

D E S C R I P T I O N**WORKPIECE CARRIER DEVICE****Technical field**

The invention relates to a workpiece carrier device according to the preamble of claim 1. Such devices are used for the processing of workpieces, especially in vacuum appliances, and in particular for coating said workpieces.

Prior art

A workpiece carrier device of the generic type is known from, for example, EP 1 153 155 A1. In that case, the base frame is rotatable about a main axle, and is driven by an electric motor. For the purpose of driving the rotary frames of the workpiece carriers that are distributed equidistantly around the main axle, said workpiece carriers are each provided with a toothed wheel which engages with a torsionally rigid ring gear which coaxially surrounds the main axle. The workpiece holders rotatably mounted on the workpiece carriers are rotated in a similar manner, in that in each case a toothed wheel on the workpiece holder engages with a ring gear which coaxially surrounds the driving axle and which is torsionally rigid in relation to the base frame.

This known workpiece carrier device is of a relatively complex structure. The toothed wheels and ring gears require a large amount of space, and may affect the coating of the workpieces in an undesirable manner. Moreover, they are subject to high temperatures and also to the materials used for the processing of the workpieces. This can result

in malfunctions, particularly obstruction of the rotary motions. Because of the given dimensions, the transmission ratios are selectable only within certain limits, which may force undesirably rapid rotation of the workpiece holders. This may possibly be controlled by means of intermediate transmissions, but the latter further complicate the structure and increase the space requirement and, moreover, increase the friction and the risk of obstruction.

In the case of one of the workpiece carrier devices disclosed by DE 198 03 278 A1, the rotation of the workpiece holders is effected by drivers which are anchored to the base frame and engage temporarily with said workpiece holders. In this case, the rotation is intermittent, which is usually disadvantageous per se and can impair the quality of the workpieces, especially when a coating consisting of a plurality of very thin layers is being applied.

Presentation of the invention

The invention is based on the object of disclosing a workpiece carrier device, of the generic type, which is of a simple structure, and reliable. This object is achieved by the features in the characterizing portion of claim 1.

The advantages achieved by the invention are that, in particular, the invention allows a workpiece carrier device of the generic type, having two, or preferably three, rotational axes, to be constructed in a very simple and space-saving manner. The drive of the workpiece holders can thereby be easily so disposed that it does not affect the processing of the workpieces. Conversely, said drive can be easily protected against being subject to the same influences as the workpieces and being thereby damaged. The

angular velocity of the workpiece holders can be adjusted over a wide range using relatively simple means.

Brief description of the drawings

The invention is explained more fully in the following with reference to figures which represent merely exemplary embodiments, and wherein:

- Fig. 1 shows, in schematic form, an axial section through a workpiece carrier device of the invention, according to a first embodiment,
- Fig. 2 shows a detail from Fig. 1,
- Fig. 3 shows a top view of the detail according to Fig. 2,
- Fig. 4 shows, in partial section, a portion of the workpiece carrier device of the invention, according to the first embodiment,
- Fig. 5 shows a portion of a workpiece holder of the workpiece carrier device of the invention, according to the first embodiment,
- Fig. 6 shows a workpiece holder according to a modified embodiment,
- Fig. 7 shows a transmission part of the workpiece carrier device of the invention, according to the first embodiment,

- Fig. 8 shows a top view of an auxiliary gear set of the workpiece carrier device of the invention, according to the first embodiment,
- Fig. 9 shows a section along IX-IX in Fig. 8 through the auxiliary gear set, and
- Fig. 10 shows, in schematic form, an axial section through a workpiece carrier device of the invention, according to a second embodiment.

Ways of realizing the invention

According to a first embodiment of a workpiece carrier device (Fig. 1) of the invention, there is disposed on a stationary base frame 1 a workpiece carrier 2 (see also Fig. 4), having a rotary frame 3 which is mounted on the base frame 1 so as to be rotatable about vertical driving axle 4 and, at the lower end, carries on its exterior a ring gear 5 (not represented in Fig. 4) with which there engages a toothed wheel 7 driven by a motor 6. The rotary frame 3 is realized as a closed housing which is approximately rotationally symmetrical about the driving axle 4 and has central tubular portions 8 between which are located, along the driving axle 4, successive projections, each constituted by an annular bottom part 9, a likewise annular cover 10 and an outer ring 11 that is concentric relative to the tubular portions 8, said outer ring 11 being joined to the outer edge of the bottom part 9, so as to constitute a single piece with the latter, and projecting somewhat over the outer edge of the cover 10.

The rotary frame 3 carries, on each of said projections, a group 12 of workpiece holders 13, respectively distributed

at the same level and in a uniform manner over a circle surrounding the driving axle 4. Each workpiece holder 13 is rotatable about a holder axis that is parallel to the driving axle 4, and comprises (see also Fig. 5) a base 14, which is located partly within a projection of the rotary frame 3, and a mount 15 for securing a workpiece 16, said mount 15 being fitted onto an axle pin 17 which is brought through the cover 10 with the base 14. The base 14 furthermore comprises a bearing pin 18 having a downwardly facing conical tip, the axis of which, as in the case of the axle pin 17, is coincident with the holder axis and is rotatably mounted in the bottom part 9, where the tip engages in a corresponding recess. The bearing pin 18 and the axle pin 17 are respectively joined by a crank-type intermediate portion comprising a driving pin 19 which is parallel to, but at a distance from, the holder axis. The base 14 is a simple bent part of substantially uniform cross-section. The fitted-on mount 15 has a cylindrical recess, open at the top, into which the workpiece 16, e.g. a milling head, is inserted.

According to a modified embodiment (Fig. 6), the axle pin 17 and the bearing pin 18 are each thicker in relation to the height, i.e. they are realized as cylinders, the axle pin 17 being integral with the mount 15 and having a cylindrical recess which is open at the top, and the bearing pin 18 having on its underside a conical recess in which there engages, for the purpose of mounting, a corresponding projection provided on the bottom part. The driving pin 19 is again at a distance from the holder axis.

A driving part 20 (not represented in Fig. 4), which is rotatable about the driving axle 4 in relation to the rotary frame, comprises a shaft 21 which is realized, for example,

as a square bar and which is located in the driving axle 4 and carries a driving disc 22 at the level of each of the groups 12. The driving disc 22 is aligned horizontally, i.e. it is located in a plane normal to the shaft 21 to which it is connected in a torsionally rigid manner. The driving axle 4 passes through said driving disc 22 (see also Figs. 2, 3) at an anchorage point 23, the centre point, as an output point 24, of said driving disc 22 being at a distance of an eccentricity E from said anchorage point 23. The distance of the driving pin 19 of each workpiece holder 13 from the respective holder axis likewise always corresponds to the eccentricity E , the latter viewed as a vector revolving in the horizontal plane normal to the driving axle 4, with the driving part 20.

Each of the driving discs 22 is connected, via a transmission part 25, to the driving pins 19 of the group 12 of workpiece holders 13 located on their level, said transmission part 25 having a circular central coupling cutout whose edge closely surrounds the driving disc 22, and is also connected, for each workpiece holder 13, to a driving aperture 26 through which there projects the driving pin 19 of said workpiece holder 13, said driving pin 19 being closely surrounded by the edge of said driving aperture 26, such that the transmission part 25 is in each case connected in a rotatable manner, but otherwise with little play, both to the driving part 20 and to the workpiece holders 13. If the base 14 of the workpiece holder 13 is realized as in Fig. 5, it can be threaded very easily into the driving aperture 26, and the mount 15 subsequently fitted on.

The transmission part 25, which is represented in schematic form only in Figs. 2, 3, may be realized as a flat stamped

part (see Fig. 7) having an inner ring 27, which surrounds the said coupling cutout, and an outer ring 28, in which there are provided, distributed over the circumference, in this case twenty driving apertures 26 for engagement with the same number of workpiece holders 13. The inner ring 27 and the outer ring 28 are connected through radial spokes 29 which, in the example, are weakened by radial slots 30 going out from the central coupling cutout, such that they constitute predetermined breaking points which break in the event of an obstruction of one of the workpiece holders 13 of the respective group 12.

The shaft 21 is connected to the output of an auxiliary gear set 31 which is attached to the base frame 1. Said gear set 31 is realized as a planetary gear set (Figs. 8, 9), having a base plate 32, which is screwed onto the base frame 1, and a ring gear 33 mounted on said base plate 32 so as to be rotatable about the driving axle 4, and a sun gear 34, which is connected in a torsionally rigid manner to the output of the auxiliary gear set 31 and thereby to the shaft 21, and which is likewise mounted on the base plate 32 so as to be rotatable about the driving axle 4. Said sun gear 34 is surrounded by three equal planetary gears 35, which are rotatable about axes that are parallel to the driving axle 4, and which engage both with the ring gear 33 and with the sun gear 34. The ring gear 33 has an outwardly projecting stem-like projection 36 which, upon rotation of the rotary frame 3, strikes against the latter such that the ring gear 33, upon further rotation of the rotary frame 3 in the same direction, is torsionally rigid in relation to said rotary frame 3 and is rotated together with it. The projection 36 thus constitutes the drive of the auxiliary gear set 31. The auxiliary gear set 31 is additionally closed by a cover

plate which is screwed onto the base plate 32 and which has a central aperture for the shaft 21.

When the rotary frame 3 is rotated about the driving axle 4 by the motor 6, the projection 36 is driven concomitantly and the ring gear 33 of the auxiliary gear set 31 is rotated concomitantly, such that the driving part 20 is rotated about the driving axle 4, this being at a greater angular velocity, corresponding to the transmission ratio of the auxiliary gear set 31, which ratio can be selected from a wide range. Each of the driving discs 22 attached eccentrically to the shaft 21 causes the respective transmission part 25 acting in combination with said driving disc 22 to be likewise subjected to a circular motion having a radius corresponding to the length of the eccentricity E, but without said transmission part 25 being rotated concomitantly, owing to its engagement with the driving pins 19 of the workpiece holders 13 of the respective group 12. The driving pins 19 are driven concomitantly by the motion of the transmission part 25, and likewise execute a circular motion, having a radius corresponding to the length of the eccentricity E, about the respective holder axes, resulting in a corresponding rotation of the workpiece holders 13 about said axes.

The design of the first exemplary embodiment described may be modified in many respects without departure from the scope of the invention. Thus, instead of driving discs for connecting the shaft to the transmission part, it is also possible to provide cranks, each of which is connected to the shaft in a torsionally rigid manner and rotatably connected to the respective transmission part; in particular, the shaft may have crank-type outward bends, similar to the workpiece holder according to Fig. 5. The

transmission part could also be of a different design, e.g. star-shaped. What is crucial is that there is an eccentric driving part which is rotatable about the driving axle, i.e. a driving part having an eccentric output point at which it engages rotatably with the transmission part, while the transmission part likewise engages rotatably with a likewise eccentric drive point on the respective workpiece holder. The number of workpiece holders driven via a transmission part may vary over a wide range, but each transmission part should engage with at least two, so that it cannot execute any uncontrolled motions. The workpiece holders may also be disposed at different distances from the driving axle, rendering possible a more dense arrangement. It is also possible for the workpiece holders of each second group to be directed downwards in such a way that their mounts point towards those of the next-lower group, and for the one or other mounts to be sprung, such that workpieces that are otherwise difficult to fix in position can in each case be clamped between a lower and an upper mount.

The connection between the driving part and the transmission part may also be realized by means of ball-bearings, as may the connection between the transmission part and the workpiece holders, particularly the driving pins of same. The auxiliary gear set may be replaced by a separate drive, or the driving part may also be anchored directly onto the base frame, though the orientation of the workpieces while revolving about the driving axle remains the same relative to the base frame. Different, or additional, predetermined breaking points may also be provided, e.g. at the connection between the shaft on the one hand and each of the driving discs or cranks on the other hand, or at each workpiece holder or its connection to the transmission part. The design of the rotary frame as a closed housing has the

advantage that it protects the driving mechanism against the influences to which the workpieces are subjected, but other realizations are not thereby precluded. Finally, a plurality of rotary frames may be disposed around the toothed wheel and driven, via the latter, by a common motor.

Fig. 10 shows a second embodiment of a workpiece carrier device according to the invention. Here, a plurality of workpiece carriers 2, corresponding to that described in connection with the first exemplary embodiment, are disposed around a main axle 38 about which the base frame 1 can be rotated by a motor 39. The ring gears 5 engage with a stationary toothed wheel 40. Owing to the engagement of the ring gears 5 with the toothed wheel 40, rotation of the base frame 1 causes each of the rotary frames 3 to be rotated about the respective driving axle 4, while the workpiece carriers 2 revolve about the main axle 38. The workpiece carriers 2 thus constitute, in a manner known per se, planetary elements which revolve about the main axle 38 and about which elements, in turn, revolve the rotating workpiece holders 13, as moon elements, a single drive effecting all motions. In other respects, the functioning of the workpiece carriers 2 corresponds exactly to that described in connection with the first exemplary embodiment. The variations in the design of the workpiece carriers from the represented example that are stated there are also possible in this case.

List of references

- 1 Base frame
- 2 Workpiece carrier
- 3 Rotary frame
- 4 Driving axle

- 5 Ring gear
- 6 Motor
- 7 Toothed wheel
- 8 Tubular portion
- 9 Bottom part
- 10 Cover
- 11 Outer ring
- 12 Group
- 13 Workpiece holder
- 14 Base
- 15 Mount
- 16 Workpiece
- 17 Axle pin
- 18 Bearing pin
- 19 Driving pin
- 20 Driving part
- 21 Shaft
- 22 Driving disc
- 23 Anchorage point
- 24 Output point
- 25 Transmission part
- 26 Driving aperture
- 27 Inner ring
- 28 Outer ring
- 29 Spoke
- 30 Slot
- 31 Auxiliary gear set
- 32 Base plate
- 33 Ring gear
- 34 Sun gear
- 35 Planetary gear
- 36 Projection
- 37 Cover plate
- 38 Main axle

- 39 Motor
- 40 Toothed wheel

C L A I M S

1. A workpiece carrier device having at least one workpiece carrier (2) which comprises a rotary frame (3), mounted on a base frame (1) so as to be rotatable about a driving axle (4), and a driving part (20) which is likewise rotatable about the driving axle (4) in relation to the rotary frame (3), as well as a plurality of workpiece holders (13) which are at a distance from the driving axle (4) and are mounted on the rotary frame (3) so as to be rotatable about holder axes that are parallel to said driving axle (4), **characterized in that**, for the purpose of rotating the workpiece holders (13) in relation to the rotary frame (3) of those workpiece holders (13), there is provided at least one rigid transmission part (25) which engages rotatably with, on the one hand, the driving part (20) at an output point (24) which is at a distance of an eccentricity (E) from the driving axle (4), and, on the other hand, at least two workpiece holders (13) each at a drive point at a distance of an equal eccentricity (E) from the holder axis.
2. The workpiece carrier device according to claim 1, **characterized in that** the driving part (20) comprises a driving disc (22) which is aligned perpendicularly relative to the driving axle (4) and whose centre point constitutes the output point (24), and which is mounted at an anchorage point (23) located on the driving axle (4), whilst the transmission part (25) has a circular coupling cutout whose edge surrounds the driving disc (22).

3. The workpiece carrier device according to either of claims 1 or 2, **characterized in that** each workpiece holder (13) comprises a driving pin (19), of round cross-section, which is parallel to the holder axis and which engages with a corresponding driving aperture (26) on the transmission part (25).
4. The workpiece carrier device according to any one of claims 1 to 3, **characterized in that** each workpiece holder (13) has a base (14), at which the drive point is located, with an axle pin (17) mounted on the rotary frame (3) so as to be rotatable about the holder axis, and has a mount (15), which is mounted on the axle pin (17), for securing the workpiece (16).
5. The workpiece carrier device according to claims 3 and 4, **characterized in that** the base (14) of each workpiece holder (13) comprises a bearing pin (18) which is mounted on the rotary frame (3) so as to be rotatable about the holder axis, and an intermediate portion bent outwards laterally in the manner of a crank, which connects the bearing pin (18) to the axle pin (17) and includes the driving pin (19).
6. The workpiece carrier device according to either of claims 4 or 5, **characterized in that** the rotary frame (3) is realized as a closed housing which surrounds the driving part (20) and each transmission part (25), and also the portion of the base (14) of each of the workpiece holders (13) at which the drive point is located, whilst the axle pin (17) of said workpiece holders (13) is brought outwards through the housing.

7. The workpiece carrier device according to any one of claims 1 to 6, **characterized in that** the workpiece carrier (2) comprises a group (12) of workpiece holders (13) which are disposed at the same level around the driving axle (4), as well as a transmission part (25) which engages with all workpiece holders (13) of the group (12).
8. The workpiece carrier according to any one of claims 3 to 6 and claim 7, **characterized in that** the workpiece holders (13) of the group (12) are distributed uniformly over a circle surrounding the driving axle (4), and the transmission part (25) comprises a ring with driving apertures (26) distributed in corresponding manner over the same.
9. The workpiece carrier device according to either of claims 7 or 8, **characterized in that** the workpiece carrier (2) comprises a plurality of groups (12) of workpiece holders (13) distributed along the driving axle (4).
10. The workpiece carrier device according to any one of claims 1 to 9, **characterized in that** the driving part (20) is operatively connected to the base frame (1) in such a way that, upon rotation of the rotary frame (3), it rotates in relation to the base frame (1) at an angular velocity which differs from that of said rotary frame (3).
11. The workpiece carrier device according to claim 10, **characterized in that** the driving part (20) is connected in a torsionally rigid manner to an output of an auxiliary gear set (31) anchored on the base frame

(1), the drive of which said auxiliary gear set (31) is connected to the rotary frame (3) in such a way that it is concomitantly driven by the rotary motion of the latter.

12. The workpiece carrier device according to claim 11, **characterized in that** the auxiliary gear set (31) is realized as a planetary gear set, with a ring gear (33) connected to the drive, a sun gear (34) which is connected to the output and coaxially surrounded by the ring gear (33), and with at least one planetary gear (35) which engages with the ring gear (33) and with the sun gear (34).
13. The workpiece carrier device according to any one of claims 10 to 12, **characterized in that** it comprises a plurality of workpiece carriers (2) whose driving axles (4) are parallel to a main axle (38) about which the base frame (1) is rotatable.
14. The workpiece carrier device according to claim 13, **characterized in that** the workpiece carriers (2) surround the main axle (38), and the rotary frame (3) of each workpiece carrier (2) carries a ring gear (5) which engages with a stationary toothed wheel (40) which is coaxial with the main axle (38).