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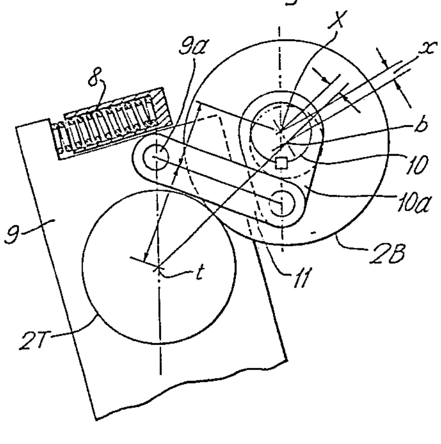
(54) **Binding strap apparatus.**

(57) A strap binding apparatus in which a binding strap (3) is fed, held and tensioned by and between a reversible traction wheel (2T) and a back-up wheel (2B) of a binding head (1) has the traction wheel (2T) rotatably supported on an axis (t) which is located at a predetermined fixed position. A supporting plate (9) supports a drive system (6, 7) to drive the traction wheel (2T) and is rotatably supported around the fixed axis (t). A spring (8) between the supporting plate and a frame of the binding head (1) urges rotation of the supporting plate (9) in one sense. The back-up wheel (2B) is supported to be rotatable on an eccentric shaft (10) which is rotatable around an eccentric axis (X) eccentric with respect to a base axis (b) of the eccentric shaft (10). Pivotal movement is transmitted from the supporting plate (9) to the eccentric shaft (10) through a link (11) so that reaction forces of the drive system (6, 7) rotate the supporting plate (9) in the other sense to cause the back-up wheel (2B) to be urged towards the traction wheel (2T) to tighten the grip on the strap (3).

Fig. 2.



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Description

BINDING STRAP APPARATUS

The present invention relates to a strap binding apparatus used in a binding machine for binding heavy articles such as strip coils, tubes, piled plates, with a steel-band or plastics strap or the like.

In a typical strap binding apparatus a binding strap is fed and held by and between a reversible traction wheel and a back-up wheel of a binding head, to cause the strap to be fed forwards to enable it to be wound around article to be bound, a leading portion of the strap being gripped by the binding head; a following portion of the strap being fed in the opposite direction to take up stack and wind the articles tightly and apply tension to it; and, the overlapping strap portions of the leading portion and the following portion being bonded under the tension to one another.

A conventional apparatus will be described in detail with reference to the drawings. Such apparatus has its driven traction wheel mounted on a rotatable eccentric shaft so that the separation between it and a fixed axis back-up wheel is variable to vary the nip pressure applied to the strap. The eccentric mounting is arranged to be "self-energizing" so that as the tension in the strap increases the wheels are brought closer together to grip the strap more tightly. Such conventional strap binding apparatus has problems particularly resulting from the eccentric mounting of the traction wheel and its drive. Ideally an improved apparatus is made such that it has a compact design and is capable of assuring a self-energizing in a stable manner according to variations of the binding conditions at the time of strap tensioning, and easily adjusting the self-energizing, thereby to widen the range of binding conditions to be applied.

According to this invention such an apparatus is characterised in that:

the traction wheel is rotatably supported on an axis which is located at a predetermined fixed position;

a supporting plate for supporting a drive system to drive the traction wheel is supported in a manner rotatable around the fixed axis;

a spring is disposed between the supporting plate and a frame of the binding head to urge rotation of the supporting plate in one sense;

the back-up wheel is rotatably supported on an eccentric shaft which is rotatable around an eccentric axis eccentric with respect to a base axis of the eccentric shaft;

the eccentric shaft is supported to be rotatable around its base axis; and,

a pivotal movement is transmitted from the supporting plate to the eccentric shaft through a link so that reaction forces of the drive system rotate the supporting plate in the other sense to cause the back-up wheel to be urged towards the traction wheel and so tighten the grip on the strap.

More specifically, according to the present invention, the traction wheel connected to the drive system is disposed at a fixed position and the back-up wheel is eccentrically moved to and away from the traction wheel, thereby to establish a proper relationship in which the pressing force, the torque transmission and tightening tension are well balanced. Further, preferably provision is made such that the relationship may be readily adjusted by changing the mounting position of the eccentric transmission system.

Preferably the pressing force between the traction wheel and the back-up wheel at the time when the strap is fed and taken up, may be adjusted by a spring load, as done in the conventional apparatus. However, the traction wheel for producing a self-energizing strap tension, is disposed at a predetermined position and the relevant strap guide members are disposed also at predetermined positions. Accordingly, when tensioning the strap, these members are operated such that tension is applied to the winding strap more securely, and the pressing force of the back-up wheel which is variable according to its eccentric movement, is followingly generated. Therefore, the self-energizing proceeds more smoothly, thus eliminating the need of an excessive pressing force to be applied. Accordingly, the pressing force applied according to the present invention may be smaller than that required in the conventional apparatus, as shown in Table to be discussed later. In other words, a predetermined strap tension may be assured with a smaller pressing force. This may be accelerated by selecting such section shape of each of the peripheral grooves of the traction wheel as to be advantageous in generation of the tension.

The mounting position of the link-lever connection for transmitting the eccentric movement to the back-up wheel, may be so adjusted as to generate a proper pressing force suitable for the tension according to given binding conditions.

Further, since the traction wheel having the drive device is disposed at a fixed predetermined position, the binding strap operating apparatus and, consequently, the binding head may be made in a compact design.

A particular example of an apparatus in accordance with this invention will be now be described, and contrasted with the prior art with reference to the accompanying drawings; in which:-

Figure 1 is a perspective view of main portions of a binding strap operating apparatus in accordance with the present invention;

Figure 2 is a diagrammatic side elevation of the operating members of the apparatus in Figure 1;

Figure 3(a) is an enlarged side view of the peripheral surface of a normal back-up wheel;

Figure 3(b) is an enlarged side view of the peripheral surface of a preferable back-up wheel;

Figure 4(a) is a perspective view of a testing machine;

Figure 4(b) is a side view of a sample used for conducting a test with the use of the testing machine in Figure 4(a);

Figure 5 is a side view, schematically illustrating strap binding;

Figure 6 is a perspective view of main portions of a conventional binding strap operating apparatus; and,

Figure 7 is a schematic side view of the main portions in Figure 6, illustrating how they operate at the time of strap tensioning.

A conventional strap binding is carried out with the use of a multi-functional binding head 1 which is vertically movable with respect to the frame of the binding machine. As shown in Figure 5, the strap binding includes the steps of: feeding a band-like binding strap 3 by a strap operating apparatus 2; winding the strap around articles to be bound 4 over one revolution; gripping the leading portion 3a of the strap 3 by a grip unit of the binding head 1; taking up the following portion 3b of the strap 3, causing the strap to wind the articles 4 without looseness; strongly tensioning the following portion 3b to apply tension to it; and bonding, under the tension, the overlapping strap portions of the leading portion 3a downstream of the gripped portion and the following portion 3b to each other with a seal fitment or the like.

After the overlapping strap portions have been bonded to each other, the strap portion thus bonded is cut and separated from the rearwardly connecting portion 3c of the strap 3. When a device serving as an underlay is transversely pulled out, the bonded strap portion is loosened by an amount of the gap generated by the removal of the underlay. However, such looseness is absorbed within a resilient return range of the strap, so that the article is held by the residual tension. In Figure 5, an arrow f represents the strap feeding direction, while an arrow tt represents the strap taking-up and tensioning direction.

Figure 6 shows a main portion of a conventional strap operating apparatus 2 in the binding head 1 above-mentioned, while Figure 7 shows how the strap is tensioned.

The operating apparatus 2 includes a traction wheel 2T having a knurled-type grooved peripheral surface, and a back-up wheel 2B having a smooth peripheral surface. A binding strap 3 passes between both peripheral surfaces of the wheels 2T and 2B and is held between them under pressure.

According to this conventional structure, the back-up wheel 2B is supported such that the wheel 2B is followingly rotated around the axis b of the back-up wheel 2B at a fixed predetermined position with respect to the frame of the binding head 1. The traction wheel 2T to be drivingly rotated is incorporated in an eccentric mechanism such that the wheel 2T comes near the back-up wheel 2B to press on it through the binding strap 3. More specifically, the traction wheel 2T is supported on an eccentric housing 5 such that the traction wheel 2T is drivingly rotated around the axis t of the traction wheel 2T displaced by an amount x from the pivotal base axis X of the eccentric housing 5. Provision is made such that, when the eccentric housing 5 for supporting a rotary motor 6 and a reduction gear 7 is pivoted around the base axis X, the axis t is eccentrically moved so that the traction wheel 2T is urged towards the back-up wheel 2B.

A spring 8 is disposed between the eccentric housing 5 and the frame of the binding head 1 such that the traction wheel 2T is urged twoards the back-up wheel 2B. The spring 8 enables the binding strap to be fed and taken up with a small nip pressure by the traction wheel 2T.

It is required that the binding strap 3 is strongly tensioned with a strong contact pressing force and a strong traction torque of the traction wheel 2T. Such strong tensioning may be carried out as outlined below.

Upon completion of taking-up any slack in the strap the binding strap tension increases. When the traction wheel 2T is switched to the low-speed and high-torque mode, the traction wheel 2T is reversely pulled in a direction f as shown in Figure 7 by this increase in tension. Accordingly, the traction wheel 2T is apt to move in a wedging direction in which the wedge angle α formed at the time when both wheels 2T and 2B come in contact with each other, is reduced. The wedge angle α is set, at the final stage to about 5° to 6° out of the pivot angle range of 15° to 30° covering the entire stroke. Accordingly, the pressing force between both wheels 2T and 2B is increased by the wedging effect above-mentioned. The phenomenon that the strap tension is increased together with the increase in the pressing force between both wheels, is called self-energizing. Such self-energizing is used to provide a high tension in the strap. The steel band strap 3 has a width of 3/4 to 1 1/4 inch (19 to 32 mm), a thickness of about 0.9 mm, resistance to tension of about 75 to 100 kgs/mm^2. Acordingly, applied between both wheels is a pressure force of the order of a tonne which is several times the magnitude of the strap tension.

This conventional binding strap operating apparatus has the following problems. When the binding strap is fed and the slack taken up with only a relatively small pressing force between the wheels obtained by the spring 8, adjustment of the tension is readily carried out. However in tensioning the strap, the pressing force of both wheels is increased when a small wedge angle α is set, and vice versa. The pressing force varies considerably with small variations of the wedge angle α. This makes its adjustment difficult. The optimum conditions under which the strap is tensioned without slippage by the traction wheel 2T, vary with the type and thickness of the binding strap 3 used. It is therefore difficult that predetermined setting conditions of the wedge angle α suit to all types and thicknesses of binding straps to be used. If such conditions are not properly set, the strap may slip. This not only fails to smoothly tighten the strap, but also produces a loss in motor output. On the contrary, the pressing force, if excessive, may cause the grooves in the traction wheel 2T to bite into the strap, to produce scar marks on it. This involves the likelihood that, at the final stage of such tensioning, the strap breaks at its scarred portion.

In view of its structure, with the eccentric housing 5 housing the drive system, this disadvantageously makes the housing 5 large-sized. The binding head as an outer member is accordingly made large.

The following description will discuss in more detail an example of the present invention with reference to Figures 1 to Figure 4.

From Figures 1 and 2 together with Figure 5, it is understood that the apparatus of the present invention is generally similar to the conventional apparatus, in that the present apparatus belongs to a strap binding apparatus in which:
a binding strap 3 as held by and between a traction wheel 2T and a back-up wheel 2B of a binding head 1, is fed to wind articles to be bound 4 over one revolution; the leading portion of the strap 3 is gripped; the following portion of the strap 3 is taken up such that the articles to be bound 4 are wound without looseness with the strap; the strap following portion is tensioned to apply tension to the strap; and, the overlapping strap portions of the leading portion and the following portions are bonded under such tension to each other.

According to the present invention, the traction wheel 2T is so supported, in the frame of the binding head 1, as to be drivingly rotated around the axis t of the traction wheel 2T which is located at a fixed predetermined position. The traction wheel 2T is connected to a drive system including a drive motor 6 and a reduction gear 7. The drive motor 6 and the reduction gear 7 are secured to and mounted on a drive system supporting plate 9 in a manner rotatable around the same axis t.

The drive system supporting plate 9 is biased by a spring 8 which urges it counter-clockwise as shown in Figure 1 and Figure 2. The spring 8 is disposed between the frame of the binding head 1 and the supporting plate 9.

The back-up wheel 2B is supported on the binding head frame such that an eccentric shaft 10 is rotated around a base axis X parallel to the axis t of the traction wheel 2T so that the back-up wheel 2B comes near the traction wheel 2T at a fixed position. The back-up wheel 2B is supported in a manner rotatable around the axis b of the back-up wheel 2B displaced by an eccentric amount x from the base axis X of the eccentric shaft 10. When the bearing of the back-up wheel 2B is of the self-aligning type, the wheel 2B may be improved in the adaptation to the strap.

A lever 10a of the eccentric shaft 10 is connected to a pin hole 9a in the drive system supporting plate 9 through a link 11. Accordingly, counterclockwise rotation of the drive system supporting plate 9 causes the eccentric shaft 10 to be pulled and rotated clockwise through the link-lever connection. The relative angle may be changed by changing the length of the link 11 or by selecting a pin hole 9a to be connected to the link 11, out of a plurality of pin holes 9a in the plate 9. By such change, the wedge angle α to be formed at the time when both wheels come in contact with each other, may be changed and adjusted.

According to the present invention, when the binding strap 3 is fed and the slack taken up, the eccentric shaft 10 is eccentrically moved by the spring 8, and the back-up wheel 2B comes in contact with the traction wheel 2T and is pressed by the spring load. As the binding strap 3 is tightened, the increase in tension causes the reaction forces from the drive 6 to rotate the drive system supporting plate 9 clockwise. This rotates the eccentric shaft 10 counter-clockwise and urges the back-up wheel 2B towards the traction wheel 2T under a strong pressing force due to the wedging effect provided by the self-energizing. Accordingly, a large torque of the drive system 6, 7 is transmitted from the traction wheel 2T to the binding strap 2 without slip, thereby tightening the binding strap still further and exerting a high tension.

Preferably, the traction wheel 2T has saw-tooth shaped teeth on its peripheral surface as shown in Figure 3(b), which presents a larger angle in the taking-up and tensioning direction tt, in view of generation of strap tension by the traction wheel 2T, rather than a normal knurled section in the form of an equilateral triangle as shown in Figure 3(a). In this case, the pressing force required may be decreased, for example, from 8 tonnes to 6.5 tonnes, and the depth h of each peripheral groove may be reduced. This reduces the scarring caused by the traction wheel 2T on the binding strap due to the bite by the traction wheel 2T.

In order to obtain the relationship between the binding strap tension and the pressing force between the traction wheel and the back-up wheel, a test was conducted of a sample by means shown in Figure 4(b) in which the back-up wheel presents an eccentric amount of 5 mm, with the use of a testing machine shown in Figure 4(a). In the test, the binding strap 3 was held by and between the traction wheel 2T and the back-up wheel 2B and the pressing force was changed by adjusting a screw 14 of the testing machine, thereby to change the strap tension exerted by screws 15 of the testing machine. The test results are shown in the following Table, together with the results obtained according to the prior art.

	Sample	Strap Tension (kgf)	Pressing Force (kgf)
Prior art	A	1600	3750
	B	2000	5000
	C	2200	5750
Present invention	A	1600	3000
	B	2000	4000
	C	2200	5000

The pressing force in the Table refers to the maximum value which can be applied before occurrence of strap slip. It is understood from the Table that, according to the present invention, an equivalent strap tension was provided with a smaller pressing force than that required in the prior art.

According to the present invention, in strap binding, the self-energizing at the time when the binding strap is tightened, proceeds smoothly, thereby to minimize the loss of the drive power. This enables the strap portions to be bound under a great strap tension with a small pressing force. Proper adjustment may be made to accommodate the variations of the binding conditions, thereby to widen the applicable range. Further, the operating apparatus and the binding head may be made in a compact design.

Claims

1. A strap binding apparatus in which:
a binding strap (3) is fed and held by and between a reversible traction wheel (2T) and a back-up wheel (2B) of a binding head (1), to cause the strap (3) to be fed forwards to enable it to be wound around article (4) to be bound,
a leading portion (3a) of the strap being gripped by the binding head (1);
a following portion (3b) of the strap being fed in the opposite direction to take up stack and wind the articles (4) tightly and apply tension to it; and,
the overlapping strap portions of the leading portion and the following portion being bonded under the tension to one another,
characterised in that:
the traction wheel (2T) is rotatably supported on an axis (t) which is located at a predetermined fixed position;
a supporting plate (9) for supporting a drive system (6, 7) to drive the traction wheel (2T) is supported in a manner rotatable around the fixed axis (t);
a spring (8) is disposed between the supporting plate and a frame of the binding head (1) to urge rotation of the supporting plate (9) in one sense;
the back-up wheel (2B) is rotatably supported on an eccentric shaft (10) which is rotatable around an eccentric axis (X) eccentric with respect to a base axis (b) of the eccentric shaft (10);
the eccentric shaft (10) is supported to be rotatable around its base axis (b); and,
a pivotal movement is transmitted from the supporting plate (9) to the eccentric shaft (10) through a link (11) so that reaction forces of the drive system (6, 7) rotate the supporting plate (9) in the other sense to cause the back-up wheel (2B) to be urged towards the traction wheel (2T) and so tighten the grip on the strap (3).

2. An apparatus according to claim 1, in which the eccentric shaft includes an actuating lever (10a) and the link is connected to the end of the actuating lever (10a).

3. An apparatus according to claim 1 or 2, in which the eccentric shaft (10) is rotated in the opposite sense to that of the supporting plate (9) as a result of the link.

4. An apparatus according to any one of the preceding claims, in which the traction wheel (2T) is formed with sawtooth-shaped teeth (Figure 3b) to enhance their grip on the strap (3).

Fig.1.

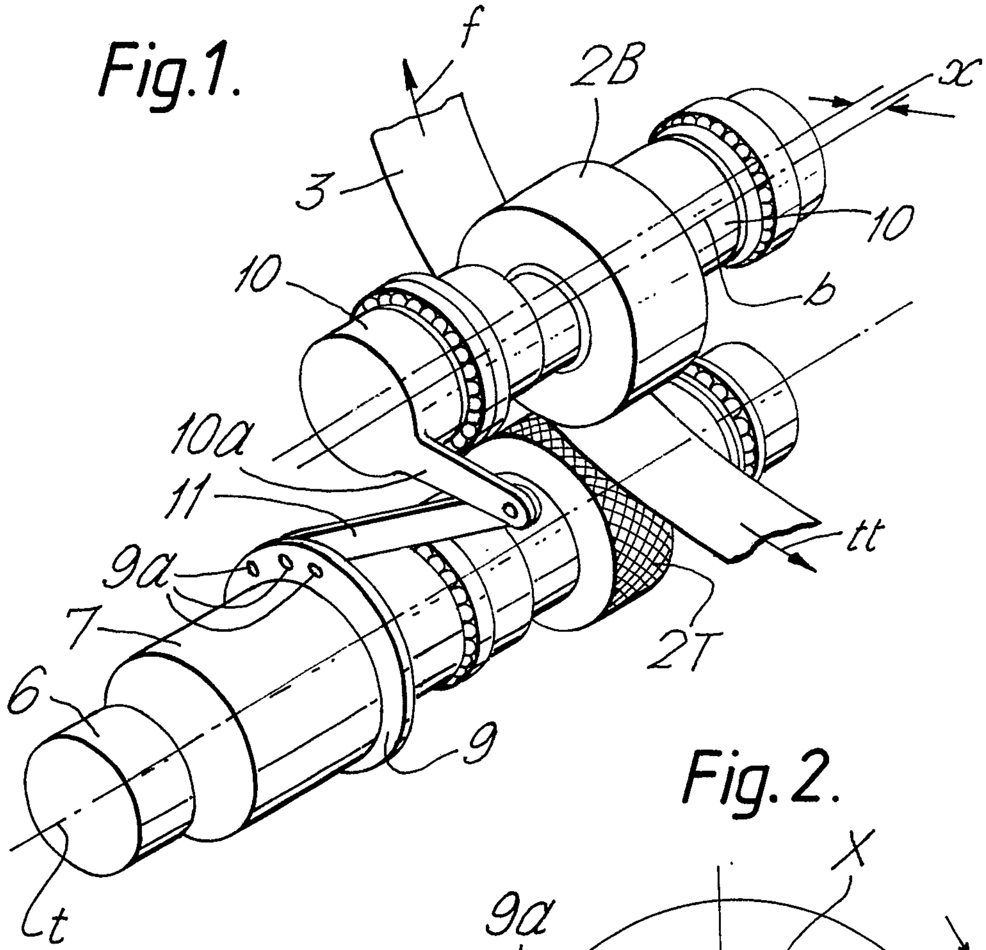


Fig.2.

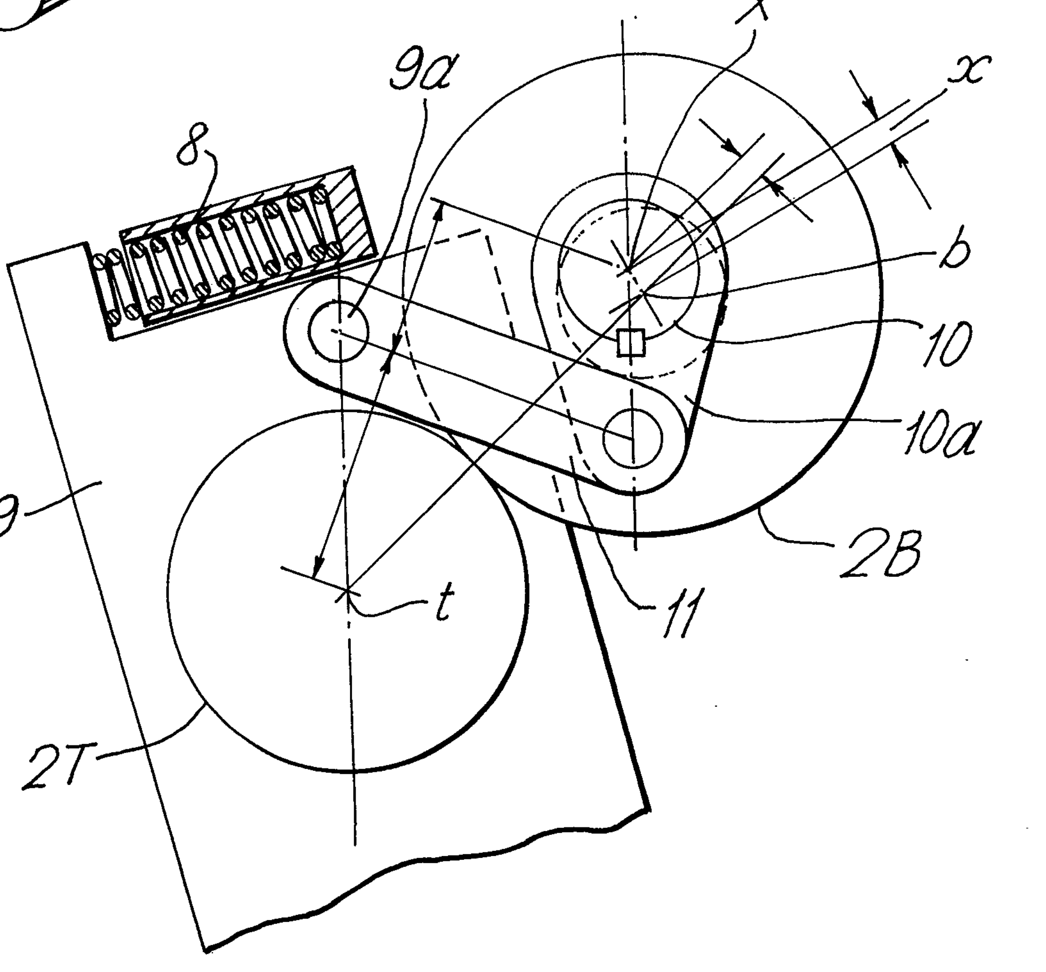


Fig.3a.

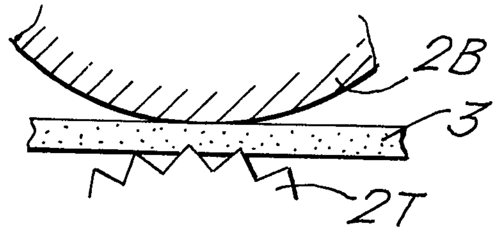


Fig.3b.

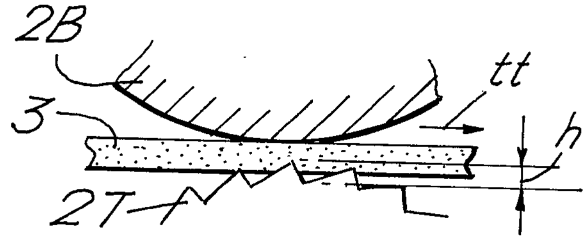


Fig.4a.

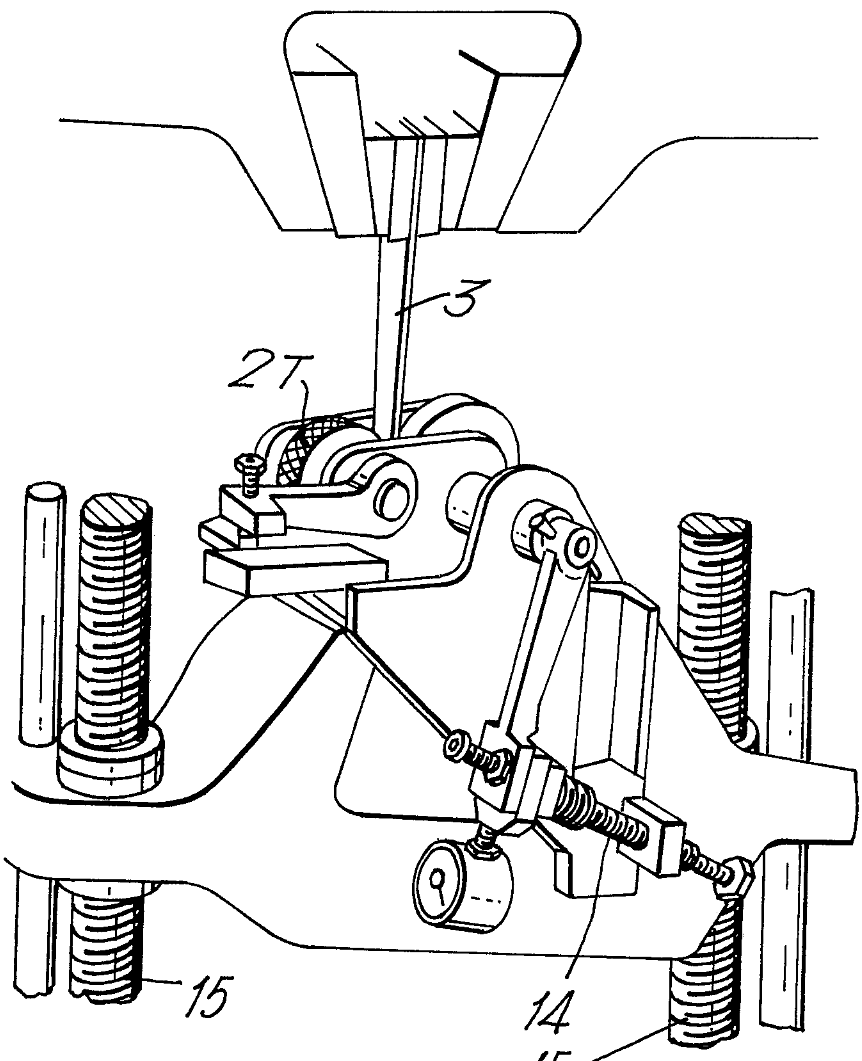


Fig.4b.

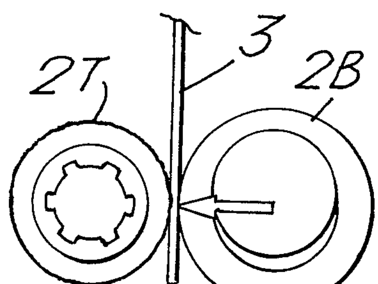


Fig.5.

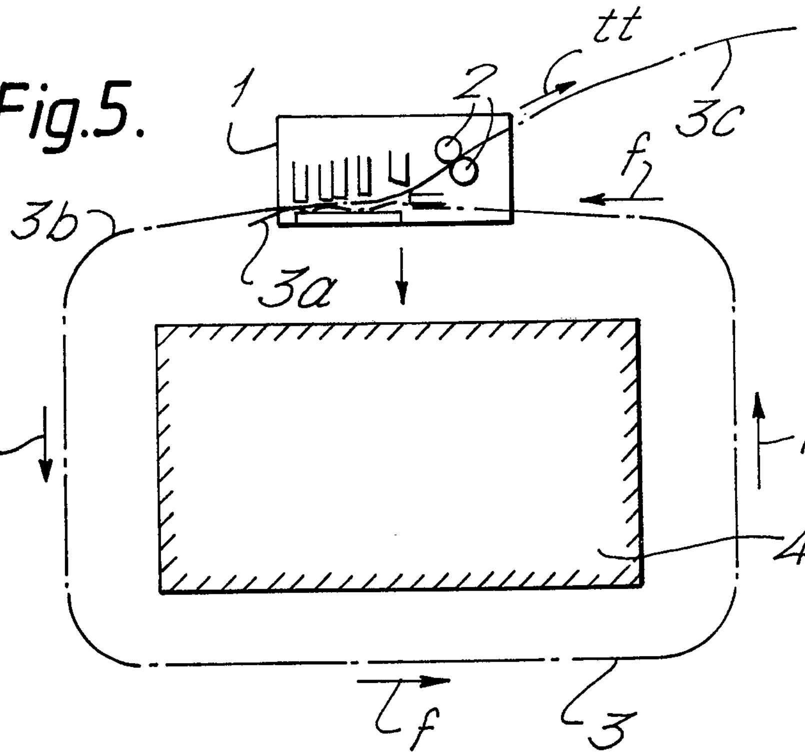


Fig.6.

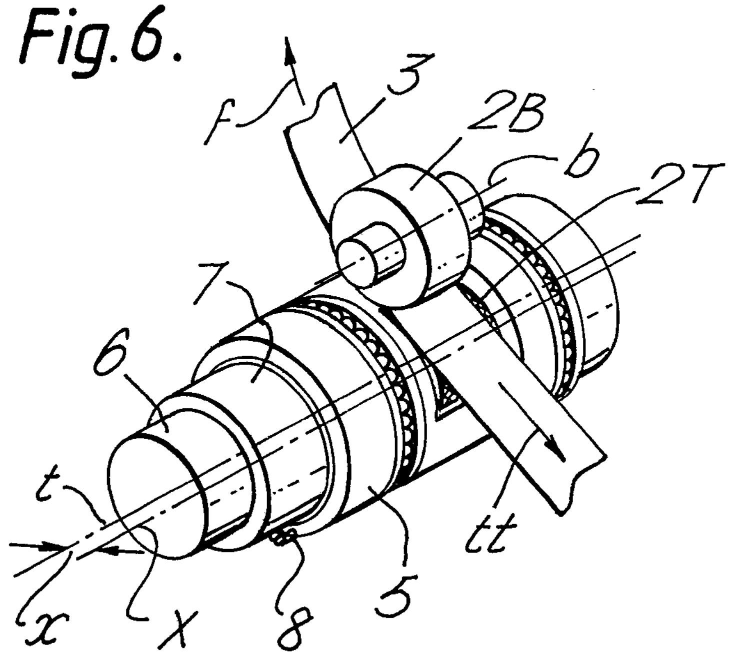
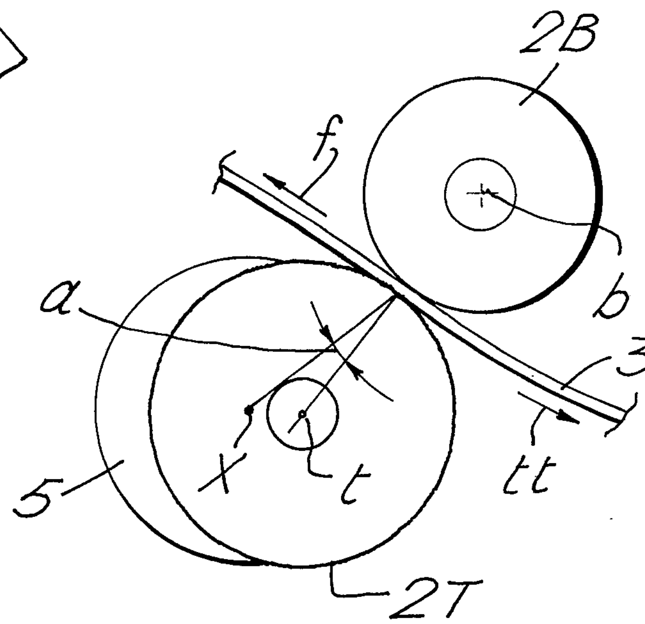


Fig.7.



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EUROPEAN SEARCH REPORT

Application Number

EP 89 30 3670

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
A	US-A-4 212 238 (J.R. SIMMONS et al.) * Whole document * ---	1	B 65 B 13/22 B 65 H 20/02
A	EP-A-0 095 643 (HOESCH) -----		
			TECHNICAL FIELDS SEARCHED (Int. Cl.4)
			B 65 B B 65 H F 16 H B 25 B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	20-07-1989	SCHELLE,J.

CATEGORY OF CITED DOCUMENTS

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