

(19) **DANMARK**

(10) **DK/EP 2847111 T3**



Patent- og
Varemærkestyrelsen

(12) **Oversættelse af
europæisk patentskrift**

-
- (51) Int.Cl.: **B 65 G 39/20 (2006.01)** **B 65 G 13/06 (2006.01)** **B 65 G 17/24 (2006.01)**
B 65 G 47/34 (2006.01) **B 65 G 47/53 (2006.01)** **B 65 G 54/02 (2006.01)**
H 02 K 16/02 (2006.01) **H 02 K 17/16 (2006.01)** **H 02 K 49/00 (2006.01)**
H 02 K 49/04 (2006.01)
- (45) Oversættelsen bekendtgjort den: **2019-11-18**
- (80) Dato for Den Europæiske Patentmyndigheds bekendtgørelse om meddelelse af patentet: **2019-08-14**
- (86) Europæisk ansøgning nr.: **13787459.0**
- (86) Europæisk indleveringsdag: **2013-03-12**
- (87) Den europæiske ansøgnings publiceringsdag: **2015-03-18**
- (86) International ansøgning nr.: **US2013030364**
- (87) Internationalt publikationsnr.: **WO2013169343**
- (30) Prioritet: **2012-05-07 US 201261643730 P**
- (84) Designerede stater: **AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR**
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- (54) Benævnelse: **Transportør med ruder, som aktiveres ved hjælp af elektromagnetisk induktion**
- (56) Fremdragne publikationer:
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Fortsættes ...

12-14]

DESCRIPTION

BACKGROUND

[0001] The invention relates generally to power-driven conveyors and more particularly to belt conveyors having electrically conductive rollers inductively actuated by interaction with a magnetic field.

[0002] Conveyor belts with article-supporting rollers are used to divert or orient articles as they are being conveyed. The belt rollers are rotated by contact with bearing surfaces or actuating rollers underlying the conveyor belt. As the belt advances, the belt rollers ride on the bearing surfaces or actuating rollers and are caused to rotate. The rotating belt rollers propel conveyed articles across or along the belt in the direction of the rollers' rotation. These belts are effective in sorting, orienting, registering, singulating, and otherwise diverting conveyed articles. But they do have some shortcomings. One shortcoming is noise. Contact between the belt rollers and the actuating rollers is noisy, especially at high belt speeds. Another shortcoming is roller wear. The frictional contact between the belt rollers and the bearing surfaces or actuating rollers wears away the belt rollers. And the need for frictional contact to rotate the belt rollers means that oil or other lubricants contaminating the conveyor cause the belt rollers to slip and alter the intended article trajectories.

Furthermore, the rotational speed of the belt rollers and, consequently, the speeds of the articles depend on belt speed.

[0003] US2010/230245 A1 discloses a conveyor comprising a conveyor belt having a plurality of permanently magnetic rollers having axes of rotation, wherein the conveyor belt advances in a direction of belt travel; a magnetic-field source generating a primary magnetic field passing through the conveyor belt and a method for conveying articles comprising supporting articles atop permanently magnetic rollers in a conveyor belt which advances in a direction of belt travel; and subjecting the permanently magnetic rollers to a primary magnetic field.

[0004] US 4,781,286 discloses a power and free roller conveyor which has a plurality of spaced rollers defining a conveyor path and to each of which is fixed a drive that comprises the secondary of a linear induction motor. The primary of the linear induction motor is positioned adjacent the drivers to enable an interaction of magnetic flux and current resulting from the propagation of a magnetic wave along the primary to cause the drivers and the rollers to rotate. The drivers are optional and the primary can be located near the rollers to act directly on the rollers. The rollers or drivers can be made of copper or aluminium.

SUMMARY

[0005] The present invention provides a conveyor belt in accordance with claim 1, the use

according to claim 8 and a method according to claim 13. These shortcomings are addressed by a conveyor comprising a conveyor belt advancing in a direction of belt travel, having a plurality of electrically conductive rollers having axes of rotation and a magnetic-field source generating a primary magnetic field passing through the conveyor belt. The rollers are made of aluminum or copper so that the primary magnetic field is inducing a current in the electrically conductive rollers that produces a secondary magnetic field that interacts with the primary magnetic field to produce a force that rotates the electrically conductive rollers.

[0006] In another aspect of the invention, a method for conveying articles comprising: supporting articles atop electrically conductive rollers in a conveyor belt; subjecting the electrically conductive rollers to a primary magnetic field; wherein the rollers are made of aluminum or copper. The method is further comprising inducing a current in the electrically conductive rollers with the primary magnetic field to produce a secondary magnetic field that interacts with the primary magnetic field to produce a force that rotates the electrically conductive rollers; and propelling articles along the conveyor belt with the rotating electrically conductive rollers.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] These aspects and features of the invention, as well as its advantages, are described in more detail in the following description, appended claims, and accompanying drawings, in which:

FIG. 1 is an isometric view of a portion of a conveyor embodying features of the invention, including conductive belt rollers rotated by electromagnetic induction;

FIG. 2 is an enlarged isometric view showing a magnetic-field-generating stator and one of the belt rollers of FIG. 1;

FIG. 3 is an enlarged view of the belt roller of FIG. 2 showing circulating currents induced in the belt roller;

FIGS. 4A-4C are side views of the stator of FIG. 2 showing the magnetic flux pattern as the field moves from left to right in the figure;

FIG. 5 is an isometric view of a portion of a conveyor as in FIG. 1, except with in-line, rather than transverse, belt rollers;

FIG. 6 is an isometric view of a portion of a conveyor as in FIG. 1, except with oblique belt rollers;

FIGS. 7A-7D are isometric views of a conveyor using fixed conductive rollers as in FIG. 1 atop a turntable to act as a conveyor sorter, which is not part of the present invention;

FIG. 8 is an isometric view of a conveyor having a series of fixed conductive rollers as in FIG. 1

configured as a sorter, which is not part of the present invention;

FIG. 9 is an isometric view as in FIG. 2 of an electrically conductive roller with helical grooves and actuated by a Halbach array;

FIG. 10 is an isometric view of a magnetic roller coating with a conductive plate, which is not part of the invention; and

FIG. 11 is a block diagram of a stator drive usable with the stators of FIGS. 1, 2, and 4-8.

DETAILED DESCRIPTION

[0008] A portion of a conveyor embodying features of the invention is shown in FIG. 1. The conveyor 20 comprises a conveyor belt 22 conventionally driven in a direction of belt travel 24. The belt includes a plurality of rollers 26 arranged to rotate freely on axes 28 in the direction of belt travel 24. The axes are defined by axles retained in the belt. In the example shown, the conveyor belt is a modular plastic conveyor belt constructed of a series of hingedly linked rows 30 of one or more belt modules having body sections extending from a first end to an opposite second in the direction of belt travel. The rollers 26 are mounted in cavities 32 in the belt with salient portions of the rollers protruding above an outer conveying surface 34 of the belt. Articles 36 are conveyed atop the belt rollers 26. Although the rollers are shown residing in cavities in the module bodies of a modular plastic belt, they could be mounted atop the belt or extend through a bottom surface of the belt or be carried in a flat belt or a ceramic belt.

[0009] The rollers 26, as also shown in FIG. 2, are cylindrical and made of an electrically conductive material, such as aluminum or copper. The aluminum or copper could form the outer surface of the rollers, or the aluminum or copper could be covered by another material, such as a plastic or elastomeric material that would exhibit desirable properties for contact with conveyed articles. The roller 26 is depicted in FIG. 2 as a hollow conductive tube. Underlying the conveyor belt along a portion of the carryway is a magnetic-field source, such as the stator 136 of a linear induction motor. The stator has a series of poles 38 that are energized to produce a magnetic flux wave that travels along the length of the stator in a propagation direction 40 transverse to the direction of belt travel 24 in this example. As shown in FIGS. 3 and 4A-4C, the magnetic flux wave 42 traveling along the stator 136 induces a circulating current I in the electrically conductive roller 26 passing through the field. The current I produces a magnetic field that opposes the change in the flux of the magnetic field produced by the stator 136. The interaction of the stator field (the primary field) with the induced field (the secondary field) produces a force that rotates the roller at a rotational speed ω and a tangential velocity v at the top of the roller opposite to the propagation direction 40. In this way, the article 36 conveyed atop the rollers in FIG. 1 will be pushed off the side of the belt 22 in the transverse direction 44 when it reaches the magnetic-field-producing stators 136. If the propagation direction of the magnetic wave is reversed in the

stator, the rollers 26 will rotate in the opposite direction and push the article 36 off the other side of the conveyor belt 22. The axes of rotation 28 of the belt rollers are perpendicular to the stator-wave propagation direction 40 and parallel to the direction of belt travel 24, which causes the rollers to push conveyed articles across the conveying surface 34 in the direction 44 perpendicular, or transverse, to the direction of belt travel. For this reason, the rollers 26 in the conveyor belt 22 of FIG. 1 are referred to as transverse rollers.

[0010] In the conveyor 46 shown in FIG. 5, a conveyor belt 48 has electrically conductive belt rollers 50 whose axes of rotation 52 are perpendicular to the direction of belt travel 24. These rollers are referred to as in-line rollers because they propel conveyed articles 36 in or opposite to the direction of belt travel 24. The stator 52 underlying the belt 48 on the carryway is rotated 90° from the stator 136 of FIG. 1 to produce a magnetic flux wave that has a propagation direction 54 in the direction of belt travel 24 to propel articles rearward on the conveying surface 34 of the belt. If the rearward tangential velocity of the rollers is equal to the forward speed of the belt, the conveyed article will remain stationary in space, which is useful in zero-back-pressure accumulation of backed-up articles. The belt speed and the propagation speed of the stator wave can be changed relative to each other to propel the articles rearward or forward. If the stator field is reversed, the belt rollers 50 rotate forward and accelerate articles at a speed faster than the belt speed to achieve article separation.

[0011] The conveyor 56 in FIG. 6 uses a conveyor belt 58 that has obliquely arranged conductive belt rollers 60 to divert conveyed articles 36 across the conveying surface of the belt along trajectories oblique to the direction of belt travel 24. The rollers 60 are freely rotatable on oblique axes 62. A magnetic-field-producing stator 64 creates a magnetic wave that travels along the linear stator in a stator-wave propagation direction 66 perpendicular to the axes of the oblique rollers 60. The forward-traveling stator wave causes the electrically conductive rollers to rotate opposite to the wave and push the articles obliquely rearward. If the stator field is reversed, the rollers reverse their rotation and push the articles 36 obliquely forward.

[0012] Although the conductive rollers in the conveyors of FIGS. 1, 5, and 6 are shown in endless conveyor belts, or mats, capable of advancing in a direction of belt travel, the rollers could also be embedded in or mounted on fixed, immobile mats, which are embodiments which are not within the scope of protection of the claims and thus do not form part of the present invention. The mats could even be formed by a plurality of rollers or conveyor-belt sections long enough to extend over the stator. As another example, which is not within the scope of protection of the claims and thus do not form part of the present invention,

[0013] FIGS. 7A-7B show a turntable 70 topped with a stator 72 and a roller mat 74 having a plurality of freely-rotatable electrically conductive rollers 76. The roller mat 74 could be realized, for example, as a few rows of the in-line-roller conveyor belt 48 of FIG. 5. In FIG. 7A, the article 36 is fed or drawn onto the roller mat 74 in a first infeed direction 78. The in-line rollers 76 are inductively actuated by the stator 72 with a magnetic stator wave traveling opposite to the first direction 78. When the article 36 is centered on the turntable 70, the stator

is de-energized. The turntable is then rotated 90° counterclockwise as shown in FIG. 7B until the article is positioned as in FIG. 7C. The stator 72 is then reenergized to produce a magnetic wave that travels in a propagation direction 80 to rotate the rollers in the opposite direction and push the article 36 off the turntable in an outfeed direction perpendicular to its infeed direction 78 as shown in FIG. 7D. Of course, the turntable can be rotated to any outfeed angle.

[0014] Another arrangement of a fixed mat of rollers is shown in a conveyor section 83 configured as a sorter in FIG. 8. which is an embodiment which is not within the scope of protection of the claims and thus do not form part of the present invention. Three roller mats 84, 85, 86 are arranged in series, linked together, and supported in a frame 88. Stators 90, 91, 92 underlie the mats. The first roller mat 84 has in-line rollers 50 used to draw an article 36 onto the conveyor. The first stator 90 propagates a magnetic wave in the first propagation direction 94 to rotate the rollers toward the second roller mat 85. The speed of the propagating wave determines the rotational speed of the electrically conductive in-line rollers 50. The roller speed can be set high enough to propel the article 36 all the way across the second roller mat 85. Or it can be set low enough so that the article stops on the second roller mat 85. If the article is not propelled past the second mat, the second stator 91 can be energized to produce a magnetic wave that travels in either transverse direction 96 to rotate the transverse electrically conductive rollers 26 in the opposite direction and direct the article 36 off a selected side of the conveyor. Articles 36 that are propelled past the second roller mat 85 onto the third roller mat 86 are directed off the end of the conveyor section 83. The third stator 92 generates a magnetic flux wave that travels in the same propagation direction 94 as the first stator 90 to propel the article 36 off the end. The fields produced by the first and third stators 90, 92 can be reversed, and articles can be fed onto the sorter and off its end in the opposite direction.

[0015] The stators shown underlying moving conveyor belts in FIGS. 1, 5, and 6 can be replaced by magnets, such as permanent magnets or electromagnets arranged with alternating polarities along the direction of belt travel. The static, but spatially varying, magnetic field produced by these time-invariant magnetic-field sources can rotate the rollers as long as the roller belt is advancing in the direction of belt travel. In that way, the rollers "see" a magnetic field that is changing as the belt advances in the direction of belt travel through the magnetic field. The spatial variation in the magnetic field encountered by the rollers as they advance with the belt induces a current in the electrically conductive rollers that causes them to rotate. Once the belt stops, however, no current is induced in the rollers, which will then coast to a stop. As shown in FIG. 9, the permanent magnets underlying the rollers 100 can be arranged in a Halbach array 102, which increases the magnitude of the magnetic field above the array and decreases it below the array. The arrows on each magnet in the Halbach array indicate the direction of the magnetic field along that face of the magnet. Because the rollers are advanced by the belt through a stronger magnetic field, the magnetic coupling and the roller torque are increased. Helical slots 104 in the periphery of the electrically conducted rollers 100 of FIG. 9 bias the rotation direction.

[0016] In the examples described thus far, stators and magnets served as sources, or primaries, of a magnetic circuit and electrically conductive rollers served as secondaries of the

magnetic circuit. But the principle of operation could be reversed by making the roller a magnet (the primary) and underlying the conveyor belt with a conductive strip (the secondary) as shown in FIG. 10. which is not part of the invention. The magnetic roller 106 acts as a source producing a magnetic field. Magnetic poles 108 are separated by helical slots 110 in the periphery of the roller. As the roller advances in the direction of belt travel 24, the twisted poles induce a current in an underlying electrically conductive element, such as a metallic strip or plate 112, that creates an induced magnetic field. The interaction of the primary magnetic field produced by the magnetic roller with the induced magnetic field in the electrically conductive element produces a force that causes the freely rotatable magnetic roller 106 to rotate.

[0017] As shown in FIG. 11, the stators 114 are controlled by a motor drive system 116, such as a variable-frequency drive, that is coupled to a system controller 118 that can be used to coordinate stator frequency with belt speed and belt stopping and starting.

[0018] Although the invention has been described with the electrically conductive and magnetic belt rollers as article-supporting rollers, the rollers are not limited to use as rollers that contact articles directly. For example, the electrically conductive or magnetic belt rollers could be used to contact the carryway to help propel the conveyor belt, itself, along its path. Or the electrically conductive or magnetic belt rollers could be used to drive other rollers or non-roller components in the belt.

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

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- [US4781286A \[0004\]](#)

Patentkrav

1. Transportør (20, 46, 56) omfattende:
 - 5 et transportbånd (22, 48, 58), som har et antal elektrisk ledende ruller (26, 50, 60), som har omdrejningsakser, hvorved transportbåndet bevæger sig fremad i en bevægelsesretning,
en magnetisk-felt-kilde (136, 52, 64, 90, 91, 92), som frembringer et primært magnetisk felt, som passerer igennem transportbåndet, hvorved rullerne er
10 fremstillet af aluminium eller kobber, således at det primære magnetiske felt inducerer en strøm i de elektrisk ledende ruller, og som frembringer et sekundært magnetisk felt, som samvirker med det primære magnetisk felt med henblik på at frembringe en kraft, som bringer de elektrisk ledende ruller til at rotere.
15
 2. Transportør ifølge krav 1, hvorved den magnetiske-felt-kilde omfatter en serie af magneter med alternerende polaritet anbragt langs bevægelsesretningen.
 3. Transportør ifølge krav 2, hvorved serierne af magneter danner en Halbach-
20 array.
 4. Transportør ifølge krav 1, hvorved den magnetiske-felt-kilde omfatter en stator, som ligger under transportbåndet, og som frembringer det magnetiske felt og danner en linjeinduktionsmaskine med de elektrisk ledende ruller.
25
 5. Transportør ifølge krav 2, hvorved magneterne er elektromagneter.
 6. Transportør ifølge krav 2, hvorved magneterne er permanentmagneter.
 - 30 7. Transportør ifølge krav 1, hvorved de elektrisk ledende ruller omfatter elektrisk ledende cylindriske rør.

8. Anvendelse af et transportbånd (22, 48, 58), som har et antal elektrisk ledende ruller (26, 50, 60) med omdrejningsakser, hvorved de ledende ruller (26, 50, 60) er fremstillet af aluminium eller kobber, i en transportør, som omfatter en magnetisk-felt-kilde (136, 62, 64, 90, 91, 92), som frembringer et primært magnetisk felt, der passerer igennem transportbåndet og inducerer en strøm i de elektrisk ledende ruller, og som producerer et sekundært magnetisk felt, der samvirker med det primære magnetiske felt med henblik på at frembringe en kraft, som bringer de elektrisk ledende ruller til at rotere, og hvorved transportbåndet bevæger sig fremad i en bevægelsesretning.
- 10 9. Anvendelse ifølge krav 8, hvorved de elektrisk ledende ruller er artikelunderstøttende ruller.
- 15 10. Anvendelse ifølge krav 8, hvorved de elektrisk ledende ruller er på linje liggende ruller.
11. Anvendelse ifølge krav 8, hvorved de elektrisk ledende ruller er tværgående ruller, og hvorved de elektrisk ledende ruller er skrå ruller.
- 20 12. Anvendelse ifølge krav 8, hvorved transportbåndet yderligere omfatter:
- en række af båndmoduler (30), som er hængslet forbundet i forlængelse af hinanden med henblik på at danne et transportbånd, idet hvert modul omfatter en legemssektion, der strækker sig fra en første ende til en anden ende i bevægelsesretningen, hvorved i det mindste nogle af modulernes legemssektion har en transportoverflade, i det mindste et hulrum, som er tildannet i legemssektionen og munder ud i transportoverfladen, og en elektrisk ledende rulle, som roterbart er anbragt i hulrummet med henblik på at rotere.
- 25 13. Fremgangsmåde til transport af artikler (36), hvilken fremgangsmåde omfatter:
- 30

understøtning af artikler på toppen af elektrisk ledende ruller (26, 50, 60), som er fremstillet af aluminium eller kobber, i et transportbånd (22, 48, 58), som bevæger sig fremad i en bevægelsesretning,

5 udsættelse af de elektrisk ledende ruller for et primært magnetisk felt, inducering af en strøm i de elektrisk ledende ruller med det primære magnetiske felt med henblik på at frembringe et sekundært magnetisk felt, som samvirker med det primære magnetiske felt med henblik på at frembringe en kraft, som bringer de elektrisk ledende ruller til at rotere, og fremdrivning af artikler langs transportbåndet med de roterende elektrisk le-

10 dende ruller.

14. Fremgangsmåde ifølge krav 13, og som yderligere omfatter fremføring af transportbåndet igennem det magnetiske felt med henblik på at bringe de elektrisk ledende ruller til at rotere.

15

15. Fremgangsmåde ifølge krav 13, og som yderligere omfatter ændring af det magnetiske felt med henblik på at inducere strømmen i de elektrisk ledende ruller.

DRAWINGS

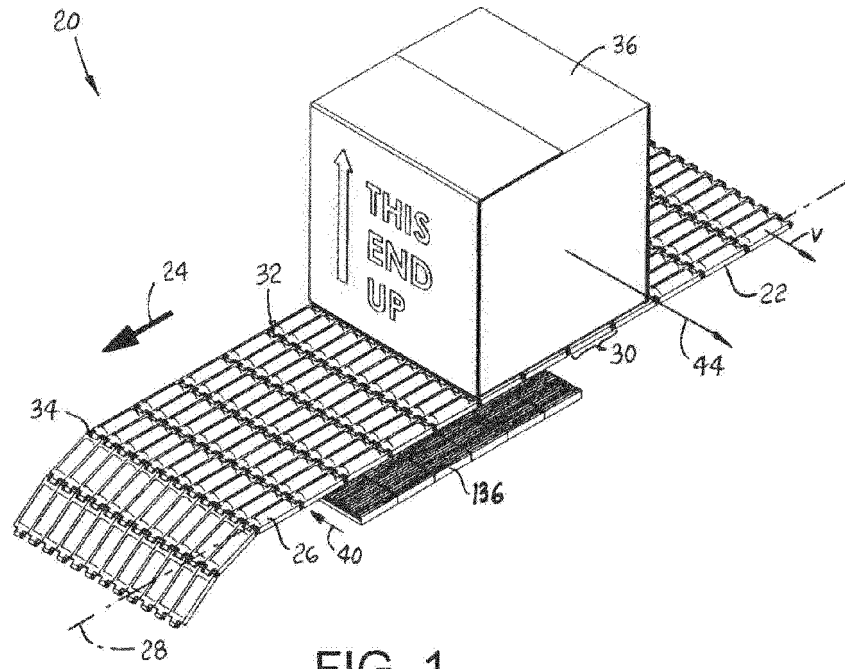


FIG. 1

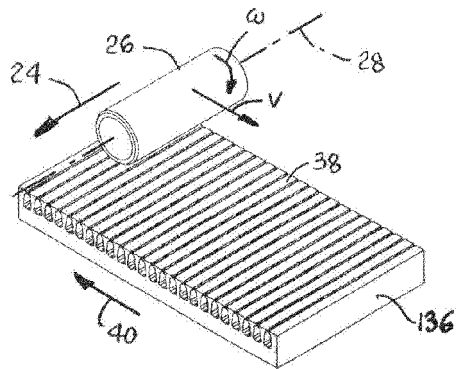


FIG. 2

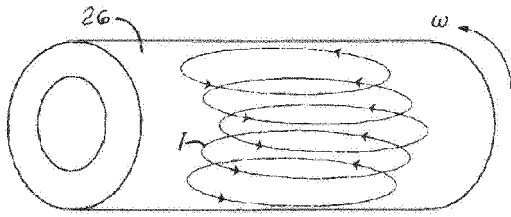


FIG. 3

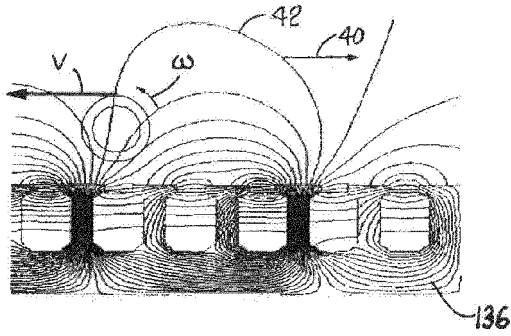


FIG. 4A

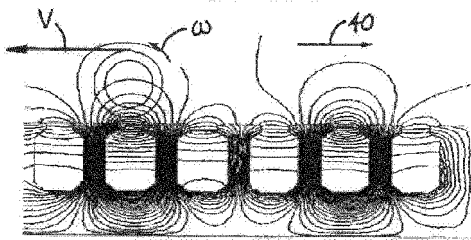


FIG. 4B

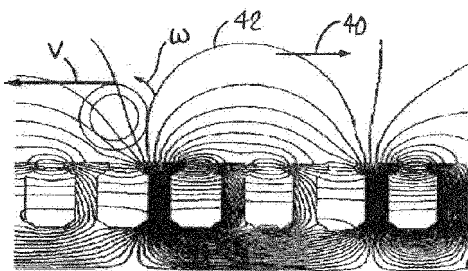


FIG. 4C

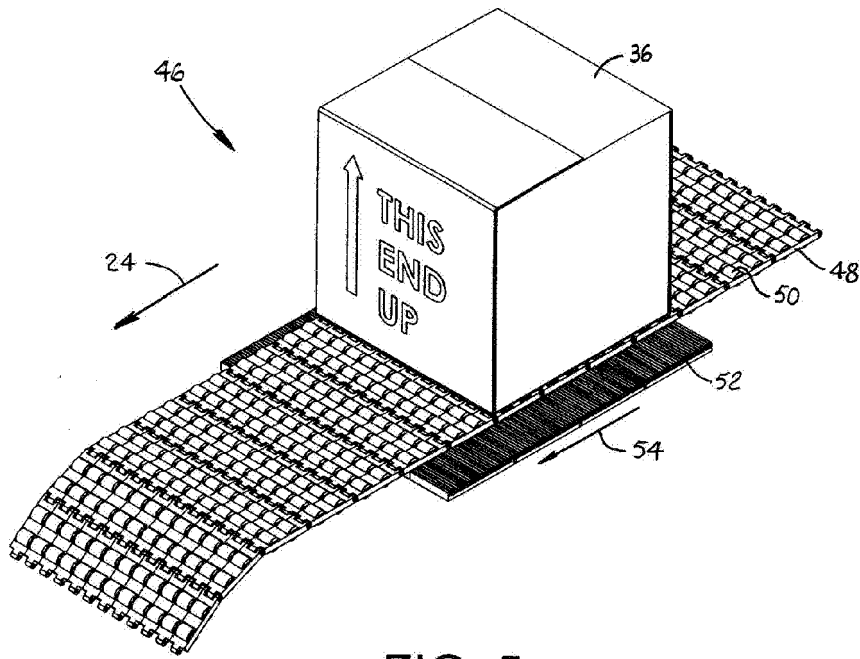


FIG. 5

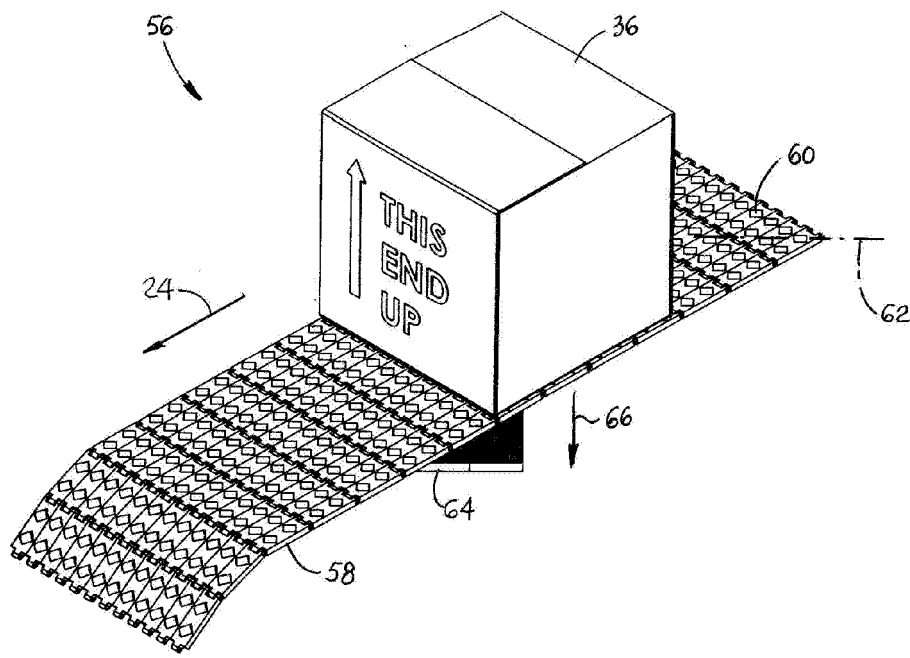


FIG. 6

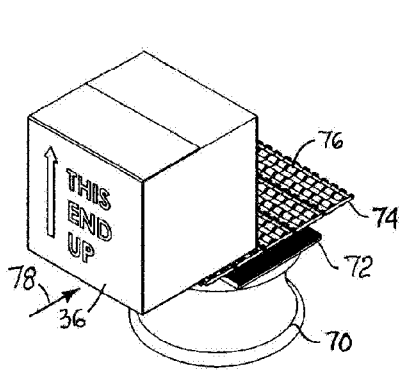


FIG. 7A

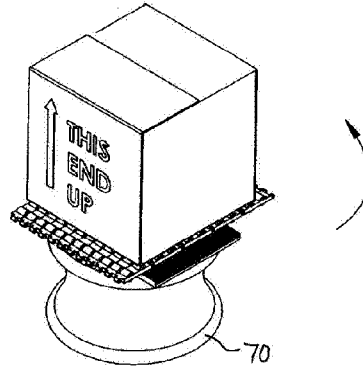


FIG. 7B

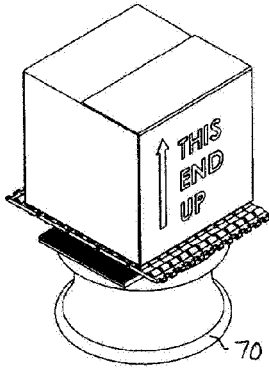


FIG. 7C

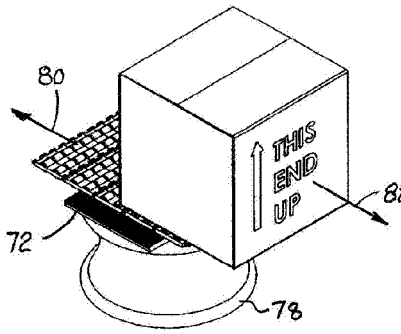


FIG. 7D

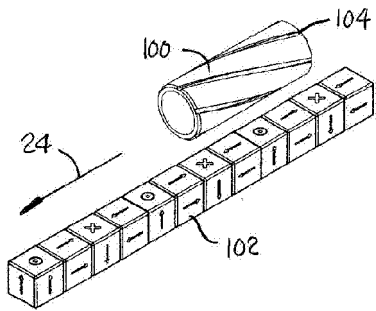


FIG. 9

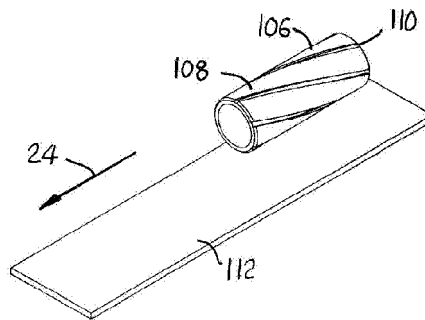


FIG. 10

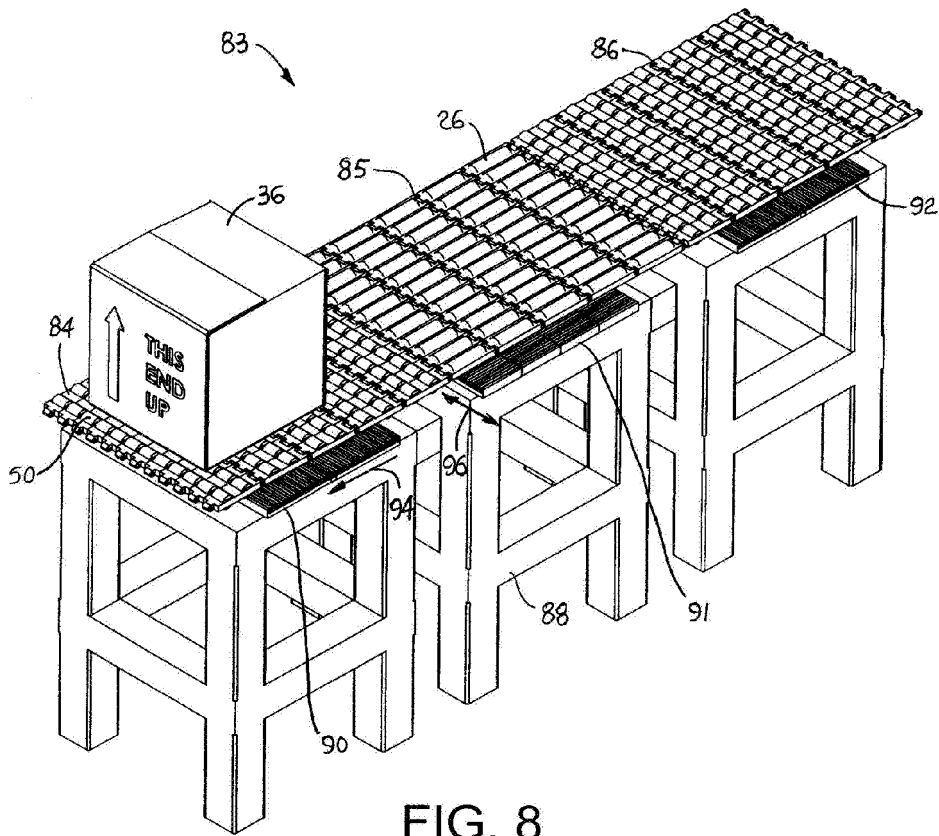


FIG. 8

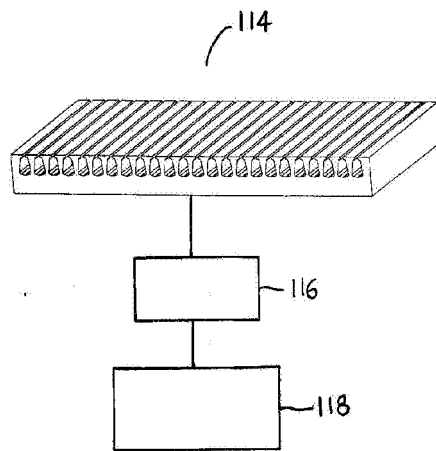


FIG. 11