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(71) Applicant
Mauser-Werke Oberndorf GmbH (FR Germany),
Teckstrasse 11, 7238 Oberndorf, Federal Republic of Germany

(72) Inventors
Gerhard Band
Gunther Ross

(74) Agent and/or Address for Service
Wheatley & MacKenzie,
Scottish Life House, Bridge Street, Manchester M3 3DP

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None

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G1M
F2Q
F2K

(54) Coordinate measuring machine

(57) In a coordinate measuring machine of gantry design, toothed belt transmissions (13), (16), (19) for the longitudinal movement are respectively associated with the two columns, which transmissions are driven by a common power source (8). A toothed belt (19) is arranged parallel to the guideway of the columns, clamped securely by its two ends (20) and guided by tensioning rollers (21) about a drive pinion (18). The toothed belt (19) is in engagement with a transmission member (22) with a facing toothed profile, which acts as a linear measuring system, there being one for each column. A computer monitors the relative positions of the two columns.

FIG. 3

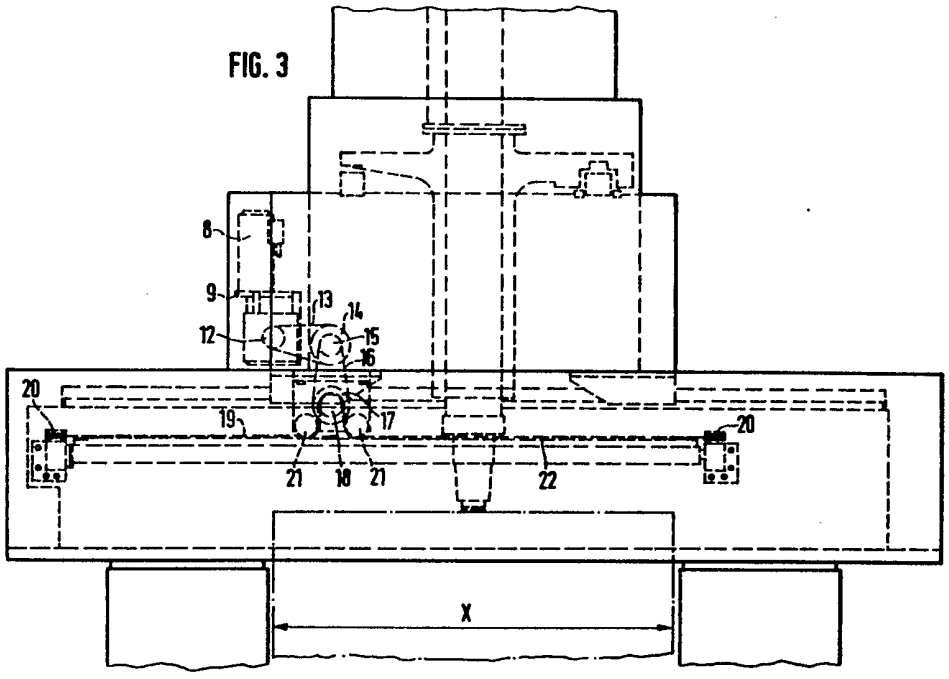

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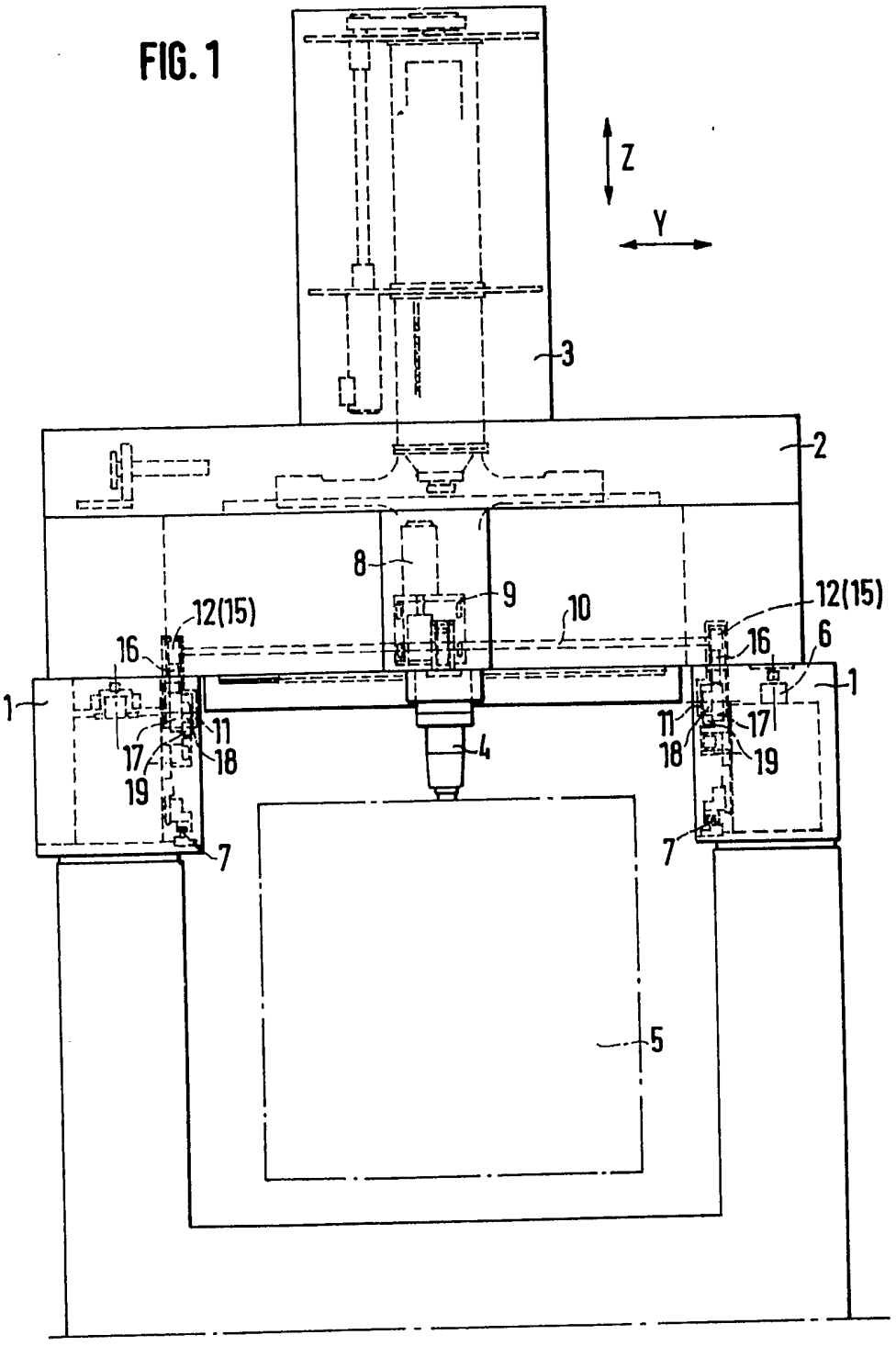
FIG. 1



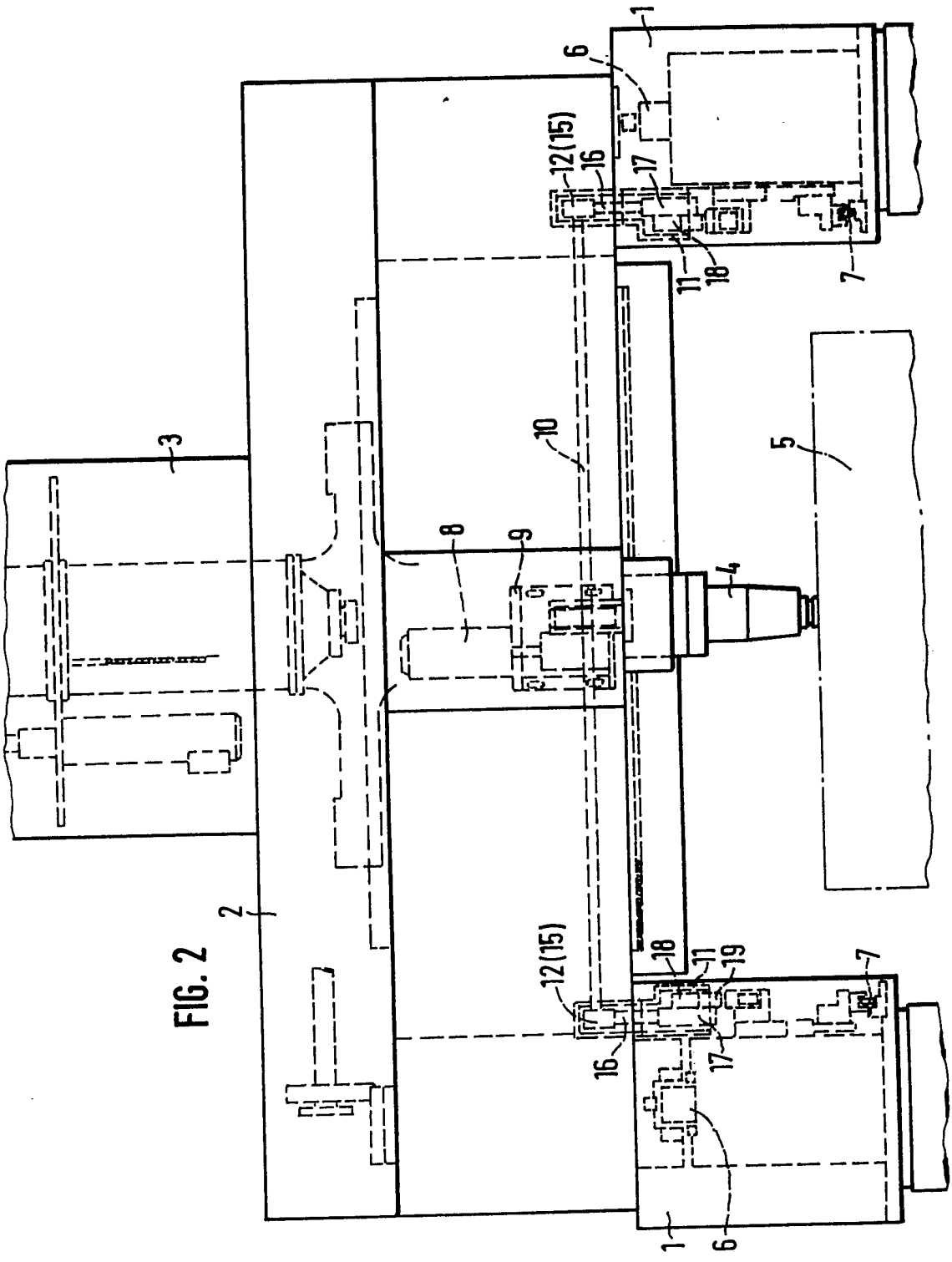


FIG. 2

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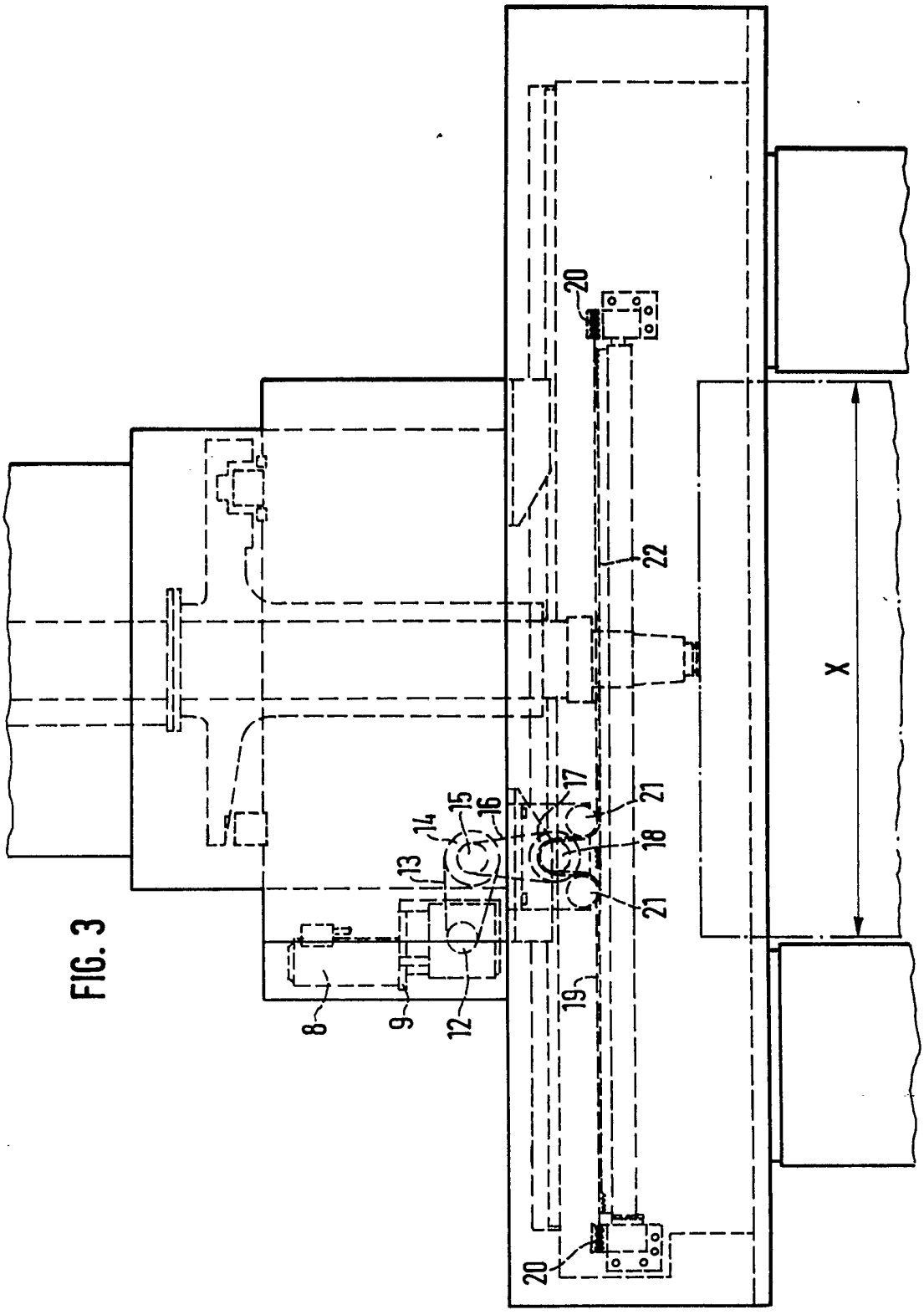

FIG. 3

SPECIFICATION

Coordinate measuring machine of gantry design

The invention relates to a coordinate measuring machine of gantry design, in which the columns on both sides of the measuring table are arranged to move longitudinally on guideways and are firmly connected to each other by a bridge for receiving the support for the measuring head and which furthermore, along the guideways of both columns, respectively comprises a measuring device for an indication of the position of the columns.

A coordinate measuring machine, in particular linear measuring machine, of the aforementioned type is known from German AS 22 48 194. This publication discloses a solution of the problem, if the two vertical columns are to be moved with precision along the measuring table along the associated guides, in order to displace both columns with regard to a reference position with exactly the same spacing along the axis of travel. This German AS 22 48 194 reveals that the aforementioned problem cannot be completely eliminated even when using expensive precision components, for which reason, as a solution, two measuring devices are provided on the guides of the columns, whereof the output signals are compensated together with the output signal of a third measuring device. Each column of this known coordinate measuring machine is moved by means of an associated precision screw, which is screwed into a frictionless or low-friction nut. The nut is respectively provided on the associated column. It is provided in axial alignment with a large diameter opening in the associated column.

The purpose of this opening is to ensure that during rotation the screw does not contact the column. German OS 31 50 978 discloses a measuring machine of gantry design, which comprises a guide rail extending centrally. The gantry is formed by two columns and the bridge. Incorporated in the feet of these columns are air bearings, by means of which the gantry slides on the base plate. The drive for the gantry is integrated in the housing and comprises friction rollers, which operate on the quide rail.

Based on the aforementioned prior art, it is the object of the invention to provide a coordinate measuring machine of the aforementioned type, which comprises a drive which runs quietly is damped and free from play at speeds, has a good distribution of the dynamic power introduction and a low deformation of the guides in order to increase the guiding accuracy.

This object is achieved according to the invention due to the fact that associated with each of the two columns is a toothed belt drive for the longitudinal movement, which are both connected as regards drive to a common power source. In this case, according to the invention, the toothed belt may be arranged parallel to the guideway of the columns, fixed securely by its two ends and in its active central region guided in a meandering manner around a drive pinion and in engagement with a facing toothed profile of a transmission member arranged in parallel below the toothed belt. This transmission member may be a slightly pre-tensioned toothed belt. It can equally well be a toothed rack. The toothed belt may be kept by two tensioning rollers in positive engagement with the drive pinion and the transmission member, in which case the tensioning rollers are arranged respectively on both sides of the drive pinion with axes of rotation offset slightly below the drive pinion. The common source of power may be a drive motor located approximately in the centre of the bridge, which drives a drive shaft extending parallel to the bridge, which is connected as regards drive to the toothed belt drives on the columns.

A transmission step consisting of two further toothed belt wheels can be incorporated between the drive wheel driven by the drive shaft and the drive pinion for the toothed belt. Finally, the toothed belt and the transmission member can be attached respectively to the facing inner sides of the stationary regions of the columns on retaining devices, whereas the toothed belt transmission with the drive pinion is incorporated on the inner sides of the longitudinally movable areas of the columns in a housing device.

In this coordinate measuring machine according to the invention, ingenious use is made of the possibility of producing a drive with toothed belts due to the symmetrical construction on the left hand side and right hand side of the bridge. In the case of this double drive and in order to guarantee measuring accuracy, two linear measuring systems are incorporated, which in the case of a cold start of the machine, autmatically allows recognition of the angular position of the XY-plane by way of reference marks and constantly monitors the angular deviation during measurement and makes compensations by computer. The angular deviation, which is determined by the spacing errors of the toothed belt drive, can be compensated for by computer by the guide error compensation. In this coordinate measuring machine, one advantage is obtained by the slightly pretensioned toothed belt for the rotary and longitudinal drive, which has a small amount of play. Furthermore, the load distribution to several toothed belt teeth due to the meandering toothed belt guidance over the drive pinion and the positive feed transmission to a slightly pre-tensioned toothed belt with counter profile, for example a rack, is advantageous. The solution according to the invention is suitable

for travel axes of any length, since the length of the toothed belt does not have any influence on the stiffness of the drive. Furthermore, the guiding accuracy is not influenced, because the degrees of freedom of the two planes staggered by 90° are guaranteed. This means that a rigid transmission in the driving direction, for example of the X-axes, is provided, whereas a resilient compensation of the toothed belt in the two other coordinate directions Y and Z is respectively provided.

The symmetrical introduction of power leads to an improvement in the acceleration or deceleration and to an improvement in the dynamic behaviour of the bridge. In all, the construction according to the invention provides high rigidity with simulataneously good damping behaviour.

One embodiment of the invention is illustrated in the drawings, in which:

Figure 1 shows a coordinate measuring machine of gantry design in a view of the Y and Z-direction;

Figure 2 is an enlarged cutaway view from the coordinate measuring machine according to Fig. 1 with the drive of the two columns;

Figure 3 is an enlarged cutaway view of the coordinate measuring machine with the drive in the view of the X-direction.

The coordinate measuring machine of gantry design is composed essentially of the columns 1, bridge 2, the support 3 for the measuring head 4 and the measuring table 5. The bridge 2 is securely connected to the two columns 1, which are able to move longitudinally on both sides of the measuring table 5 on guideways 6. Associated with each column 1 is a measuring device 7 as the longitudinal scale, by which an indication of position of the columns is achieved. A drive motor 8 is incorporated in a retaining device 9 approximately in the centre of the bridge between the two columns, which device 8 drives a drive shaft 10, which extends on both sides of the drive motor parallel to the bridge as far as the individual drives of the columns. Housing devices 11 are provided for receiving the drives for the columns 1, respectively on their facing inner sides. The drive shaft 10 is thus respectively connected as regards drive to a drive wheel 12, which by way of a toothed belt 13 drives an intermediate wheel 14, which on the same rotary shaft sets a further intermediate wheel 15 in rotation. Finally, by way of a toothed belt 16, this intermediate wheel 15 drives a toothed belt wheel 17, which sets the driving pinion 18 arranged in a non-rotary manner on the same shaft in rotation. A toothed belt 19 arranged parallel to the guideway 6 of the columns 1, which is clamped with its two ends 20 securely in a retaining device of the coordinate measuring machine, is guided by its central region in a meandering manner over the drive pinion 18. Two tensioning rollers 21 arranged at the side of the drive pinion 18 below the axes of rotation of this drive pinion ensure a positive engagement of the toothed belt 19 on the drive pinion 18 and on the counter profile of a transmission member 22 travelling below the toothed belt 19. This transmission member may likewise to a toothed belt, according to Fig. 3 this transmission member with a toothed profile is constructed as a toothed rack.

CLAIMS

1. Coordinate measuring machine of gantry design, in which the columns are arranged to move longitudinally on both sides of the measuring table on guideways and are securely connected to each other by a bridge for receiving the carrier for the measuring head and which moreover along the guideway of both columns respectively comprises a measuring device for an indication of position of the columns, wherein associated with the two columns are respective toothed belt drives for the longitudinal movement wich are both in driving connection with a common power source.

2. Coordinate measuring machine according to claim 1, wherein the toothed belt is arranged parallel to the guideway of the columns, is clamped securely by its two ends and in its active central region is guided in a meandering manner around a drive pinion and is in engagement with a facing toothed profile of a transmission member arranged in parallel below the toothed belt.

3. Coordinate measuring machine according to claim 1 or 2, wherein the transmission member is a slightly pre-tensioned toothed belt.

4. Coordinate measuring machine according to claim 1 or 2, wherein the transmission member is a toothed rack.

5. Coordinate measuring machine according to claim 1 or 2, wherein the toothed belt is held by two tensioning rollers in positive engagement with the drive pinion and the transmission member, in which case the tensioning rollers are arranged respectively on both sides of the drive pinion with axes of rotation offset slightly below the drive pinion.

6. Coordinate measuring machine according to the preceding claims, wherein the common power source is a drive motor located approximately in the centre of the bridge, which motor drives a drive shaft extending parallel to the bridge, which shaft is in driving connection with the toothed belt drives on the columns.

7. Coordinate measuring machine according to claims 1, 2 and 6, wherein a transmission stage of two further toothed belt wheels is incorporated between the drive wheel driven by the drive shaft and the drive pinion for the toothed belt.

8. Coordinate measuring machine according to the preceding claims, wherein the toothed

belt and the transmission member are attached respectively to the facing inner sides of the stationary regions of the columns on retaining devices, whereas the toothed belt transmission with the drive pinion is incorporated in a housing device on the inner sides of the longitudinally movable regions of the columns.

9. Coordinate measuring machine of gantry design substantially as herein described with reference to the accompanying drawings.

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