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(71) Applicant: **Sund Birsta AB**
85125 Sundsvall (SE)

(72) Inventor: **Östling, Kenneth**
SE-864 91 MATFORS (SE)

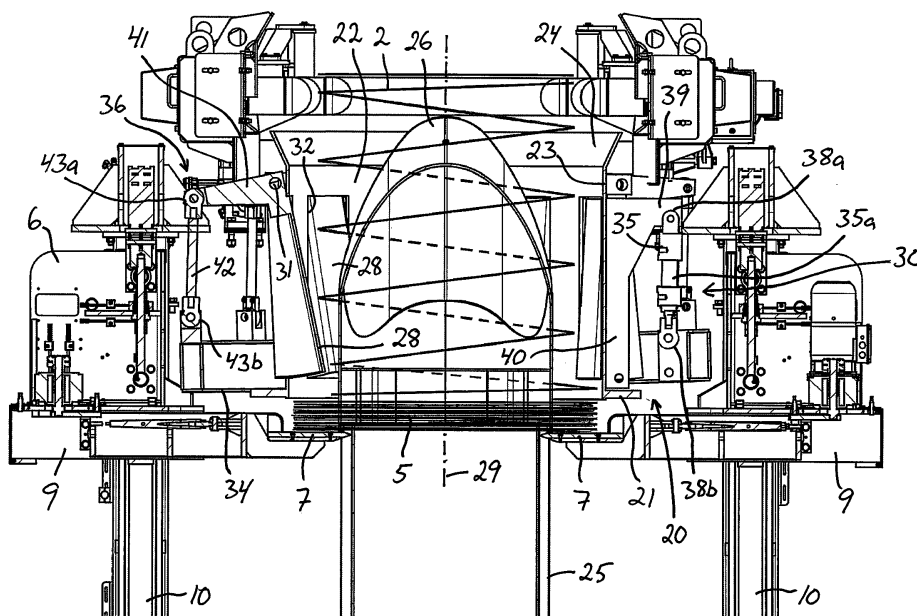
(74) Representative: **Löfgren, Jonas et al**
Bjerkéns Patentbyrå KB
Box 1274
801 37 Gävle (SE)

(54) COIL-FORMING MACHINE

(57) A coil-forming machine for accumulating a series of preformed loops of wire (2) in order to form an upright coil of wire (5), the machine comprising a wire guiding arrangement (20) with:

- a housing (21) defining a wire guiding channel (22);
- guide members (28) pivotally mounted to the housing so as to be pivotable into the wire guiding channel in order to come into contact with loops of wire falling downwards through the wire guiding channel; and
- an actuating device (30) comprising:

- an annular actuating member (34);
- actuators (35) for tilting the actuating member (34) in relation to the housing (21); and
- link mechanisms (36) which connect the guide members (28) to the actuating member (34) to thereby allow the actuators (35) to control the pivotal positions of the guide members via the actuating member and the link mechanisms.

**Fig 4****EP 3 260 212 A1**

Description

FIELD OF THE INVENTION AND PRIOR ART

[0001] The present invention relates to a coil-forming machine according to the preamble of claim 1 for receiving a series of preformed loops of wire and for accumulating said loops of wire in order to form an upright coil of wire.

[0002] In this description and the subsequent claims, the term "wire" encompasses metallic wires of thinner type as well as metallic wire rods.

[0003] Metallic wire produced in a rolling mill is normally accumulated in coils of essentially cylindrical configuration in a coil-forming machine, whereupon the coils can be compacted and bound in order to facilitate subsequent storing and transportation of the coils. It is a common practice to deliver the rolled wire to the coil-forming machine with the rolled wire arranged in the form of overlapping loops laying on an essentially horizontal conveyor, wherein the loops of wire at the end of the conveyor are allowed to fall vertically downwards from the conveyor into an upwardly open coil-forming chamber provided in the coil-forming machine.

[0004] Various forms of coil-forming machines of the above-mentioned type for receiving a series of preformed loops of wire falling from a delivery end of a conveyor and for accumulating said loops of wire in order to form an upright coil of wire have been proposed and come into use. A coil-forming machine according to the preamble of claim 1 is for instance previously known from US 6 158 683 A. This previously known coil-forming machine is provided with pivotal guide members for influencing the horizontal positioning of the loops of wire as they fall downwards through the coil-forming chamber so that they drop somewhat eccentrically with respect to the centre axis of the coil-forming chamber and are distributed in a desired pattern in the formed coil of wire so as to thereby improve the stability and compactness of the coil. In the coil-forming machine according to US 6 158 683 A, each guide member may be provided with its own actuator in the form of an eccentric motor or a pneumatic or hydraulic cylinder for controlling the pivotal position of the guide member. This solution is not very appropriate when there is a desire to use a larger number of guide members, in view of the fact that a large number of guide members would also require a large number of actuators, which in its turn would imply an increased cost for the machine and require a rather complex control system for controlling the actuators. US 6 158 683 A also discloses an embodiment where the pivotal positions of all guide members are controlled by the rotation of an annular actuating member, wherein the actuating member on its inner side is provided with an annular eccentric guide cam which acts on each individual guide member via a horizontally moveable actuating rod provided with a cam follower roller at its outer end. A disadvantage with the last-mentioned solution is that it does not offer any pos-

sibility to vary the sequence in which the guide members are moved, since the guide members can only be moved in accordance with one single predetermined sequence of movements given by the design of the guide cam.

SUMMARY OF THE INVENTION

[0005] The object of the present invention is to provide a coil-forming machine of new and favourable design, which in at least some aspect offers an advantage as compared to previously known coil-forming machines.

[0006] According to the invention, this object is achieved by a coil-forming machine having the features defined in claim 1.

[0007] The coil-forming machine according to the present invention comprises:

- one or more support members for supporting a coil of wire formed in the coil-forming machine; and
- a wire guiding arrangement, wherein the wire guiding arrangement comprises:
 - a housing which defines an upwardly open wire guiding channel,
 - a plurality of pivotal guide members distributed about a vertical centre axis of the wire guiding channel, wherein each guide member is pivotally mounted to the housing so as to be pivotable into the wire guiding channel towards the centre axis thereof in order to come into contact with loops of wire which are falling downwards through the wire guiding channel towards said support member or members and thereby influence the horizontal positioning of these loops of wire in the wire guiding channel and in the coil of wire formed on said support member or members, and
 - an actuating device for pivoting the guide members.

[0008] The above-mentioned actuating device comprises:

- an annular actuating member;
- a set of actuators connected to the actuating member, wherein the actuating member is tiltable in relation to the housing under the effect of the actuators; and
- a plurality of link mechanisms, wherein each link mechanism forms a connection between one of the guide members and the actuating member to thereby allow the actuators to control the pivotal positions of the guide members via the actuating member and the link mechanisms.

[0009] With the coil-forming machine of the present invention, the pivotal positions of all guide members may be controlled by tilting the annular actuating member,

which can be achieved in a rapid and simple manner by means of a limited number of actuators. Hereby, it will be possible to control the pivotal positions of a large number of pivotal guide members by means of rather few actuators, at the same time as the pivoting movements of the guide members easily can be varied by altering the frequency and/or amplitude of the tilting movements of the actuating member.

[0010] According to an embodiment of the invention, the actuating member is also vertically moveable in relation to the housing under the effect of the actuators. Hereby, the pivotal position of all the guide members may also be simultaneously changed by a vertical movement of the actuating member.

[0011] According to another embodiment of the invention, the set of actuators comprises three actuators distributed about a centre axis of the actuating member. Three actuators distributed about the centre axis of the actuating member will be sufficient for controlling the inclination and vertical position of the annular actuating member in an accurate manner.

[0012] According to another embodiment of the invention, each actuator has the form of a pneumatic or hydraulic cylinder. The use of actuators in the form of pneumatic or hydraulic cylinder will make it possible to give the actuating device a simple and reliable construction.

[0013] Further advantages as well as advantageous features of the coil-forming machine according to the present invention will appear from the following description and the dependent claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] With reference to the appended drawings, a specific description of preferred embodiments of the invention cited as examples follows below. In the drawings:

- Fig 1 is a perspective view of a coil-forming machine according to an embodiment of the present invention,
- Fig 2 is a planar view from above of the coil-forming machine of Fig 1,
- Fig 3 is a lateral view of the coil-forming machine of Fig 1,
- Fig 4 is a vertical section according to the line IV-IV in Fig 3,
- Fig 5 is a perspective view from below of a wire guiding arrangement included in the coil-forming machine of Fig 1,
- Fig 6 is a perspective view from above of the wire guiding arrangement of Fig 5,
- Fig 7 is a perspective view corresponding to Fig

6, but with the housing of the wire guiding arrangement omitted,

Figs 8a-8c are lateral views of the wire guiding arrangement of Fig 5, with the annular actuating member of the wire guiding arrangement shown in different positions, and

Figs 9a-9c are planar views from above of the wire guiding arrangement of Fig 5, with the moveable components of the wire guiding arrangement shown in positions corresponding to the positions according to Figs 8a-8c.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS OF THE INVENTION

[0015] Figs 1-3 show a coil-forming machine 1 according to an embodiment of the present invention for receiving a series of preformed loops of wire 2 and for accumulating said loops of wire 2 in order to form an upright coil of wire 5 (schematically illustrated in Fig 4). In the illustrated example, the preformed loops of wire 2 are delivered to the coil-forming machine 1 laying in an overlapping arrangement on a horizontal conveyor 4, wherein the loops of wire 2 are allowed to fall down into a coil-forming space of the coil-forming machine 1 from a delivery end 3 of the conveyor 4. However, the loops of wire 2 may be delivered to the coil-forming machine in any other suitable manner.

[0016] The coil-forming machine 1 comprises a machine frame 6, which is to be mounted to a floor or other support structure, and one or more support members 7 (see Fig 4) for supporting a coil of wire 5 formed in the coil-forming machine. In the illustrated embodiment, there are two such support members 7. Each support member 7 is moveably mounted to the machine frame 6 and vertically moveable in relation to the machine frame 6 by means of an actuator 8, for instance in the form of an electric motor. In the illustrated example, each support member 7 is carried by a holding unit 9, which in its turn is vertically moveable under the effect of the actuator 8 along two vertical guide rails 10 fixed to the machine frame 6. However, the support members 7 and the equipment for moving the support members in relation to the machine frame 6 could also have any other suitable design.

[0017] The coil-forming machine 1 further comprises a wire guiding arrangement 20 which is configured to receive the loops of wire 2 as they fall from the conveyor 4 and guide them towards the support members 7 for the formation of a coil of wire 5 thereon. The wire guiding arrangement 20 comprises a housing 21, which is fixed to the machine frame 6 and which defines an upwardly open wire guiding channel 22 (see Figs 2, 4 and 6). The housing 21 preferably comprises a tubular wall 23 which delimits the wire guiding channel 22, or at least a section

thereof, in radial direction. A funnel-shaped inlet portion 24 (see Figs 4 and 6) is with advantage provided at an upper end of the wire guiding channel 22 in order to facilitate the entrance of the loops of wire 2 into the wire guiding channel 22.

[0018] A mandrel 25 with a tapered upper end 26 extends vertically through the wire guiding channel 22 at the centre thereof. An annular passage for the loops of wire 2 is formed between the envelope surface of the mandrel 25 and the inner surface of the tubular wall 23 and it is thereby ensured that the loops of wire 2 falling downwards through the wire guiding channel 22 will be correctly positioned in relation to the support members 7 and the coil of wire 5 formed thereon. The tapered upper end 26 of the mandrel 25 and the funnel-shaped inlet portion 24 will co-operate in guiding the loops of wire 2 into the annular passage between the envelope surface of the mandrel 25 and the inner surface of the tubular wall 23.

[0019] The wire guiding arrangement 20 also comprises a plurality of pivotal guide members 28 distributed about a vertical centre axis 29 (see Figs 4 and 9a) of the wire guiding channel 22 and an actuating device 30 for pivoting the guide members 28. The guide members 28 are preferably six or more in number and evenly distributed about the vertical centre axis 29 of the wire guiding channel 22. In the illustrated embodiment, the wire guiding arrangement 20 is provided with nine guide members 28. Each guide member 28 is pivotally mounted to the housing 21 so as to be pivotable into the wire guiding channel 22 towards the centre axis 29 thereof in order to come into contact with loops of wire 2 which are falling downwards through the wire guiding channel 22 and thereby influence the horizontal positioning of these loops of wire 2 in the wire guiding channel 22 and in the coil of wire 5 formed on the support members 7. The guide members 28 can be made to displace the loops of wire 2 in a variable and desired manner in relation to the centre axis 29 of the wire guiding channel 22 so as to thereby control the distribution of the loops of wire 2 in the coil of wire 5 formed on the support members 7.

[0020] Each guide member 28 is pivotally mounted to the housing 21 by a joint 31 (see Figs 4 and 6) which is provided at an upper end of the guide member 28 and which forms a horizontal pivot axis for the guide member. The joints 31 are provided on the outside of the wire guiding channel 22 and each guide member 28 is pivotable into the wire guiding channel 22 through an opening 32 in the tubular wall 23 in order to allow the guide member to hit the outer edge of a loop of wire 2 falling downwards through the wire guiding channel 22 and thereby push the loop of wire sideways.

[0021] The support members 7 may be lowered gradually under the effect of the actuator 8 as the height of the coil of wire 5 formed on the support members 7 increases, to thereby keep the upper end of the coil of wire 5 at a given level below the guide members 28.

[0022] The above-mentioned actuating device 30 com-

prises an annular actuating member 34, which preferably has the form of a closed ring. As an alternative, the actuating member 34 may have the form of an open ring. In the illustrated embodiment, the actuating member 34 is designed as a circular ring, but it may as an alternative be designed as a polygonal ring.

[0023] In the illustrated embodiment, the actuating member 34 surrounds the wire guiding channel 22. Thus, in this case, the actuating member 34 extends around the tubular wall 23 at a distance therefrom. However, the actuating member 34 could as an alternative be located at a level below the lower end of the wire guiding channel 22.

[0024] The actuating device 30 further comprises:

- a set of actuators 35 connected to the actuating member 34 for controlling the position thereof; and
- a plurality of link mechanisms 36, wherein each link mechanism 36 forms a connection between one of the guide members 28 and the actuating member 34 to thereby allow the actuators 35 to control the pivotal positions of the guide members 28 via the actuating member 34 and the link mechanisms 36.

[0025] The actuators 35 are distributed, preferably evenly, about the centre axis of the actuating member 34. The set of actuators preferably comprises three actuators 35 evenly distributed about the centre axis of the actuating member 34. Thus, in the latter case the angles between the actuators 35 are 120°. The actuators 35 are controlled by an electronic control unit (not shown) in order to move the actuating member 34 in a desired manner in relation to the housing 21 and thereby pivot the guide members 28 in a desired manner. The actuating member 34 is arranged to be tiltable in relation to the housing 21 in any desired direction under the effect of the actuators 35 and is preferably also arranged to be vertically moveable in relation to the housing 21 under the effect of the actuators 35. In the illustrated embodiment, the actuating member 34 is suspended from the actuators 35.

[0026] Two lateral supports 44 (see Figs 5-7) are with advantage provided between the actuating member 34 and the housing 21 in order to prevent uncontrolled lateral movements of the actuating member 34 in relation to the housing 21. The lateral supports 44 are arranged at two different locations as seen in the circumferential direction of the actuating member 34. Each lateral support 44 consists of a link which at a first end is articulately connected to the actuating member 34 by a joint 45, preferably in the form of a ball joint or spherical bearing, and at an opposite second end is articulately connected to the housing 21 by another joint (not shown), preferably in the form of a ball joint or spherical bearing.

[0027] Each actuator 35 preferably has the form of a pneumatic or hydraulic cylinder. In the illustrated embodiment, each actuator 35 is a hydraulic cylinder with a cylinder part 35a and a piston (not shown) received in the

cylinder part 35a, wherein the piston is displaceable in relation to the cylinder part 35a and fixed to a piston rod 35b. The cylinder part 35a is articulately connected to the housing 21 by a joint 38a, preferably in the form of a ball joint or spherical bearing, and the associated piston rod 35b is articulately connected to the actuating member 34 by another joint 38b, preferably in the form of a ball joint or spherical bearing. As an alternative, the cylinder part 35a may be articulately connected to the actuating member 34 and the piston rod 35b articulately connected to the housing 21. It would also be possible to use other types of actuators for moving the actuating member 34, such as for instance electromechanical actuators. As a further alternative, each actuator could comprise an electric motor and a motion transferring mechanism, for instance in the form of a crank arm, for transferring a rotary motion of an output shaft of the electric motor or an associated gearing into a vertical movement of a link which is articulately connected to the actuating member 34 by a joint in the form of a ball joint or spherical bearing.

[0028] In the illustrated example, the above-mentioned joint 38a between the housing 21 and an actuator 35 is provided at the outer end of a horizontally extending arm 39 of a bracket 40, which is fixed to the tubular wall 23 on the outside thereof.

[0029] In the illustrated embodiment, each link mechanism 36 comprises:

- an arm 41 which is fixed to the associated guide member 28 at an upper end thereof and extends at an angle from the guide member 28, wherein the arm 41 faces away from the wire guiding channel 22; and
- a link 42 which at a first end is articulately connected to said arm 41 by a joint 43a, preferably in the form of a ball joint or spherical bearing, and at an opposite second end is articulately connected to the actuating member 34 by another joint 43b, preferably in the form of a ball joint or spherical bearing.

[0030] The link mechanisms 36 may of course also have any other suitable configuration, as long as they are capable of transferring a tilting or vertical movement of the actuating member 34 into a corresponding pivotal movement of the guide members 28.

[0031] Figs 8a-8c and 9a-9c illustrates how the actuators 35 may control the pivotal positions of the guide members 28 by tilting the actuating member 34 or moving the actuating member 34 in vertical direction.

[0032] Figs 8a and 9a show the wire guiding arrangement 20 with the actuating member 34 horizontally arranged in a lower end position, wherein all guide members 28 are pivoted into the wire guiding channel 22 to a maximum extent. When the guide members 28 are in this position, they are capable of stopping the loops of wire 2 which are falling downwards through the wire guiding channel 22, and it is thereby possible, when so needed, to accumulate a desired number of loops of wire 2 on the

guide members 28 before the guide members are retracted in order to allow these loops of wire to drop down onto the support members 7.

[0033] Figs 8c and 9c show the wire guiding arrangement 20 with the actuating member 34 horizontally arranged in an upper end position, wherein none of the guide members 28 is pivoted into the wire guiding channel 22. When the guide members 28 are in this position, loops of wire 2 may fall downwards through the wire guiding channel 22 without coming into contact with any of the guide members 28, i.e. without being subjected to any guiding action from the guide members 28.

[0034] Figs 8b and 9b show the wire guiding arrangement 20 with the actuating member 34 tilted and arranged between the above-mentioned lower and upper end positions, whereby the guide members 28 are pivoted into the wire guiding channel 22 to different extents so as to thereby push a passing loop of wire 2 horizontally in order to make the loop of wire assume an eccentric position in relation to the centre axis 29 of the wire guiding channel 22. The actuators 35 can be made to continuously vary the inclination of the actuating member 34 as desired to thereby continuously vary the direction in which the loops of wire 2 are pushed by the guide members 28 when passing through the wire guiding channel 22. The frequency and/or amplitude in which the actuating member 34 is tilted by the actuators 35 may be adjusted as desired in order to control the manner in which the guide members 28 act on the loops of wire 2 which are falling downwards through the wire guiding channel 22.

[0035] The invention is of course not in any way restricted to the embodiments described above. On the contrary, many possibilities to modifications thereof will be apparent to a person with ordinary skill in the art without departing from the basic idea of the invention such as defined in the appended claims.

Claims

1. A coil-forming machine for receiving a series of pre-formed loops of wire (2) and for accumulating said loops of wire (2) in order to form an upright coil of wire (5), the coil-forming machine (1) comprising:

- one or more support members (7) for supporting a coil of wire (5) formed in the coil-forming machine (1); and
- a wire guiding arrangement (20), wherein the wire guiding arrangement comprises:

- a housing (21) which defines an upwardly open wire guiding channel (22),
- a plurality of pivotal guide members (28) distributed about a vertical centre axis (29) of the wire guiding channel (22), wherein each guide member (28) is pivotally mounted to the housing (21) so as to be pivotable

into the wire guiding channel (22) towards the centre axis (29) thereof in order to come into contact with loops of wire (2) which are falling downwards through the wire guiding channel (22) towards said support member or members (7) and thereby influence the horizontal positioning of these loops of wire (2) in the wire guiding channel (22) and in the coil of wire (5) formed on said support member or members (7), and

- an actuating device (30) for pivoting the guide members (28),

characterized in that the actuating device (30) comprises:

- an annular actuating member (34);
- a set of actuators (35) connected to the actuating member (34), wherein the actuating member (34) is tiltable in relation to the housing (21) under the effect of the actuators (35); and
- a plurality of link mechanisms (36), wherein each link mechanism (36) forms a connection between one of the guide members (28) and the actuating member (34) to thereby allow the actuators (35) to control the pivotal positions of the guide members (28) via the actuating member (34) and the link mechanisms (36).

2. A coil-forming machine according to claim 1, **characterized in that** the actuating member (34) is also vertically moveable in relation to the housing (21) under the effect of the actuators (35).
3. A coil-forming machine according to claim 1 or 2, **characterized in that** the set of actuators comprises three actuators (35) distributed about a centre axis of the actuating member (34).
4. A coil-forming machine according to claim 3, **characterized in that** the actuators (35) are evenly distributed about the centre axis of the actuating member (34).
5. A coil-forming machine according to any of claims 1-4, **characterized in that** each actuator (35) has the form of a pneumatic or hydraulic cylinder.
6. A coil-forming machine according to claim 5, **characterized in that** said pneumatic or hydraulic cylinder has a cylinder part (35a) articulately connected to the housing (21) by a joint (38a), preferably in the form of a ball joint or spherical bearing, and an associated piston rod (35b) articulately connected to the actuating member (34) by another joint (38b), preferably in the form of a ball joint or spherical bearing.

7. A coil-forming machine according to any of claims 1-6, **characterized in that** the actuating member (34) is suspended from the actuators (35).

8. A coil-forming machine according to any of claims 1-7, **characterized in that** the actuating member (34) surrounds the wire guiding channel (22).

9. A coil-forming machine according to any of claims 1-8, **characterized in that** each link mechanism (36) comprises:

- an arm (41) which is fixed to the associated guide member (28) at an upper end thereof and extends at an angle from the guide member (28), wherein the arm (41) faces away from the wire guiding channel (22); and
- a link (42) which at a first end is articulately connected to said arm (41) by a joint (43a), preferably in the form of a ball joint or spherical bearing, and at an opposite second end is articulately connected to the actuating member (34) by another joint (43b), preferably in the form of a ball joint or spherical bearing.

10. A coil-forming machine according to any of claims 1-9, **characterized in:**

- **that** the housing (21) comprises a tubular wall (23) which delimits the wire guiding channel (22) or at least a section thereof in radial direction; and
- **that** the guide members (28) are pivotable into the wire guiding channel (22) through openings (32) in the tubular wall (23).

11. A coil-forming machine according to any of claims 1-10, **characterized in that** each guide member (28) is pivotally mounted to the housing by a joint (31) which is provided at an upper end of the guide member (28) and which forms a horizontal pivot axis for the guide member.

12. A coil-forming machine according to any of claims 1-11, **characterized in that** a funnel-shaped inlet portion (24) is provided at an upper end of the wire guiding channel (22).

13. A coil-forming machine according to any of claims 1-12, **characterized in that** the coil-forming machine (1) comprises a mandrel (25) with a tapered upper end (26), wherein the mandrel (25) extends vertically through the wire guiding channel (22) at the centre thereof.

14. A coil-forming machine according to any of claims 1-13, **characterized in:**

- **that** said one or more support members (28) are vertically moveable in relation to the housing (21); and
- **that** the coil-forming machine (1) comprises one or more actuators (8) for moving said one or more support members (7) vertically in relation to the housing (21).

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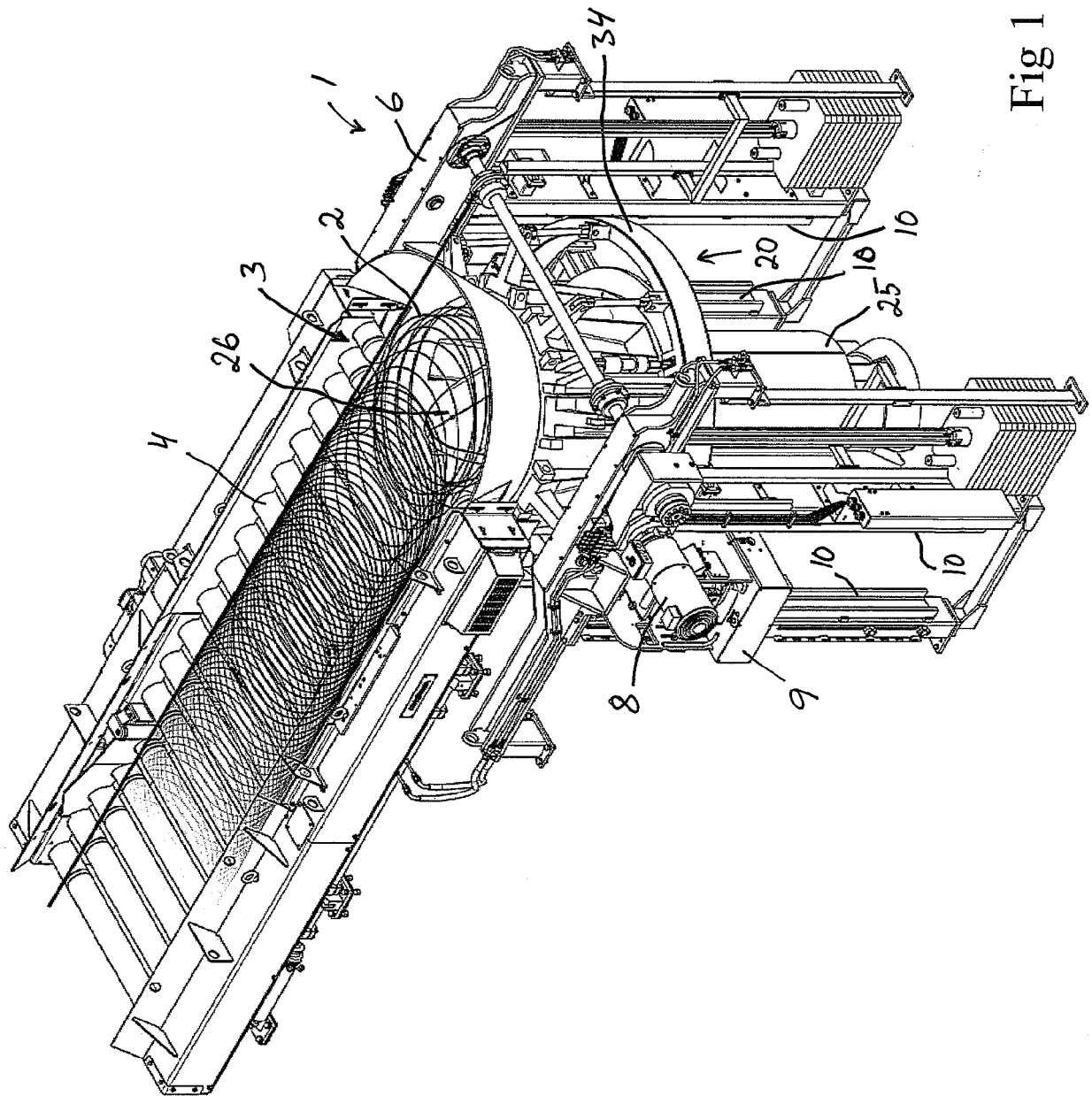


Fig 1

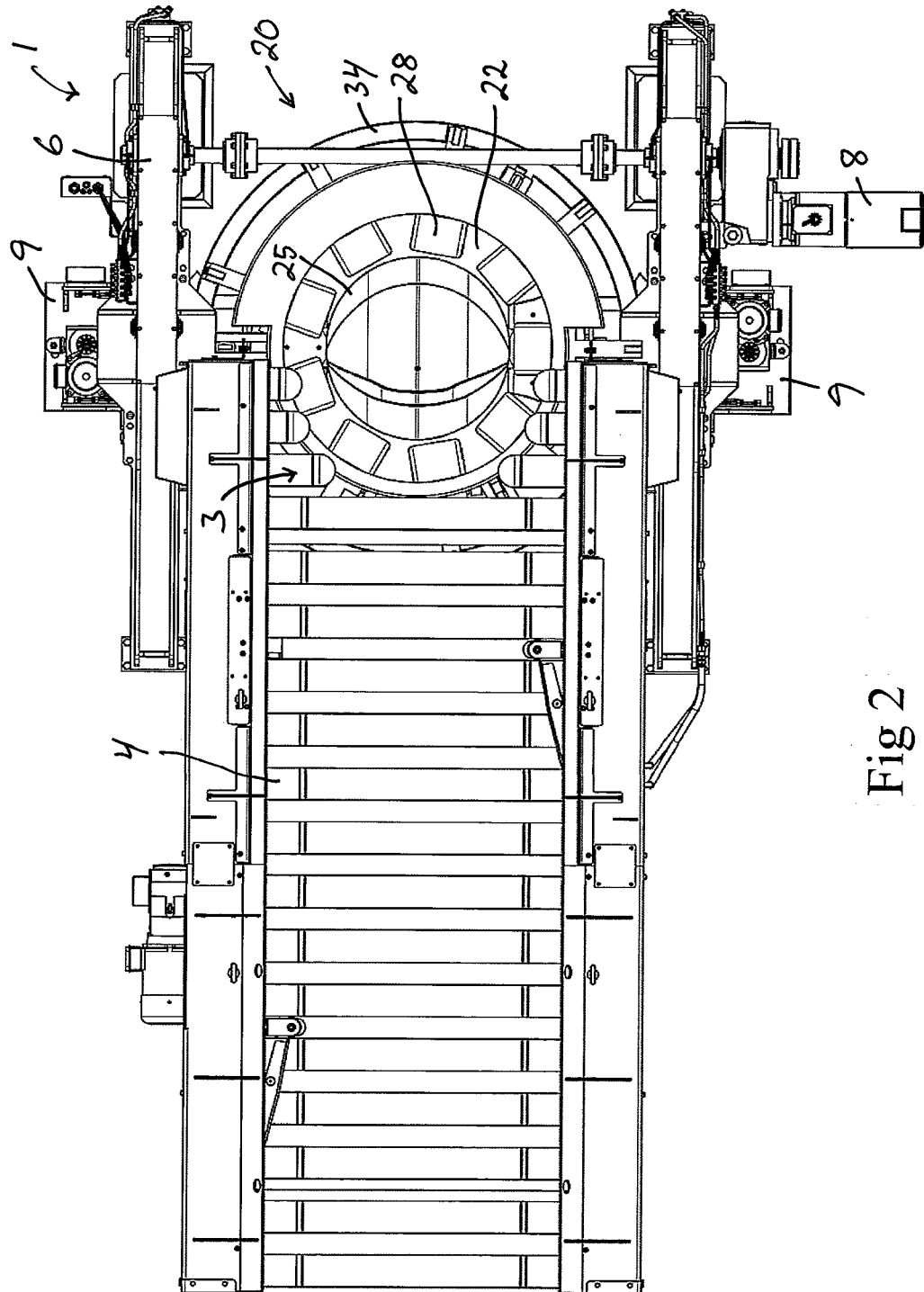


Fig 2

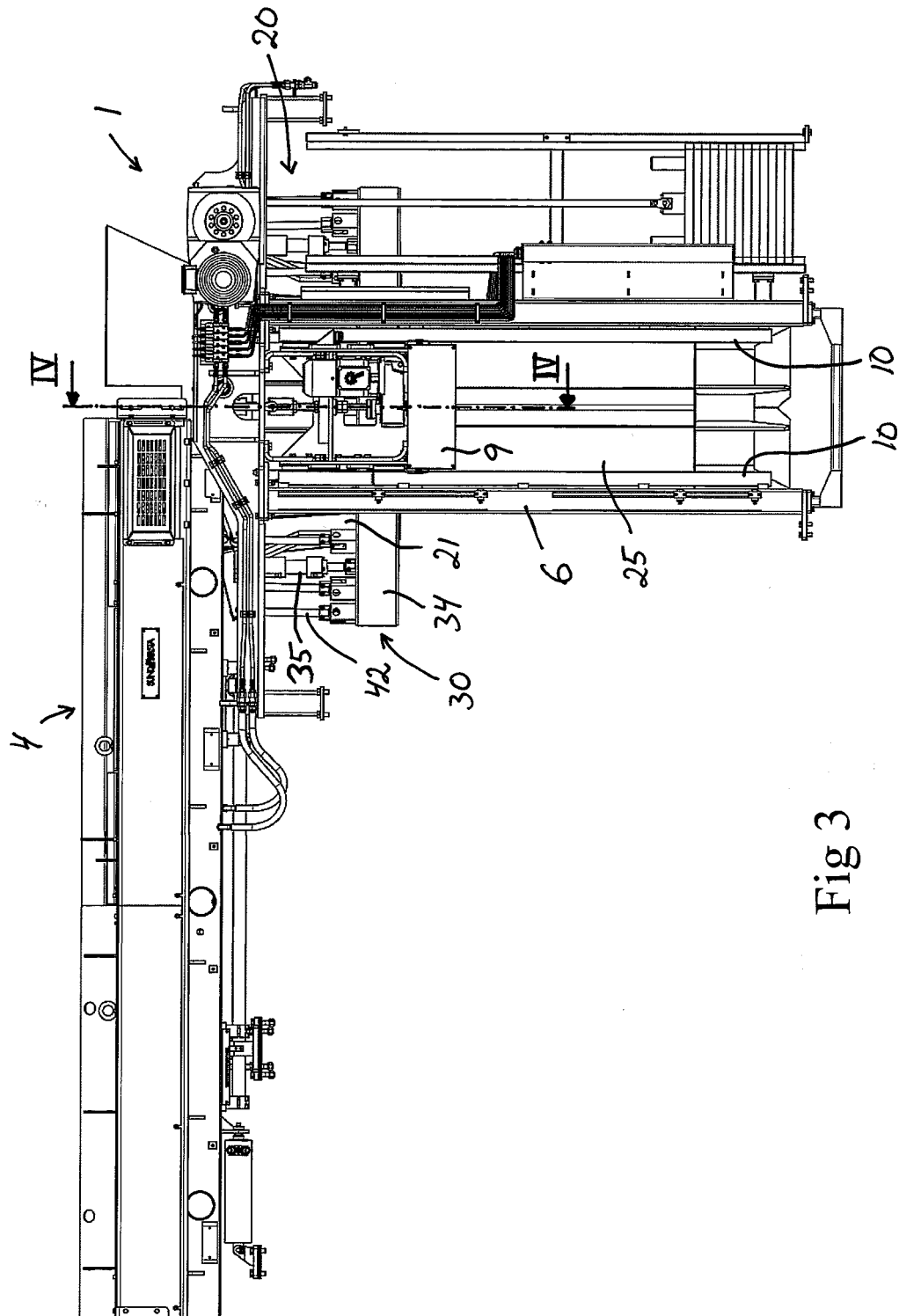


Fig 3

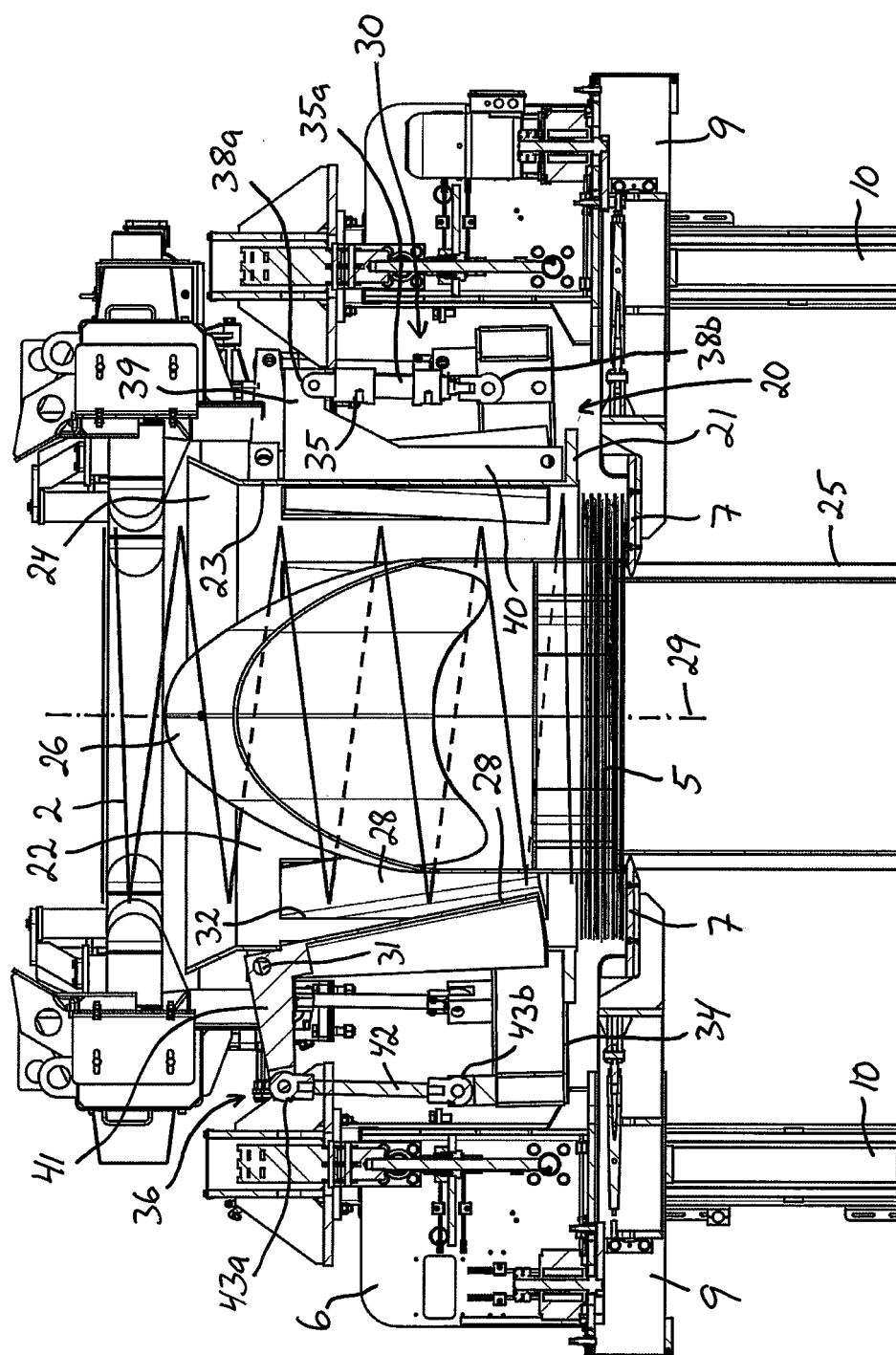
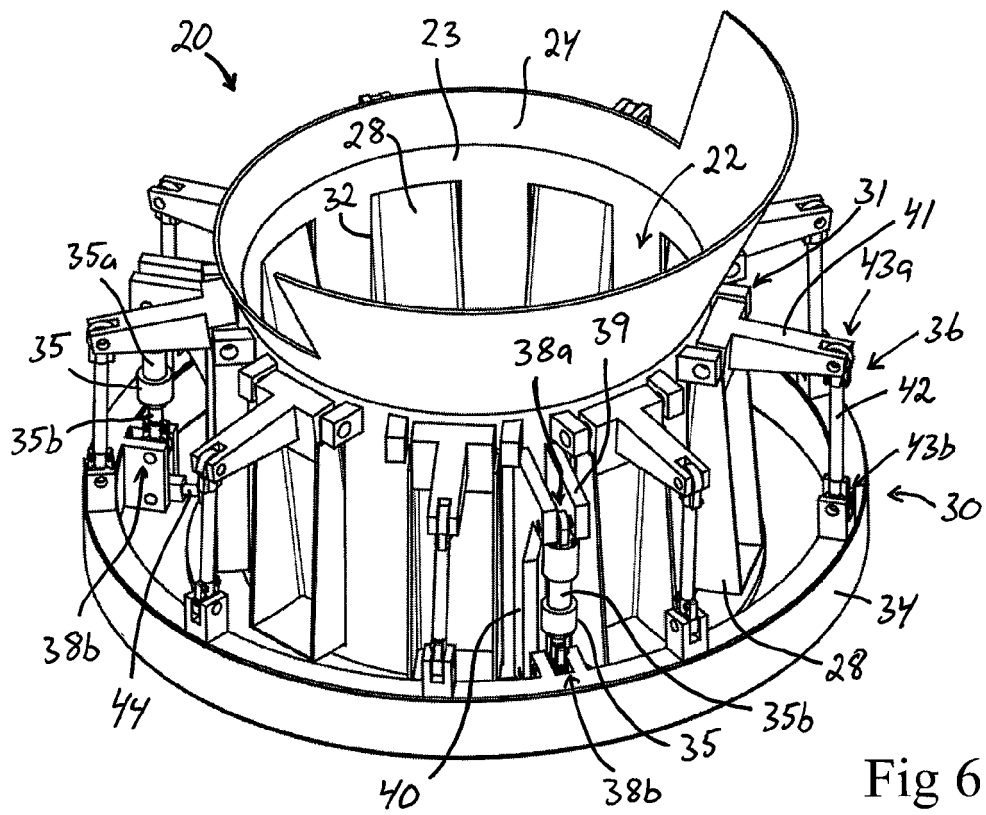
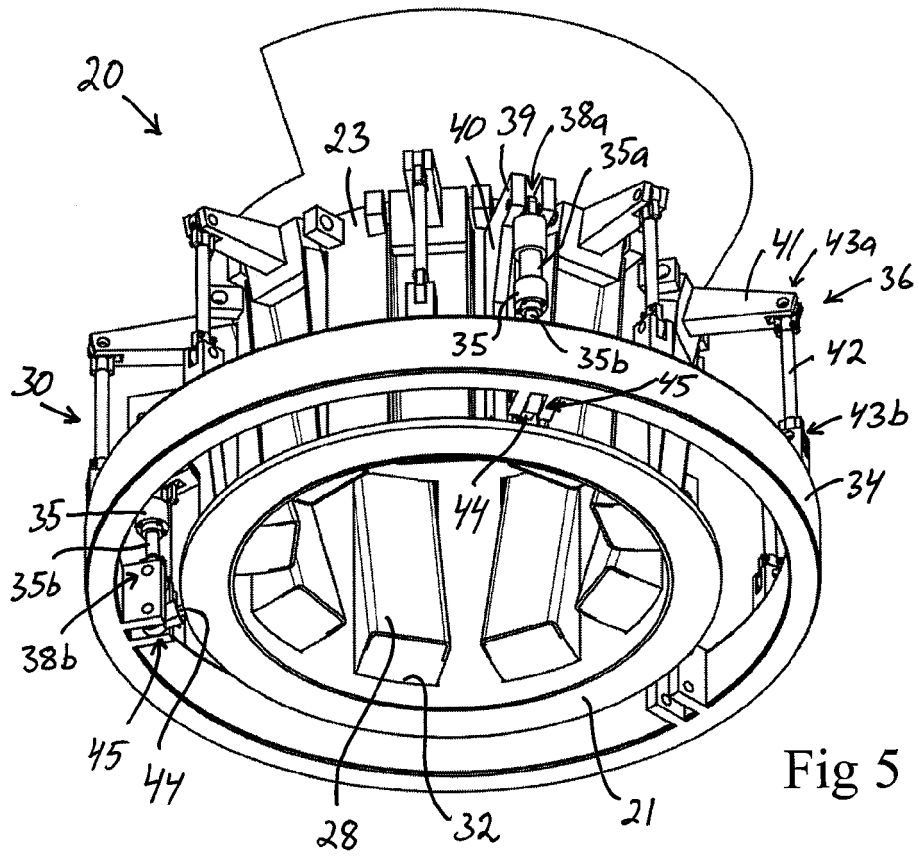


Fig 4



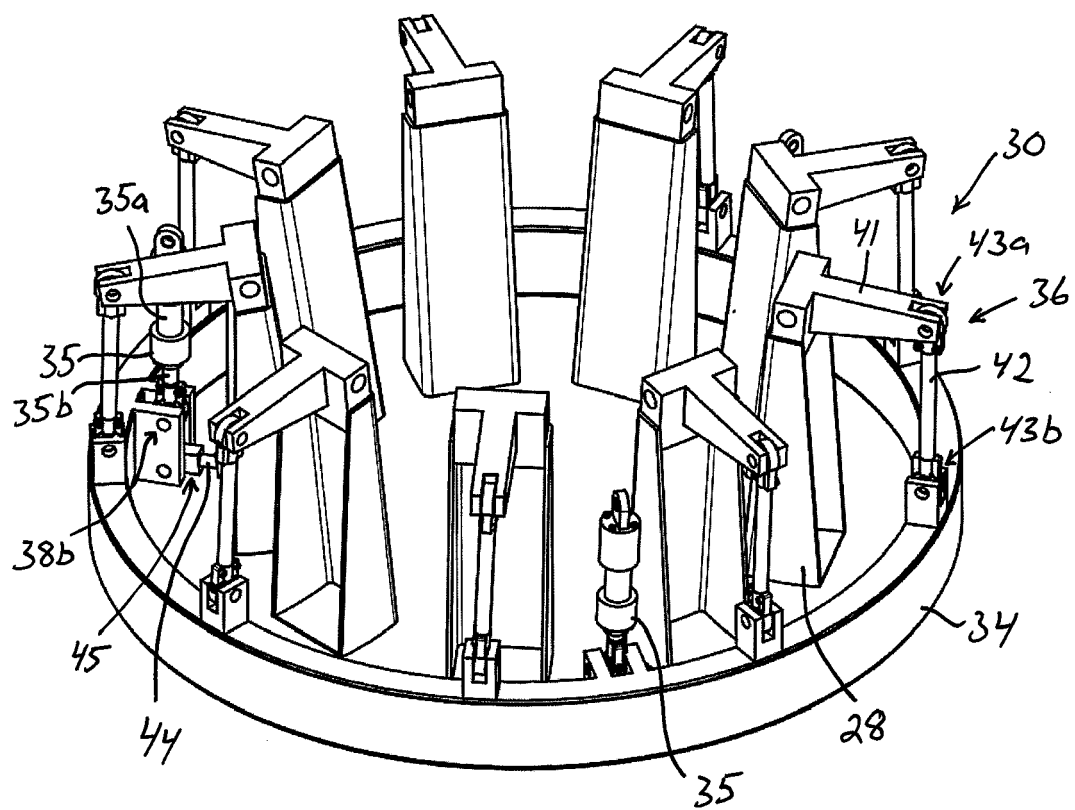
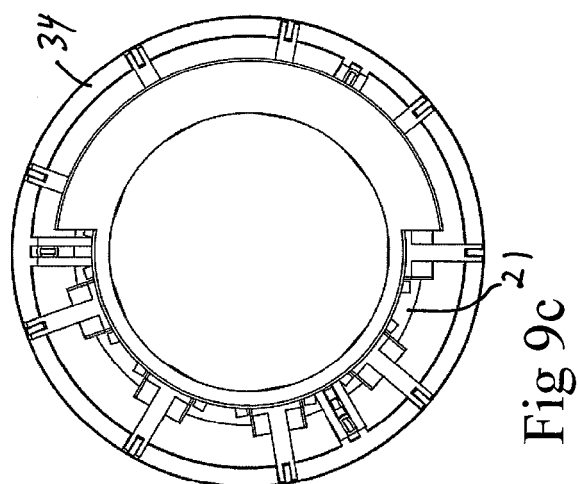
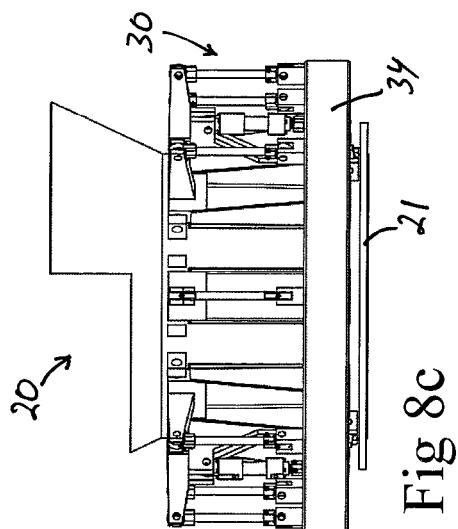
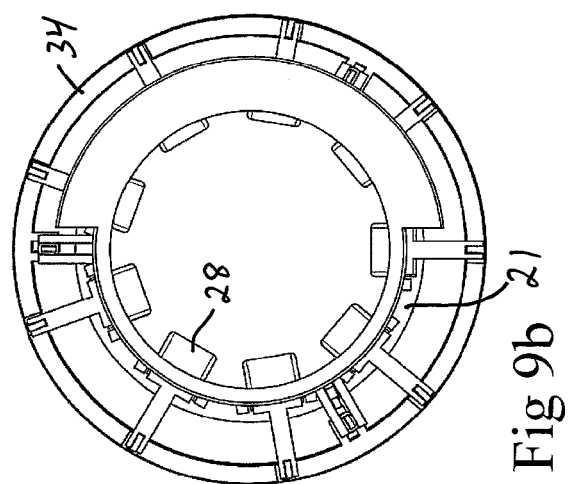
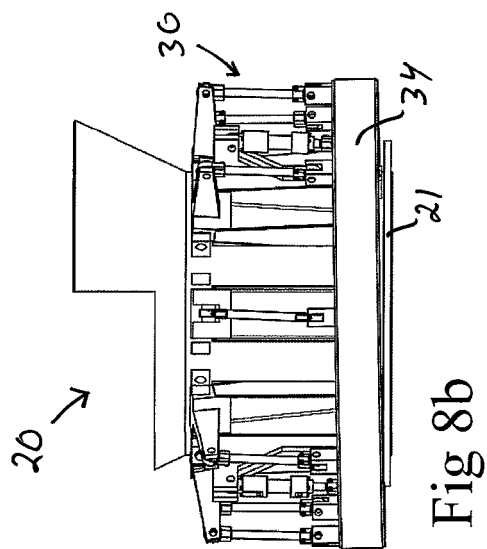
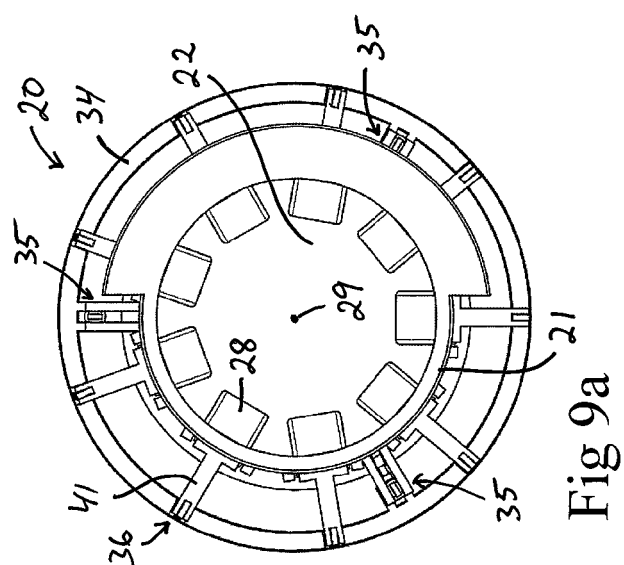
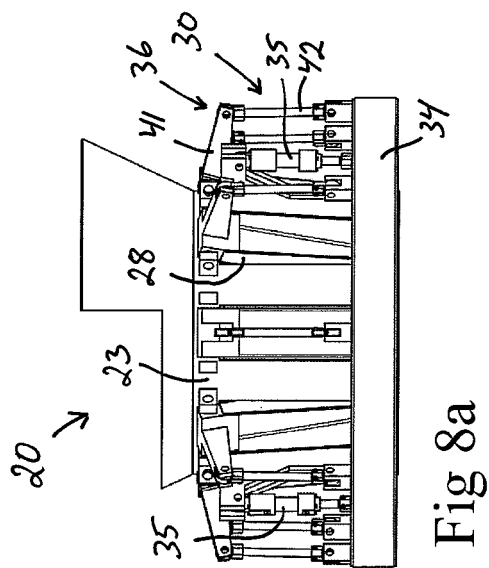


Fig 7





EUROPEAN SEARCH REPORT

Application Number
EP 16 17 5294

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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A	EP 1 201 327 A2 (SMS DEMAG AG [DE]) 2 May 2002 (2002-05-02) * paragraphs [0011], [0012]; figures *	1-14	
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 15 December 2016	Examiner Charvet, Pierre
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