Device for adjusting and altering the spatial position of articles

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The invention relates to a device for adjusting and altering the spatial position of articles, particularly of specimens in a treatment chamber for the irradiation or vacuum-coating of same, such as for example, for electron microscopy, said device comprising a supporting frame and a specimen carrier mounted thereon by means of a tilting platform. The specimen carrier is rotatable around at least two of its spatial axes with the aid of driving means actuated from outside.

Devices of this type serve for the treatment of articles under certain conditions of pressure, temperature and radiation, when it is necessary during the treatment to continuously or intermittently alter the spatial position of the articles while maintaining the prevailing critical conditions. For example, such devices can be used for the treatment of articles with corpuscular radiation or other kinds of irradiation, such as X-rays or ultraviolet rays, for a variety of technical and scientific purposes. Other applications are high-vacuum coating of articles for the preparation of specimens for electron microscopy, for refining purposes and other coatings on metalloids and metals, rhodoids, etc. as well as deep-freeze drying.

The adjustment or alteration of the spatial position of the articles to be so treated and the movements of the specimen carrier require a high degree of precision. It is therefore, necessary for the motion of the specimen carrier around different spatial axes to be carried out independently and simultaneously, so that the desired angular position of the article to be treated can be quickly and simply adjusted. It is, however, difficult to tilt the specimen carrier by means of the tilting platform without at the same time rotating the former. This is particularly objectionable when articles are to be vacuum-coated, since as a result, the production of a uniform coating becomes difficult or even impossible. If the driving motion for the rotation of the specimen carrier is transmitted by means of rope drives or endless cord drives, it is neither possible to ensure the required degree of accuracy nor any independent motion, since on the one hand, oscillations of the rope transmission or endless cord drive are transmitted to the specimen carrier and on the other hand, any tilting of the platform simultaneously involves the rotation of the specimen carrier. This is due to the fact that the driving pulley for the rotation of the specimen carrier remains stationary during the tilting motion, whereas the roller attached to the specimen carrier follows the movement, since the ropes or cords unroll on the stationary pulley.

According to the invention a differential gear is mounted on the tilting platform for the purpose of rotating the specimen carrier. Thus objectionable oscillations of the specimen carrier during the movement of the tilting platform are avoided and the motion of the specimen carrier can be performed independently from one another. Preferably the satellite carrier of said differential gear is positively connected with the specimen carrier and the two other gear elements of the differential gear co-operating with the satellites each being positively connected with one drive gear, one of said drive gears being integral with the supporting frame, whereas the other drive gear is positively connected with the drive for the rotation of the specimen carrier. By means of the drive gears the gearing elements are driven in opposite direction during the tilting motion of the tilting platform, and as a result, the satellite carrier remains stationary, provided the ratios of transmission have been appropriately chosen, so that the specimen carrier will not rotate but performs merely a tilting motion jointly with the tilting platform. If, however, the drive provided for the rotation of the specimen carrier is actuated, the said drive will rotate one of the gearing elements by means of the drive gear connected with said drive, whereas the other gearing elements remain stationary, as a result of which the satellite carrier is entrained and rotates the specimen carrier. Both drives can also be actuated simultaneously, so that the specimen carrier is tilted together with the tilting platform and rotated at the same time. During these operations, the adjusting paths of the specimen carrier are maintained in a constant relationship to the adjusting paths of the associated drives, said relationship depending solely on the pre-set gear ratio.

According to a preferred embodiment of the invention the differential gear may consist of a ball or roller bearing, the balls or rollers representing the planets, the case carrying the balls or rollers the satellite carrier, and the races the other two gearing elements co-operating with the planets. This embodiment has proved particularly practical, since it is not only simple and inexpensive, but above all because it makes it possible to produce a differential gear of the smallest dimensions.

According to a further embodiment of the invention a thrust bearing serves as a differential gear, the bearing being supported on both sides, preferably by means of balls engaging in guide grooves of the races in such a manner as not to be displaceable in a radial direction but rotatable and loaded in an axial direction by a pressure spring. Experience has shown that with the use of a thrust bearing the driving connections to the various gearing elements as well as the desired frictional force between the balls or rollers and the races can be achieved in a simple manner. The pressure spring provided according to the invention and determining the direction between the components of the bearing can be easily exchanged and therefore, adapted to individual requirements. The arrangement in a bearing precluding radial displacement by means of balls engaging in grooves of the races offers the further advantage that additional friction bearings otherwise required for the support of the bearing may be dispensed with. This feature is particularly important when the device according to the invention is used in a vacuum, since in view of the evaporation of the lubricants in vacuum the bearing cannot be lubricated.

The driving connections between the races and the drive gears can be produced in a simple manner according to the invention by providing a circumferential gearing on each of the two races, a helical gear engaging in each of said circumferential gearings, the helical gears being positively connected with the two drive gears by means of shafts or the like and driving the races at the same angular speed in opposite direction when the tilting platform performs its tilting motion.

Further details of the invention are described hereafter with reference to the accompanying drawings illustrating an embodiment of the invention. In the drawings

FIG. 1 is a side elevation of the device according to the invention,
FIG. 2 is a top plan view of the device partly in section,
FIG. 3 illustrates a detail in a partially sectional bottom plan view on a larger scale.
The device shown in FIGS. 1 and 2 comprises a supporting frame 1, formed by two ring segments 2 and 3 superimposed in space relative to each other, with brackets 4, 5 and 6 located in between. The supporting frame 1 is mounted on slide bars 7 and 8 transversing the bracket 4 in such a manner as to be slideable in a vertical direction, said displacement being performed by a threaded spindle 9 also traversing the bracket 4 and co-operating with a female thread provided in said bracket.

Between the brackets 5 and 6 on the open side of the supporting frame 1 a tilting platform 10 is pivoted, on which a specimen carrier 11 is mounted so as to be rotatable on an axis extending in perpendicular relation to its plane. The tilting platform 10 is rotatably mounted around a horizontal axis by means of a shaft 12 having a key slot therein and traversing the bracket 5, whereas for the rotation of the specimen carrier 11 another shaft 13 having a key slot therein and traversing a bracket 6 and two horizontally extending shafts 14 and 15 is provided. The specimen carrier 11 together with the article fastened thereon can be adjusted to any desired spatial position or made to perform a certain sequence of movements suitably actuating the threaded spindle 9 and the grooved shafts 12 and 13.

For the drive of the threaded spindle 9 and the grooved shafts 12 and 13 electric motors can be provided. The angular position of the tilting platform 10 can be read on a dial 16 integral with the same.

As illustrated in FIGS. 3 and 4, a differential gear is provided in the housing 17 of the tilting platform 10 closed by a plate-shaped cover 19 fastened by means of bolts 18 for the purpose of ensuring the tilting of the tilting platform 10 and the rotation of the specimen carrier 11 completely independently from one another. The differential gear comprises an axial ball bearing whose balls 20 represent the satellites, the cage 21 guiding the balls 20, forming the satellite carrier, whereas the races 22 and 23 constitute the two remaining gear elements co-operating with the satellites. The cage 21 is positively connected with a hollow shaft 24 rotatably located in the housing 17, the slotted lug 25 of the specimen carrier 11 shown in FIG. 5 being insertable into said hollow shaft.

The axial ball bearing 20 and 21 is supported on both sides by means of balls 26 and 27, each guided by a cage 28 and 29 respectively and engaging in guide grooves 26' and 27' of the races 22 and 23. In addition, the axial ball bearing is loaded in an axial direction by a cup or disc spring 30. Between the slide bars 7 and 8 protruding from the housing 17, the slotted lug 25 of the specimen carrier 11 shown in FIG. 5 being insertable into said hollow shaft.

Between the hollow shaft 24 on the one hand and the races 22, 23, the cages 28, 29 and the ring 31 located between the balls 27 and the cup spring 30 on the other hand, a clearance is provided to preclude any additional sliding friction during the relative motion of these parts.

Each of the two races 22 and 23 presents a circumferential gear, each of which a helical gear 32 and 33 respectively, engages the helical gear 32 being mounted on the shaft 14 and the helical gear 33 on the shaft 15. Attached to the extremity of the shaft 14 protruding from the housing 17 of the tilting platform 10 is a gear wheel 34 mating with a gear wheel 35 mounted on a trunnion 36. The trunnion 36 is rotatably mounted in the bracket 6 on one side and in the supporting arm 37 of the housing 17 of the tilting platform 10 on the other side and comprises a gear wheel 38 which is positively connected with a worm gear 39, non-rotatably, but axially slidably mounted on the grooved shaft 13. The shaft 13, gear wheel 38 and the trunnion 36 constitute an additional driving means connected to the carrier relative to the tilting platform to rotate the carrier. Mounted on the extremity of the shaft 15 protruding from the housing 17 is a gear wheel 40 engaged with gear wheel 41 non-rotatably screwed on to a flange 42 of the bracket 6. The shafts 14 and 15 are rotatably mounted in a flange-like extension 43 of the supporting arm 37.

On its other side, the housing 17 of the tilting platform 10 is rotatably mounted on the bracket 5 by means of the supporting arm 44 positively connected with the bracket 5, the shaft 12 by means of gear wheels or worm gears (not shown), said grooved shaft serving for the swiveling of the tilting platform 10. In the bracket 5 tapped holes 45 and 46 are provided on both sides of the grooved shaft 15, FIG. 3, for the attachment of the horseshoe-shaped ring segment 5. In addition, an annular groove 47, FIG. 4, open towards the specimen carrier 11, FIGS. 4 and 5, is provided in the plate-shaped cover 19 of the tilting platform, said groove 47 serving to receive a preferably electrical heating device for the specimen carrier 11, the lead-in wires of said heating device passing through bores 48 to the base of the specimen groove 49. Finally, it can be seen from FIG. 5 that the specimen carrier 11 presents a T-shaped groove 49 serving for the attachment of the articles to be treated and if necessary, also for the removal of the specimen carrier 11 from the tilting platform 10.

The operation of the device according to the invention appears obvious from FIGS. 3 and 4. By rotating the shaft 12 the tilting platform 10 is swiveled around an axis extending in the longitudinal axis of the supporting arms 37 and 44 and through the plane X—X (FIG. 1) of the inserted specimen carrier 11 by means of a gear (not shown) located in the bracket 5. If during this swiveling motion the grooved shaft 13 remains idle, the trunnion 36 and the gear wheel 35 are also standing still, as a result of which the gear wheels 34 and 40 roll on their associated gear wheels 35 and 41, the shafts 14 and 15 being rotated in the same direction and driving the races 22, 23 by means of the helical gears 32, 33 in the opposite direction but at the same angular speed, the balls 20 riding on the races 22 and 23, as a result of which the cage 21 and the hollow shaft 24 together with the inserted specimen carrier 11 remain idle. It is thus possible to swivel the specimen carrier 11 around an axis extending in its plane without a simultaneous rotation of same around the axis extending in perpendicular relation to its plane. If, however, the grooved shaft 13 located in the bracket 6 is driven, the same rotates by means of the worm gear 39 and the gear wheel 38 the trunnion 36 together with the gear wheel 35 mounted thereon, as a result of which the gear wheel 34 and the shaft 14 are also entrained, said shaft imparting a rotating motion to the race 22 by means of the helical gear 32. However, the race 23 remains inoperative, since neither the tilting platform 10 nor the gear wheel 41 are moved, the balls 20 riding on the inoperative race 23 and being entrained by the race 22 at half speed, so that the cage 21 and the hollow shaft 24 likewise rotate. Thus the specimen carrier 11 is rotated around its central axis without any swiveling motion of the tilting platform 10.

It is fairly obvious that if the two grooved shafts 12 and 13 are actuated simultaneously, the tilting platform 10 can be swiveled together with the specimen carrier 11 and at the same time, the specimen carrier 11 can be rotated. By means of the device according to the invention the specimen carrier can thus be rotated around two of its spatial axes independently from one another, so that it can be accurately adjusted to the required position and any desired motion can be performed therewith. In addition, any adjustment of the specimen carrier 11 and every motion is reproducible in a simple manner.

We claim:

1. A device for adjusting and altering the spatial position of articles, particularly of specimens in a treat-
ment chamber for irradiation or vacuum-coating for electron microscopy comprising a supporting frame, a tilting platform pivotally mounted on said supporting frame on an axis, a specimen carrier rotatably mounted on said tilting platform, a driving shaft connected to the tilting platform to swing the latter, additional driving means connected to the carrier relative to the tilting platform to rotate the carrier and including a differential gear and a planet cage with planet elements, two driving elements in the form of raceways which are in driving connection with the planet elements whereby one of the planet elements is connected to the carrier, a driving gear wheel coaxial with the tilting platform and which is driven from the additional driving means, and a second drive gear coaxial with the tilting platform and connected to drive the latter.

2. A device according to claim 1, in which the planet cage is secured to the carrier to rotate therewith and the two driving elements are in driving connection.

3. A device according to claim 1, in which a bearing is provided having a cage guiding the rolling means and races, said bearing operating as a differential gear.

4. A device according to claim 1, in which a bearing is provided having a cage guiding the rolling means and races, said bearing operating as a differential gear, and a thrust bearing is provided coaxial with the first mentioned bearing, the said first-mentioned bearing being supported on both ends to be rotatable but not displaceable in a radial direction.

5. A device according to claim 1, in which a bearing is provided having a cage guiding the rolling means and races, said bearing operating as a differential gear, and a thrust bearing is provided coaxial with the first-mentioned bearing, the said first-mentioned bearing being supported on both ends to be rotatable but not displaceable in a radial direction, and the races of the thrust bearing presenting guide grooves and balls are provided engaging in the said guide grooves to support the bearing.

6. A device according to claim 5, in which a pressure spring is provided for the thrust bearing in axial direction of force.

References Cited by the Examiner

UNITED STATES PATENTS

2,445,016 7/1948 Bentley
3,022,066 2/1962 Benes

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