

MULTI-FORMAT SPINDLE TRANSPORT DEVICE FOR TRANSPORTING AND COOLING FLAT SUBSTRATES

Description:

The invention relates to a multi-format spindle transport device for transporting and cooling flat substrates, in particular optically readable data carriers such as, for example, CD, CD-R, CD single, DVD, DVD single as well as different formats of optically readable business cards according to the preamble of claim 1.

The production of optically readable data carriers of the above-mentioned type involves the use of an injection molding machine to make blanks from plastic pellets, typically polycarbonates, which blanks are then processed in further steps until a finished CD, CD-R, DVD, etc. is obtained at the end of the production line. After exiting the injection molding machine, the blanks are still hot and must be cooled down before being treated further. Typically, the temperature is at about 100 °C, when removed from the injection molding machine and placed into the multi-format spindle transport device. During transport through the multi-format spindle transport device, the blank cools down as a result of radiation and possible additional cooling measures. For example, a fan may be provided to produce a laminar air flow upon the surface of the blanks. When removed from the multi-format spindle transport device, the blank should have a process temperature of about 22 °C.

Known spindle transport devices using spindles to transport blanks along a cooling zone include three spindles disposed in symmetric and parallel relationship and each having a thread turn and a particular thread undercut width. Such a spindle transport device is disclosed, for example, in EP 1 100 080 A2. Disadvantageous is here however that a change of production, for example from CD to DVD or from CD to DVD single requires modification of the present

spindle transport device or replacement with another transport device to receive blanks of different thickness or different diameter.

DE 100 28 399 discloses a spindle transport device which is able to process CD blanks as well as DVD blanks, without requiring any modification, and includes four spindles arranged non-symmetrically to one another for transport of CD and DVD blanks as well as CD and DVD single blanks.

Substrates having non-circular outer contour, such as, for example, DVD cards known from JP 2002170286 A or with diameters deviating from standardized diameters for CDs and DVDs or their singles cannot be transported however by a spindle transport device of this type.

The invention is based on the object to provide a multi-format spindle transport device which can be suited to essentially all data carrier formats.

Keeping the spindle transport principle is advantageous for space-saving reasons because a greatest possible number of substrates can be stored in small space.

This object is attained by a multi-format spindle transport device having the features of claim 1. Advantageous configurations and developments are set forth in the sub-claims.

The essential advantage of the present invention is the flexibility of the multi-format spindle transport device to suit almost all data carrier formats. Modification of the production to another format thus no longer requires an exchange of the spindle transport device. As a result, the multi-format spindle transport device according to the invention is universally applicable.

As the spindle holder is so constructed as to allow variation of the relative spatial arrangement of the four spindles disposed in parallel relationship, it is possible to conform the multi-format spindle transport device according to the invention to substrates of most different outer contour. This is in particular of interest in connection with the production of optically readable business cards which oftentimes have a non-symmetric configuration. Examples of frequently processed formats include CDs of a thickness of 1.2 mm and a diameter of 120 mm or 80 mm, DVDs of a thickness of 0.6 mm and a diameter of 120 mm or 80 mm, as well as optically readable business cards of a thickness of 1.2 mm and dimensions of 85x58 mm², 85x60.8 mm², 86x60 mm², 80x60 mm², 3.5"x2.5", whereby the shorter sides may have an arcuate configuration. Of course, any other formats are conceivable, for example those with an equilateral triangle having a side length of same magnitude.

In order to suit the spindle transport device to varying substrate formats, at least one spindle must be adjustable relative to the others and must be fixably supported. Advantageously, two spindles are respectively combined to a pair in fixed spaced-apart relationship and adjustably supported relative to the other pair. Of course, it is also possible to individually position all spindles.

It has been shown especially advantageous to configure the device according to the invention such that both spindle pairs can be disposed symmetrically to a vertical symmetry plane of the spindle holder.

Preferably, the spindle holder includes at least one front plate and a back plate as well as spindle carriers for support of respectively two spindles. Front and back plates can be securely arranged on a base plate.

According to a particularly advantageous embodiment, each spindle carrier is made of two parts, having a forward part and a rearward part. Ball bearings are

preferably provided for support of the spindles.

The spindle carriers are swingably supported about at least one longitudinal axis in parallel relationship to the longitudinal spindle axis, preferably however about two such axes. Part of the spindle holder may include pivot arms on which the spindle carriers are respectively swingably supported about a first axis and which in turn are swingable about a second axis. Advantageously, the pivot arms are also made of two parts, with a forward pivot arm being connected to the forward part of the spindle carrier and with a rearward pivot arm being connected to the rearward part of the spindle carrier.

The pivot axes for both spindle carriers may be realized by shafts which extend at least along the length of the spindles in parallel relationship thereto. The shafts are supported on their front and rear sides in parts of the spindle holder. The shaft, which represents the pivot axis of the spindle carrier relative to both pivot arms supporting it, is hereby only connected with the spindle carrier. The other shaft about which the pivot arms swing is also provided for support of the pivot arms upon the front and back plates of the spindle holder.

Advantageously, means are provided for securing the spindle carrier in the position in which the just processed substrates are in engagement with all four spindles. In this way, the device can be adjusted firmly to the desired substrate format.

The spindle carriers can be secured by clamping sleeves, for example, which are arranged about shafts attached in coaxial relationship to the pivot axes. In cooperation with appropriate bracing means like screws, the shafts are braced securely by the clamping sleeves with the front and back plates of the spindle holder and the pivot arms. Markings may be applied on the spindle holder, the spindle carriers and the pivot arms to simplify the relative position for certain

frequently processed substrate formats. It is of advantage to select a respective mirror symmetrical adjustment to a vertical length plane of the spindle transport device for both corresponding spindle pairs. So long as the processed substrates are in engagement with all four spindles, a non-symmetrical alignment is, however, also conceivable.

Preferably provided for rotating the spindles is a servomotor which drives all spindles in synchronism. The motor is supported on the spindle holder. Toothed belts are advantageously used for motion transmission and are typically provided on only one, preferably the forward side of the spindle holder whereas the spindles are only rotatably supported on the backside of the holder.

According to a preferred embodiment, each spindle carrier has a first toothed belt pulley which propels via a toothed belt the spindle pair disposed in the spindle carrier. This first toothed belt pulley in turn is driven by a second toothed belt which is in mesh with a second toothed belt pulley. The rotation axes of both toothed belt pulleys are preferably configured in coaxial relationship to the pivot axes of the spindle carrier and the pivot arm. According to one embodiment, the toothed belt pulleys are supported directly on both shafts which are attached along the pivot axes. The second toothed belt runs preferably along the respective forward pivot arm on which the spindle carrier is supported; it may, however, also be fitted inside this pivot arm. A third toothed belt driven by the shaft of the servomotor propels both second toothed belt pulleys.

During transport of circular substrates with the multi-format spindle transport device according to the invention, the substrates rotate about their own rotation axis. This rotation movement is caused by friction to which the substrates are exposed as a result of their placement on the thread root of the rotating spindles. In case of circular substrates, the rotation movement ensures an even cooling and less edge stress.

On the other hand, when non-circular substrates are involved, the rotation movement forced upon the substrate as a consequence of the contact with the thread root of the transport spindles is undesired because it may cause the substrates between the spindles to be pushed up and subsequently tilt. As a result, the transport is interrupted, and the substrates may become damaged. Therefore, the transport of substrates of non-circular outer contour advantageously involves the use of an anti-rotation mechanism.

Advantageously, the anti-rotation mechanism acts from below onto the substrates and lifts them slightly so as to be still in engagement with all transport spindles but no longer resting on the base of the spindle threads. As a result, friction between substrate and spindle is minimized and the forced rotation movement is prevented.

Lifting the substrates may take place either in midsection, or advantageously the provision of two strips is desired which extend upon the length of the spindles along the shafts which represent the pivot axes of the spindle carriers about the pivot arms. According to a preferred embodiment, the strips are so configured as to enclose the shafts. A clamping mechanism is used to adjust the strips in such a manner as to slightly lift the substrates from the spindle base while the substrates maintain engagement with the threaded spindle turns.

It may, however, also be sufficient to lift the substrates on only one side. In this case, a strip is attached only on this side.

According to a particular advantageous configuration of the invention, the spindles are provided with at least two thread turns of different width so that substrates with at least two different thicknesses can be transported by the spindle transport device according to the invention, such as, e.g., CDs and DVDs.

An exemplified embodiment of the present invention will now be described in more detail with reference to following figures, in which:

Fig. 1 is a front view of an embodiment of a multi-format spindle transport device according to the invention,

Figs. 2, 3 are schematic sectional views of a spindle transport device according to Fig. 1 for two different optically readable business card formats and with two different variants of an anti-rotation mechanism, and

Fig. 4 shows two alternative embodiments of an anti-rotation mechanism.

Fig. 1 illustrates a front view of an embodiment of a multi-format spindle transport device according to the invention. Mounted on a base plate 30 are a supporting attachment plate 40 and a front plate 42, illustrated by dashdot lines. A back plate corresponding to the front plate is not shown.

The following description of the spindle transport device according to the invention is made in detail only in relation to the right side. The description is however applicable in analog manner for corresponding parts on the left side for which primed reference characters are used.

Secured to the attachment plate 40 is a servomotor 20, with a pivot arm 22 being supported on the lower end of the attachment plate for pivoting about a shaft 15. The shaft 15 connects the front plate 42 and the attachment plate 40 of the spindle transport device with the back plate. The pivot arm includes a forward pivot arm 22 and an unillustrated rearward pivot arm which is supported on the back plate for pivoting about the shaft 15 and extends parallel to the forward pivot arm 22. Both these pivot arms are connected at their other end by a further shaft 11 via which a spindle carrier 4 is swingably supported on the pivot arms.

The pivot arms are guided in the front plate and analogous in the back plate via pins 45 and the shaft 11, respectively, in oblong holes 44 and 46 which extend on arcuate sections about the shaft 15. In this way, the pivot movement about the shaft 15 is stabilized and the pivot angle of the pivot arms is restricted to a reasonable degree.

The spindle carrier 4 as well as the pivot arm 22 are made of two parts and include a forward part, visible in Fig. 1, and a rearward part, not visible. Two parallel threaded spindles 1 and 2 are supported by ball bearings in the spindle carriers 4. The spindle carriers 4 are supported by ball bearings. The length axes of the spindles 1, 2 do not correspond with the pivot axis of the spindle carrier 4 which pivot axis is in coincidence with the shaft 15. On the side facing the front plate 42, the spindles 1, 2 are fixedly connected with toothed belt pulleys 5, 6. The toothed belt pulleys 5, 6 are in engagement with a first toothed belt pulley 10 via a toothed belt 8 which is routed within the forward part of the spindle carrier 4. This first toothed belt pulley 10 runs on the shaft 11 about which also the pivot movement of the spindle carrier 4 relative to the pivot arm 22 takes place. The first toothed belt pulley 10 interacts via a further toothed belt 12 with a second toothed belt pulley 14. The second toothed belt pulley runs on the shaft 15, representing at the same time the pivot axis for the pivot movements of the pivot arm 4, and is connected by a further toothed pulley 16 with the toothed belt pulley 18 propelled by the shaft of the servomotor 20. This toothed belt 16 drives both spindle pairs 1, 2; 1', 2' of the spindle transport device according to the invention in synchronism.

In order to secure during operation the position of the spindle pairs 1, 2; 1', 2' with respect to the just processed substrate format, unillustrated clamping sleeves are provided about the shafts 11, 15. These clamping sleeves extend along the entire length of the shafts 11, 15 between the forward and rearward

parts of the pivot arm 22 and interact with further also unillustrated locking means such as, for example, thumb screws or shim rings which are provided on the outer side of the front and back plates and the pivot arm, respectively. In this way, the pivot arm 22, which is swingably supported on the shaft 15, can be locked relative to the front plate 42, and the spindle carrier 4, which is swingably supported on the shaft 11, can be locked relative to the pivot arm 22.

The spindles 1, 2; 1', 2' are configured preferably at least double-threaded, with thread turns of different thickness being provided. One of the threads may receive substrates of a thickness of 1.2 mm and a second one substrates of a thickness of 0.6 mm.

Fig. 1 shows a CD or DVD by way of dashdot line in engagement with the thread turns of all spindles 1, 2; 1', 2'. The adjustment of the respective pivot arms 22, 22' and spindle carriers 4, 4' in symmetry to a vertical length plane of the spindle transport device according to the invention is visible. The circular substrate rests evenly in all thread turns upon the thread root. Thus, as the spindles rotate the substrate also rotates during operation about its rotation axis as a result of friction between the substrate and the spindle base, and cools down in an especially uniform manner.

Figs. 2 and 3 show schematic illustrations though a spindle transport device according to the invention, with two different formats of non-circular substrates being received in the thread turns of the spindles 1, 2. Corresponding parts are again labeled with primed reference characters. In order to suit the device to other formats and to ensure that the substrate are in engagement with the thread turns of all spindles, the pivot arms 22 are adjusted steeper than shown in Fig. 1 and the spindle carriers 4 are laterally pivoted to a greater degree.

When non-circular substrates are involved, there is the risk that the substrates are pushed up perpendicular to the transport direction as a result of the forced rotation movement in the transport device caused by friction between substrate and thread root of the spindles, i.e. are moved out of the even engagement with all spindles, and may get damaged. To prevent this, the provision of an anti-rotation mechanism is required. In Fig. 2, a strip 24 acts as anti-rotation mechanism. The strip embraces the shaft 11, about which the spindle carriers 4, 4' are swingably supported, and extends along the entire length of the spindles 1, 2. A knurled screw 28 secures and adjusts the strip 24 on the shaft 11. In the present embodiment, the strip 24 has a nose 25. The strip 24 is so adjusted that the substrate rests on the nose 25 during transport along the spindles 1, 2 and thus is slightly lifted from the spindle base of the subjacent spindle 2, while still engaging the thread turns of the spindle 2.

Fig. 3 shows a further conventional format of optically readable business cards in engagement with the spindles of the spindle transport device according to the invention, which uses an alternative variation of the anti-rotation mechanism. The known strip 24 was further equipped with an additional rail 26 which again extends along the entire length of the spindles and provides a contact surface for the substrates. As a result, substantially rectangular substrate formats may also be processed having narrow sides of arcuate configuration. As shown here, it is indeed sufficient to provide only one anti-rotation mechanism on one side of the spindle transport device. However, the side should be selected in relation to the spindle rotation direction, as indicated by the arrow in Fig.3.

Fig. 4 shows a detailed view of two possible configurations of a strip 24 acting as anti-rotation mechanism and secured by a clamping mechanism. The advantage of a securement through clamping resides in the possibility of a rapid installation to a spindle transport device according to the invention, when the operation is

changed from circular substrates to substantially rectangular business card formats.

At operation, a newly produced substrate is removed by a known extraction device, for example a pivot arm 48 with gripper from a mold of an injection molding machine and placed from atop into the spindle threads of the spindle transport device according to the invention as provided for the concerned substrate thickness. The spindles must hereby be positioned with the assistance of a position sensor by the servomotor 20 in such a manner that the respective spindle threads are readied for receiving the substrate in the depositing position. As soon as the substrate has been deposited, the servomotor 20 drives the spindles 1, 1', 2, 2' via the toothed belts 16, 12, 12', 8, 8' in synchronism, and the deposited substrate is transported along the transport path. When a further substrate should be deposited, the spindles are halted in a position in which the substrate can be placed into the matching thread turns. As soon as a substrate has reached the end of the transport path, the servomotor 20 is stopped and the substrate is removed by a further known extraction device from the spindle transport device for subsequent processing.

In order to suit the spindle transport device to a different substrate format, the locking means on the shafts 15, 15' and 11, 11', respectively, are loosened, the pivot arms 22, 22' and the spindle carriers 4, 4' are pivoted into the new desired positions and again tightened. The new position is characterized preferably by a mirror-symmetric alignment of the pivot arms 22, 22' and spindle carriers 4, 4'. The substrates must be in engagement with all spindles, and the anti-rotation mechanism for non-circular substrate formats must be additionally adjusted such that the substrates are prevented from resting on the thread roots of the subjacent spindles 2, 2'. To facilitate the adjustment of the pivot arm position and spindle carrier position for typical substrate formats, position markings may be

provided on the spindle holder, the spindle carriers 4, 4' as well as the pivot arms 22, 22'.

Assurance must be made however for each adjustment that the transport device is freely accessible from atop for loading.

The multi-format spindle transport device according to the invention allows transport of flat substrates of varying outer contours and cooling at the same time. Conforming to new substrate formats can easily be realized.

List of Reference Characters

1, 1', 2, 2'	spindle
4, 4'	spindle carrier
5, 5', 6, 6'	toothed belt pulleys
8, 8'	toothed belt
10, 10'	first toothed belt pulley
11, 11'	shaft
12, 12'	toothed belt
14, 14'	second toothed belt pulley
15, 15'	shaft
16	toothed belt
18.	motor toothed belt pulley
20	servomotor
22, 22'	pivot arm
24, 14'	strip
26	strip
28, 28'	knurled screw
30	base plate
40	front plate
44, 44', 46, 46'	oblong holes
45, 45'	pin
48	pivot arm

Claims:

1. Multi-format spindle transport device for transporting and cooling flat substrates, in particular optically readable data carriers, comprising four spindles (1, 1', 2, 2') disposed in a spindle holder in parallel relationship, as well as drive means for rotating the spindles, characterized in that
the spindle holder is so constructed as to allow adjustment of the relative spatial arrangement of the spindles (1, 1', 2, 2') relative to one another such that substrates of varying formats can be brought into engagement with all four spindles (1, 1', 2, 2') at a same time.
2. Multi-format spindle transport device according to claim 1, characterized in that
at least one spindle in the spindle holder is received detachably, adjustably and securably relative to the other spindles (1, 1', 2, 2').
3. Multi-format spindle transport device according to claim 1 or 2, characterized in that
two spindles (1, 2) respectively are arranged in pairs at a fixed distance relative to one another and adjustably supported relative to the other spindles (1', 2').
4. Multi-format spindle transport device according to claim 1 to 3, characterized in that
the two spindle pairs (1, 2; 1', 2') can be arranged in symmetry relative to a vertical plane of the spindle holder.

5. Multi-format spindle transport device according to claim 1 to 4,
characterized in that
the spindle holder includes a front plate and a back plate.
6. Multi-format spindle transport device according to claim 1 to 5,
characterized in that
spindle carriers (4, 4') are provided which form part of the spindle holder and
in which two spindles (1, 2; 1', 2') are supported respectively.
7. Multi-format spindle transport device according to claim 6,
characterized in that
the spindle carriers (4, 4') are made of two parts and each including a
forward part (4, 4') and a rearward part.
8. Multi-format spindle transport device according to claim 6 or 7,
characterized in that
the spindle carriers (4, 4') are swingably supported about at least one length
axis in parallel relationship to the longitudinal spindle axis.
9. Multi-format spindle transport device according to claim 8,
characterized in that
the spindle carriers (4, 4') are swingably supported about two different length
axes.
10. Multi-format spindle transport device according to claim 9,
characterized in that
pivot arms (22, 22') are provided on which the spindle carriers (4, 4') are
respectively supported for rotation about a first axis and which are swingably
configured about a second axis.

11. Multi-format spindle transport device according to one of the claims 8 to 10, characterized in that
shafts (11, 15; 11', 15') are provided as pivot axes for both spindle pairs (1, 2; 1', 2') and extend at least along the length of the spindles (1, 2; 1', 2').
12. Multi-format spindle transport device according to one of the claims 6 to 11, characterized in that
means for securing the spindle carriers (4, 4') are provided.
13. Multi-format spindle transport device according to claim 12, characterized in that
the spindle carriers (4, 4') are locked by clamping sleeves which are securable on the shafts (11, 15; 11', 15') and braceable against the front and back plates of the spindle holder.
14. Multi-format spindle transport device according to one of the claims 1 to 13, characterized in that
a servomotor is provided to rotatably drive the spindles (1, 2; 1', 2').
15. Multi-format spindle transport device according to one of the claims 1 to 14, characterized in that
toothed belts are provided for driving the spindles (1, 2; 1', 2').
16. Multi-format spindle transport device according to claim 15, characterized in that
each spindle carrier (4, 4') has attached thereon a first toothed belt pulley (10, 10') which is in engagement via a toothed belt (8, 8') with the two spindle pairs (1, 2; 1', 2'), respectively.

17. Multi-format spindle transport device according to claim 16,
characterized in that
a second toothed belt pulley (14, 14') is respectively provided via which the
first toothed belt pulley (10, 10') of each spindle carrier (4, 4') is driven by
means of toothed belts (12, 12').
18. Multi-format spindle transport device according to claim 16 and 17,
characterized in that
the rotation axes of the first and second toothed belt pulleys (10, 10'; 14, 14')
are each in coaxial relationship to one of the pivot axes of the spindle
carriers (4, 4').
19. Multi-format spindle transport device according to one of the claims 16 to 18,
characterized in that
a further toothed belt (16) is provided via which the servomotor (20) drives
both second toothed belt pulleys (14, 14').
20. Multi-format spindle transport device according to one of the claims 1 to 19,
characterized in that
an anti-rotation mechanism is provided for preventing a rotation of non-
circular substrates.
21. Multi-format spindle transport device according to claim 20,
characterized in that
the anti-rotation mechanism acts substantially from below on the substrates.

22. Multi-format spindle transport device according to one of the claims 20 or 21, characterized in that
the anti-rotation mechanism includes at least one strip (24) which extends substantially along the length of the spindles (1, 1', 2, 2') and on which the substrates rest.
23. Multi-format spindle transport device according to claim 22, characterized in that
at least one strip (24) is adjustable by a clamping mechanism.
24. Multi-format spindle transport device according to one of the claims 22 or 23, characterized in that
the at least one strip (24) is attached on one of the shafts (11, 11') on which the spindle carriers (4, 4') are supported.
25. Multi-format spindle transport device according to one of the claims 22 to 24, characterized in that
only one strip (24) is provided on one side of the spindle holder.
26. Multi-format spindle transport device according to one of the preceding claims, characterized in that
the spindles (1, 1', 2, 2') have each at least two thread turns with differently wide thread undercuts to be able to receive substrates of different thickness.

Abstract

The invention relates to a multi-format spindle transport device for transporting and cooling flat substrates, in particular data carriers that can be optically read. The device comprises four spindles (1, 1', 2, 2') that are arranged in parallel in a spindle holder, and drive means for rotating the spindles. However, substrates with non-circular outer contour or with a diameter that deviates from the standard cannot be transported by a spindle transport device of this type. To solve this problem, the spindle holder is configured in such a way that the relative spatial arrangement of the spindles (1, 1', 2, 2') in relation to one another can be adjusted, so that substrates of different formats can be engaged simultaneously by all four spindles (1, 1', 2, 2').