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(54) Web processing apparatus

(57) The present invention relates to a web tensioning assembly configured to exert a tension on a web in a process direction and to balance the tension across a width of the web extending substantially in a direction perpendicular to the process direction. The invention also pertains to a web processing apparatus comprising such a web tensioning assembly.

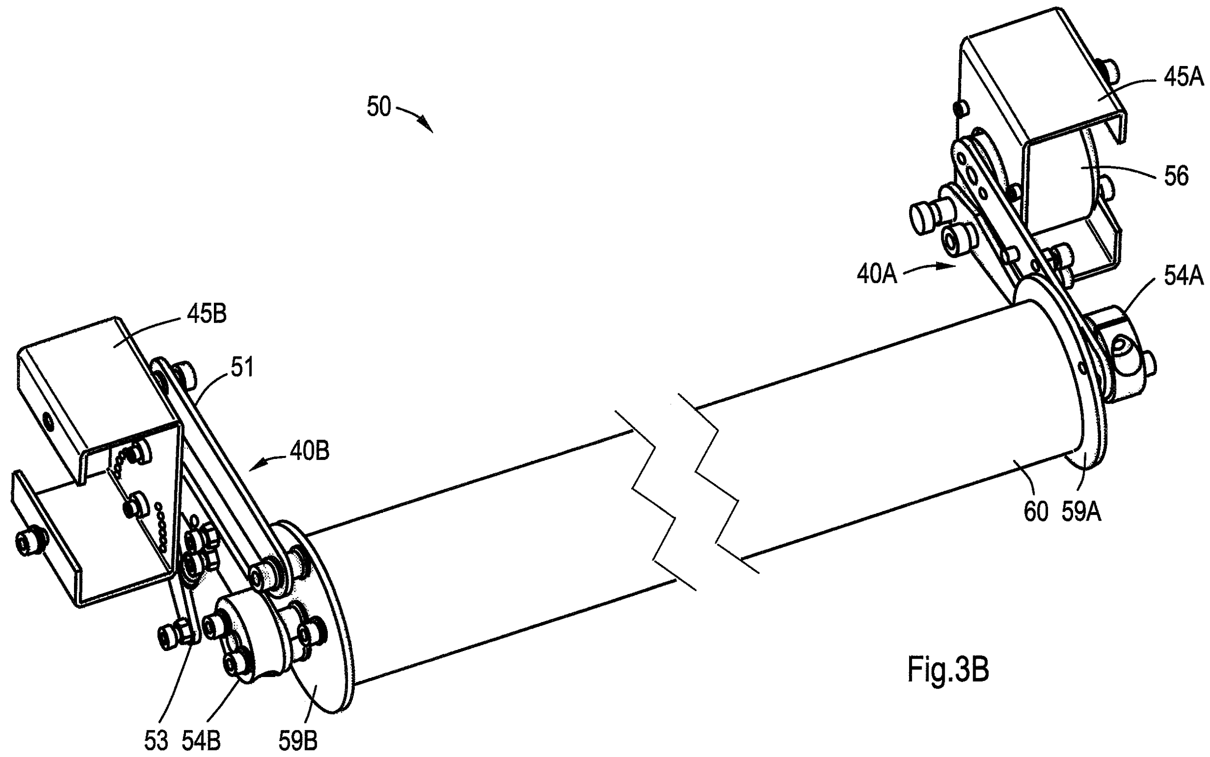

Fig.3B

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Description

[0001] The present invention relates to a web tensioning assembly configured to exert a tension on a web in a process direction and to balance the tension across a width of the web extending substantially in a direction perpendicular to the process direction. The invention also pertains to a web processing apparatus comprising such a web tensioning assembly.

[0002] Web tensioning assemblies that exert a tension on a web in a process direction are known. An example of such assembly is a suspended roller assembly. Such assembly comprises a roller rotatably mounted on an axis, which axis is mounted on two linkages, which are mounted freely rotatable in a frame. If the web is fed in a curve around such a roller, the position and weight of the roller exerts a tension on the web in the feed direction. Such arrangement can however not account for differences in path length across the width of the web, resulting in a variation in tension across the web.

[0003] It is an object of the present invention to provide a web tensioning assembly for applying tension in process direction that takes account for differences in path length across the width of the web. To this end a web tensioning assembly is provided according to claim 1.

[0004] The web tensioning assembly for tensionably guiding a web in a web processing apparatus according to claim 1, takes account for applying a tension in transport or processing direction while the web is transported along the web transport path. The web tensioning assembly comprises an elongated torsion-resilient element, which extends in an axial direction. The elongated torsion-resilient element is resilient to a torsional loading of the element. If a torsional load is applied on the elongated torsion-resilient element, e.g. an axial torsional load, the elongated torsion-resilient element may deform to a certain extend while resisting against said deformation.

The elongated torsion-resilient element is suspended on the axial end portions of the elongated torsion-resilient element on a suspension means. The suspension means comprising a first and a second suspension linkage, which are both non-rotatably connected to the opposing end portions of the elongated torsion-resilient element at a first portion of the first and second suspension linkages. The first and second suspension linkages are rotatably mountable to a frame at a second portion of the suspension linkages. The second portion of the first and second suspension linkages are located remotely with respect to the first portion, thereby constituting a mechanical arm between the end portions of the elongated torsion-resilient element and the points of rotation at the second portion on which the suspension linkages are rotatably mountable to the frame.

The first and second suspension linkages are independently rotatable at the second portions of the first and second suspension linkages about an axis extending substantially parallel to the axial direction of the elongated torsion-resilient element.

The web tensioning assembly further comprises a web guiding means for guiding the web over the elongated torsion-resilient element. This web guiding means surrounds the elongated torsion-resilient element at least partially.

The web tensioning assembly is arranged such that the web tensioning assembly is configured to exert a tension on the web in the process direction and balances the tension across the width of the web. The width of the web is the width of the web in the direction extending substantially perpendicular to the process direction.

By arranging the web tensioning assembly, e.g. such that the web guiding means rests on the web on a position where the web transport path is curved, the arrangement of the web tensioning assembly creates a force by means of the weight of the web tensioning assembly which is via the mechanical arm of the suspension linkages, transferred onto the web via the web guiding means, thereby exerting a tension on the web in process direction. If during operation a difference in path length occurs across the width of the web, the web tends to curve due to path length differences of the web. By the curving of the web across the width of the web, the web may exert a non-uniform mechanical pressure on the web guiding means. By exerting a non-uniform mechanical pressure on the web guiding means the web guiding means may be rotated to some extend about an axis of rotation extending parallel to the process direction. The web guiding means passes this rotation on to the elongated torsion-resilient element, following the rotation of the web guiding means. Because the elongated torsion-resilient element is non-rotatably connected to the suspension linkages, which are independently rotatable, the rotation of the web guiding means are transferred into a torsional deformation of the elongated torsion-resilient element. This elongated torsion-resilient element deforms to a certain extend while resisting against said deformation. This resisting against the deformation urges the web guiding means back to the equilibrium position thereby urging the web into its normal orientation, correcting for path length differences across the width of the web.

[0005] It is further known to correct for path length differences across a web, by using a separate gimbal assembly. Such a gimbal assembly forces a web back into its normal transport path by introducing a rotational degree of freedom in the web transport path, which is resiliently urged towards a desired equilibrium situation.

It is a disadvantage of such a gimbal assembly, that such a gimbal assembly introduces an additional degree of freedom in at least a portion of the web transport path, thereby introducing a position uncertainty. Such a position uncertainty in the web transport path degrades the accuracy of the web transport and introduces complexity in driving the transport means of the web transport path by means of servomotors.

[0006] Using the gimbal assembly in sequential addition to a web tensioning assembly increases the required cumulative space of these assemblies, in particular because the separate application of a gimbal assembly in sequential addition to a web tensioning assembly needs a stretch of web between both assemblies to be able to introduce the necessary degree of freedom of the web at the gimbal assembly.

[0007] The functional merging of the web tensioning function in the process direction and the balancing of the tension across the width of the web increases the quality of the web transport in the web transport path. While the application of the separate functions requires a stretch of web in between the two functions, in the present invention both functions are merged into one location. This reduces the required space to house both functions, and reduces the stretch of web in between the web tensioning in process direction and the balancing of the tension across the width of the web. A large tension across the width of the web may result in damaging the web and even tear the web, thereby rendering the web possibly unusable.

[0008] In an embodiment of the web tensioning assembly according to the present invention, the web guiding means comprises a roller. Preferably the roller surrounds the elongated torsion-resilient element at least partially, such that the web guiding means guides the web via the roller over the elongated torsion-resilient element. A roller is advantageous because this implementation for the web guiding means enables a simple and efficient guidance of the web, while deformations of the web due to tensional differences across the width of the web are easily passed towards the elongated torsion-resilient element.

[0009] In a further embodiment, the web tensioning assembly further comprises a bearing for moveably mounting the roller on the elongated torsion-resilient element. A bearing such as e.g. a ball bearing, dry-running, hydrodynamic or hydrostatic bearing enables a smooth rotation of the web guiding means, in particular the roller over the elongated torsion-resilient element. Thereby the web guiding means minimises the influence on the motion of the transport of the web, while the web tensioning assembly applies its tension in process direction.

[0010] In another embodiment, the roller of the web tensioning assembly is freely rotatable about an axis of rotation extending substantially parallel to the axial direction of the elongated torsion-resilient element. By enabling the roller to rotate freely about an axis of rotation extending substantially parallel to the axial direction of the elongated torsion-resilient element, the roller's rotation influences the movement of the web transport minimally, while the deformation of the web due to tensional differences across the width of the web are easily transferred into a resilient deformation of the elongated torsion-resilient element.

[0011] In another embodiment, the roller of the web tensioning assembly is rotatable over a limited portion of an axial revolution. The interfacing between the web and the web guiding means may be rolling of sliding, or any combination of these interfacing types. By allowing a partial rotation of the roller the web tensioning assembly is prevented to apply a too large frictional shear tension on the web.

[0012] In another embodiment, the roller of the web tensioning assembly is rotatably fixed in axial direction with respect to the suspension means, thereby creating a sliding interface between the web guiding means and the web. The web slides along the contacting surface of the web while the web is being transported in process direction. In case of sliding interfacing between the web and the web guiding means, the contacting surface of the web guiding means, which contacts the web during the transport of the web in process direction, is preferably smooth and applies a low frictional force in process direction.

[0013] In a further embodiment, the web tensioning assembly comprises a drag linkage extending between the frame and an eccentric location at an axial end portion of the roller, such that an axial rotation of the roller is prevented. By mounting an element, such as a drag linkage, between the frame on which the web tensioning assembly is mounted and a location of the roller, which lays at a distance with respect to the axis of axial rotation of the roller, the axial rotation of the roller is thereby prevented. It is found that locating the drag linkage at an end portion of the roller, e.g. the sides of the roller, near the outer surface of the roller, the drag linkage is most efficient, as this applies the largest mechanical arm to prevent a rotation of the roller.

[0014] In a further embodiment, the drag linkage is selectably engaged and disengaged with the roller, thereby enabling selectably respectively a sliding or a rotating interfacing between the web guiding means and the web. The selection may e.g. be implemented as a clamping of the drag linkage to the roller. When the drag linkage is clamped to the roller, the roller is prevented to rotate over the elongated torsion-resilient element, and when the drag linkage is unclamped from the roller, the roller is freely rotatable with respect to the elongated torsion-resilient element.

[0015] In another embodiment, the suspension means is in operation urged towards a predetermined angular equilibrium position with respect to the frame. By applying an urging force from the frame on the suspension means, the suspension means will be urged towards an angular equilibrium position with respect to the frame. This is e.g. advantageous in cases where the web tensioning assembly does not apply its tensioning of the web in process direction at a location along the web transport path where the web guiding means rests its full weight via the mechanical arm of the suspension means on the web. The urging of the suspension means, in general enables an operator to choose the tension that is applied on the web in process direction and enables the web tensioning assembly to maintain a predetermined equilibrium position, different from the fully resting position, i.e. the situation in which the suspension means are freely rotatable with respect to the frame and no urging force is applied from the frame to the suspension means. The urging force from the frame to the suspension means is preferably applied on both suspension linkages, but may also be applied to only one of the suspension linkage.

[0016] In a further embodiment, the suspension means is spring loaded towards the predetermined angular equilibrium position. A spring enables the configuration of the equilibrium position to the carried out with a simple construction. Depending on the actual arrangement of the spring with respect to the suspension means, the web guiding means are supported by the spring or alternatively an additional pressure is applied on the web via the web guiding means, e.g. may be implemented by directing the spring force in the direction of the gravitational movement of the web guiding means.

[0017] In another embodiment of the web tensioning assembly according to the present invention, the elongated torsion-resilient element is a torsion bar. The torsion bar is an element, which resiliently deforms under a torsional load. The relation between the deformation of the torsion bar and the torsional load, may be chosen to fulfil the desired behaviour of the elongated torsion-resilient element. Torsion bars may be designed to perform a deformation in linear proportional relation with the applied torsional load, or may be chosen to have a non-linear relation with the applied torsional load. A linear relation will be appreciated in particular when the deformation, and the proportional resisting counter force or the elongated torsion-resilient element, should increase in a linear fashion when the torsional load on the elongated torsion-resilient element increases. A non-linear relation will be in particular appreciated when e.g. the resisting counter force should only come into play when the deformation of the elongated torsion-resilient element passes a certain threshold. The elongated torsion-resilient element may consist of a single torsion bar, or may comprise a plurality of interconnected torsion-resilient sub-elements.

[0018] In a further embodiment, the torsion bar is formed such that it comprises a substantially star formed axial cross-section. A star formed axial cross-section of a torsion bar is in particular advantageous in configurations where the torsional load in applied in an axial direction. Such a torsion bar may be formed as a single integral part, or be constructed, e.g. by joining two or more elongated strips of metal, plastics or the like.

[0019] In another further embodiment, the torsion bar is formed such that it comprises a substantially a cylindrical axial cross-section. A cylindrical formed axial cross-section of a torsion bar is in particular advantageous in configurations where the torsional load is applied in an axial and/or in process direction. Cylindrical torsion bars have in general a very simple construction and may be relatively cheap.

[0020] In another embodiment, the suspension means is functionally connected to an angular position encoder, such that the angular position of the suspension means with respect to the frame is measurable. By monitoring the angular position of the suspension linkages, the behaviour of the web guiding means can be monitored. If the behaviour occurs to be extraordinary this may point out that something should be adapted in the processing of the web. Alternatively this may be used to detect an absence of a web under the web guiding means, in particular in configurations where the web guiding means rest on the web, an absence of such a web is easily detectable using an angular position sensor measuring the position of the suspension linkages. Such a sensor may be implemented on one of the suspension linkages or on a plurality thereof.

[0021] In another aspect the present invention pertains to a web processing apparatus, comprising a web feed station for feeding a web, a web processing station for processing the web and a web tensioning assembly according to the present invention.

[0022] In a further embodiment of this aspect of the invention, the web processing apparatus comprises a printing station for applying marking material to the web. It is important in such stations to provide the web in a defined fashion and therefore the web should be delivered under a certain tension in process direction, while the differences in path length and tension across the width of the web should be balanced to perform a printing operation on defined positions of the web.

[0023] In a further embodiment of this aspect of the invention, the web processing apparatus comprises a recording station for recording an image from the web. It is important in such stations to provide the web in a defined fashion and therefore the web should be delivered under a certain tension in process direction, while the differences in path length and tension across the width of the web should be balanced to perform a recording operation on defined positions of the web.

[0024] Below, the present invention is elucidated with reference to the appended drawings showing non-limiting embodiments and in which:

- Fig. 1 shows a perspective view of an embodiment of a printing device;
- Fig. 2A shows a first perspective view of an embodiment of a roll-to-roll web processing device according to the present invention for use with the printing device of Fig. 1;
- Fig. 2B shows a second perspective view of the embodiment of the roll-to-roll web processing device of Fig. 2A;
- Fig. 3A shows a first schematic perspective view of an embodiment of the web tensioning assembly of the roll-to-roll web processing device of Fig. 2;
- Fig. 3B shows a second schematic perspective view of an embodiment of the web tensioning assembly of the roll-to-roll web processing device of Fig. 2;
- Fig. 4A shows a schematic illustration of the nominal

configuration of the web tensioning assembly;

Fig. 4B shows a schematic illustration of a deformed configuration of the web tensioning assembly;

Fig. 5A shows a schematic front view of the nominal configuration of the web tensioning assembly;

Fig. 5B shows a schematic front view of a first deformed configuration of the web tensioning assembly;

Fig. 5C shows a schematic front view of a second deformed configuration of the web tensioning assembly;

[0025] In the drawings, like reference numerals refer to like elements or elements having a similar function.

[0026] Fig. 1 shows a printing device 10 for printing an image or text on a relatively large object, in particular on a relatively large and flat object. Such a printing device 10 is well known in the art. The printing device 10 comprises a support assembly 12 on which a printing surface 14 is arranged. As illustrated, the printing surface 14 may be provided with suction holes for pulling the object onto the printing surface 14 and thereby holding the object flat on the printing surface 14. A guiding assembly 16 is provided for supporting and guiding a carriage 18. The carriage 18 is movably supported by the guiding assembly 16 such that the carriage 18 may be moved over the printing surface 14. For example, the guiding assembly 16 may be movably supported on the support assembly 12 such that the guiding assembly may be moved in a y-direction (as indicated in Fig. 1) and the carriage 18 may be moveably supported by the guiding assembly 16 such that the carriage may be moved in a x-direction guided by the guiding assembly 16. The carriage 18 is provided with a printing element such as an inkjet printhead for printing the image or the text on the object arranged on the printing surface 14 by ejecting ink drops at predetermined positions. It is noted that the guiding assembly 16 and / or the carriage 18 may be supported such that they may be moved in a z-direction, thereby enabling to print on different media (i.e. objects) having a different dimension in the z-direction (when positioned on the printing surface 14).

[0027] The printing device 10 further comprises an interface assembly 20. The interface assembly 20 is configured for connecting a roll-to-roll web processing device to the printing device 10 such that the printing device 10 is enabled to print on a media that is supplied from a roll instead of a medium that is positioned on the printing surface 14, although it is noted that in an embodiment the medium that is supplied from a roll may be moveably supported by, guided over and positioned on the printing surface 14. In such an embodiment, the medium may be transported from a supply roll arranged at a first side of the printing surface 14 to a media receiving roll arranged at a second side of the printing surface 14. Hereinafter, an embodiment, which is illustrated in the drawings, is elucidated, in which embodiment a media supply roll and a media receiving roll are arranged at one side of the printing surface 14.

[0028] Fig. 2A and 2B show a roll-to-roll web processing device 22 configured for being coupled to the printing device 10 of Fig. 1. The roll-to-roll web processing device 22 comprises a first media roll slot 24 and a second media roll slot 26 for supporting two media rolls. In particular, in the illustrated embodiment, a first media roll may supply a medium, while a second media roll may receive the medium after it has been printed. For supporting the media rolls, each slot 24, 26 is configured for receiving an media roll supporting device 28. The media roll supporting device 28 is configured to receive and support the media roll. Thereto, the media roll supporting device 28 comprises an elongated element around which the media roll may be arranged. The elongated element may be a bar or axle having a cylindrical cross-section, for example. Also other suitable shapes may be employed. The media roll supporting device 28 further comprises a support means and may further comprise an assembly of a number of parts, possibly providing additional functionality. In any case, the media roll supporting device 28 is removeably supported in at least one slot 24, 26; preferably the media roll supporting device 28 is supported in a suitable slot 24, 26 at each end of the media roll supporting device 28.

[0029] For printing, the medium supplied from a roll arranged in the roll-to-roll web processing device 22 is guided through the roll-to-roll web processing device 22 such that the media is moveably supported by and positioned on a media printing surface 30, possibly provided with means for holding the medium substantially flat on the media printing surface 30. Such means may include, but are not limited to, suction means. For guiding, one or more medium guiding rolls may be provided. For example, a first guiding roll 32A and a second guiding roll 32B may be provided. The second guiding roll 32B, in combination with mechanisms 40A and 40B form a web tensioning assembly according to the present invention.

[0030] One or both media rolls may be driven by a motor means 36, for example through the media roll supporting device 28 supporting the media roll. In Fig. 2A - 2B, the motor means 36 are arranged at one side of the roll-to-roll web processing device 22 and, hence, each media roll supporting device 28 is driven at one end thereof. In an embodiment, motor means 36 may be provided at both ends of the media roll supporting device 28. As shown in Fig. 2B, drive coupling means 38 are provided for operatively coupling the motor means 36 and the media roll supporting device 28.

Fig. 3A and Fig. 3B show a schematic perspective view of an embodiment of the web tensioning assembly 50 of the roll-to-roll web processing device of Fig. 2. Mechanisms 40A and 40B are mounted on a respective portion of the frame 45A and 45B. Mechanisms 40A and 40B comprise respectively suspension linkages 49A and 49B, which are non-rotatably connected to torsion bar 55 at a first portion of the respective suspension linkages 49A and 49B. The respective suspension linkages 49A and

49B are rotatably mounted to the portions of the frame 45A and 45B at a second portion of the respective suspension linkages 49A and 49B thereby forming a mechanical arm between the point of rotation at the second portions and the first portions on which the torsion bar 55 are non-rotatably connected. The torsion bar 55 is connected to the suspension linkages 49A and 49B by means of respective collars 54A and 54B which are fixedly clamped on the torsion bar 55 and connected to the suspension linkages 49A and 49B by means of two bolts each.

Flanges 59A and 59B are rotatably mounted over the torsion bar 55, as well as roller carrier flanges 58A and 58B. The flanges 58A, 58B, 59A and 59B are mounted on the torsion bar 55 by means of a dry-running plastic bearing bushing 52. Flange 59A and roller carrier flange 58A are non-rotatably connected to each other by means of bolts, just as the opposing pair of flanges.

Suspension linkage 49A is connected to an angular position sensor 56 which measures the angular orientation of the suspension linkage 49A. The signal of the sensor 56 is fed to a signal processing unit (not shown).

The rotation of the coupled flanges 59B and 59A are prevented by drag linkage 51, which is connected to the frame 45B and a portion of the flange 59B remote from the axis of rotation.

Fig. 3B shows the situation in which a roller 60 is fitted on the construction as presented in Fig. 3A. The roller 60 is mounted on the roller carrier flanges 58A and 58B by means of a wringing fit. In combination with the drag linkage 51 the roller 60 is prevented to roll along with the web, creating a sliding interface between the roller 60 and the web. As depicted in Fig. 2A and 2B the web transport path curves up at the web tensioning assembly 50. The weight of the web tensioning assembly rests in the curve of the web. Suspension linkage 49B is provided with a spring loading assembly 53 to controllably influence the amount of tension that the web tensioning assembly exerts on the web. By means of this spring loading assembly 53 it is possible to urge the web tensioning assembly into a predetermined equilibrium position and/or to selectably control the amount of tension on the web.

Fig. 4Ashows a schematic illustration of the nominal configuration of the web tensioning assembly and Fig. 4B shows a schematic illustration of a deformed configuration of the web tensioning assembly. The web tensioning assembly is equipped with a star shaped torsion bar 55. For reasons of clarity the web guiding means, in particular the roller is not shown.

In the situation of Fig. 4A, the web slides or rolls along the web guiding means (not shown) and is kept at the required tension in process direction, i.e. the transport direction.

In the situation of Fig. 4B, the web is transported along the web guiding means, but a path length difference occurs. Therefore in the depicted situation, the web tends to curve such that the side is the web near linkage 49B is pushed slightly downwards and the portion near linkage 49A is pulled up slightly. The web guiding means rotate accordingly and urges the torsion bar 55 accordingly as depicted. Because the torsion bar 55 is non-rotatably connected to the both suspension linkages 49A and 49B, the torsion bar 55 is twisted over its length. This twisting deformation invokes a counterforce generated by the torsion bar 55 which urges the torsion bar back into the situation of Fig. 4A. By returning into the situation of Fig 4A the torsion bar 55 pushes the web guiding means along. The web guiding means, in this case the roller (not shown) pushes the web back into its nominal equilibrium position.

[0031] Fig. 5Ashows a schematic front view of the nominal configuration of the web tensioning assembly, Fig. 5B shows a schematic front view of a first deformed configuration of the web tensioning assembly and Fig. 5C shows a schematic front view of a second deformed configuration of the web tensioning assembly.

[0032] Figures 5A, 5B and 5C show another effect that exerts the torsion bar 55 when the web guiding means are tilted by the web due to path length and tension differences across the width of the web. Because the torsion bar 55 is non-rotatably connected to the suspension linkages 49A and 49B, also non-rotatable in a direction of rotation perpendicular to the plane of the figure, a relative movement of the suspension linkages result in a torsional load on the torsion bar 55, urging the torsion bar 55 into an S-shaped deformation over its length as depicted in Fig. 5B and Fig 5C. Fig. 5A show the nominal equilibrium position of the web tensioning assembly, comparable to the situation as depicted in Fig. 4A. The torsion bar 55 is partly surrounded by web guiding means, here a roller 60 with is freely rotatably mounted on torsion bar 55 by means of a dry-running bearing bushing 52A and 52B. Figs. 5B and 5C depict the deformed situations where the nominal situation of the suspension means of Fig. 5A is depicted in dashed lines. The torsion bar 55 is here deformed in an S-shape at the resilient character of the torsion bar 55 urges the torsion bar 55 back into its nominal straight shape, urging the roller 60 along with it. Therefore also this effect contributes to the balancing of the tension differences across the width of the web.

In practise it shall be clear that both the effects of Figs 4A and 4B and the effect of Figs. 5A, 5B and 5C may occur at the same time and depending on the actual resilient properties of the torsion bar 55 any one of the effects may prevail over the other ones.

Claims

1. Web tensioning assembly for tensionably guiding a web in a web processing apparatus, comprising

    - an elongated torsion-resilient element extending in an axial direction having at least two opposing axial end portions;

- a suspension means for suspending said elongated torsion-resilient element, the suspension means comprising a first and second suspension linkage each linkage being non-rotatably connected to the opposing axial end portions at a first portion of respectively the first and second suspension linkage, the first and second suspension linkage are rotatably mountable to a frame at a second portion of the first and second suspension linkage, the second portion being located remotely with respect to said first portion, such that the first and second suspension linkage are independently rotatable about an axis extending substantially parallel to said axial direction;
- and a web guiding means at least partially surrounding the elongated torsion-resilient element for guiding the web over said elongated torsion-resilient element;

arranged such that the web tensioning assembly is configured to exert a tension on the web in a process direction and to balance the tension across a width of the web extending substantially in a direction perpendicular to the process direction.

2. Web tensioning assembly according to claim 1, wherein the web guiding means comprises a roller.

3. Web tensioning assembly according to claim 2, wherein the web tensioning assembly further comprises a bearing for moveably mounting the roller on the elongated torsion-resilient element.

4. Web tensioning assembly according to any one of claims 2 - 3, wherein the roller is freely rotatable about an axis of rotation extending substantially parallel to the axial direction of the elongated torsion-resilient element.

5. Web tensioning assembly according to any one of claims 2 - 4, wherein the roller is rotatable over a limited portion of an axial revolution.

6. Web tensioning assembly according to any one of claims 2 - 3, wherein the roller is rotatably fixed in axial direction with respect to the suspension means.

7. Web tensioning assembly according to claim 6, further comprising a drag linkage extending between the frame and an eccentric location at an axial end portion of the roller, such that an axial rotation of the roller is prevented.

8. Web tensioning assembly according to any one of preceding claims, wherein the suspension means is in operation urged towards a predetermined angular equilibrium position with respect to the frame.

9. Web tensioning assembly according to claim 8, wherein the suspension means is spring loaded towards the predetermined angular equilibrium position.

10. Web tensioning assembly according to any one of preceding claims, wherein the elongated torsion-resilient element is a torsion bar.

11. Web tensioning assembly according to claim 10, wherein the torsion bar is formed such that it comprises a substantially star formed axial cross-section.

12. Web tensioning assembly according to claim 11, wherein the torsion bar is formed such that it comprises a substantially cylindrical axial cross-section.

13. Web tensioning assembly according to any one of preceding claims, wherein the suspension means is functionally connected to an angular position encoder, such that the angular position of the suspension means with respect to the frame is measurable.

14. Web processing apparatus, comprising a web feed station for feeding a web, a web processing station for processing the web and a web tensioning assembly according to any one of preceding claims.

15. Web processing apparatus according to claim 14, wherein the web processing station comprises a printing station for applying marking material to the web.

16. Web processing apparatus according to any one of claims 14 - 15, wherein the web processing station comprises a recording station for recording an image from the web.

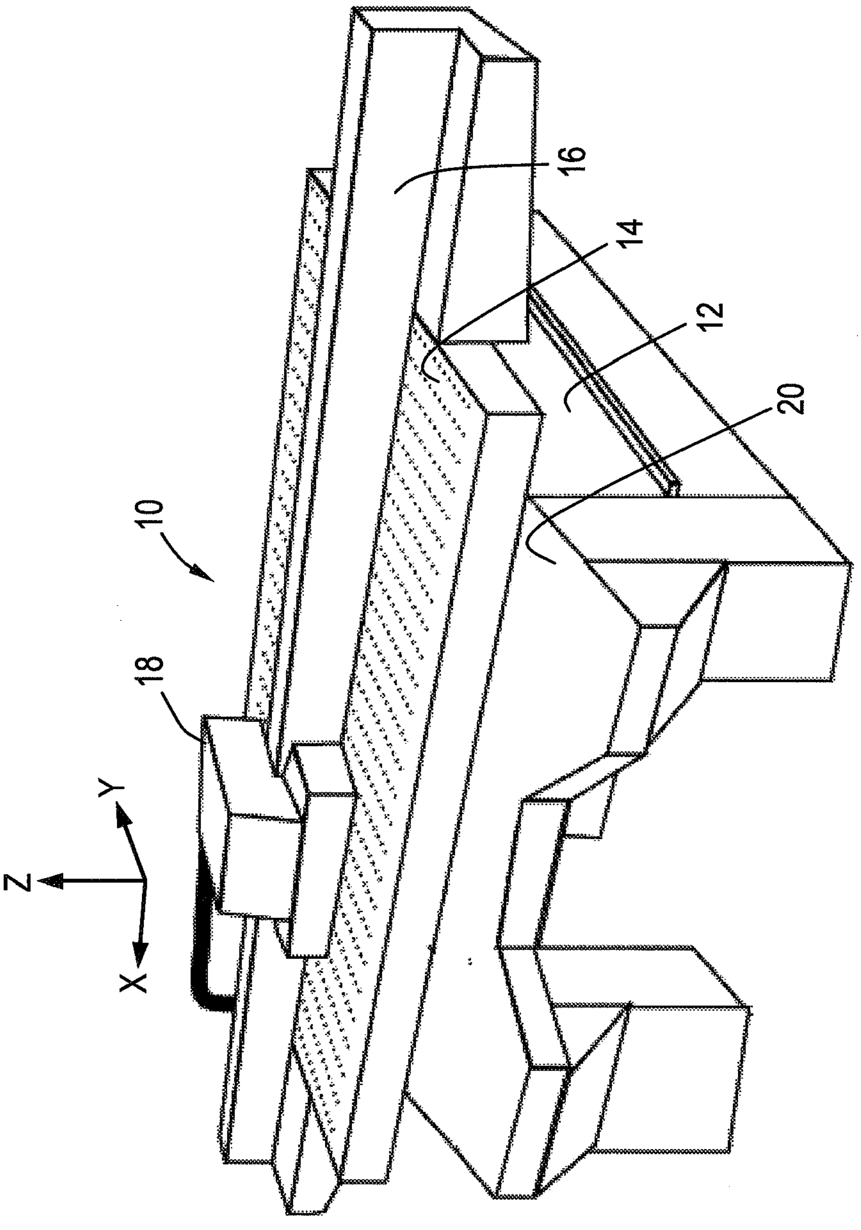

Fig.1

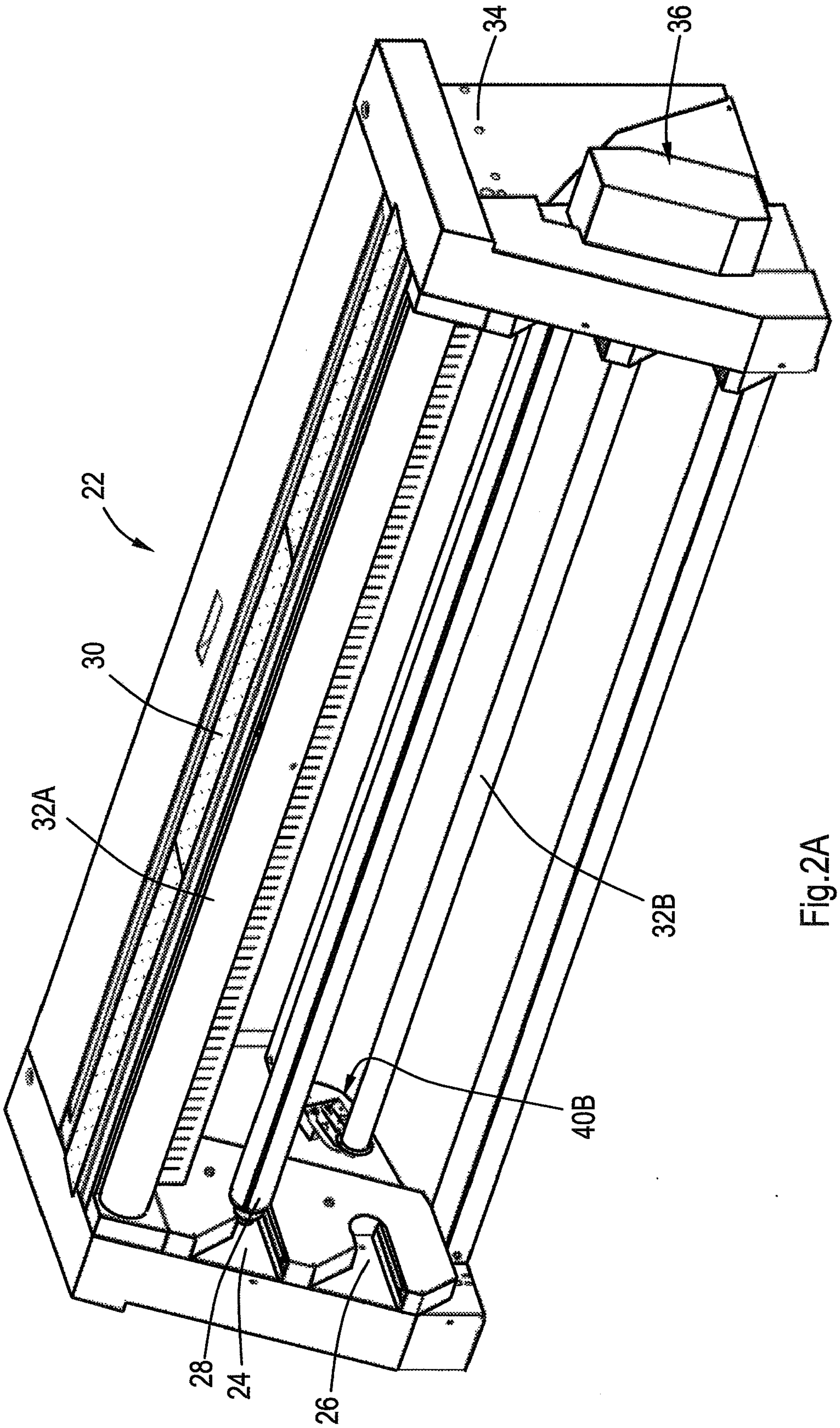

Fig.2A

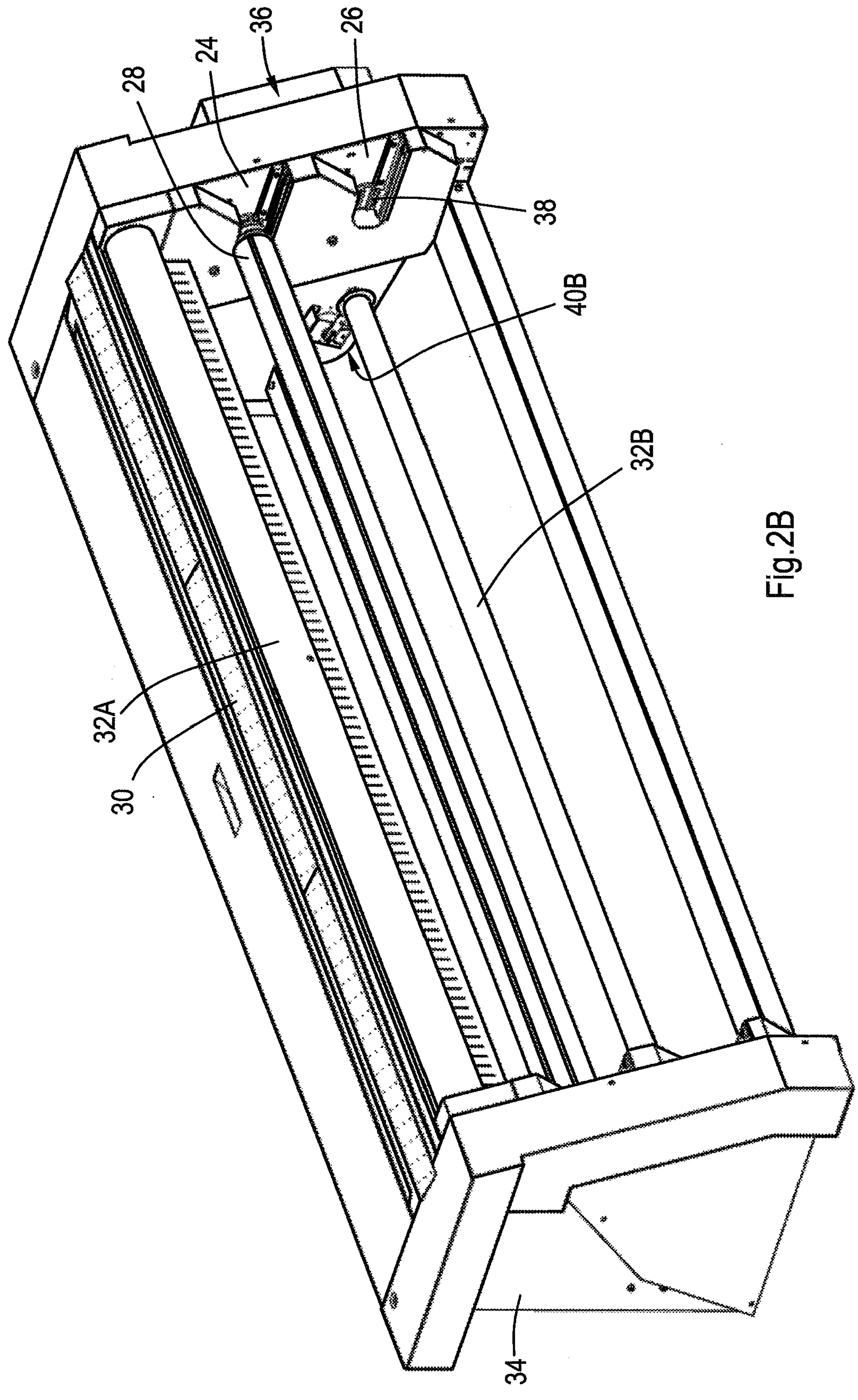

Fig.2B

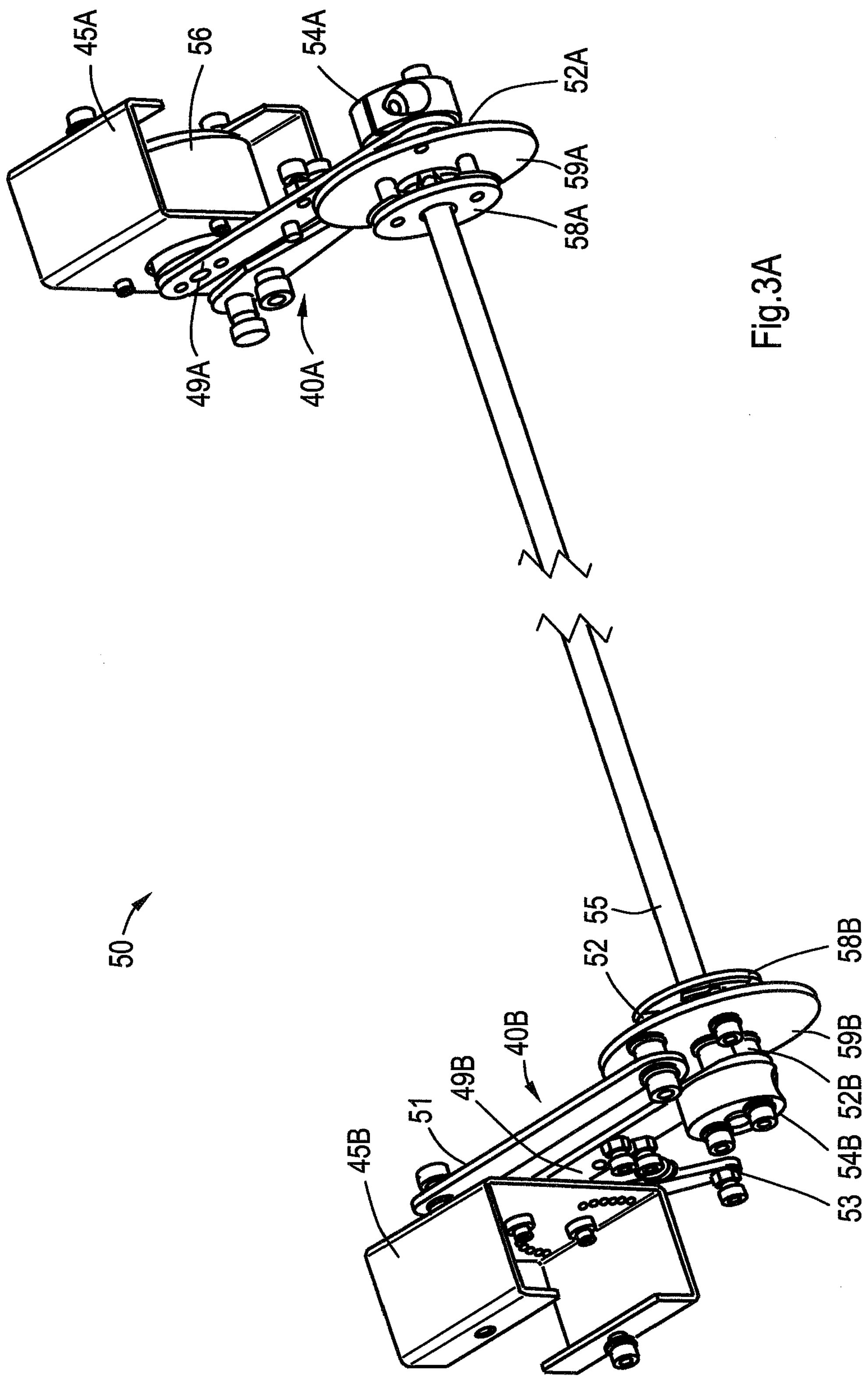
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Fig.3A

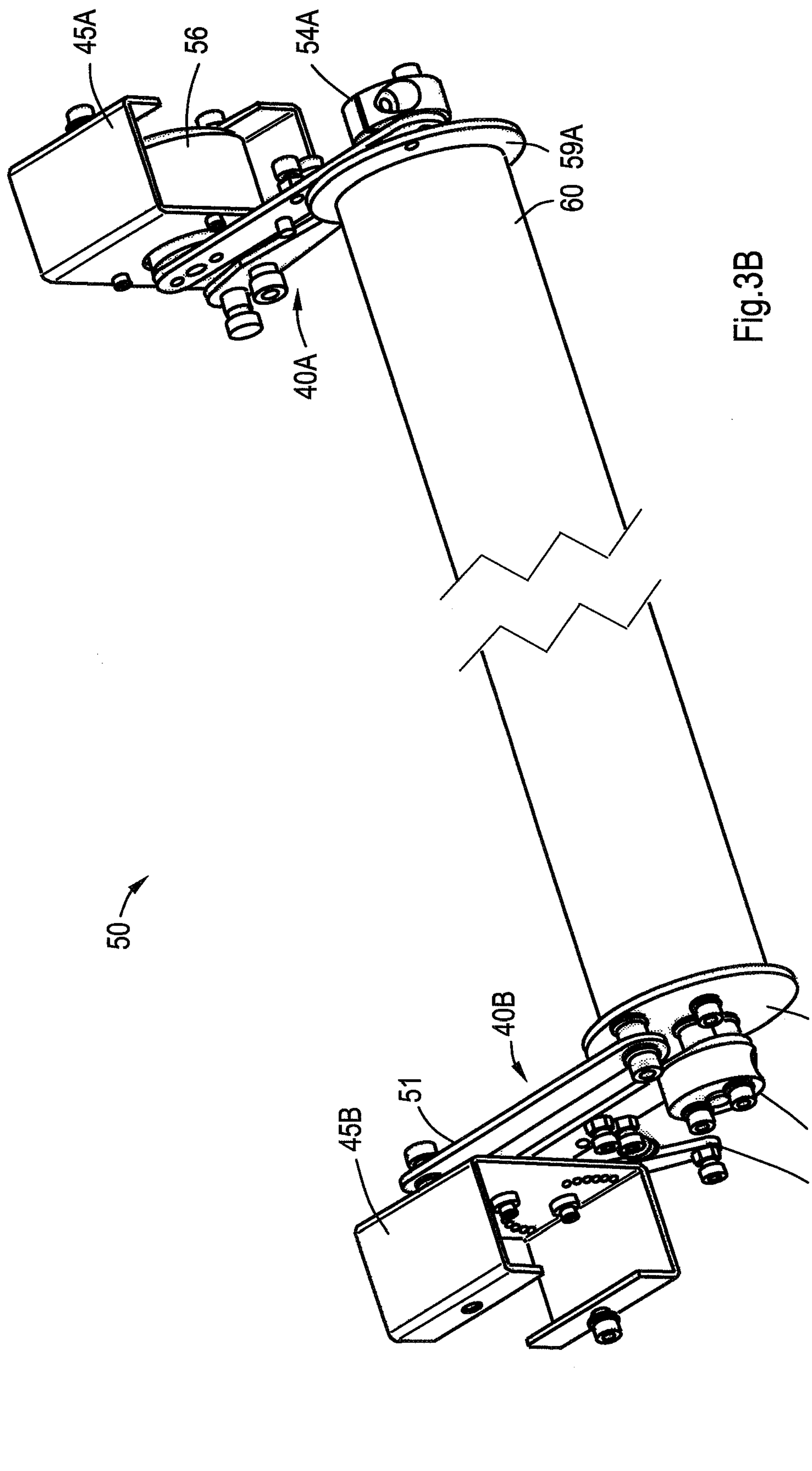

Fig.3B

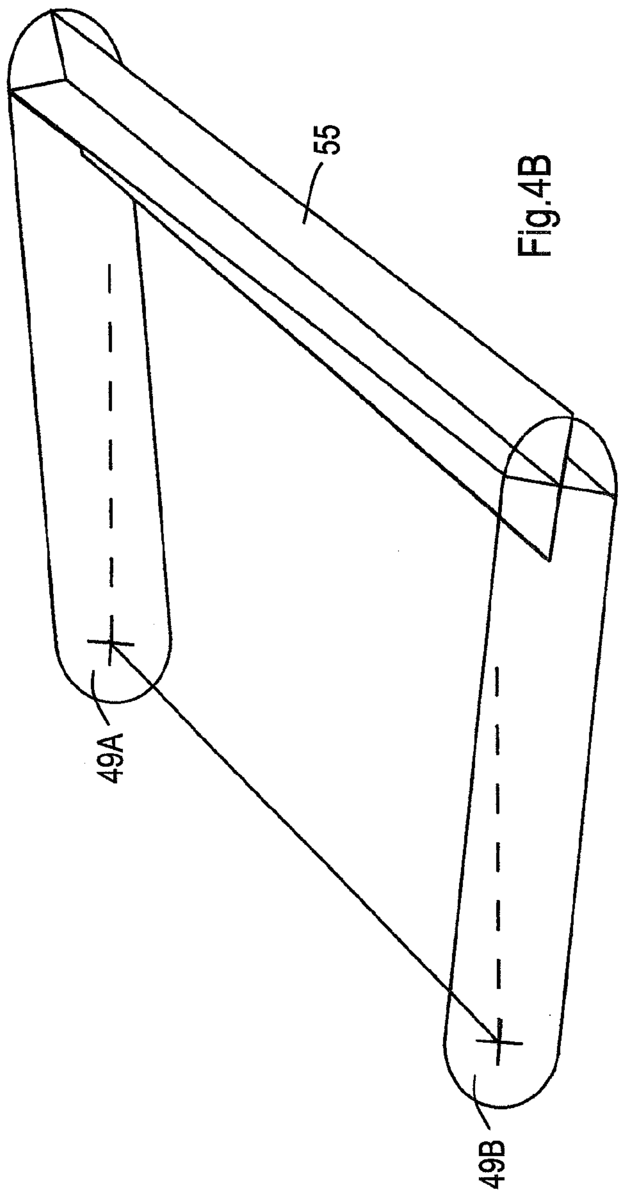

Fig.4B

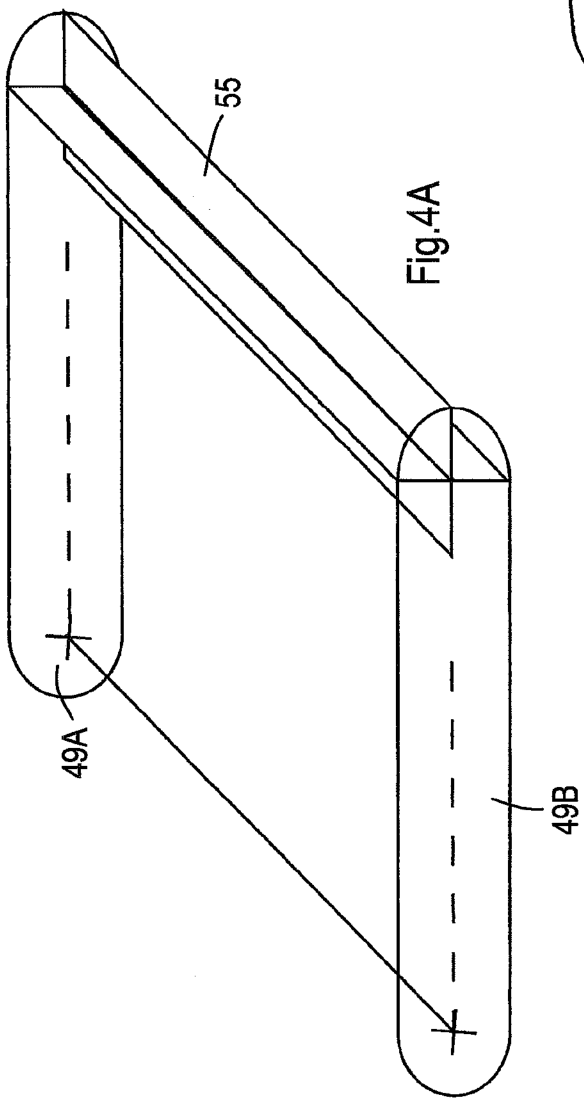

Fig.4A

Fig.5A

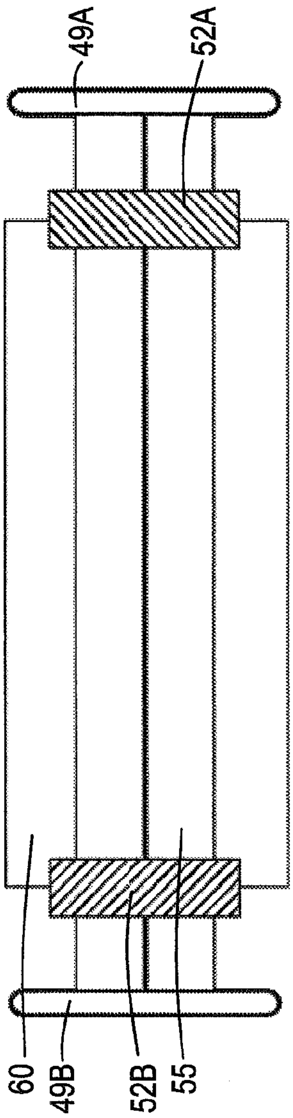

Fig.5B

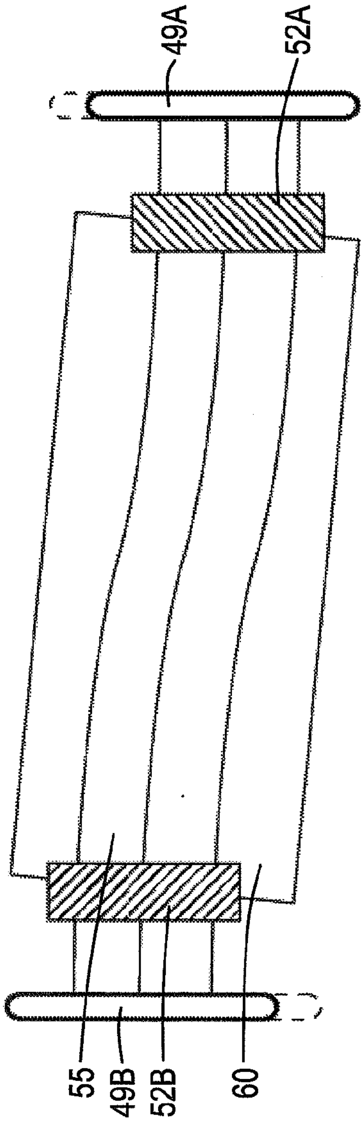

Fig.5C