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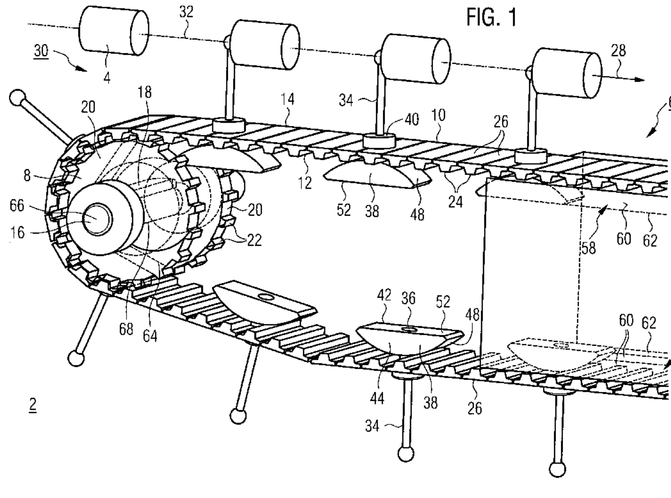
(54) **Title**: CONVEYING AND ISOLATING DEVICE

FIG. 1



(57) **Abstract**: An isolating device (2) for isolating objects, in particular fuel pellets (4) for a nuclear plant, fed in groups, comprises a conveying device (6) having a conveying belt (10) which has a conveying side (14) and a backing side (12) and is guided over at least two deflection pulleys (8) and on which a number of pushing elements (34) protruding from the conveying side (14) of the conveying belt (10) are arranged. The isolating device (2) shall be designed for a particularly reliable and interruption-free isolation at a high processing speed. For this purpose, it is provided according to the invention that each pushing element (34) is connected with a directing element (38) arranged on the backing side (12), said directing element (38) including a sliding surface (52) facing away from the conveying belt (10), the conveying device (6) comprising a guide rail (58) having a guiding surface (62) for the directing elements (38) being arranged in at least one partial section of the conveying belt (10) lying between the deflection pulleys (8), the sliding surface (52) and the guiding surface (62) being of complementary shape so that the sliding surface (52) of each directing element (38) can slide on the guiding surface (62) of the guide rail (58).

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Description

Conveying and isolating device

The invention relates to a conveying device comprising a conveying belt which has a conveying side and a backing side and is guided over at least two deflection pulleys and on which a number of pushing elements protruding from the conveying side of the conveying belt are arranged. The invention also relates to an isolating device for isolating objects fed in groups, the isolation device comprising such a conveying device.

The nuclear fuel necessary for operating a nuclear plant is usually provided in the form of so-called pellets or tablets of substantially cylindrical shape. Before such fuel pellets, consisting, for example, of enriched uranium oxide, are inserted into a fuel-rod cladding tube for being arranged in a reactor core, the individual pellets are usually thoroughly inspected. For this purpose, the fuel pellets are preferably fed to an inspection line of an automated inspection device. Fuel pellets whose dimensions, quality or other physical properties do not fulfil the specified requirements will be treated as rejects and will be sorted out.

Usually, the fuel pellets are fed to the inspection device in groups in the form of coherent columns or stacks and have to be isolated before entering the inspection line. This is effected, for example, by means of a circulating conveying belt ("endless belt") guided over two deflection pulleys, which includes on its (outer) conveying side a plurality of pushing elements, in particular pushing pins, preferably arranged at uniform intervals. The pellet columns are fed to the conveying belt in the area of one of the deflection pulleys and, with suitable coordination of feeding speed, circulating speed of the conveying belt, and intervals between the pins, they are put between the pushing pins and thus isolated.

Such an isolating device is known, for example, from DE 41 24 278 A1. On it, the pushing pins are screwed to the conveying belt by means of a flat nut. During operation, disturbances of the isolating process occur from time to time, making it necessary to slow down or even stop the conveying belt and possibly requiring a manual correcting intervention. This means that the overall processing speed is reduced and the operators are possibly exposed to increased radiation due to the manual interventions.

It is, therefore, the object of the present invention to provide a conveying device of the above-mentioned type as well as an isolating device comprising the conveying device, which enables a particularly reliable and interruption-free isolation of objects fed in groups, at, at the same time, a high processing speed.

This problem is solved according to the invention by connecting each pushing element with a directing element arranged on the backing side, said directing element including a sliding surface facing away from the conveying belt, the conveying device comprising a guide rail having a guiding surface for the directing elements being arranged in at least one partial section of the conveying belt lying between the deflection pulleys, and the sliding surface and the guiding surface being of complementary shape so that the sliding surface of each directing element can slide on the guiding surface of the guide rail.

Preferably, each directing element includes a rolling surface facing the conveying belt, and at least one of the deflection pulleys includes a ring groove formed in its periphery for receiving and guiding the directing elements moving past it during operation of the conveying belt. Advantageously, the rolling surface is curved and the sliding surface is substantially flat.

The invention is based on the knowledge that the problems occurring during operation of the plants known so far are, in any case in part, due to the fact that the pushing elements or pins are not uniformly aligned to the conveying belt and are in particular - relative to the direction of movement of the conveying belt - inclined forwards or backwards. That means that the distances between the free ends of the pushing pins might slightly vary, in spite of a regular arrangement of the base pieces of the pushing pins fastened on the conveying belt. At a relatively high feeding speed of, for example, ten fuel pellets per second, however, even such slight irregularities might have an effect, leading to an interruption of the quasi-continuous isolating process.

To avoid such difficulties, an alignment of the pushing elements as regular as possible, preferably normal to the running surface of the conveying belt, is now provided. For this purpose, each pushing element is connected, preferably through a connecting piece passing through a recess in the conveying belt, with a directing element designed in such a way that during operation of the conveying belt, it slides in, and along, a guide rail allocated to it, arranged on the (inner) backing side, thus being guided. The connecting piece and/or the directing element can be an integral part of the pushing element or else be separate parts rigidly connected with each other by corresponding connecting elements. As the directing element has on its side facing away from the conveying belt a flat sliding surface supported by an allocated sliding surface of the guide rail, sliding over the latter when moving, an automatic alignment of the directing elements and thus also of the pushing elements is guaranteed - in any case in the area of the guide rail.

Furthermore, a centering of the pushing elements or pins in their nominal position, preferably vertically protruding from the conveying belt, especially also in the turning points of the conveying belt, is provided. For this purpose, each deflection pulley includes a circulating recess or ring groove formed in its periphery, i.e. in the running surface for the conveying belt. This ring groove serves, on the one hand, for an unhindered movement of the passing directing elements past the deflection pulley. On the other hand, it effects, in the manner of a circularly curved guide rail, the guidance and alignment of the directing elements, especially also in the area of the deflection pulleys, so that the pushing element connected with the respective directing element is always in preferably radially outward orientation during its passage past the deflection pulley.

In a particularly expedient embodiment, each directing element has two front faces in the shape of segments of a circle, oriented parallelly to the plane of rotation of the conveying belt. The chords of the two segments of a circle are connected with each other through a flat sliding surface facing away from the conveying belt. The arcs of a circle of the segments are connected with each other through a curved rolling surface facing the conveying belt and touching it at least in its apex area. Expediently, the radius of the circle characterizing each segment is substantially identical with the outer radius of at least one of the deflection pulleys, preferably of all deflection pulleys. Advantageously, the segment height characterizing each segment is substantially identical with the depth of the ring groove in at least one of the deflection pulleys, preferably of all deflection pulleys. Advantageously, the outer shape and dimension of all directing elements are substantially identical. Accordingly, advantageously, the outer radius and the depth of the ring groove of the deflection pulleys for the conveying belt are also substantially identical. In the simplest variant, two deflection pulleys can be provided, each of them effecting a 180° deflection of the conveying belt otherwise extending in a straight line. Alternatively, however, the conveying belt could also be guided over more than two deflection pulleys. In addition, mere supporting pulleys without deflection of direction can be provided.

The described geometry of directing elements and deflection pulleys offers the advantage that each directing element, during its movement along the deflection pulley, projects over the latter's outer radius in no place and at no time and that, at the same time, the center of its sliding surface always touches the allocated sunk-in guiding surface of the deflection pulley. In this way, the preferably rod-shaped pushing elements are at all times aligned normal to the conveying belt. Furthermore, the conveying belt encompasses each deflection pulley in that case in an exact arc of a circle without any "bulges". In this way, so-called polygon effects are avoided, which – in particular when the deflection pulley acts as a drive roller for the conveying belt – might cause undesired longitudinal vibrations due to a discontinuous power transmission.

In addition, the width of the directing element and the width of the ring grooves in the deflection pulleys are advantageously coordinated in such a way that a lateral guidance is given, too.

In an advantageous embodiment, teeth are arranged on each deflection pulley, engaging a complementary row of teeth of the conveying belt, so that a slip-free, positive transmission of motion from a preferably driven deflection pulley to the conveying belt is realized, preferably in a form-locking manner.

Advantageously, the conveying device is a component of an isolating device for isolating objects fed in groups, in particular fuel pellets for a nuclear plant, a feeding device for the objects to be isolated being provided in the area of one of the deflection pulleys, in particular in the area of a 180° deflection pulley.

The discharge or release of the isolated objects is advantageously provided near a deflection point for the conveying belt, through which a directional deviation is effected in an angular range between 5° and 40°, in particular between 5° and 10°.

For example, the discharge point can be arranged – viewed in conveying direction – closely behind a point where the conveying belt is deflected or "bent" from a horizontal position into an orientation inclined obliquely downwards. With a suitable horizontal guidance of the objects to be isolated, the pushing elements are then lowered on the deflection pulley and automatically "disappear" under the isolated objects, thus releasing them. Due to the fact that a deflection only takes place in the above-mentioned angular range and no full 180° deflection is provided, the pushing elements have at the discharge point a relatively low rotational speed, which facilitates their release.

The advantages achieved with the invention consist in particular in that a suitable guidance of the pushing elements on a circulating conveying belt by means of associated rail-guided "sliding blocks" provides that the pushing elements are aligned in any place and at any time, in particular also at the deflection points, in an exactly defined manner, preferably normal to the conveying belt. This enables a particularly reliable feeding and withdrawing of objects onto/from the conveying belt, even at a relatively high conveying speed.

One exemplary embodiment of the invention is explained in detail by means of a drawing in which:

Fig. 1 is a perspective, partially sectional, view of an isolating device for fuel pellets (detail),

Fig. 2 is a section through one of the deflection pulleys of a conveying belt in an isolating device according to Fig. 1, and

Fig. 3 is another perspective view of an isolating device for fuel pellets.

Identical parts are marked with identical reference numbers in all figures.

The isolating device 2 shown in Fig. 1 in a perspective view serves for isolating and subsequently conveying fuel pellets 4 made of fissile material, for instance uranium oxide, fed in groups in the manner of columns or stacks.

The isolating device 2 comprises a conveying device 6 with a conveying belt 10 guided over two deflection pulleys 8. Each of the two deflection pulleys 8, only one of which is shown in Fig. 1, effects a 180° deflection of direction of the "endless" circulating conveying belt 10. The conveying belt 10 has an inner backing side 12 facing the deflection pulleys 8 and an outer conveying side 14. The deflection pulley 8 shown in Fig. 1 is designed at the same time as a drive roller for the conveying belt 10 and is connected by means of a shaft 16 with a drive unit (not shown), which comprises an electric motor and possibly a transmission. For an effective transformation, as slip-free as possible, of the rotational movement of the deflection pulley 8 into a forward movement of the conveying belt 10, the deflection pulley 8 includes two axially spaced toothed wheels 20, connected through a central shaft piece18, of identical orientation, having teeth 22 arranged on their peripheries, said teeth 22 engaging a corresponding row of teeth 24 on the backing side 12 of the conveying belt 10. In this way, a positive power and movement transmission is realized. In the exemplary embodiment, the conveying belt 10 – similar to a link-articulated chain – consists of a plurality of links 26 flexibly connected with each other, or of a reinforced plastic toothed belt, respectively, which are profiled on the backing side 12 to form the row of teeth 24. The second deflection pulley, not shown here, is of similar construction as the deflection pulley 8 visible in Fig. 1; however, it is designed as a simple roller without a drive of its own.

The conveying belt 10 is designed for conveying fuel pellets 4 in the horizontally oriented conveying direction 28 marked by an arrow. The cylindrical fuel pellets 4 stacked in columns are fed to the conveying belt 10 in Fig. 1 during operation of the plant, coming from the left side, in a feeding region or feeding device 30 arranged above the deflection pulley 8. By means of a guidance (not shown), the freedom of motion of the fuel pellets 4 is restricted in such a way that they can only move above the conveying belt 10 and in parallel to the latter's longitudinal orientation in the conveying direction 28 (i.e. in this case, from left to right), the trajectory 32 being represented by a dash-dotted line. The isolation as well as the subsequent conveyance of the fuel pellets 4 is effected by means of pushing elements 34, in particular pushing pins, fastened at regular intervals on the conveying belt 10 and protruding outwards therefrom. The isolation is effected in the area of the deflection pulley 8 by the pushing elements 34 which, due to their circulating movement around the deflection pulley 8, push between the individual fuel pellets 4, with a suitable coordination of feeding speed and circulating speed of the conveying belt. Then, the fuel pellets 4 separated in this manner are pushed on by the pushing elements 34 in the conveying direction 28 and thus conveyed to the right, e.g. to an inspection section, not shown here, with associated image processing systems.

The conveying device 6 is designed for a particularly reliable isolation of the fuel pellets 4, even at high circulating speeds of the conveying belt 10. For this purpose, the pushing elements 34 are fastened on the conveying belt 10 in such a manner that they automatically align normal to the conveying belt 10 and cannot slant in particular in, or against, the conveying direction 28. For this purpose, each pushing element 34 passes through a corresponding recess in the conveying belt 10 and rigidly connected, e.g. screwed, by means of a connecting piece 36, to a directing element 38 arranged on the backing side 12. On the opposite side, i.e. the conveying side 14, an additional support of the pushing element 34 is provided through an enlarged base 40 resting on the conveying belt 10. During circulation of the conveying belt 10, each directing element 38 slides in a guidance adapted thereto in such a manner that this so-called slide-block or slide-shoe guidance effects an automatic alignment and centering of the directing element 38 and thus also of the pushing element 34 connected with it.

In detail, as is clearly visible, e.g. also by means of the drawing of Fig. 2, each directing element 38 comprises two front faces 42 in the shape of segments of a circle 44, which are parallel to each other and to the conveying direction 28. The arcs of a circle 46 of the two segments of a circle 44 are connected with each other by a curved rolling surface 48 facing the conveying belt 10. The chords 50 of the two segments of a circle 44 are connected with each other by a flat sliding surface 52 facing inwards and facing away from the conveying belt 10. The connecting piece 36 of the pushing element 34 passes through a recess centrically formed into the directing element 38 and fastened (e.g. screwed) therein, so that the apex 56 of the directing element 38 touches the conveying belt 10 when the latter is in straight-line, uncurved orientation. When the conveying belt 10 is bent through the effect of the deflection pulley 8, it can completely or partially adapt itself to the rolling surface 48, the directing element 38 rolling on the conveying belt 10, so to speak; therefore, it is called here "rolling surface". Each directing element 38 as a whole has, therefore, the shape of a cylinder segment (based on a straight full cylinder) generated by parallel displacement of a segment of a circle 44, the rolling surface 48 representing a corresponding part of an envelope of cylinder.

In a straight-line section of the conveying belt 10, lying between two deflection pulleys 8, each pushing element 34 is aligned by the directing element 38 connected therewith sliding in a straight-line guide rail 58, which is represented only schematically and in a sectional view in Fig. 1. The guide rail 58 is arranged on the backing side 12 of the conveying belt 10 and has two lateral guiding surfaces 60 as well as an inner guiding surface 62. The dimensions are chosen such that the front faces 42 of each directing element 38 can slide along the lateral guiding surfaces 60 of the guide rail 58, while being guided. Accordingly, the flat sliding surface 52 of the directing element 38 slides on the inner guiding surface 62 of the guide rail 58. As the sliding surface 52 of the directing element 38 rests flatly on the inner guiding surface 62 of the guide rail 58 and cannot tilt, the alignment of each pushing element 34 normal to the conveying belt 10 is guaranteed – in any case in the area of the sections provided with the guide rail 58.

Furthermore, a corresponding guidance of each directing element 38 and thus an alignment of the pushing element 34 normal to the conveying belt is provided also in the area of the deflection pulley 8. For this purpose, the deflection pulley 8 includes a peripheral ring groove 64 of constant depth between the two toothed wheels 20 which are in contact with the conveying belt 10. The ring groove 64 serves for receiving and guiding each directing element 38 while the latter passes the deflection pulley. For illustration and better visibility, the corresponding areas are represented in Fig. 1 partly in sectional view or transparent.

Furthermore, the geometrical relations are clearly recognizable in the schematic sectional view of Fig. 2, showing no details: the radius characterizing each segment of a circle 44 is identical with the outer radius R of the deflection pulley 8, i.e. with the (identical) radii of the two toothed wheels 20. The segment height h characterizing each segment of a circle 44, i.e. the distance between the apex 56 and the chord 50, is identical with the depth T of the ring groove 64. Thus, the conveying belt 10 follows the outer profile of the deflection pulley 8 defined through the radius of the toothed wheels 20 (= outer radius R of the deflection pulley 8). While orbiting around the central axis 66, the directing element 38 is conveyed sunk into the ring groove 64. More precisely, this is effected in such a way that it projects over the radius R of the toothed wheels 20 in no place and that, at the same time, the sliding surface 52 centrically touches the supporting surface 68, i.e. the outer periphery of the shaft piece 18 lying between the two toothed wheels 20. As the preferably tight conveying belt 10 rests on the entire extension of the rolling surface 48, while passing the curvature, the directing element 38 is secured against tilting around its apex 56 even on this partial section of its movement. Therefore, the pushing element 34 (viewed from the central axis 66) always protrudes exactly radially outwards.

Summarizing, it can be said that the pushing elements 34 are accurately guided and aligned both during straight-line conveyance and in the deflection points of the conveying belt 10, so that the fuel pellets 4 are released and isolated in the deflection points in a particularly reliable manner. An interrogation of element positions in this area, e.g. for selecting a subsequent automatic inspection device, will supply particularly reliable values.

Fig. 3 also shows the discharge end, opposite to the feeding side, of an isolating device 2 (here, the fuel pellets 4 are conveyed from right to left). For an easier discharge or release of isolated fuel pellets 4, it is provided that the conveying belt 10 and thus also the pushing elements 34 are lowered before the discharge point 70. For this purpose, the conveying belt 10 is brought, at the deflection point 72, from its previous horizontal orientation into an orientation inclined obliquely downwards. The deflection of direction α is in the example 15°. In this way, the pushing elements 34 are automatically lowered behind the deflection point 72 under the fuel pellets 4 guided in horizontal direction, thus releasing them. Contrary to the region of the following deflection pulley 8, where a deflection of direction of the conveying belt 10 by 165° is effected, the pushing elements 34 have on the deflection point 72 a relatively low rotational speed, which facilitates the release of the fuel pellets 4. The deflection on the deflection point 72 is effected in the exemplary embodiment by a formed part 74 correspondingly profiled on its side facing the conveying belt 10, which acts at the same time in the above-mentioned manner as a guide rail for the directing element 38 of the pushing elements 34, the conveying belt 10 sliding over the supporting surface 76 of the formed part 74. Alternatively, a deflection pulley, similar to the end-side deflection pulley 8, could be provided in this place for a deflection of direction.

While specific embodiments have been described in detail, it will be appreciated by those skilled in the art that various modifications and alternatives to those details could be developed in light of the overall teachings of the disclosure. Accordingly, the particular embodiments disclosed are meant to be illustrative only and not limiting as to the scope described herein, which is to be given the full breadth of the appended claims and any and all equivalents thereof.

List of reference numbers

2	Isolating device
4	Fuel pellet
6	Conveying device
8	Deflection pulley
10	Conveying belt
12	Backing side
14	Conveying side
16	Shaft
18	Shaft piece
20	Toothed wheel
22	Tooth
24	Row of teeth
26	Link
28	Conveying direction
30	Feeding device
32	Trajectory
34	Pushing element
36	Connecting piece
38	Directing element
40	Base
42	Front face
44	Segment of a circle
46	Arc of a circle
48	Rolling surface
50	Chord
52	Sliding surface
56	Apex
58	Guide rail
60	Lateral guiding surface
62	Guiding surface

64 Ring groove

66 Central axis

68 Supporting surface

70 Discharge point

72 Deflection point

74 Formed part

76 Supporting surface

α Deflection angle

h Segment height

R Outer radius

T Depth

Claims

1. Conveying device (6) comprising a conveying belt (10) which has a conveying side (14) and a backing side (12) and is guided over at least two deflection pulleys (8) and on which a number of pushing elements (34) protruding from the conveying side (14) of the conveying belt (10) are arranged, characterized in that each pushing element (34) is connected with a directing element (38) arranged on the backing side (12), said directing element (38) including a sliding surface (52) facing away from the conveying belt (10), the conveying device (6) comprising a guide rail (58) having a guiding surface (62) for the directing elements (38) being arranged in at least one partial section of the conveying belt (10) lying between the deflection pulleys (8), the sliding surface (52) and the guiding surface (62) being of complementary shape so that the sliding surface (52) of each directing element (38) can slide on the guiding surface (62) of the guide rail (58).

2. Conveying device (6) according to claim 1, each directing element (38) including a rolling surface (48) facing the conveying belt (10), and at least one of the deflection pulleys (8) including a ring groove (64) formed in its periphery for receiving and guiding the directing elements (38) moving past it during operation of the conveying belt (10)

3. Conveying device (6) according to claim 1 or 2, the rolling surface (48) being curved, and the sliding surface (52) and the guiding surface (62) being substantially flat.

4. Conveying device (6) according to claim 3, the rolling surface (48) and the sliding surface (52) of each directing element (38) connecting two front faces (42) in the shape of segments of a circle (44) with each other.

5. Conveying device (6) according to claim 4, the radius of the circle characterizing each segment of a circle (44) being substantially the same as the outer radius (R) of at least one of the deflection pulleys (8).

6. Conveying device (6) according to claim 4 or 5, the segment height (h) characterizing each segment of a circle (44) being substantially the same as the depth (T) of the ring groove (64) in at least one of the deflection pulleys (8).

7. Conveying device (6) according to any of claims 1 to 6, each pushing element (34) being connected with a directing element (38) by means of a connecting piece (36) passing through a recess in the conveying belt (10).

8. Conveying device (6) according to any of claims 1 to 7, teeth (22) being arranged on each deflection pulley (8), which engage a complementary row of teeth (24) of the conveying belt (10).

9. Isolating device (2) for isolating objects, in particular fuel pellets (4) for a nuclear plant, fed in groups, including a conveying device (6) according to any of claims 1 to 8, a feeding device (30) for the objects to be isolated being provided in the area of one of the deflection pulleys (8).

10. Isolating device (2) according to claim 9, a discharge of isolated objects being provided near a deflection point (72) for the conveying belt (10), through which a directional deviation is effected in an angular range between 5° and 40°, in particular between 5° and 10°.

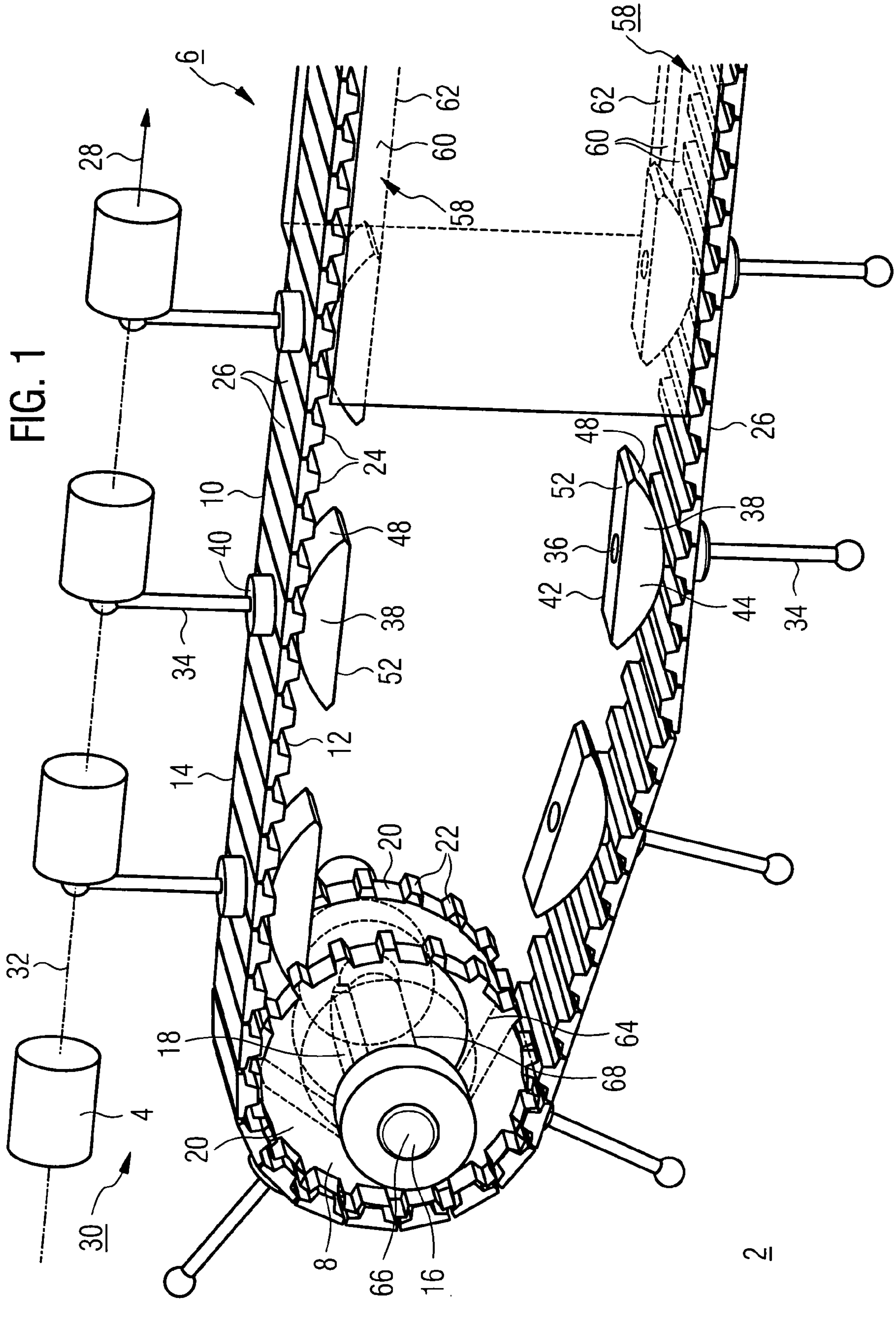

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FIG. 1

FIG. 2

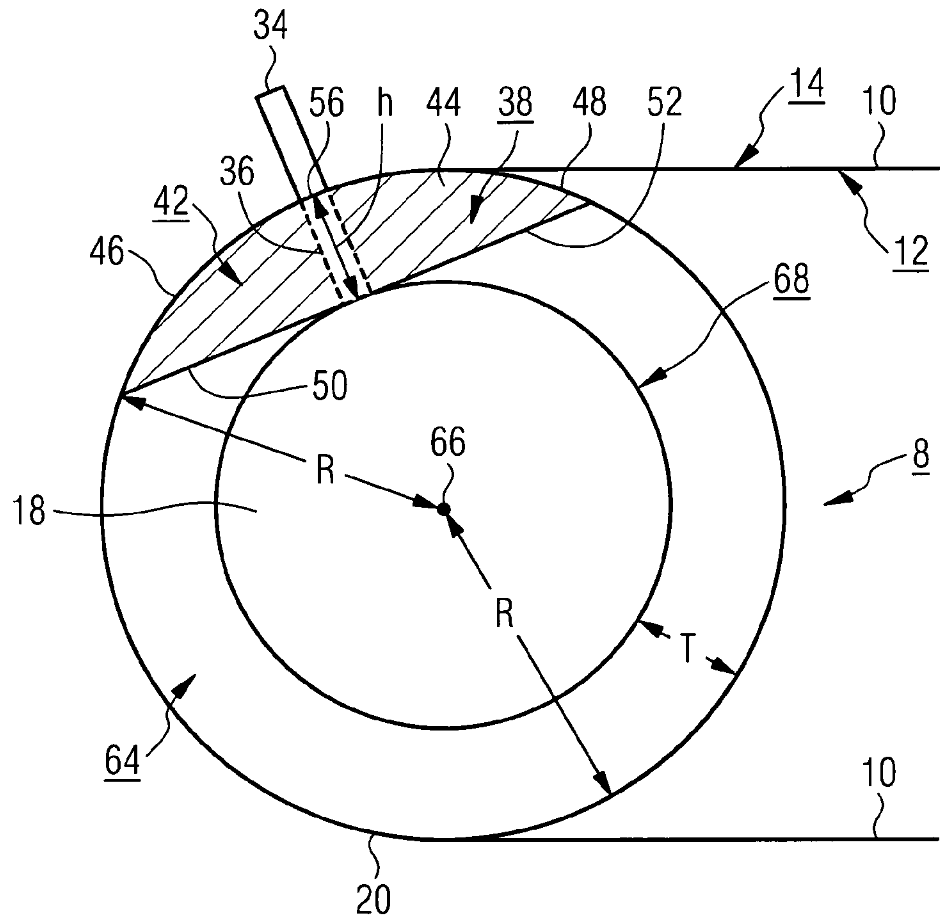
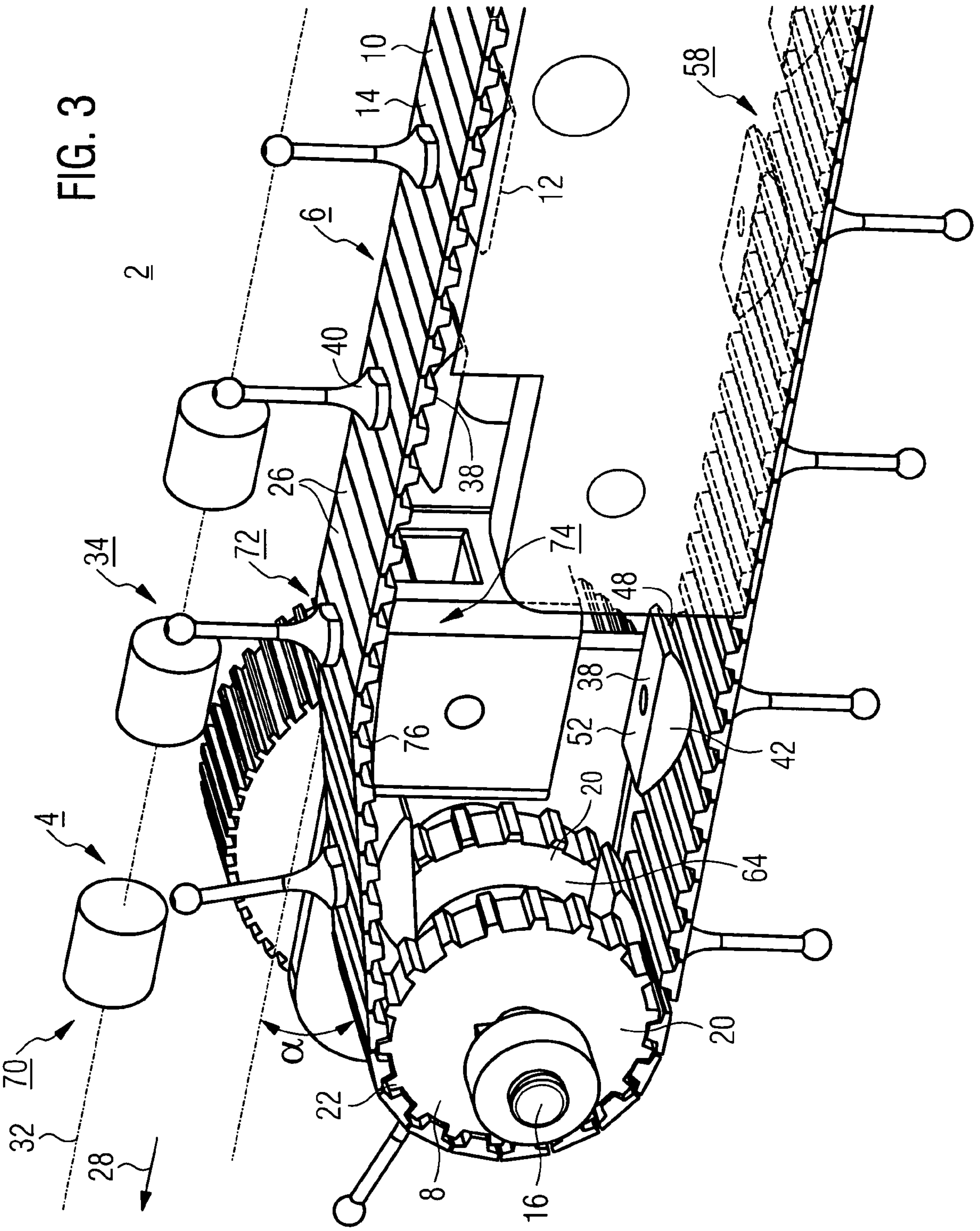


FIG. 3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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2009/002987

A. CLASSIFICATION OF SUBJECT MATTER
INV. B65G19/24

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B65G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 41 24 278 A1 (ADVANCED NUCLEAR FUELS GMBH [DE]) 28 January 1993 (1993-01-28) cited in the application the whole document -----	1-10

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 July 2009	05/08/2009

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Hillebrand, A

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2009/002987

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 4124278 A1	28-01-1993	DE 9116289 U1	06-08-1992