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(57) Abrégé :

A magnetic force transmitting device has at least two substantially roller-shaped bodies (12, 14) rotatively mounted next to each other. Magnetic spirals (18, 20) are arranged in the circumferential area of the rollers in such a way that like poles point outwards.

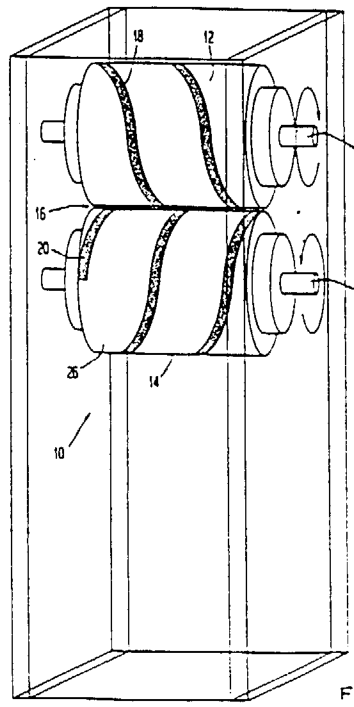

Fig.

Magnetic force transmitting device

The invention relates to a force transmitting device in accordance with the generic part of claim 1.

Magnetic force transmitting devices are known with which a driving force is transmitted from one pivoted body to another pivoted body. The bodies are parallel to each other in axis and positioned next to each other, and the power transmission is performed due to the magnetic effect according to the manner of toothed wheels which mesh together and which form a gear. The problem with this known type of force transmitting devices is that the transmission losses increase as the amount of force to be transmitted increases. On the other hand, magnetic force transmitting devices are superior to mechanical force transmitting devices as regards freedom from or low degree of wear.

It is further known to use magnetic forces for the provision of magnetic clutches. Such clutches can, if designed accordingly, be made to have a comparatively low degree of play and can ensure a variable clutch function due to the realisation of electromagnets without mechanical adjustment movements. The activation of the electromagnets requires a corresponding consumption of energy. Nevertheless, such clutches are used if the low degree of wear, but also the neutralisation of vibrations and similar is relevant.

For example, magnetic agitators work according to the principle of magnetic clutches and here the low efficiency is justified by the mechanical neutralisation.

For the provision of force transmitting devices with the lowest possible degree of loss as a rule mechanical gears are used whose effective surfaces are worked to high precision. Degrees of efficiency of around 99% can be reached in this way. Such high quality gears do, however, require a continuous control as regards lubrication, bearing play and, if necessary, as regards wear for the maintenance of their high degree of efficiency.

In contrast, it is the object of the invention to create a magnetic force transmitting device in accordance with the generic part of claim 1 which is improved substantially in its degree of efficiency, particularly by orders of magnitude over know force transmitting devices of this type, and which is also suitable for very high revolutions.

This object is solved in accordance with the invention of claim 1. Advantageous embodiments result from the dependent claims.

With the magnetic force transmitting device in accordance with the invention it is particularly favourable that the magnetic spirals in accordance with the invention work slightly offset to each other and that they possess a shape which at least approaches that of an ideal spiral. As like poles of the roll bodies which are neighbours to each other point outwards in each case, the opposite identical poles are repulsed. A sliding of the magnetic spirals past each other is performed where the essential factor is that the opposite fields of the permanent magnets do not intersect, but practically enter into each other along the direction of the field lines and move out away from each other. Field lines do not intersect and no eddies arise.

With the magnetic force transmitting device in accordance with the invention the extremely high degree of efficiency obtained with a corresponding design which is practically determined by the bearing friction is especially favourable with the force transmitting device also being suitable for operation in a vacuum. During operation under atmospheric pressure, the body in each case is preferred to be exactly cylindrical so as to keep the air resistance as low as possible.

In accordance with the invention driving powers with very high revolutions can also be transmitted. This is due to the fact that the pure force transmitting is performed with an extremely low degree of loss and - under practical points of view - practically with no loss.

Thermographic studies with a high-resolution thermograph showed that the warming in the force transmitting area, that is the warming of the actual bodies, is at most 5% of the bearing warming. This was determined under the following parameters:

Powers transmitted	1.1 KW
Roll diameter	16 cm
Roll length	25 cm
Revolutions	3,200 r.p.m.
Magnetic track width	8 mm
Magnetic track distance (pitch)	8 cm
Spiral	Two-wind
Magnet material	Neodym 370
Air gap	0.2 mm
Coating material	Brass
Coating thickness	0.2 mm
Bearings	Commercial roll bearings

It is further particularly favourable if the effective width of the magnetic tracks is substantially lower than the distance between the magnetic tracks in an axial direction, that is the pitch with one-wind spirals or the half-pitch with two-wind spirals. In this way, it is prevented that the magnetic tracks which are neighbours to each other have an effect on each other. Simultaneously, such play is created in the transmission of power as is desired in accordance with the invention for the further reduction of losses. The initiation of the force transmission begins gently, that is with a slowly increasing opposing force with nevertheless no slip arising - even with a low pitch - due to the highly effective magnetic elements.

Preferably the magnetic elements are small and positioned in a row so that they form an essentially uniform magnetic track outwardly. The force transmitting between magnetic spirals positioned diagonally opposite to each other is performed in such a way that the rounded characteristic of a single magnet in each case does not yet become effective, but that rather the individual magnetic elements work as one elongated magnet. Acceleration and braking losses due to non-uniform magnetic characteristic are thus definitely avoided.

The invention can be used particularly favourably for highly effective energy neutralisation in motor/generator systems. In all cases 90% of the force transmission losses can be saved over known systems whereby completely new fields of application are opened up.

Preferably, the spirals of bodies which are neighbours to each other are directed in opposing directions so that an opposing roll rotation direction is produced. It is naturally also possible to use spirals with the same direction so that a roll direction in the same direction is produced. It is particularly favourable that any direction of rotation can be chosen simply and with one and the same driving spiral depending on the design of the driving spiral. The opposing spiral produces even slightly more reductions in losses under non-vacuum conditions as the air current generated by the rolls in the direction of the circumference is in the same direction in the neighbouring area with opposing spirals.

It is essential for a transmission with a low degree of loss to keep the surface roughness of the bodies approaching ideal rolls as low as possible. In this way, the pick-up effects for the ambient air are kept low. It is understood that with only slightly reduced air pressure the losses caused by the air pick-up can be further reduced.

The design of the magnetic spirals in accordance with the invention can be adapted to the requirements in many areas. A pitch of, for example, around 15° with a two-wind spiral creates such a distance between the individual magnetic spirals, seen in each case in the axis-parallel direction, that the neighbouring spirals have no effect on each other, that a very uniform sliding of the magnetic spirals of the neighbouring bodies past each other can be performed, and that nevertheless - assuming the use of correspondingly powerful magnets - no slip is created.

It is possible to adapt the dimensions of the bodies in accordance with the invention to the requirements in many areas. If a length of the bodies is desired which exceeds the diameter by a multiple factor, each body can be supported as required by several support bearings.

The force which can be transmitted increase as the angle of pitch increases, with, however, the losses being unsatisfactorily high even with very long rolls, for example, for an angle of pitch of 60°. If desired, the play during force transmission can be reduced despite a low pitch thanks to a multi-wind spiral, which is also often termed a multiple spiral, with a play-free position of the driving roll, i.e. a defined adjusting position of the driving roll in free wheel to exactly one position, being possible.

Furthermore, the same choice for the angle of pitch of rolls opposite each other is important.

Provided the angle of pitch is the same, the diameter of rolls opposite each other can be different. This leads to the possibility of creating step-up or step-down gearing with the force transmitting devices in accordance with the invention.

Further advantages, details and features of the invention are produced from the following description of an embodiment using the drawing.

Fig. 1 shows a slightly schematic, perspective view of a magnetic force transmitting device in accordance with the invention in one embodiment;

Fig. 2 a slightly schematic, perspective view of a magnetic force transmitting device in accordance with the invention in a further embodiment;

Fig.3 a view of a development of an essentially roll-shaped body in accordance with the invention, to show the positioning of the magnetic spirals, in a one-wind design of a force transmitting device in accordance with the invention; and

Fig. 4 a presentation of a further design of a force transmitting device in accordance with the invention in a top view of opposite roll-shaped bodies.

A force transmitting device 10 in accordance with the invention comprises two roll-shaped bodies 12 and 14 which face each other. One of the bodies, for example, body 12, is provided as the driving roll and the other, for example, body 14, as the driven roll. Both bodies are supported on the front sides in roll bearings not shown in detail here. High-quality components are used as the roll bearings which are superior to the industry standard both as regards the low degree of wear and as regards the bearing friction. The bodies 12 and 14 consist of material which is also comparatively faithful to dimension under temperature change. In the example case they are formed from aluminium. An air gap 16 is provided between the bodies 12 and 14 with the air gap simultaneously serving to compensate any deformations of the bodies 12 and 14 due to temperature. In the present embodiment it has a size of 0.2 mm with a diameter of the bodies 12 and 14 of 162mm.

The bodies of 12 and 14 each possess magnetic spirals 18 and 20 which in the example case point in opposing directions. If the body 12 is driven on a drive shaft 22 in a clockwise direction, the transmitted force can be taken up on a drive shaft 24 on the body 14 in a counter-clockwise direction.

As can be seen from Fig. 1, in the area of the air gap 16 the magnetic spirals 18 and 20 are closely next to each other in operation and as such asymmetrical in an axial direction. The magnetic spiral 18 of the driving body 12 practically pushes the corresponding part of the magnetic spiral 20 of the driven body 14 in front of it as like magnet poles are facing each other so that to this extent a repulsing effect exists. This pushing is performed with an extremely low degree of loss as the power of individual magnets from which the magnetic spirals 18 and 20 can be formed, is negligible.

The magnetic spirals 18 and 20 are positioned respectively on the circumference of the bodies 12 or 14. However, this does not mean that they are exposed outwardly. Rather, they are covered by a coating 26 made of a non-magnetic material which possesses low friction to air. For example, a polished ceramic, plastic or titanium coating can be used with a thickness of 0.2 mm being fully sufficient.

The radial distance of the magnetic spirals 18 and 20 in the neighbouring area is thus very low, for example around 0.6 mm.

The magnetic spirals 18 and 20 are provided as one-turn spirals. As small, lumped magnetic spirals are used, the effective area of the magnetic spirals 18 and 20 is substantially lower than the pitch, i.e. the distance of the neighbouring pitches of the magnetic spirals 18, 20 viewed in an axial direction. This causes corresponding play which is favourable in accordance with the invention. Nevertheless, in the start-up phase, irrespective of the position in which the driving body is situated over the driven body, no knocking occurs as the neighbouring magnetic spirals work like a spring with a progressive characteristic curve in their force transmission effect.

A further embodiment of the invention can be seen from Fig. 2. In this embodiment, four roll-shaped bodies are provided with further driven bodies 28 and 30 being used additionally to the bodies 12 and 14 respectively. The same reference numbers represent the same parts here and in the further figures.

Each neighbouring body turns in an opposing direction. Thus a force distribution of a particularly low degree of loss or with no loss can be realised with even more than four bodies being able to be used for the force distribution if required.

It is not necessary to have the bodies 12, 14, 28 and 30 positioned on top of each other in a row. Rather, they can be provided in any geometrical arrangement with the axes in principle also being able to be positioned in a square so that dual force transmission paths exist in each case.

From Fig. 3 an exemplary positioning of the magnetic spirals, for example of magnetic spiral 18 in its development can be seen. The magnetic spiral 18 consists of a number of magnetic elements 32 positioned in a row where in the embodiment shown in Fig. 3 the angle of pitch is around 8°. Here, it is a one-wind spiral so that correspondingly high play obtains as the area between the individual pitches of the magnetic spiral 18 is substantially larger than the effective width of each row of individual magnets 32.

From Fig. 4 a further embodiment of the force transmitting device in accordance with the invention can be seen. In contrast to the embodiment examples in accordance with Figures 1 and 2, here magnetic spirals 18 and 20 with the same directions are neighbours to each other. Thus, the body 12 turns in the same direction as the body 14. The air gap 16 in this embodiment has been chosen to be slightly larger, but in such a way that no slip between bodies 12 and 14 is possible.

Furthermore in the embodiment in accordance with Fig. 4 three-wind magnetic spirals 18 and 20 are used.

Patent Claims

1.

Magnetic force transmitting device with at least 2 essentially roll-shaped bodies which are pivoted next to each other, characterised in that magnetic spirals are positioned in the circumferential area of the rolls (12, 14, 28, 30) in such a way that like poles point outwards.

2.

Force transmitting device in accordance with claim 1, characterised in that the magnetic spirals (18, 20) consist of high-performance magnetic elements (32) positioned in a row.

3.

Force transmitting device in accordance with one of the previous claims, characterised in that the magnetic spirals (18, 20) show a distance (pitch) when viewed in an axis-parallel direction which is a multiple, preferably twice to 30 times as much as the width of the magnetic elements (32).

4.

Force transmitting device in accordance with any of the above claims, characterised in that the magnetic spirals (18, 20) are positioned in opposing directions to each other and the direction of rotation of the roll-shaped bodies (12, 14, 28, 30) is in an opposing direction.

5.

Force transmitting device in accordance with any of the previous claims,

characterised in that
the magnetic spirals (18, 20) are positioned in the same direction relative to each other and the direction of rotation of the roll-shaped bodies (12, 14, 28, 30) is in the same direction.

6.

Force transmitting device in accordance with any of the previous claims,
characterised in that
the angle of pitch of the spirals (18, 20) is 2° to around 60°, preferably 5° to 30° and particularly around 15°.

7.

Force transmitting device in accordance with any of the previous claims,
characterised in that
on each body (12, 14, 28, 30) 1 to 30 magnetic spirals are formed, in particular 2 magnetic spirals (18, 20).

8.

Force transmitting device in accordance with any of the previous claims,
characterised in that
the magnetic spirals (18, 20) are surrounded by a film (26) of non-magnetic material which consists in particular of titanium, a precious metal, plastic or ceramics and which in particular possesses a thickness of less than 0.2 mm.

9.

Force transmitting device in accordance with any of the previous claims,
characterised in that
neighbouring bodies (12, 14, 28, 30) are positioned with no contact on their external circumferences at a distance (air gap 16) of particularly less than one 1/100, preferably around 1/1000 of their diameter or less.

10.

Force transmitting device in accordance with any of the previous claims,

characterised in that

the roll-shaped bodies (12, 14, 18, 30) are designed as rolls with non-supported length of around once to 50 times, preferably around twice as much as the diameter.

11.

Force transmitting device in accordance with any of the previous claims,

characterised in that

the magnetic spirals (18, 20) possess the same angles of pitch.

12.

Force transmitting device in accordance with any of claims 1 to 11,

characterised in that

two bodies which neighbour each other (12, 14, 28, 30) possess different diameters.

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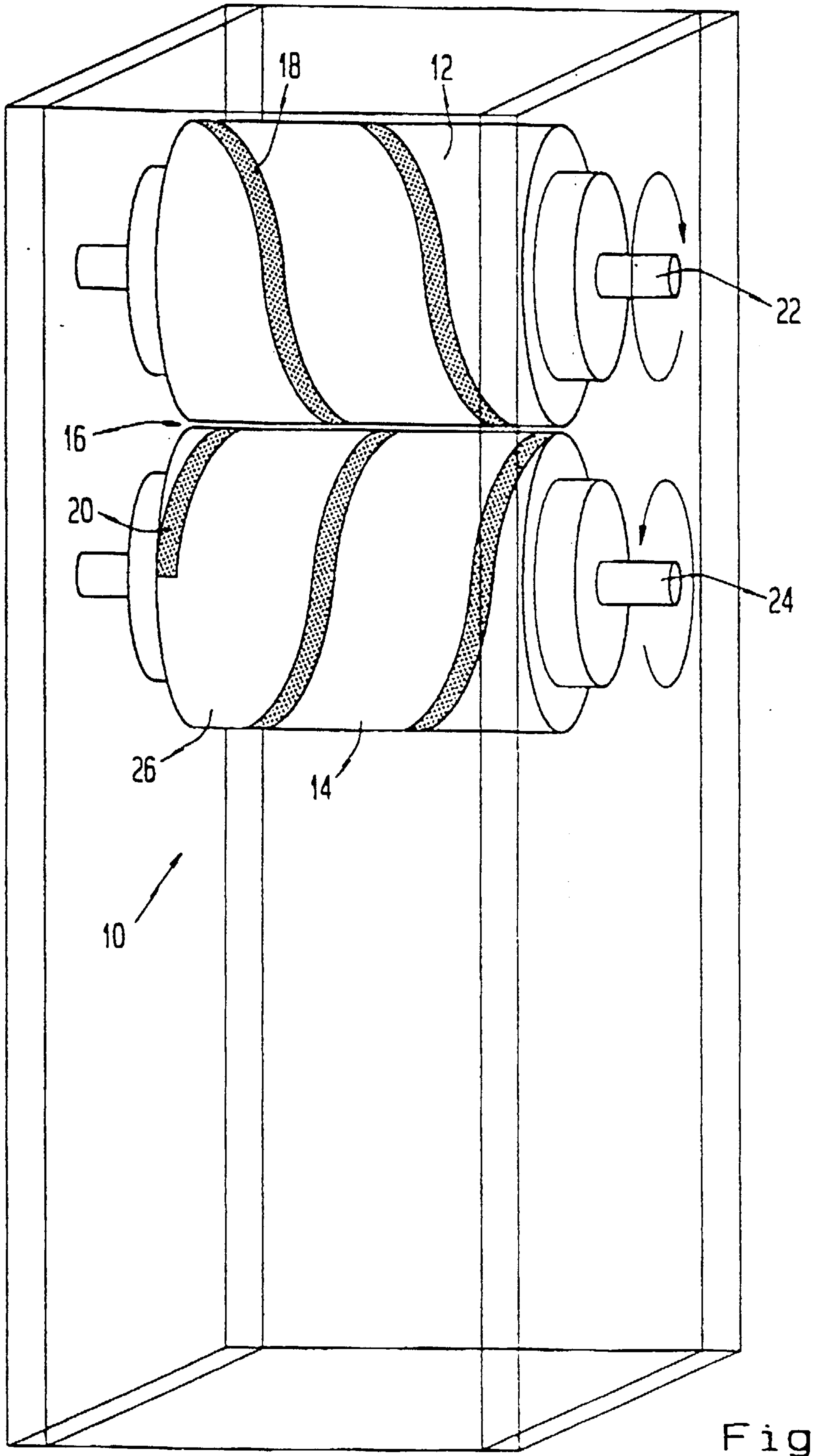

Fig. 1

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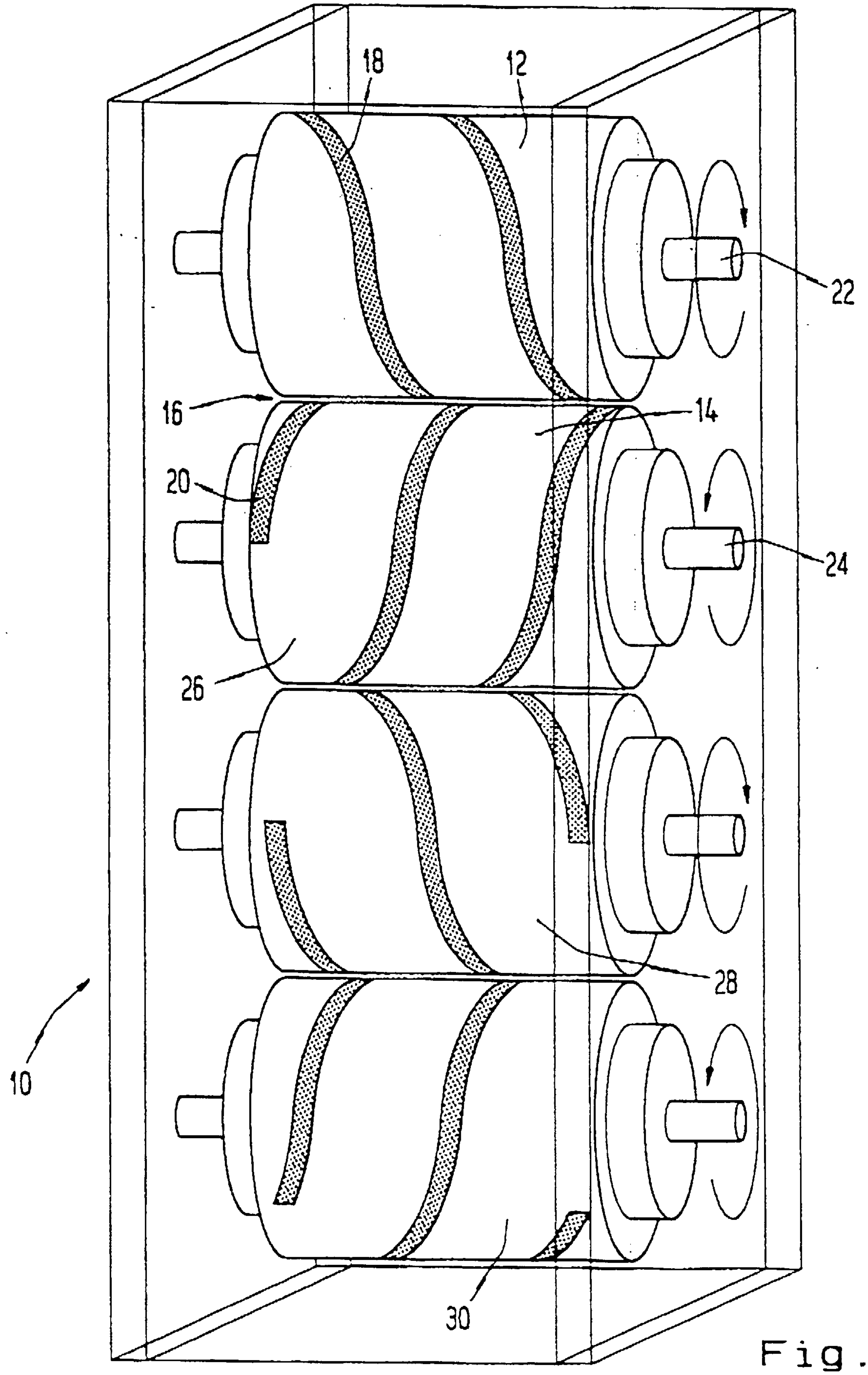

Fig.2

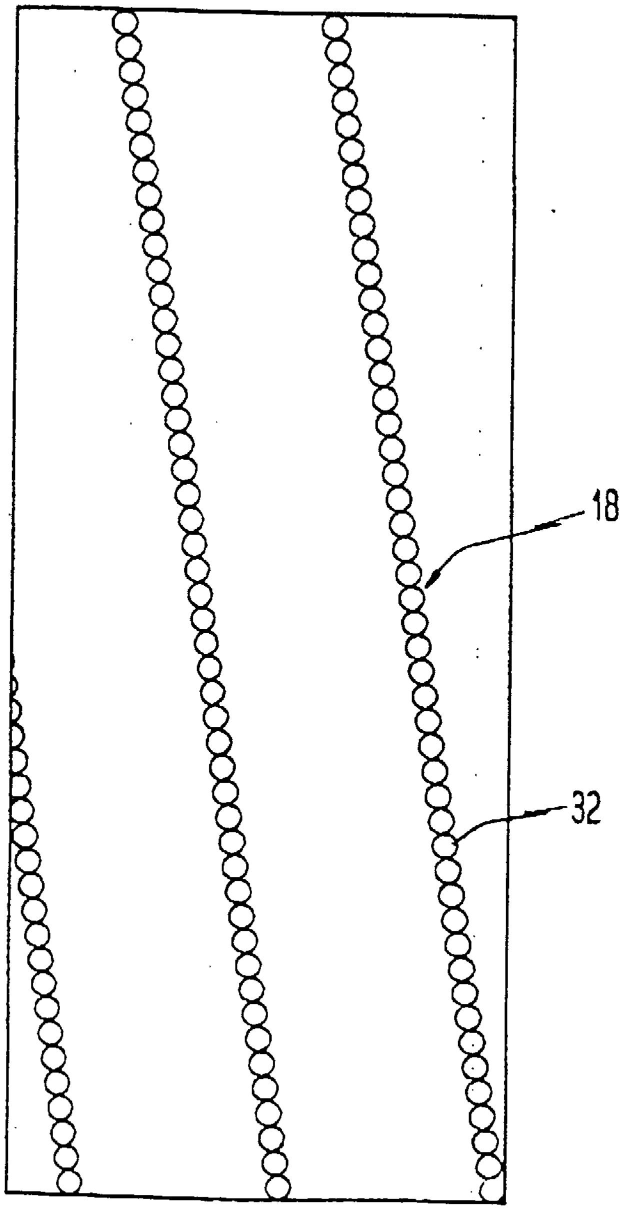

Fig.3

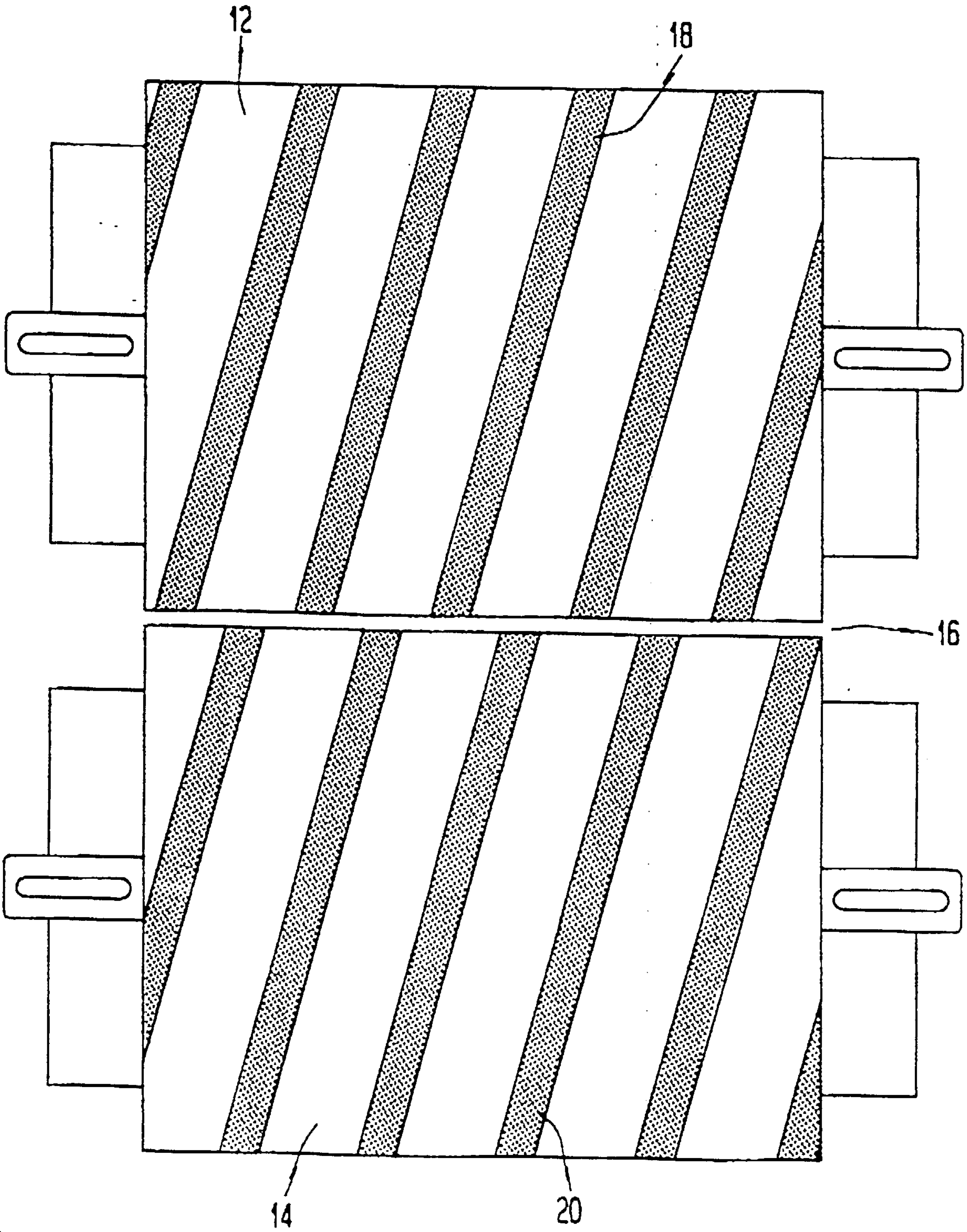

Fig.4