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(54) Device for guiding and regulating the forward step in operating machines with intermittent forward motion, particularly for automatic screen printing machines.

(57) The invention described here is a control device for regulating the intermittant forward feed step of machine that is fitted with a closed loop conveyor belt or similar piece of equipment, where great precision in the intermittant forward feed step is required, especially when the belt is of a considerable length, 80 metres or more. The device is especially applicable to automatic silk-screen printing machines, for which it has been constructed for the first time.

The invention consists of a rotating incremental type encoder transducer (17 or 37) which is used to determine and encode the forward feed step (Sr) of the conveyor belt (2) and the encoder is inserted in a form of drive belt structure consisting of two gear wheels (14,15,16) or (24,25) around which a drive belt (13 or 23) with teeth on both sides passes. The drive belt is of the type currently normally used on industrial robots and plotters, and its teeth engage with a second toothed belt (11) which is attached to one of the sides of the conveyor belt on the machine, or with one of the side strips which make the belt more rigid and which has teeth (21) applied to its upper surface so as to form a flexible rack.

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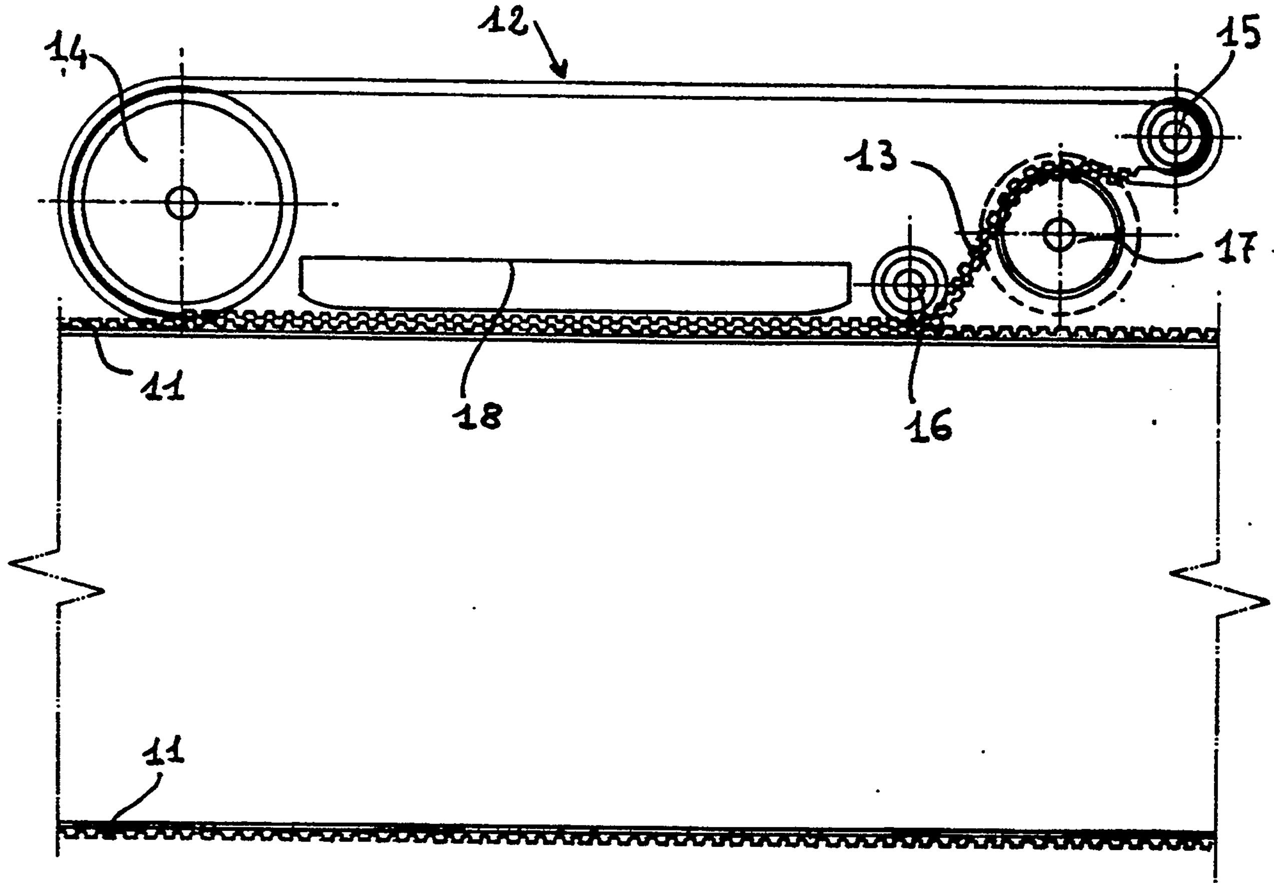

Fig. 3

The invention described here is a control device for regulating the intermittant forward feed step of machine that is fitted with a closed loop conveyor belt or similar piece of equipment, where great precision in the intermittant forward feed step is required, especially when the belt is of a considerable length, 80 metres or more. The device is especially applicable to automatic silk-screen printing machines, but can equally well be applied to all machines with an intermittant feed of considerable length, where the step is required to be particularly precise, without the precision being compromised by errors caused by the length of the machine or the conditions in which it operates.

In the field of silk-screen printing, there already exist several types of machine which work automatically; those which are fitted with closed loop conveyor belts and rotating tables.

Whether dealing with silk-screen printing systems for printing long pieces of cloth glued to long conveyor belts, or pre-cut sections of cloth, or other articles which require great precision and that successive prints are equally precise, or whether dealing with printing a repeat pattern which requires careful alignment, or overprinting a pattern in a different colour, the system which controls the feed movement of the machinery (conveyor belt, rotating table, etc.) on which the items, generally textiles, to be printed are placed is of extreme importance.

There are numerous systems around today for this purpose, and they can be divided into two different categories: those with mechanically operated sensors; and those that use optical or magnetic sensors.

In the first category there is: the device where a rotating incremental encoder transducer which measures movement is turned by a rubber roller attached to the encoder shaft that rubs against the rubber belt on the machine; the type where the encoder is turned by a toothed belt which is stretched around two toothed rollers and whose flat side, suitably ridged, is placed in contact with and drawn along by the conveyor belt on the machine, and movement is measured by the encoder having a toothed shaft which is in contact with either one of the two toothed wheels that tension the belt or with the teeth on the belt itself; the type where either the belt or a steel strip which is attached to the side of the belt and fuctions as a guide, support, and gives additional lengthwise rigidity, has holes at regular intervals which engage with teeth on the edges of the drive rollers and the encoder shares the same axle as the drive roller; and the system which is commonly used on machine tools for measuring spindle head movement where the encoder is connected to a rack.

The second category includes the system using which a position marker is printed on the conveyor belt before the first colour is printed, and a sensor is used to detect these markers and thus control the forward feed of the conveyor belt; and the system where magnetic transducers with a position detector are used to read a rigid scale which is no more than about three metres in length, so that, although this system has proved useful on machine tools, it cannot be practically applied to long belts or similar items of equipment (large diameter rotating tables, etc.).

In the system referred to the European patent Application N° 88201918.5 by the same applicant, a non-rigid magnetic position transducer is applied to one of the sides of the conveyor belt. The transducer is made of a strip of flexible magnetizeable material, and is magnetized with an alternate polarity at regular intervals, and magnetic detectors are placed at suitable intervals. They are coupled to a step counting device which corresponds to the precise nominal printing distance step, and one of the two detector devices is mounted on a bar whose length can be adjusted so that the machine can be adapted to different printing step lengths. The two detector heads can communicate, so that the first detector head transmits the data it has detected to the second, so that the second detector head stops the belt in correspondence to to the power line that the first head recorded as the start point, at a distance which corresponds to the precise distance between the two heads, thus ensuring that each distance along the strip corresponds to one printing step and becomes an element in itself, and the system functions as if it was controlled by the system which uses a rigid magnetic detector transducer.

The invention described here is similar to the systems in the first category where a rotating incremental type encoder is mechanically driven by the conveyor belt.

It is characterized by the fact that the encoder is inserted in a structure consisting of two gear wheels around which a rubber belt which is toothed on both sides passes. The belt is of a high pecision type, such as those currently normally used in robots or plotters, and is in contact with either a second toothed belt which runs along one side of the conveyor belt or its side strengthening strip. In the second of these two cases, the teeth on the transducer assembly engage with teeth on the upper surface of the side strengthening strip, so as to form a flexible rack, and the two rollers at the ends of the conveyor belt are both motorized and their speeds are perfectly synchronized.

The invention can be better understood by the following example of its use, to which it is not limited, where it has been applied to a silk-screen printing machine with a closed loop conveyor belt, although the invention can equally be applied to silk-screen printing machines with rotating tables, or silk-screen printing machines for pre-cut fabrics, or to any machine of considerable length which uses a flexible support and to which the system where an encoder is driven by a rack cannot be applied.

The example of how it can be applied is shown in the attached tables and drawings, in which:

Figure 1 outlines a plan view of a textile silk-screen printing machine;

Figure 2 is a side elevation of figure 1;

Figure 3 is a detail of one way the device can be constructed according to the invention;

Figure 4 is a detail of a second way the device can be constructed according to the invention.

With reference to figures 1 and 2, (1) is an automatic silk-screen printing machine for fabrics, consisting of a conveyor-belt (2) which is tensioned around two drive rollers (3 and 4) which are driven by two DC motors (5 and 6). Their speed is perfectly synchronized so the the conveyor belt (2) is perfectly tensioned both on its upper and lower surfaces.

The length of fabric to be printed (7) is glued to the conveyor belt, shown as a dotted line in figure 1, so that an 80 metre length of cloth can be printed on a machine 40 metre long.

The direction in which the belt rotates is shown in figure 1 by an arrow.

A drying kiln (8) is mounted on the final upper part of the machine, according to the direction in which the belt rotates, and is heated by infra-red lamps (9), for example. The automatic silk-screen printing device (10) is mounted on the other end of the belt, preferably but not necessarily in its inital area, as is outlined in the figures.

Along the entire length of the sides of the conveyor belt (2), a toothed belt (11) has been applied as shown in figure 3, consisting of a flexible belt made of a suitable material, such as rubber or thermoplastic, and one of its sides is toothed.

The detection device (12) is attached to the structure of the machine so that it is above and engages with the toothed belt (11), in such a way that it is driven by the toothed belt (11).

The detection device is constructed as in figure 3, and consists of a support structure, which is not shown in the figure, with a gear wheel (14) at one end and two smaller gear wheels (15 and 16) at the other end which keep a flexible belt loop with teeth on both sides (13) tensioned and in a loop. This double toothed belt is of the type commonly used in industrial robots and plotters, and forms a kind of track. A gear wheel which is attached to the drive shaft of an encoder (17) is positioned between the two smaller diameter gears and engages with the external teeth on the toothed belt (13).

The above described structure forms a type of track, and there is a guide (18) on its base that ensures that the external teeth in the double-toothed belt (13) engage correctly with the teeth on the single-toothed belt (11) which is attached to the side of the conveyor belt on the machine.

Figure 4 shows a variation to the example shown in figure 3. The drive assembly for the encoder (22) is again driven by a kind of track (23), however in this example the two gear wheels (24 and 25) are of the same diameter, and a gear wheel which is attached to the encoder drive shaft (27) is mounted between the two belt tensioning gear wheels in such a way that the gears engage with the teeth on the internal part of the double-toothed drive belt (23).

If the conveyor belt for transporting the fabric to be printed is fitted with a metal strip along its side making it more rigid, teeth (21) with the same length as the double-toothed drive belt teeth (23) can be applied directly to it, instead of using a toothed belt that has been glued to the metal strip. The external teeth on the drive belt (23), as shown in figure 4, engage equally well with the teeth (21) on the side rigidity strip because there is a guide (28) in between the two gear wheels (24 and 25) on the device (22), which ensures that the teeth on the belt (23) engage with the teeth on the side strip (21).

The rotating transducer (17 or 27) outputs electric signals corresponding to the rotation of its drive shaft on the basis of movements of the drive belt (13 or 23), and therefore of the movement of the conveyor belt on the machine. These signals are transmitted to a calculator which processes them, and are then transferred to the conveyor belt (2) drive motors (5 and 6) on the machine, so that precisely equal movements between one print and the next can be obtained.

The system works as follows:

The exact step distance (Sr) between one print and the next is calculated depending on the pattern to be printed, on the basis of the number of encoder drive shaft turns or fractions of turns.

The machine operator gives the control unit the OK to set the machine in motion, and the operating cycle that then takes place includes the following steps:

The control unit gives the OK for the forward feed of the conveyor belt, and the motors (5 and 6) begin to operate and drive the belt forward in the direction of the arrow for a distance equal to the set step distance (Sr) on the basis of the number of encoder drive shaft (17 or 27) turns or fractions of turns. Once the step length has been reached, a signal is sent to the control unit which stops the motors and the conveyor belt (2) stops.

The silk-screen printing device (10) then begins to operate and prints the first section.

This completes the first cycle of the machine, and the machine now begins a second cycle, and so forth, and thus there is an equal movement of a set length (Sr) at each step of the entire length of the belt.

Obviously, there is acceleration when the belt begins moving, and deceleration before it comes to a halt, but these are design details which do not affect the essence of the invention.

Each section (Sr) of the previously printed fabric is ready to have a second colour printed on top and is in precisely the same position as it was when the first colour was printed, so that alignment and printing are virtually perfect. This is also due in part to the fact that the two rollers (3 and 4) over which the conveyor belt is tensioned each have a drive motor (5 and 6) which are perfectly synchronized so that the teeth (11 or 21) on the conveyor belt always perfectly engage those on the detector drive belt (12 or 22).

In conclusion, although the description is based on how the system can be applied to an automatic silk-screen printing machine for fabrics, the invention can also be applied to cylinder presses for fabrics, where the system is used to synchronize the rotation of the roller and movement of the belt beneath, or to any kind of machine where the movements of two reciprocally operating parts must be controlled with great precision.

Claims

1) Device which guides and regulates the forward feed step of machines with an internittant forward feed, with special reference to automatic silk-screen printing machines, characterized by the fact that it has a rotating incremental type encoder (17 or 27) which determines the distance of each step (Sr) of the belt (2), and is inserted in a track type structure formed of two or more gear wheels (14 - 15 -16 or 24 - 25) around which passes a rubber high precision drive belt with teeth on both sides (13 or 23) of the type currently normally used on industrial robots and plotters, which is engaged with a second toothed belt (11) which runs along one of the sides of the conveyor belt on the machine, or with one of the steel side strips which make the belt more rigid and which has teeth (21) applied to its upper surface so as to form a flexible rack.

2) Device as per Claim 1, characterized by the fact that the two rollers (3 and 4) which tension and drive the conveyor belt (2) are each fitted with a motor (5 and 6), and that the speeds of these motors are perfectly synchronized so that the conveyor belt is perfectly tensioned and the teeth on the belt (11 or 21) engage perfectly with the teeth on the encoder drive belt (12 or 22).

3) Device as per Claim 1, characterized by the fact that the rotating incremental type encoder can either be coupled with the external teeth (17 in figure 3), or the internal teeth (27 in figure 4) of the double toothed belt (13 or 23) which supports, drives and connects the encoder (17 or 27) to the conveyor belt on the machine to which the fabric is glued.

4) Device as per Claims 1 and 2, characterized by the fact that there is a guide (18 or 28) on the base of the toothed belt (13 or 23) which has the function of ensuring that the external teeth on the drive belt (13 or 23) engage perfectly with the teeth on the toothed belt (11) or with the teeth (21) either fitted to the belt (2) or the metal side strip which makes it more rigid.

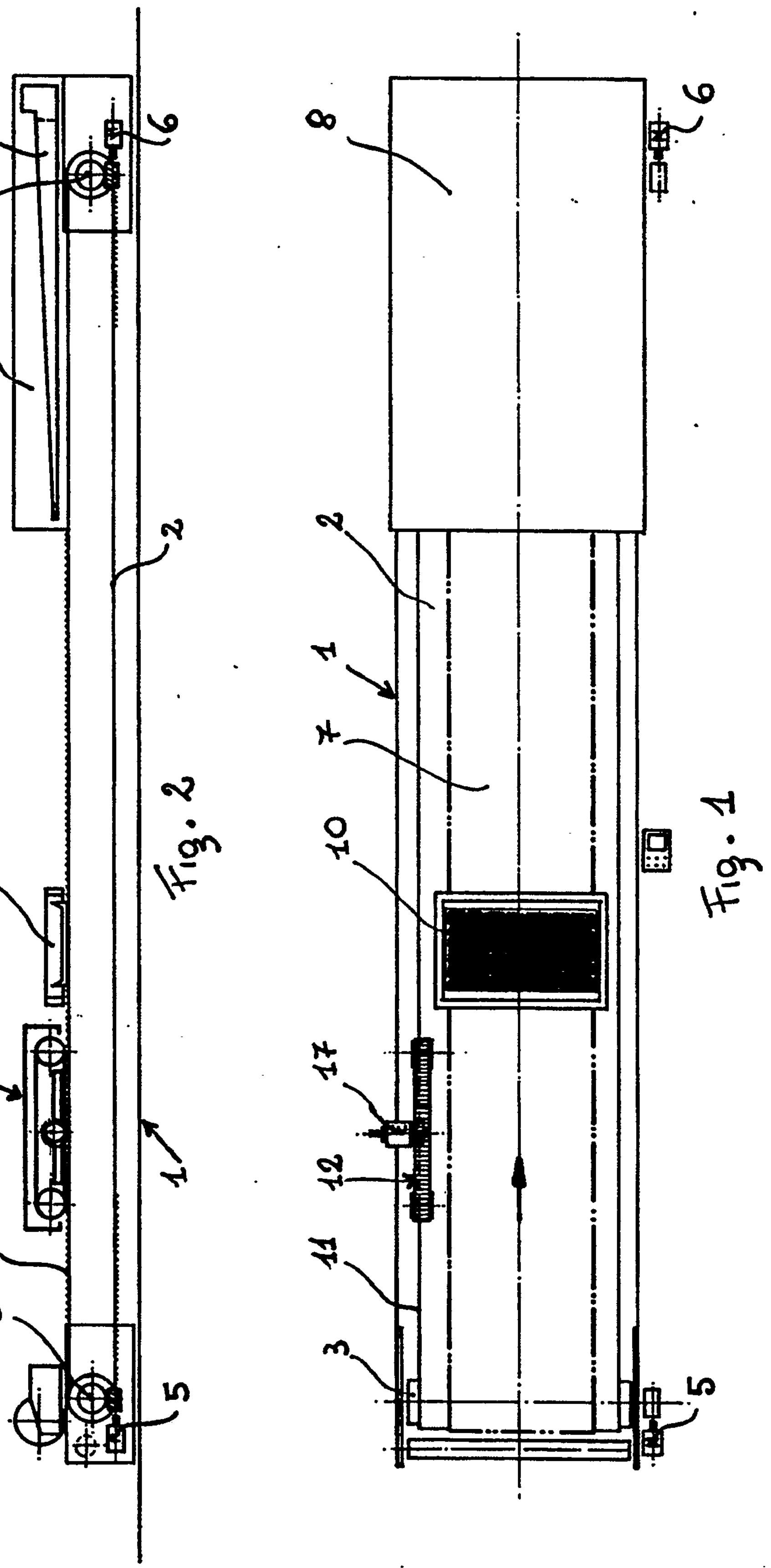

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Fig. 2
Fig. 1

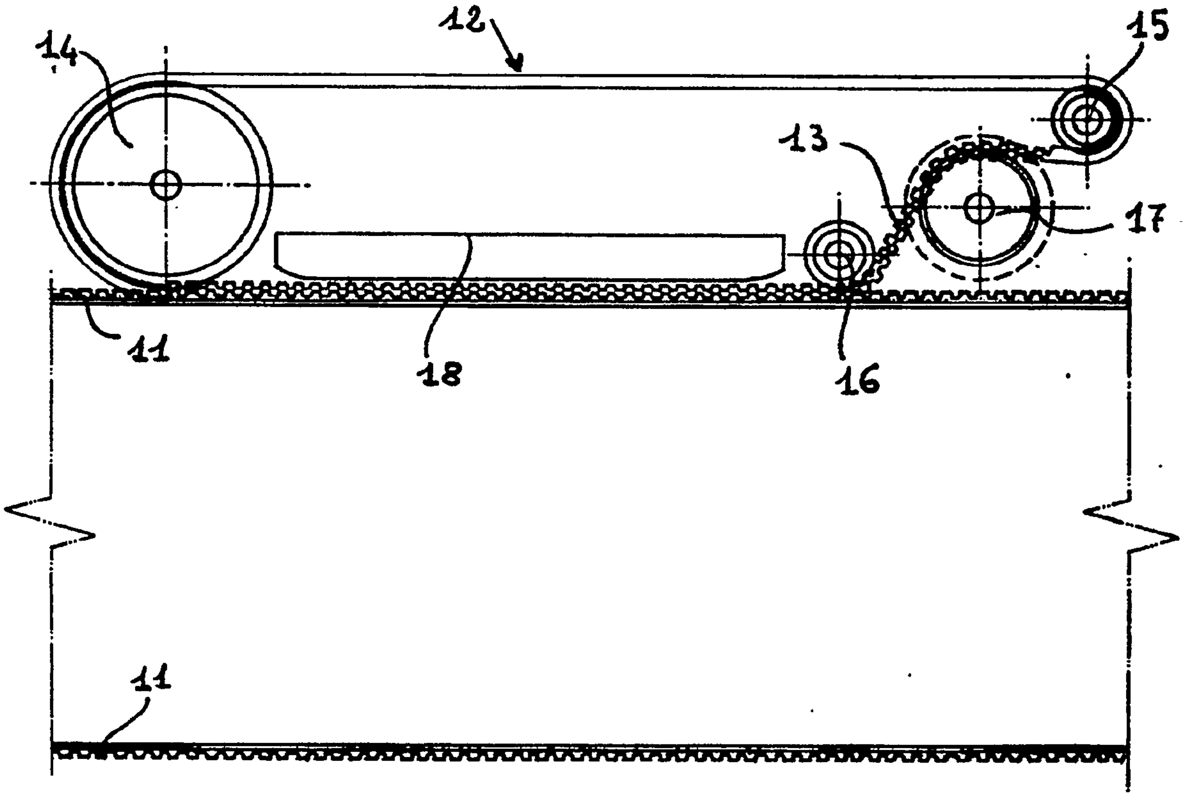

Fig. 3

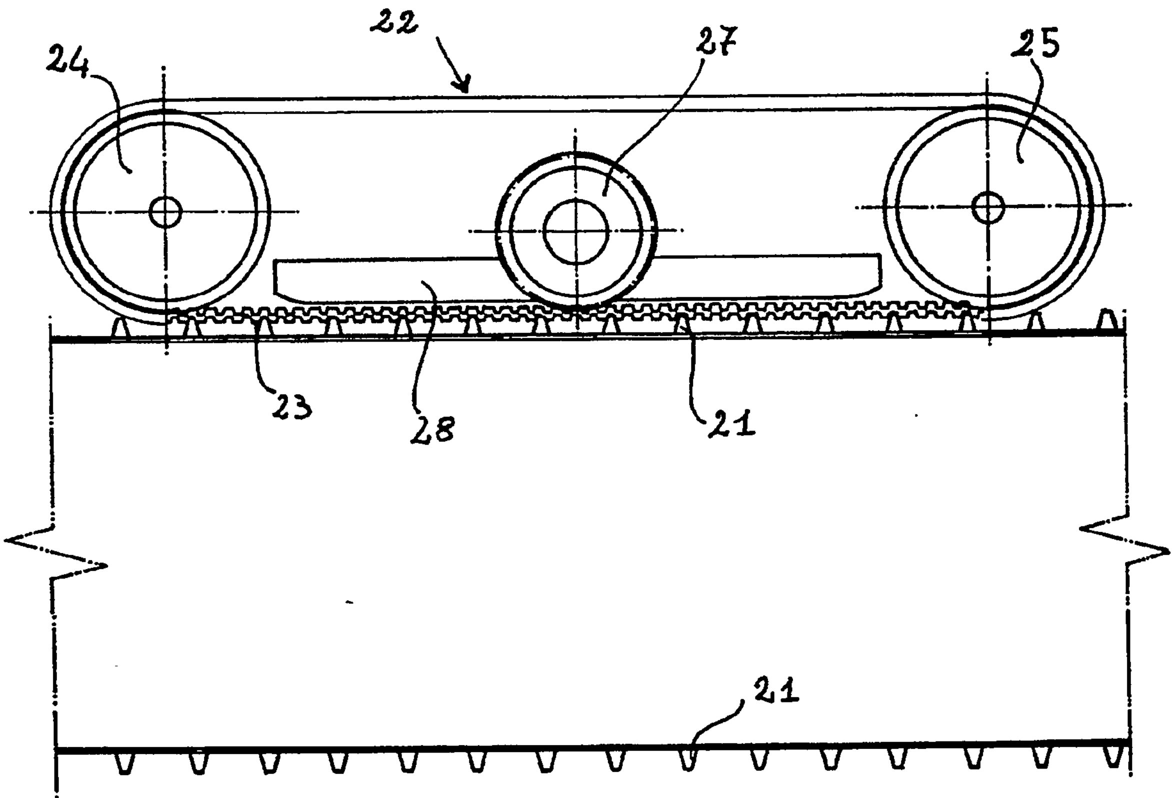

Fig. 4

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EUROPEAN SEARCH REPORT

Application Number

EP 91 20 0351

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.5)
A	EP-A-242 846 (MS MACCHINE E SISTEMI) * page 7, line 3 - page 8, line 4; figures 1-3 * -----	1-4	B41F15/10 B41F13/04
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			B41F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	09 JULY 1991	HAGBERG A.M.E.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
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T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
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