TRANSPORT ELEMENT FOR FLAT GOODS

The invention relates to a transport element for flat goods, such as sheet goods. The transport element includes an inner support member that can be connected to an axle or shaft, or that is at least provided with an axle or shaft stub, and an outer ring member that at least partially surrounds and encloses the support member and is connected thereto in a form-locking manner. The ring member is made of a rubber-elastic material having an elasticity greater than the elasticity of the material of the support member. The ring member has an outer contact surface for frictionally gripping and transporting the flat goods.

Transport elements of the above described type are frequently used in photocopy machines, printers, or other office machines for transporting paper, cardboard, film or similar sheet goods. In this context, it is known to use embodiments of the transport element having a circular support member and a circular ring member, as well as embodiments having a circular segment-shaped support member and a similarly circular segment-shaped ring member fittingly arranged thereon, e.g. so-called D-rollers.

In a generally known embodiment of such a transport element, the support member comprises a hub for receiving an axle or a shaft, and has an outer circumferential surface provided with nubs or protrusions that project radially outwardly and that are arranged uniformly distributed around the circumference of the outer circumferential surface. These nubs have a pyramidal frustum shape, with an increasing cross-sectional area as the radial distance from the hub increases. In a manner of speaking, the pyramidal frusta are standing on their heads, i.e. are arranged

with their narrower ends facing radially inwardly. Thus, each pyramidal frustum-shaped nub is connected by only a relatively small surface to the outer circumferential surface of the support member.

During the manufacturing of the known transport element, the support member is first produced from a thermosetting or thermoplastic synthetic material by an injection molding process. Next, the support member is inserted into another injection molding tool, in which the ring member is formed by injection molding a rubber-elastic material around the support member. When the material for the ring member is in a molten flowable condition, it can completely flow around and enclose the nubs on the surface of the support member.

After the material of the ring member cures, a form-locking connection results between the support member and the ring member, due to the form of the individual nubs having cross-sections tapering toward the outer circumferential surface of the support member. This interconnection achieves a rotational rigidity of the ring member relative to the support member and also secures the ring member against a radially directed pulling-off thereof. Furthermore, an axial shifting of the ring member relative to the support member is prevented, since the pyramidal frustum-shaped nubs have a smaller axial extension in comparison to the axial width of the support member, both in the area of the base and also in the area of the frustum peak of the nubs.

It has become apparent as a very great disadvantage in the known transport elements, that the effective elasticity of the trans-

port element measured in a radial direction comprises large fluctuations when evaluated around the circumferential direction along the contact surface of the ring member. In other words, different locations on the contact surface around the circumference thereof will exhibit greatly differing radially directed elasticities. These fluctuations in the elasticity result from relatively large variations or differences in the effective thickness of the ring member made of the rubber-elastic material, whereby this effective thickness is a decisive factor determining the elastic behavior of the transport element. Namely, the ring member is considerably thicker in the area between the respective nubs than in the area of the base of each respective upside-down pyramidal frustum-shaped nub. Since the elasticity of the rubber material of the ring member is generally considerably greater than the elasticity of the material of the support member, the thickness of the ring member is predominantly significant for the effective radial spring stiffness or spring constant of such a rollingly supported transport element.

As a result of the above described fluctuations of the effective spring constant or elasticity of the known transport element, such a transport element has unsatisfactory characteristics with regard to an exact conveying or transporting behavior. In other words, the known transport element does not satisfactorily and uniformly achieve an accurate and precise transport of the flat goods being conveyed. The requirements as to the exact positioning of the sheets or films being conveyed by such transport elements have constantly increased in the past and are also expected to continue to increase in the future. Therefore,

conventional transport elements can no longer meet these require ments.

Attempts to reduce the differences in the angle-dependent effective spring constants by increasing the thickness of the ring member around the entire circumference, while maintaining the same geometry of the support member, have resulted in two disadvantages. First, the axial flexural stiffness of the transport element is reduced, especially in the area of the contact surface. Secondly, the cost of the transport element is increased due to an increased consumption of the comparatively expensive rubber-elastic material of the ring member.

In view of the above, it is the object of the invention to suggest a transport element for flat goods that is characterized by only very small fluctuations (as evaluated around the circumferential direction along the contact surface of the ring member) of the radially measured effective elasticity of the rollingly supported transport element. Nonetheless, the transport element is to comprise a sufficiently rigid connection, which is secure against both rotational shifting as well as axial shifting, between the support member and the ring member. Furthermore, the transport element shall be economical to manufacture.

The above objects have been achieved according to the invention in a transport element of the above described general type, in that the support member comprises a plurality of grooves that are arranged distributed in an outer circumferential surface of the support member and that are open at least toward the outer circumferential surface. Furthermore, each groove is respectively

undercut or back-tapered in relation to the respective radial direction, and each groove has an opening width that extends over an angular range of at most 5°. Due to the very small opening width of the grooves, the support member has a circumferential contour that can be described in the first order as a circle or a circular segment. Only in the second order, does the outer circumferential surface of the support member comprise narrow grooves into which, during the surrounding injection molding of the support member, the rubber-elastic material of the ring member can penetrate and then cure in order to embody a form-locking connection.

In this context, the rubber-elastic material of the ring member located within the grooves hardly has any effect on the radially measured effective spring constant of the transport element, as a result of the narrow opening width of the grooves, due to the very effective adhesion of the rubber-elastic material onto the intrados or curved walls of the groove, especially in the narrowed area of the opening of each groove. When a radial compression loading is applied to a rollingly supported transport element according to the invention, a material compression takes place due to the build-up of the compressive stress in the area of the narrow opening cross-section of the groove in connection with the insufficient sliding ability of the material of the ring member along the intrados or curved walls of the grooves. In turn, an increase in the spring constant or stiffness results from the above described material compression. Under a condition of compression loading, a groove with the small opening width according to the invention effects a hardening of the material so that the reduced elasticity of the transport element at this

location, which would actually be expected due to the depth of the groove, is compensated for. As a result, the effective elasticity of the transport element in the area of the groove openings approximates the spring constants in the area of the webs located between each two respective grooves.

Therefore, the resulting fluctuations in the effective elasticity of the transport elements around the circumference thereof are very small in comparison to those of elements according to the state of the art. From this, it results that the transport element according to the invention has transport characteristics that are very advantageous because they are not subject to any appreciable fluctuations, and that are of decisive significance, for example, for an exact paper feed advance in printers or photocopying machines.

Through various experiments it has been determined that an optimal relationship between achieving a uniform elasticity and an increasing production effort and expense for further reduction in the size of the opening width, is achieved when the opening width extends over an angular range of 2° to 3°.

In one embodiment of the transport element, the surfaces of webs respectively located between each two neighboring grooves in the outer circumferential surface of the support member extend over an angular range of at most 20°. In this manner, even for small transport elements, a sufficient number of grooves is still provided so that a sufficient form-locking connection between the support member and the ring member is achieved. If the web surfaces respectively extend over an angular range of 5° to 10°,

then a very large number of grooves will result, without the respective thinnest portion of each web located between two adjacent grooves becoming too narrow in larger transport elements, even when the grooves are provided with a sufficient undercut.

Production advantages for the transport element can be achieved if the grooves are open to at least one end face of the support member. If the ring member and the support member are arranged to terminate axially flush with one another on at least one end face in the area of their common joint interface surface, then the transport element according to the invention comprises a constant spring stiffness as measured in the axial direction, all the way to the edge or rim at the end face having the flush termination.

According to another embodiment of the transport element of the invention, insofar as the ring member encloses the support member on at least one end face, an undesired axial shifting of the ring member in relation to the support member is prevented in at least one direction.

A further advantageous detail of the transport element according to the invention is that the cross-section of each groove respectively includes an essentially rectangular or square-sided throat portion and adjoining thereto a circular clamping portion. The diameter of the clamping portion is substantially larger than the opening width of the throat portion. Such an embodiment is characterized by a high clamping force applied to the material of the ring member enclosed within the grooves, due to the pro-

nounced undercutting or back tapering of the grooves. This embodiment can be manufactured with a small production effort and expense, due to the geometrically simple form.

If the webs arranged between two neighboring grooves comprise a minimum wall thickness, which corresponds to the opening width of the grooves, then the danger of breakage of one of the webs is extremely small, even when the support member is handled and stored without great care after it is produced by injection molding techniques and before it is surrounded or jacketed with the ring member.

According to a further embodiment of the invention, the grooves are respectively divided into two sections with regard to their length, by a respective center web. In this embodiment, a very great security against axial shifting of the ring member and the support member relative to each other can be achieved even when the ring member and the support member terminate axially flush with one another on both end faces of the transport element. In this connection, it is preferred for simplicity of production, that the central webs respectively extend at least over the entire cross-section of the associated groove.

For production reasons, it is also especially simple to achieve a further embodiment of the transport element, wherein the central webs are interconnected with one another by means of an encircling band that protrudes radially above the outer circumferential surface of the support member and that is connected with the webs. Such an encircling band preferably is located directly at the parting plane of an associated injection molding

tool used for producing the transport element. The thickness of the encircling band advantageously corresponds to the thickness of the central webs.

The invention will be described in greater detail below, in connection with two example embodiments, which are shown in the drawings, wherein:

Fig. 1 is an end view of a transport element according to the invention having a circular contour;

Fig. 2 is a lengthwise section through the transport element according to Fig. 1 along the section line II - II shown in Fig. 1;

Fig. 3 is an enlarged detail view of a portion of the support member of the transport element shown in Fig. 1; and

Fig. 4 is an end view of a transport element according to the invention having a D-shaped contour.

Figs. 1 and 2 show a transport element 1 for conveying or transporting flat goods, for example, paper or film. The transport element 1 includes an inner support member 2, which is provided with a hub 3 for receiving an axle or shaft that is not shown. The transport element 1 further includes an outer ring member 4 which completely surrounds and encloses the support member 2 and is connected therewith in a form-locking manner. The ring member 4 consists of a rubber-elastic material, having an elasticity that is substantially greater than the elasticity of the material

of the support member 2. The support member 2 is produced from a synthetic material by an injection molding process, but may alternatively be produced of metal, for example aluminum or a zinc alloy.

The finished support member 2 is inserted into a further injection molding tool and is therein surrounded with the rubber-elastic material by a further injection molding process, whereby the ring member 4 is formed. The ring member 4 is circular-shaped, as is the support member 2. The ring member 4 comprises an encircling circumferential contact surface 5 for frictionally gripping and transporting the flat goods.

Furthermore, the support member 2 comprises an outer circumferential surface 6 having a plurality of grooves 7 arranged equidistantly distributed therein. For reasons of simplicity, only three of the grooves 7 are shown in Fig. 1. As can be seen in Figs. 1 and 2, the grooves 7 are open to both end faces 8 and 9 of the support member 2. Moreover, it can be seen in the above mentioned figures, that the support member 2 and the ring member 4 terminate flush with one another on both end faces 8 and 9.

The grooves 7 are respectively divided, in relation to their length, into two respective sections 11 and 12 having respective equal lengths, by a center web 10. In this context, the center webs 10 are also formed during the injection molding production of the support member 2, wherein the center webs 10 are connected throughout or continuously with the associated intrados or curved walls as well as the floor of the grooves 7, and respectively extend over the entire cross-section of the grooves 7.

Fig. 3 shows an enlarged portion of the end view of the support member 2 of the transport element 1 shown in Fig. 1, specifically in the area of the three illustrated grooves 7. As can be seen in Fig. 3, the cross-section of each groove 7 respectively comprises an essentially rectangular or square-sided throat portion 13 and a thereto adjoining circular clamping portion 14. The diameter 15 of the clamping portion 14 is approximately three times the opening width 16 of the throat portion 13. The opening width 16 of the groove 7 extends over an angular range α of approximately 2°. The web surfaces 18 of the webs 21, which are respectively located between each two respective neighboring grooves 7 in the outer circumferential surface 6 of the support member 2, respectively extend over an angular range β of approximately 5°. As a result, the two mid-lines of neighboring grooves 7 enclose an angle γ of approximately 7°.

Finally, it can also be seen in Fig. 3 that the webs 21 respectively arranged between two neighboring grooves 7 comprise a minimum wall thickness 22 that amounts to approximately 1.2 times the opening width 16 of the grooves 7.

Fig. 4 shows an end view of a modified transport element 1', wherein both the support member 2' and also the ring member 4' comprise a D-shaped outer contour. For this reason, such a transport element 1' is also commonly known as a D-roller. The structure of the support member 2' with a plurality of grooves 7' arranged distributed around an outer circumferential surface 6' thereof is generally analogous to the structure of the transport element 1 shown and described with reference to Figs. 1 to 3.

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Claims:

1. Transport element for flat goods, comprising an inner support member that is connectable to an axle or shaft or that is provided with at least one axle or shaft stub, and an outer ring member of a rubber-elastic material which at least partially surrounds the support member and is connected to the support member in a form-locking manner, wherein the rubber-elastic material of the ring member has an elasticity that is greater than the elasticity of the material of the support member, and wherein the ring member comprises an outer contact surface for the frictionally gripping transport of the flat goods, characterized in that the support member (2) comprises a plurality of grooves (7) that are arranged distributed in an outer circumferential surface (6), are open at least toward the outer circumferential surface (6), and are undercut in relation to the respective radial direction, wherein each groove (7) comprises an opening width (16) that extends over an angular range α of at most 5°.

2. Transport element according to claim 1, characterized in that the opening width (16) extends over an angular range α of 2° to 3°.

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3. Transport element according to claim 1 or 2, characterized in that web surfaces (18) lying in the outer circumferential surface (6) of the support member (2) between two respective neighboring grooves (7) extend over an angular range β of at most 20°.

4. Transport element according to claim 3, characterized in that the web surfaces (18) extend over an angular range β from 5° to 10°.

5. Transport element according to one of the claims 1 or 4, characterized in that the grooves (7) are open to at least one end face (8, 9) of the support member.

6 Transport element according to one of the claims 1 to 5, characterized in that the ring member (4) and the support member (2) terminate axially flush with one another in the area of their common interfacial joint surface on at least one end face (8, 9).

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7. Transport element according to one of the claims 1 to 5, characterized in that the ring member encloses the support member on at least one end face.

8. Transport element according to one of the claims 1 to 7, characterized in that the cross-section of the grooves (7) respectively comprises an essentially rectangular throat portion (13) and a thereto connected circular clamping portion (14), wherein the diameter (15) of the clamping portion (14) is substantially greater than the opening width (16) of the throat portion (13).

9. Transport element according to one of the claims 1 to 8, characterized in that webs (21) arranged between two neighboring grooves (7) comprise a minimum wall thickness (22) that corresponds to the opening width (16) of the grooves (7).

10. Transport element according to one of the claims 1 to 9, characterized in that the grooves (7) are respectively divided, in relation to their length, into two sections (11, 12), by a respective center web (10).

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11. Transport element according to claim 10, characterized in that the center webs (10) respectively extend at least over the entire cross-section of the associated groove (7).

12. Transport element according to claim 9 or 10, characterized in that the center webs are interconnected with each other by means of an encircling band that protrudes radially above the outer circumferential surface of the support member and that is connected with the webs, wherein the thickness of the center webs corresponds to the thickness of the encircling band.

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13. A transport element for transporting flat goods, comprising:

an inner support member adapted to be rotationally driven about a rotational axis and comprising a first material having a first elasticity; and

an outer friction member comprising a rubbery-elastic material having a second elasticity that is greater than said first elasticity;

wherein said support member has an outer at least partial circumferential surface with a plurality of grooves arranged distributed therein, said grooves respectively have openings that open toward said outer circumferential surface and are respectively undercut radially inwardly below said openings, and said openings respectively have opening widths that each span a first angle (α) about said rotational axis of at most 5°; and

wherein said friction member is arranged on said outer circumferential surface at least partially surrounding said support member and reaching into said grooves to connect said friction member with said support member in a form-locking manner, and said friction member has an outer contact surface adapted to frictionally grip and transport the flat goods.

14. The transport element of claim 13, wherein said first angle (α) is in a range from 2° to 3°.

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15. The transport element of claim 13, wherein said support member comprises a plurality of webs respectively extending substantially radially outwardly between respective neighboring ones of said grooves, each of said webs has an outer web surface forming a portion of said outer circumferential surface, and each said outer web surface spans a second angle (β) about said rotational axis of at most 20°.

16. The transport element of claim 15, wherein said second angle (β) is in a range from 5° to 10°.

17. The transport element of claim 13, wherein said support member has two end faces substantially perpendicular to said rotational axis, and said grooves respectively have open ends at least at one of said end faces.

18. The transport element of claim 13, wherein said grooves respectively have open ends at both of said end faces.

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19. The transport element of claim 13, wherein said support member has two end faces substantially perpendicular to said rotational axis, and said support member and said friction member have a joint interface therebetween and terminate flush with each other at an area of said joint interface at least at one of said end faces.

20. The transport element of claim 13, wherein said support member has two end faces substantially perpendicular to said rotational axis, and said friction member overlaps and at least partially covers at least one of said end faces of said support member.

21. The transport element of claim 13, wherein each of said grooves has a cross-sectional shape including a substantially rectangular throat portion forming said opening and, extending therefrom, a substantially circular clamping portion forming said undercut, wherein said clamping portion has a diameter that is substantially greater than said opening width of said throat portion.

22. The transport element of claim 21, wherein said diameter is at least two times said opening width.

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23. The transport element of claim 21, wherein said diameter is about three times said opening width.

24. The transport element of claim 13, wherein said support member comprises a plurality of webs respectively extending substantially radially outwardly between respective neighboring ones of said grooves, and each one of said webs has a minimum wall thickness that is at least as large as said opening widths of said openings of said grooves.

25. The transport element of claim 13, further comprising a respective center web arranged in each one of said grooves, dividing a length thereof into two respective groove sections.

26. The transport element of claim 25, wherein each said center web extends at least entirely across a cross-section of said groove in which said center web is arranged.

27. The transport element of claim 25, further comprising an encircling band arranged projecting radially outwardly from said

outer circumferential surface of said support member, wherein said center webs are respectively connected to said encircling band and are thereby interconnected together, and wherein said encircling band has a thickness that corresponds to a thickness of said center webs.

28. The transport element of claim 13, wherein said support member and said friction member each have a full circle shape.

29. The transport element of claim 13, wherein said support member and said friction member each have a circular segment or circular sector shape.

30. The transport element of claim 13, wherein said outer contact surface of said friction member has grooves therein.

31. The transport element of claim 13, wherein said transport element has an effective elasticity measured radially at said outer contact surface, and wherein said effective elasticity is substantially uniform over a circumferential direction of said outer contact surface.

32. The transport element of claim 13, wherein said grooves extend substantially parallel to said rotational axis and are distributed with a uniform radial interspacing therebetween over a circumferential direction of said outer circumferential surface.