below in the cutting force direction against the guides of the cross rail, thereby ensuring that the head always bears against the same guideway, independently of which cutting force occurs.

The considerable weight of the head, to which there is also added the weight of the carriage and cable winch, results in considerable loading of the girder on which the carriage is carried. If the carriage was carried on the cross head of the machine tool as would be quite appropriate in the case of smaller weights, greater weights result in deformation of the uprights, thus impairing the working accuracy. To eliminate this disadvantage also it is expedient if an auxiliary girder mounted freely at both ends on the uprights **21** and independent of the cross-head **22** is provided as cross-girder for the carriage. This auxiliary girder may either carry the entire carriage or preferably may be constructed such that only the front guide rail **11** of the carriage **8**, situated closer to the head, is mounted on the said auxiliary girder, while the more remotely situated guide rail **14** is fixed to the cross head **22**. The auxiliary girder **13** then receives the principal supporting load. Owing to this auxiliary girder, bending stresses are then no longer transmitted to the uprights. The inevitable deflection of the auxiliary girder under the load of the head and carriage has no effect on the magnitude of the pull exerted on the cable, since this pull is always kept constant by the device described in the foregoing. Deflection of the auxiliary girder would of course be equivalent to an upward movement of the cross rail.

So that the carriage **8** will always be driven in synchronism with the head a feeler **20** is provided on the carriage or its arm **19**, and bears against the cable length extending vertically downward to the head, which feeler is movable in the direction of movement of the carriage and is connected to the regulator **18**. Vertical position of the cable explored by the feeler **20** corresponds to zero position of the regulator **18**, in which the supply to the hydraulic motor **17** is blocked. If the head **1** moves, a deflection of the feeler **20** occurs through the self-adjusted inclination of the cable, and the regulator releases power to the hydraulic motor **17** in the necessary direction until the vertical position of the cable has again been reached.

The present invention is not restricted to the embodiment example shown. For example, in a head having a slide vertically slidable in the elevating screw direction, known as a slide milling head, it would be advantageous to fix the cable to the slide.

The result is a permanent weight compensation of the slide carrying the screw regardless of whether the cross rail or only the slide is moved up or down.

I claim:

1. Device for compensating the head weight on portal or cantilever type machine tools, in which the head is suspended by a cable which is carried to a carriage driven synchronously with the head and slidable parallel to and above the cross rail, on a stationarily arranged cross-girder, for example on the cross head, the cable being under constant pull, characterized in that a cable winch (**5**), resiliently supported in the pulling direction of the cable (**3**), is provided on the carriage (**8**), and is driven by a motor (**7**) continuously exerting a constant torque on the cable drum (**6**), a feeler (**10***a*) movable in the cable pull direction and connected to a regulator (**10**) controlling the power supply to the motor (**7**) being provided between the cable winch (**5**) and carriage (**8**) for controlling the motor (**7**), such that on a change in position of the cable winch (**5**) owing to a change in the cable load, the power supply to the motor (**7**) is released in the one or other direction of rotation until the cable winch (**5**) has returned to its position of rest.

2. Device according to claim **1**, characterized in that the cable winch (**5**) is mounted on a slide (**12**) slidable horizontally on the carriage (**8**) in the cable pull direction.

3. Device according to claim **1**, characterized in that a hydraulic motor is provided as cable winch motor (**7**).

4. Device according to claim **1**, characterized in that the constant pull exerted by the cable winch (**5**) is greater than the weight of the head (**1**).

5. Device according to claim **1**, characterized in that in the case of a head having a slide vertically slidable in the elevating screw direction, the cable is fixed to the slide.

6. Device according to claim **1**, characterized in that an auxiliary girder (**13**) mounted freely at both ends of the uprights (**21**) and independent of the cross head (**22**) is provided as cross-girder for the carriage (**8**).

7. Device according to claim **1**, characterized in that a feeler (**20**), bearing against the cable length (**3**) extending vertically on the carriage (**8**), is movable in the direction of movement of the carriage (**8**) and is connected to a regulator (**18**) controlling the power supply to the driving motor (**17**) of the carriage (**8**) such that on lateral deflection of the cable (**3**) due to sliding of the head (**1**), power supply is released to the driving motor (**17**) until the deflection is removed.

8. Device according to claim **6**, characterized in that only the front guide rail (**11**) of the carriage (**8**) lying

nearer to the head is mounted on the auxiliary girder, while the more remotely situated guide rail is fixed to the cross head (22).

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