United States Patent

Neuman

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[54] **DEVICE FOR CORRECTING BENDING OF A HORIZONTAL MACHINE-TOOL SUPPORT ELEMENT**

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[52] **U.S. Cl.** ....**408/234**, 90/11 R, 90/16

[51] **Int. Cl.** **B23c 1/00**

[58] **Field of Search** ....90/11 R, 14, 15, 16; 77/3 A, 77/3; 408/234

[56] **References Cited**

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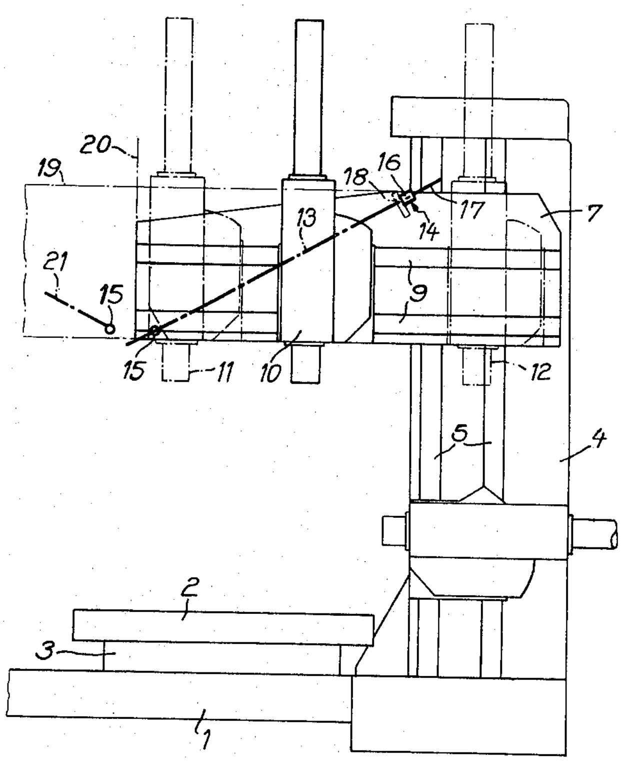
[57] **ABSTRACT**

Vertical bending stresses in machine tools having a column and a horizontal support element, such as an arm cantilevered off the column or a cross bar extending between two vertical columns, are corrected by providing at least one tie-rod disposed in the vertical plane of the support element, one end of the tie-rod being secured adjacent the lowermost surface of the support element and the other end of the tie-rod being adjacent the uppermost surface of the support element, the tie-rod thus being obliquely disposed to the column.

7 Claims, 5 Drawing Figures



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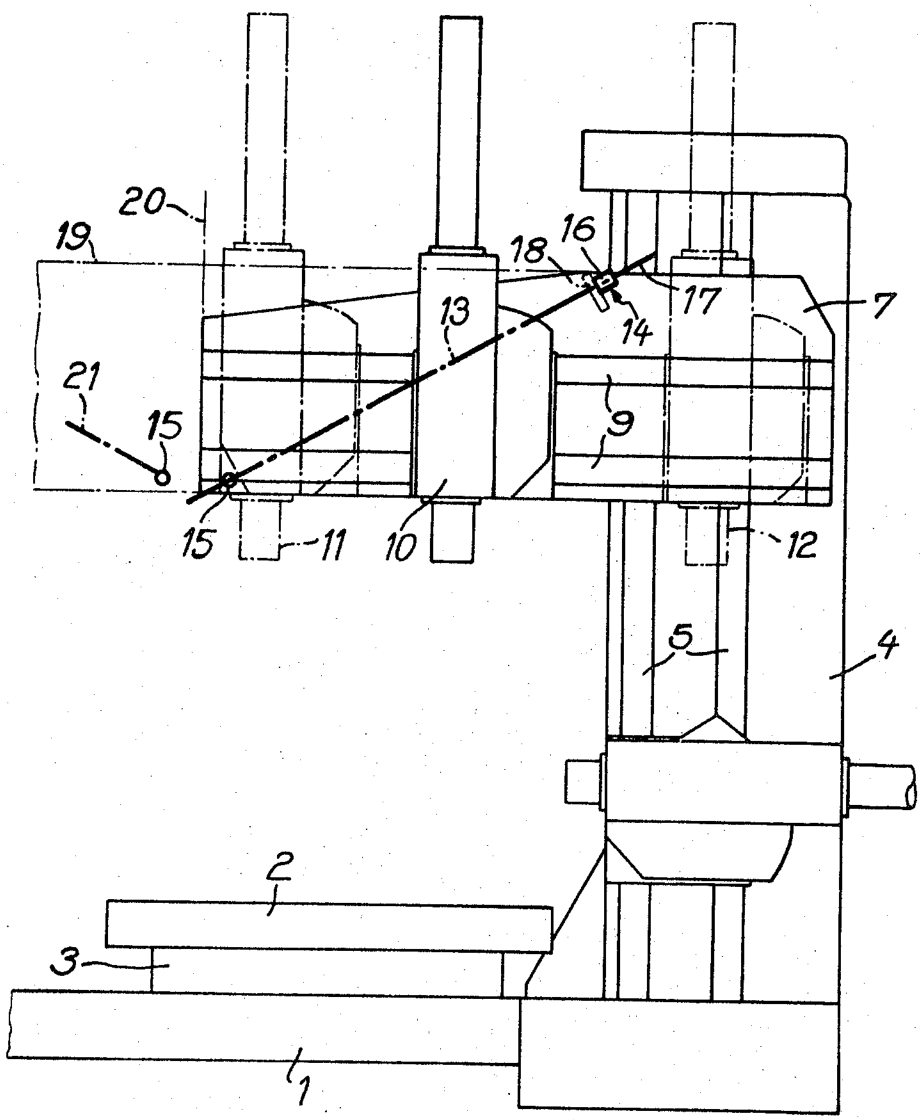

FIG.1

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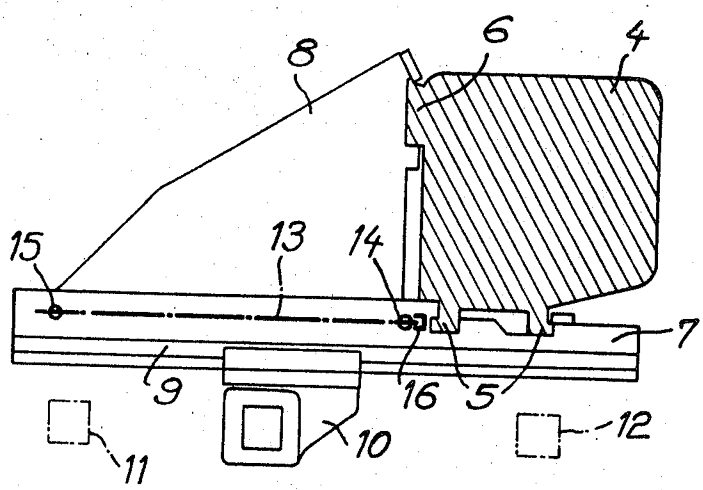

FIG.2

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FIG. 3

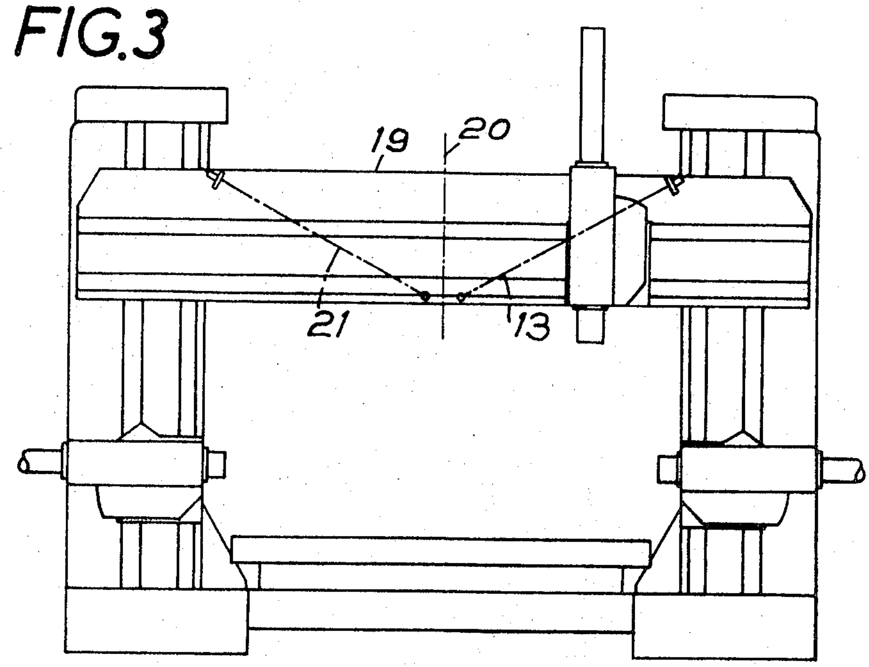


FIG. 4

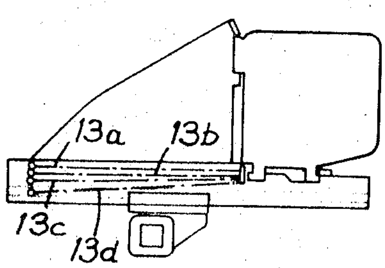
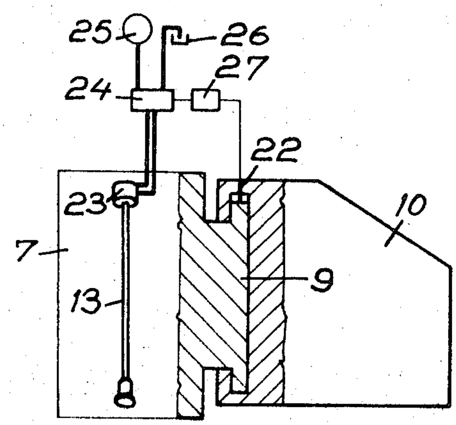


FIG. 5



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DEVICE FOR CORRECTING BENDING OF A HORIZONTAL MACHINE-TOOL SUPPORT ELEMENT

BACKGROUND OF THE INVENTION

Certain machine tools, such as vertical lathes, planing, milling and grinding machines have a horizontal support element along which at least one tool slide is displaceable. If the machine tool concerned has only one column, the horizontal support element is an arm cantilevered off this column. If the machine has two columns, the horizontal support element is a crossbar extending between these columns.

The horizontal support element formed by the arm or crossbar bends to a degree depending on the position occupied by the slide and on the weight of the latter. There are therefore errors of straightness in the displacements and of parallelism between the various possible positions.

In order to overcome this disadvantage and so improve machining precision, many devices for correcting bending have been proposed, for example, that described in French Pat. No. 1,537,934, which uses a fluid transfer device.

SUMMARY OF THE INVENTION

An object of the invention is to create a device for correcting bending which is simpler than known devices, is easier to manufacture and assemble, requires no maintenance, is easy to adjust and does not increase the overall dimensions of the machine, the efficiency and precision of the results obtained with this correcting device being nonetheless equivalent to those obtained with the known devices.

According to the invention, the correcting device comprises at least one tie-rod which is disposed in a substantially vertical plane of the support element, this plane being close to the axis of advance of the side; extends obliquely, has one end fixed to the support element by upper anchoring means in the vicinity of the column and has its other end fixed to the support element by lower anchoring means; and co-operates with means for adjusting its tension.

BRIEF DESCRIPTION OF THE DRAWINGS

An embodiment of the invention is illustrated, by way of example only, in the accompanying drawings, in which it is applied to a single-column vertical lathe. This application is not to be regarded as a limitation.

In the drawings:

FIG. 1 is a diagrammatic elevation showing the vertical lathe;

FIG. 2 is a plan view, also diagrammatic and partly in section, showing the column, the arm and angle and the tool slide of this vertical lathe.

FIG. 3 is a diagrammatic elevation of another embodiment of the invention wherein a vertical lathe includes two columns;

FIG. 4 is a plan view, also diagrammatic and partly in section, showing a column, arm, angle and tool slide similar to that of FIG. 2 but embodying a plurality of tie-rods of the invention; and

FIG. 5 is a diagrammatic view, partly in section, showing means for detecting overload bending forces and for regulating the tension of tie-rods of the invention to compensate therefore.

DETAILED DESCRIPTION OF THE INVENTION

Referring to FIG. 1, a vertical lathe to which the invention may be applied includes a bed **1** supporting a rotary plate **2** by way of a seat **3**. The bed **1** is attached by any suitable means to upstanding column **4** having vertical guides **5, 6** situated in two planes perpendicular to one another. An arm **7** and integral angle brace **8** are slidably mounted on the guides **5** and **6** respectively, and are connected to a conventional device for producing vertical reciprocation (not shown). The arm **7** is therefore cantilevered off the column. It has a horizontal guide **9** on which a tool holder **10** is slideably mounted. This slide is connected to conventional driving means (not shown) by which it can be advanced between two limit positions **11, 12** shown by phantom lines. In the example chosen, the arm **7** measures approximately 4 meters between the two limit positions **11, 12** of the slide, and the holder **10** weighs approximately 6 tons. If special precautions are not taken, displacement of the holder **10** along the arm causes fairly distinct bending of the arm. In the case of this vertical lathe the deflection may be as much as 0.2 mm.

Experience has shown that the provision, in the arm **7**, of a tie-rod **13** under particular conditions defined below reduces this deflection considerably.

As FIG. 2 shows, the tie-rod **13** is placed in a substantially vertical plane of the arm **7**, this plane being a short distance from and parallel to the guides **9** and opposite the holder **10**. Within this vertical plane the tie-rod **13** is inclined. One end of it is attached to the arm **7** by anchoring means **14** situated on the upper portion of the arm close to the column **4** (FIG. **1**). The opposite end is attached, also to the arm **7**, by anchoring means **15** situated lower down and close to the free end of this arm. The tie-rod **13** therefore slopes downwards from the column towards the free end of the arm, that is to say, towards the cantilevered portion. The angle of slope is approximately 30° in the example shown but may be between about 20° to about 45°, **depending on the type of machine and the capacity of the machine.**

The tie-rod **13** is prestressed and provided with means for adjusting its tension. The adjustment means may be of the screw-and-nut type like that illustrated diagrammatically in FIG. 1, which shows clearly a nut **16** threaded on end **17** of the tie-rod **13** which bears against abutment **18** on the arm **7**. The tension-adjusting means may be of another type, for example, a hydraulic jack.

The tie-rod **13** exerts on the arm **7** an oblique force whose magnitude is precalculated but is adjusted experimentally, to minimize the deflection occurring when the slide is displaced along the arm. The tension acting on the tie-rod, when the slide is, for example, in its right-hand limit position **12**, produces a contrary deflection whose value must be such that it compensates for the deflection arising from the load on the slide when the latter reaches its left-hand limit position **11**.

It is merely necessary to measure the resultant deflection, after a preliminary tension adjustment, and then to adjust the tension until perfect compensation is obtained.

Experience shows that the deflection so compensated when the slide is in its limit position remains within very low limits for all intermediate positions of the slide.

By means of the tie-rod prestressed in this way, very high precision is obtained as regards the straightness of the horizontal path of the holder **10** and the parallelism of the vertical displacement of the holder of the slide in the various positions occupied by the latter.

By example, if the vertical lathe described above has no tie-rod associated with its arm **7**, the deflection occurring when the slide is in its left-hand limit position is 0.2 mm, whereas if the arm has a tie-rod **13**, to which a prestressing force of the order of **26** tons is applied, the deflection can be reduced to 0.01 mm. Similarly, in the case of a single-column vertical grinding machine whose capacity is similar to that of the above-mentioned vertical lathe, and in which the elements are designed to give greater rigidity, the provision of a suitably prestressed tie-rod for the arm has the effect of reducing the deflection, which would otherwise be 0.02 mm., to 0.001 mm.

In other words, the use of the tie-rod 13 and its permanent prestressing lead to a great increase in the geometrical precision of the movable slide and consequently in machining precision.

Obviously, permanent adjustment of the tension of the tie-rod **13** applies when the total weight of the holder **10** varies little with changes of tools or other accessories. If, however, it varies enough to reduce appreciably the precision obtained, it may be an advantage to control the adjusting means **16** by means of an additional device, more particularly control means which responds to overloading of the movable slide, or simply to correct the tension in the tie-rod **13** by acting directly on the means **16** and referring, for example, to a vernier, which might be graduated either in units of tension of the tie-rod or in units of weight of the slide.

An example of such control means is illustrated in FIG. **5**. With reference thereto, a device for detecting overload of the carriage **10** is constituted by a piezoelectric gauge **22** interposed between this carriage and the guide **9**. The member for regulating the tension of the tie-rod **13** is a hydraulic jack **23**, connected selectively by a valve **24** to a pump **25** and a drainage reservoir **26** for regulating the intensity of the force applied to this tie-rod. The overload signal delivered by the gauge **22** pilots the control circuit **27** which actuates the valve **24**.

In the preceding description, the device embodying the invention has been applied to a cantilevered arm and has only one tie-rod **13**. This tie-rod may be a solid or tubular rod. Alternatively as shown in FIG. **4**, instead of a single tie-rod, there might be a plurality of tie-rods **13***a*, **13***b*, **13***c* and **13***d* distributed in a cluster and attached either to the anchoring means **14** and **15** or to anchoring means distributed in a particular fashion at the top and bottom of the arm **7**. In the latter case, the tie-rods are all oblique.

The device embodying the invention may be applied not only to a cantilevered arm **7** but also to a crossbar extending between two columns. As is shown in FIG. **1**, in which chain-lines indicate a crossbar **19** whose ends are guided along the guides on the column **4** and along guides on another column situated symmetrically relative to the column **4** in relation to the plane **20**, the device according to the invention then has two single or multiple tie-rods **13** and **21**. These two tie-rods **13** and **21** are disposed as in the preceding arrangement and co-operate with the same tensioning means. They are merely disposed symmetrically relative to the plane **20**. In other words, the tie-rods **13** and **21** converge downwards from the upper anchoring means **14** close to the columns to the lowering anchoring means **15** mounted in the central portion of the crossbar FIG. **3** more specifically illustrates this embodiment of the invention wherein a cross-bar **19** extends between two columns.

The invention is also useful, of course, where the machine has a plurality of slides displaceable horizontally along the arm or crossbar.

The invention is not restricted to the embodiment illustrated and described in detail, and various modifications may be made to it without exceeding its scope.

I claim:

1. A device for correcting bending of a horizontal machine-tool support element projecting at right angles from at least one upstanding column and along which at least one movable slide is displaceable between two extreme positions, comprising at least one tie-rod disposed in a substantially vertical plane of said support element, said plane being disposed adjacent the path of advance of said slide, said tie-rod being secured at one end adjacent the lowermost surface of said support element and adjacent one of said extreme positions, and the other end being adjacent the uppermost surface of said support element and adjacent the other of said extreme positions, whereby said tie-rod is obliquely disposed to said column, and means for axially stressing said tie-rod to adjust the tension therein.

2. A device according to claim **1**, wherein the support element is a cantilevered arm, said tie-rod slopes downwardly towards the free end of said arm and is anchored close to said end.

3. A device according to claim **1**, wherein said support element is a crossbar disposed between two columns and includes a pair of tie-rods distributed in converging relation sloping downwards from upper anchoring means adjacent the columns to a lower anchoring means mounted in the central portion of the crossbar.

4. A device according to claim **1**, wherein said tie-rod slopes at an angle between about 20° to 45°.

5. A device according to claim **3**, wherein a plurality of tie-rods are arranged in a cluster, diverging downwards away from one another.

6. A device according to claim **1**, wherein said means to adjust the tension of said tie-rod is an adjustable nut threadedly advancable on said rod and positioned against an abutment on said support element whereby the force exerted is determined experimentally to give the desired precision for the straightness of the displacement of at least one movable slide.

7. A device according to claim **1**, wherein the means for adjusting the tension of said tie-rod is controlled by control means responsive to overloading of the movable slide.

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