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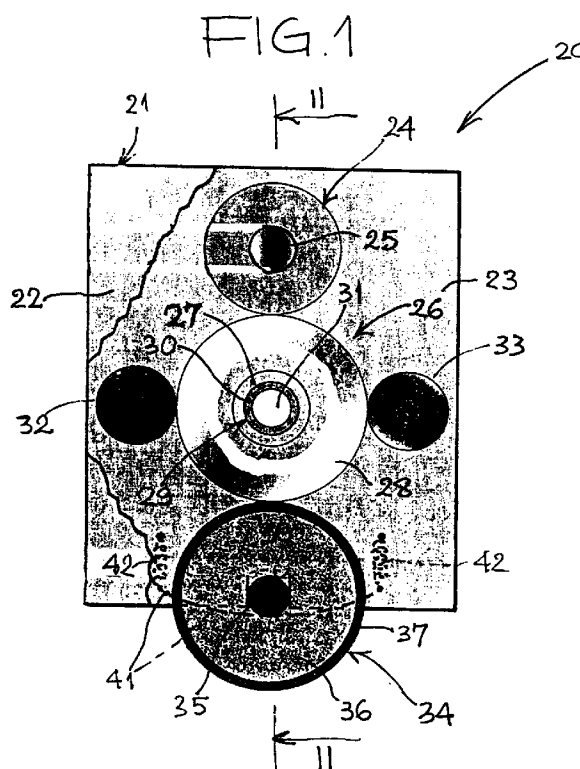
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(54) **Device, method and an equipment for thermally transferring an image onto an article**

(57) The device comprises a support structure (21) in which is mounted a motorised drive roller (24) rotatable about a fixed axis (X-X) in contact with a heating roller (26) which is rotatable in contact with a roller pad (34). The heating roller (26) and the roller pad are rotatable about respective axes (Y-Y; Z-Z) movable with respect to the support structure (21). The roller pad (34) is resiliently urged against the heating roller (26) towards the drive roller (24). A pair of free rollers (32, 33) retain the heating roller (26) between the roller pad (34) and the drive roller (24).



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Description

The present invention relates to devices for the thermal transfer of images onto articles.

In the description and in the following claims the term "images" is intended in a broad sense to mean a text, a drawing or a logo, a barcode, or any other two-dimensional graphic representation.

The invention relates in particular to a device for the thermal transfer of images onto articles, of the type defined in the introduction to Claim 1.

A device of this type is known from European patent application EP-A-0 572 999 in the name of the same applicant. This known device comprises a roller pad rotatable about an axis fixed with respect to a support plate, in contact with a heating roller which is freely rotatable. The roller pad is driven to rotate by means of a transmission comprising a belt passing over two return pulleys carried by the support plate. This latter can assume a raised position, in which the said belt is clamped between a return pulley and a wheel driven to rotate by a stationary motor to cause rotation of the roller pad and the heating roller in heat exchange relation. For printing an image on an article the support plate is lowered in such a way as to displace the roller pad towards the article. In this stage the belt transmission is uncoupled from the motor and the roller pad turns by friction with a moving ribbon which carries the image to be transferred to the article.

An object of the present invention is to provide an improved heat transfer device.

According to the invention this and other objects are achieved by a device according to the attached Claim 1.

The invention further relates to a process and an apparatus for printing images onto articles the characteristics of which are defined in the attached claims.

Further characteristics and advantages of the invention will become apparent from the following detailed description which is given purely by way of non-limitative example with reference to the attached drawings, in which:

Figure 1 is a partially sectioned front view of a device according to the invention;

Figure 2 is a sectioned view taken on the line II-II of Figure 1;

Figures 3 and 4 show variants of embodiments of the device according to Figure 1;

Figures 5 to 7 are schematic representations of three different apparatus including a device according to the invention;

Figure 8 is a partial schematic representation of a machine for performing a printing process according to the invention;

Figure 9 shows a roll on which both an inked ribbon and a receiver ribbon are wound, in a juxtaposed state, for use in a process according to the inven-

tion; and

Figures 10a, 10b and 10c show a sequence of operations in a printing machine according to the invention.

With reference to Figures 1 and 2, a device 20 according to the invention comprises a support casing 21. In the exemplary embodiment illustrated this casing has a substantially inverted U-shape with two facing side walls 22 and 23. Between these walls, in the upper part of the support casing 21, there is mounted a drive roller 24 rotatable about an axis X-X fixed with respect to the casing. This drive roller is constituted, at least in its outer parts, by a thermal insulation material, preferably a high hardness elastomeric material.

To one end of the roller 24 is connected a pulley 25 which can be connected to an electric drive motor by means of a belt or chain.

Beneath the roller 24, between the walls 22 and 23 of the support casing is mounted a heating roller generally indicated 26. This heating roller has an essentially tubular form and comprises an inner hub 27 of hard metal, such as nitrided steel, and an outer annular element 28 of material having a high thermal conductivity, preferably aluminium anodised on its outer surface.

The inner hub 27 of the heating roller 26 is rotatably mounted, substantially without radial play, about a heating device generally indicated 29 and comprising an outer cylindrical cladding 30 of hard metal material, for example nitrided steel fixed about a heater element 31 of type known per se, including within its interior one or more resistors. Conveniently the inner surface of the hub 27 and the outer surface of the element 30 are lapped for the purpose of reducing the friction between them and ensuring an optimum transmission of heat from the heater element 31 to the outer heat conductive element 28 of the heating roller 26.

As is shown in Figure 2, the ends of the heater element 31 are mounted with radial play in corresponding apertures positioned in the side walls 22 and 23 of the support casing 21. The heating roller 26, which is rotatably mounted about the heater element 31, is thus rotatable about an axis Y-Y which is movable relative to the support casing 1.

As is seen in Figure 1, the heating roller 26 is disposed between a pair of rollers 32 and 33 of thermal insulation material freely rotatably mounted about respective axes which are fixed with respect to the support casing 1.

Beneath the heating roller 26, between the side walls 22 and 23 of the support casing 21, is mounted a roller pad generally indicated 34. In the illustrated embodiment this roller comprises a shaft 35 on which is fixed a cylindrical layer 36 of thermal insulation material clad by a thin layer 37 of thermally conductive material. The thermal insulation layer 36 is constituted for example by a, preferably soft, elastomeric or plastics material. The thermally conductive surface layer 37 of the

roller pad 34 is constituted for example by a thermally conductive silicone material.

In the illustrated embodiment the ends of the shaft 35 of the roller pad 34 extend into corresponding lower slots 38 and 39 of the side walls 22 and 23 of the support casing.

The said ends of the shaft 35 of the roller pad are supported by support elements 40 and 41 in the form of leaf springs the ends of which, as seen in Figure 1, are suspended at the side walls 22 and 23 of the support casing by means of springs 42. These springs and the associated elements 40 and 41 tend to urge the roller pad 34 against the heating roller 28, this latter in turn being urged against the drive roller 24.

The diameter of the roller pad 34 is such that it is held in contact with the heating roller 26 without the ends of its shaft 35 engaging the bottom of the associated slots 38 and 39 of the side walls 22 and 23 of the support casing.

The roller pad 34 is therefore rotatable with respect to the support casing 21 about an axis Z-Z parallel to the axes X-X and Y-Y, this axis Z-Z not however being fixed with respect to the support casing 21.

In operation, when the drive roller 24 is driven to rotate by means of the associated pulley 25, it causes rotation of the heating roller 26 about the heating element 31. The heating roller 26 in turn drives the roller pad 34 to rotate. Since the drive roller 24 is (at least superficially) made of thermally insulating material it absorbs almost no heat from the heating roller 26. This latter on the other hand transfers heat to the surface layer 37 of the roller pad 34. This latter can then be applied to an article, with the interposition of a ribbon which, on its face facing the article, carries the image of thermofusible ink, to transfer this image thermally onto the article.

To cause application of the roller pad 34 onto an article to achieve the thermal transfer thereto, various arrangements can be adopted.

Some of these will now be described with reference to Figures 3 to 7.

In Figure 3 there is shown an arrangement in which the support casing 21 of the device 20 described above is connected to a supporting structure 50 so as to be movable in an essentially vertical direction with respect thereto. In the embodiment shown in Figure 3 the support casing 21 of the device 20 is connected to the supporting structure 50 by means of a pair of articulated arms 43 in such a way as to form an articulated parallelogram. The support casing 21 is connected to the rod 44a of a fluid pressure cylinder 44 the body 44b of which is pivotally connected to the supporting structure 50.

The pulley 25 connected to the drive roller 24 is coupled by means of a belt 45 to a pulley 46 driven to rotate by an electric motor 47 fixed to the supporting structure 50.

Conveniently, for the purpose of avoiding tensioning or stretching of the transmission belt 45, the axes of the

pulleys 25 and 47 preferably lie in a plane parallel to the arms 43.

In operation, energisation of the electric motor 47 causes rotation of the rollers 24, 26 and 34. By application of the roller pad 34 onto the article for transference of an image from a ribbon, there is caused a downward displacement of the support casing 21 by means of the cylinder 44.

In Figure 4 there is shown a variant embodiment in which the supporting structure 50 is mounted slidably along one or more guides 51 and is connected to a belt or chain 48 passing over two pulleys 49 one of which, in a manner not illustrated in Figure 4, has a drive motor associated therewith.

For a good printing of an image onto an article it is convenient that the speed of rotation of the roller pad 34 is suitably controlled as will be described hereinafter.

In Figure 5 there is shown a printing station for the thermal transfer of images from a ribbon 4 to an article A, in which the thermal transfer of the image takes place with the ribbon 4 stationary, whilst the article A is stationary. The transfer of the image takes place with apparatus of the type previously described with reference to Figure 4. To one of the pulleys 49 there is associated an electric motor 52 which, via a control unit 15 is synchronised with the motor 47 which, via the rollers 24 and 26, drives the rotation of the roller pad 34. Synchronisation between the motors 52 and 47 is such that the tangential velocity of the roller pad 34 in the image transfer phase is substantially equal to the speed of advance of the supporting structure of the device.

In Figure 6 there is shown another station for printing an image from a ribbon 4 onto an article A in linear motion on a belt or strip conveyor 53, driven by a motor 52'. The printing apparatus of Figure 6 is substantially of the type previously described with reference to Figure 3, with the supporting structure 50 stationary. Conveniently the apparatus of Figure 6 comprises a control unit 15 arranged to synchronise the motors 47 and 52' in such a way that in the thermal transfer phase of an image from the ribbon 4 to the article A the peripheral tangential velocity of the roller pad 34 is substantially equal to the linear velocity of displacement of the article A.

In Figure 7 there is shown a similar apparatus for printing an image from a ribbon 4 to an article A disposed rotatably on a pair of rollers 54 and 55, at least one of which is driven to rotate by a motor 52". The apparatus of Figure 7 comprises a device of the type previously described with reference to Figure 3, with the supporting structure 50 stationary. The motors 47 and 52" are synchronised by a control unit 15 in such a way that during thermal transfer of an image from the ribbon 4 to the article A the peripheral tangential velocity of the roller pad 34 is substantially equal to the peripheral tangential velocity of the article A.

The device for the thermal transfer of images according to the invention in the various embodiments

described up to now can be utilised in a final station of apparatus for printing onto articles images preliminarily provided on a ribbon according to one of various known methods, for example according to one of the methods known from European patent application EP-A-0 572 999 or according to one of the procedures which will be described hereinafter.

In Figure 8 the reference numeral 1 generally indicates a printing machine for performing a method according to the invention.

In the machine 1 an inked ribbon 2 is unwound from a roll 3 and a receiver ribbon 4 is unwound from a roll 5.

The inked ribbon 2 comprises a substrate 2a for example of mylar or polyester, on one face of which is applied a thermofusible ink layer 2b.

The receiver ribbon 4 comprises a substrate 4a, also constituted for example by a film of mylar or polyester, to one face of which is applied a coating or layer 4b of a substantially transparent material. In a first embodiment the layer 4b is thermofusible at a temperature greater than that of the ink 2b of the inked ribbon 2. The material of the layer 4b of the receiver ribbon 4 can be a wax, for example a paraffin wax, or a resin.

The ribbons 2 and 4 arrive at a first station 6 in which they pass in juxtaposed relation between a thermal print head 7, for example of the dot matrix type, and a counter-roller 8.

In particular the inked layer 2b of the inked ribbon 2 faces the transparent layer 4b of the receiver ribbon 4.

In the station 6 the thermal print head 7 causes selective transfer of ink 2b from the inked ribbon 2 to the transparent layer 4b of the receiver ribbon 4 in such a way as to form on the receiver ribbon a positive mirror image of the image which it is desired to print onto an article. This positive mirror image is indicated 9 in Figure 8.

In operation the thermal print head 7 is made to operate at a temperature such that it is able to cause selective transfer of ink from the inked ribbon to the receiver ribbon, but lower than the temperature at which the transparent layer 4b separates from the substrate 4a of the receiver ribbon.

In this phase the receiver ribbon 4 is in contact with the counter-roller 8 which "absorbs" a significant quantity of heat maintaining the receiver belt at a lower temperature than that of the inked ribbon 2 which is however in direct contact with the thermal print head 6.

Downstream from the station 6 the receiver ribbon 4 then reaches a further station 10 in which the positive mirror image is thermally transferred onto the surface of an article A carried for example by a conveyor belt 11. The station 10 is for example of the type shown in Figure 6.

At the station 10 the receiver ribbon 4 is now heated by means of a heat transfer device of type previously described, to a temperature such as to cause the transfer onto the surface of the article A both of the image and of a portion 4c of the transparent layer 4b with

which the receiver ribbon 4 is coated.

At the station 10 the contact surface between the ribbon 4 and the article A is relatively rather more extensive than the surface (line of dots) of contact between the head 6 and the ribbon 2 in the station 6. In the station 10 there is a transfer of a "mass" of heat to the receiver ribbon 4 which encourages a good transfer onto the article of the image and of part of the transparent coating of the ribbon 4.

At the station 10 the transfer of the image onto the article A can also be achieved whilst this article is stationary.

The portion 4c of the transparent material transferred onto the article A provides an effective protection for the image.

In the machine described above with reference to Figure 8 the ribbons 2 and 4 are unwound from two separate rolls indicated 3 and 5 respectively.

It is however possible to modify the machine according to Figure 8 in such a way that it includes a single roll from which both the inked ribbon 2 and the receiver ribbon 4 are unwound at the same time having been preliminarily wound on this roll or reel in juxtaposed condition as is shown in Figure 9.

This arrangement, as well as being a structural simplification of the machine, allows an easier reloading of new ribbons.

In the embodiment of the invention described above the transparent layer 4b of the ribbon is thermofusible at a higher temperature of that of the inked layer of the inked ribbon.

It is however possible to achieve selective transfer of this transparent layer in the second phase of the process thanks (only or also) to differences in the characteristics of layers of release agents interposed, in the inked ribbon, between the substrate 2a and the inked layer 2b and, in the receiver ribbon, between the substrate 4a and the transparent layer 4b.

In Figures 10a and 10c there is illustrated an embodiment of the printing machine according to the invention in which real time printing of an image having predetermined characteristics is made possible.

For this purpose, as is shown in Figure 10a, at the station 6 there is first formed a positive mirror image of that desired on the transparent layer 4b of the receiver ribbon 4 in the manner previously described with reference to Figure 8.

After this operation the inked ribbon 2 and receiver ribbon 4 are both caused to advance further at the same speed, whilst the printing station 6 is deactivated, until the previously-formed positive mirror image is carried to the second print station 10.

In Figures 10a and 10c the print station 10 is shown inverted with respect to the arrangement shown in Figure 8.

The positive mirror image is then transferred onto an article A at the station 10, again in the manner previously described with reference to Figure 8.

After this operation the ribbons 2 and 4 are made return, by an amount substantially equal to the distance travelled by the receiver ribbon 4 between the first station 6 and the second station 10, as is shown in Figure 10b, until these ribbons are brought back to the position illustrated in Figure 10c, in which the transfer of ink from ribbon 2 to ribbon 4 commencing from portions of these ribbons utilized for the preceding image print can be recommenced.

The above-described method can be performed by means of an appropriate prearrangement of an electronic control unit of the machine, indicated 15 in Figure 10a, which controls the motors which drive the advance and return of the two ribbons.

As an alternative to what has been described with reference to Figures 10a to 10c, it is however possible to achieve the same result by stopping the inked ribbon in the position of Figure 10a and, having raised the head 6, then making only the receiver ribbon 4 advance and, after transfer of the image onto the article in the station 10 causing the receiver ribbon 4 to retract in such a way as to achieve the condition shown in Figure 10c, from which printing of a new image can be started.

Claims

1. A device for thermal transfer of images onto articles (A), comprising

a support structure (21),
a heating roller (26) and a roller pad (34) mounted rotatably in contact with one another, and
motor means (24, 25, 45-47) operable to cause rotation of both the heating roller (26) and the roller pad (34);

the roller pad (34) being intended to be applied to an article (A) with the interposition of a ribbon (4) which, on the face facing the article, carries an image of thermofusible ink for thermal transfer of the image onto the article (A);

characterised in that

the said motor means comprise a motorized drive roller (24) rotatably mounted about an axis (X-X) which is fixed with respect to the said structure (21), in contact with the heating roller (26);

the heating roller (26) and the roller pad (34) being mounted rotatably about respective axes (Y-Y; Z-Z) which are movable relative to the said structure (21); the roller pad (34) being associated with resilient means (41, 42) tending to urge it against the heating roller (26) towards the drive roller (24); the heating roller (26) being associated with lateral guide means (32, 33) operable to retain it between the drive

roller (24) and the roller pad (34).

2. A device according to Claim 1, characterised in that the drive roller (24) is constituted, at least in its radially outermost zone, by a thermal insulation material, preferably an elastomeric material.
3. A device according to Claim 1 or Claim 2, characterised in that the roller pad (34) comprises a radially inner portion (36) of thermal insulation material, provided with a coating (37) of thermally conductive material, preferably a silicone.
4. A device according to any preceding claim, characterised in that the heating roller (26) comprises a tubular body (28) of thermally conductive material, preferably aluminium or an alloy thereof, rotatably mounted about a tubular casing (30, 31) of thermally conductive material containing at least one heater resistor.
5. A device according to any preceding claim, characterised in that the said guide means comprise two rollers (32, 33) freely rotatable about respective fixed axes with respect to the support structure (21); the said guide rollers (32, 33) being disposed on opposite sides of the heating roller (26).
6. A device according to any preceding claim, characterised in that it includes a supporting structure (50) to which the said support structure (21) is connected so as to be movable along a predetermined direction; between the said structures (50, 21) there being provided actuator means (44) operable to cause displacement of the support structure (21) with respect to the supporting structure (50).
7. A device according to Claim 6, characterised in that the support structure (21) is coupled to the supporting structure (50) by articulated quadrilateral connection means (43).
8. A device according to Claim 6 or Claim 7, characterised in that the said drive roller (24) is coupled to a motor (47) fixed to the said supporting structure (50).
9. A device according to any preceding claim for thermal transfer of an image onto a stationary article (A), characterised in that the said support structure (50, 21) is associated with second motor means (52) operable to cause a displacement in a predetermined direction, substantially parallel to the surface of the article intended to receive the image; control means (15) being provided to control the said first motor means (47) and the said second motor means (52) in such a way that during transfer of an

image the peripheral tangential velocity of the roller pad (34) is substantially equal to the speed of displacement of the support structure (50, 21) along the said direction.

10. A device according to any of Claims 1 to 8 for the transfer of an image onto an article (A) in linear motion in a predetermined direction; characterised in that it comprises control means (15) adapted to control the said motor means (47) in such a way that during transfer of an image onto an article (A) the peripheral tangential velocity of the roller pad (34) is substantially equal to the speed of displacement of the said article (A).
11. A device according to any of Claims 1 to 8 for the transfer of an image onto an article (A) in rotary motion about an axis; characterised in that it comprises control means (15) operable to control the said motor means (47) in such a way that during the transfer of an image onto the article (A) the peripheral tangential velocity of the roller pad (A) is substantially equal to the peripheral tangential velocity of the article (A).
12. Use of a thermal transfer device according to one or more of the preceding claims for printing images onto an article (A).
13. A method of printing an image onto an article (A) including
 - a first phase of selective thermal transfer of thermofusible ink (2b) from a flexible inked ribbon (2) to a face of a flexible receiver ribbon (4) in such a way as to form on the receiver ribbon (4) a positive mirror image (9) of an image to be printed onto the article (A), and
 - a second phase in which the positive mirror image (9) is thermally transferred from the receiver ribbon (4) to the article (A) by means of a device according to any of Claims 1 to 11, in such a way as to form a desired image on the article;
 - the receiver ribbon (4) having a coating or layer (4b) of a substantially transparent material on the face intended to receive the positive mirror image (9);
 - the positive mirror image (9) being transferred onto the said coating or layer (4b) of the receiver ribbon in the first phase (4);
 - both the image and a portion (4c) of the said coating or layer (4b) of the receiver ribbon (4), which covers the said image, being transferred to the article (A) in the second phase.
14. A process according to Claim 13, characterised in that the coating or layer (4b) of the receiver ribbon

(4) is thermofusible at a higher temperature than that of the ink (2b) of the inked ribbon (2).

15. A method according to Claim 13 or 14, in which the inked ribbon (2) comprises a supporting substrate (2a) on which is applied an ink layer (2b) with the interposition of a layer of a first release agent and in which the receiver ribbon (4) comprises a substrate (4a) on which the said substantially transparent coating or layer (4b) is applied with the interposition of a layer of a second release agent;
 - characterised in that the layers of release agents on the inked ribbon (2) and the receiver ribbon (4) are formed in such a way that in the first phase the inked ribbon (2) can yield ink to the receiver ribbon (4), and in the second phase the receiver ribbon (4) can yield to the article (A) the ink (9) received in the first phase and a portion of the said substantially transparent coating or layer (4b).
16. A method according to any of Claims 13 to 15, characterised in that the inked ribbon (2) and the receiver ribbon (4) are unwound from a single coil onto which they have previously been wound in juxtaposed condition.
17. A method according to any of Claims 13 to 15, characterised in that the inked ribbon (2) and the receiver ribbon (4) are unwound from separate rolls or coils (3,5).
18. A method according to any of Claims 13 to 17, in which for printing an image in real time the positive mirror image (9) is formed, in the first phase, on the receiver ribbon (4) at a first station (6), then at least the inked ribbon (2) is caused to advance whilst the first station (6) is deactivated, to transfer the receiver ribbon (4) to a second station (10) at which the said second phase is performed; after the said second phase has been performed the receiver ribbon (4) is caused to retract by an amount substantially equal to the distance previously travelled from the said first to the said second station (6; 10), to allow the subsequent transfer of ink from the inked ribbon (2) to the receiver ribbon (4) at the first station (6) substantially starting from portions of such ribbons immediately upstream of the portions utilized for the printing of the preceding image.
19. Printing apparatus for performing the method according to one or more of Claims 13 to 18, comprising a first station (6) operable to perform a selective thermal transfer of thermofusible ink (2b) from a flexible inked ribbon (2) to a face of a flexible receiver ribbon (4) in such a way as to form on the receiver ribbon (4) a positive mirror image (9) of the image to be printed on an article (A), and a second station (9) operable to effect thermal transfer of the

positive mirror image (9) from the receiver ribbon (4) to the article (A) in such a way as to form the desired image on it; the machine being characterised by the fact that the second station (10) comprises a device according to one or more of claims 1 to 11, is able to apply to the receiver ribbon (4) a higher temperature than that applied to the inked ribbon (2) in the first station (6) in such a way that both the image and a portion (4c) of the said coating or layer (4b) of the receiver ribbon (4) are transferred to the article (A).

20. Apparatus according to Claim 19 for the performance of the method according to Claim 18, characterised in that it comprises means (15) operable to cause a reversal of the displacement of the inked ribbon (2) and the receiver ribbon (4).

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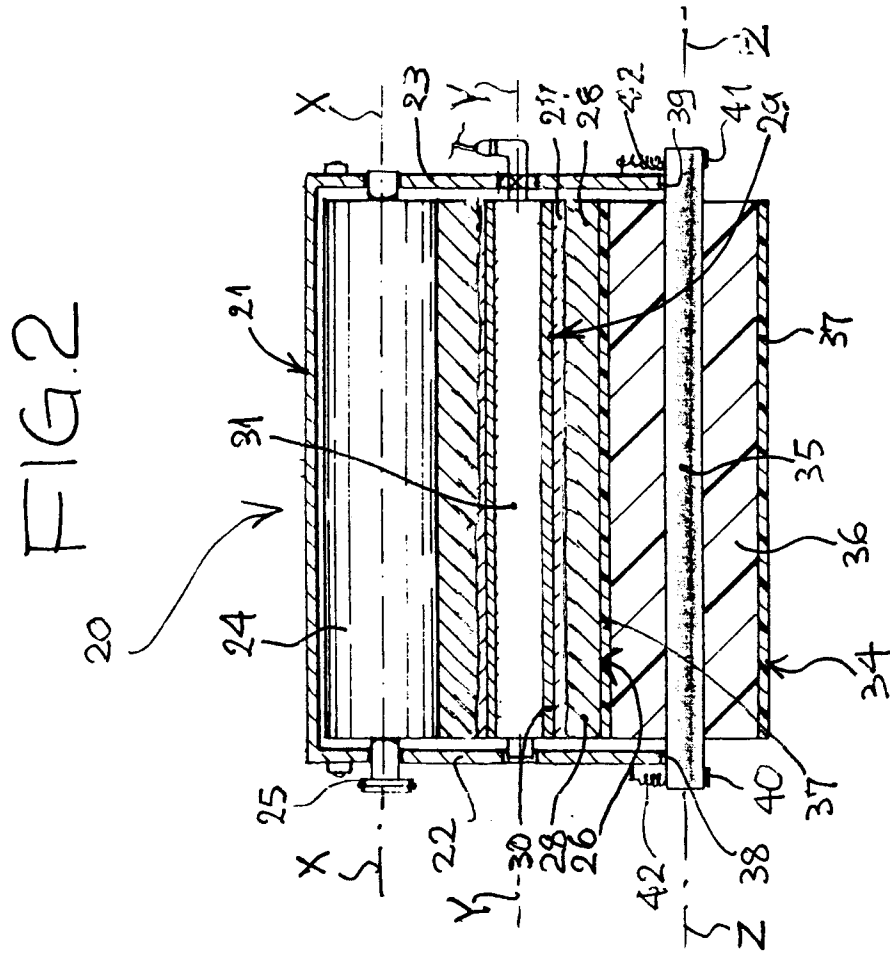
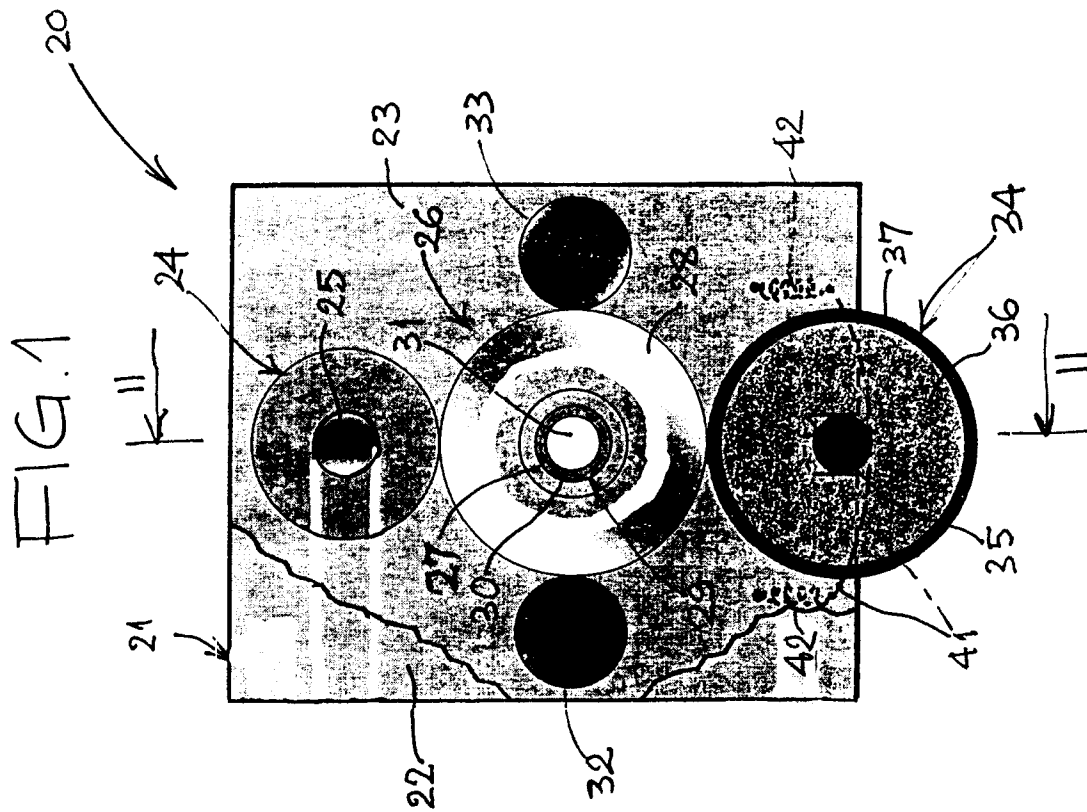


FIG. 4

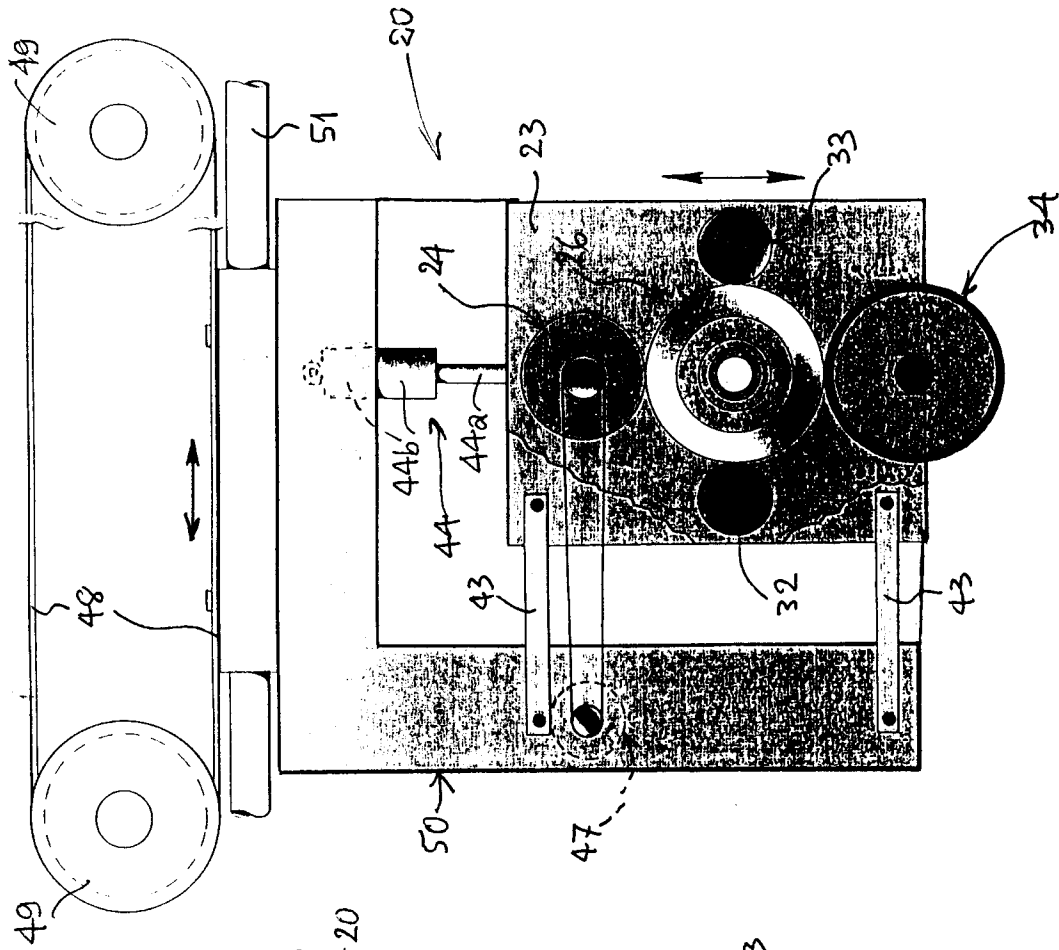
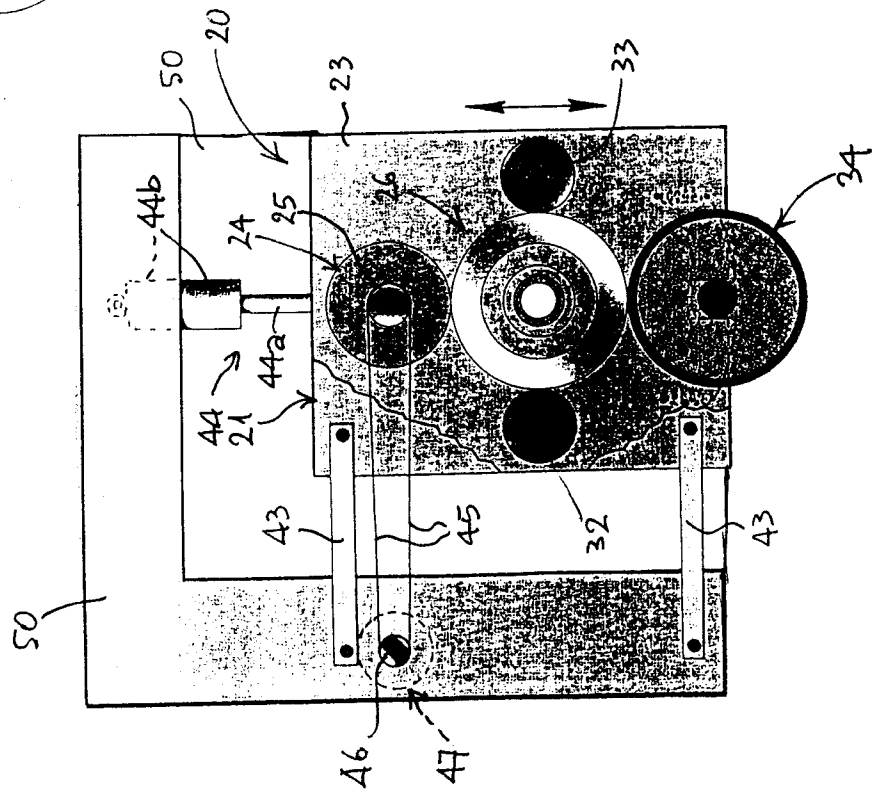


FIG. 3



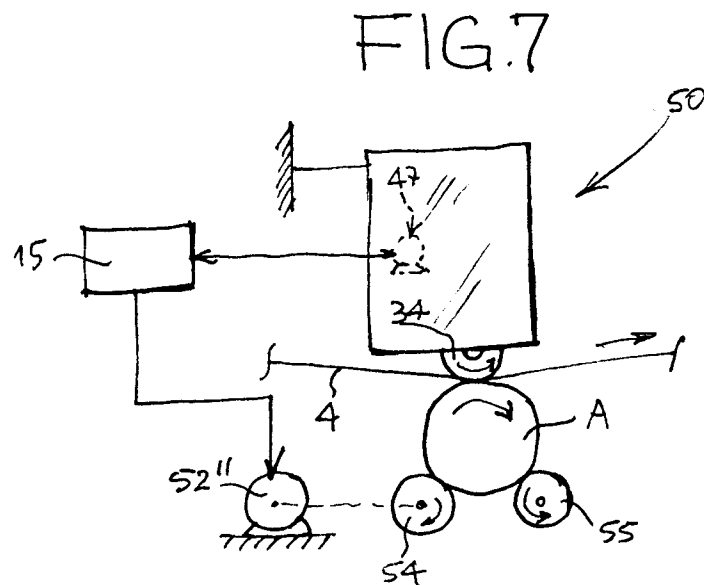
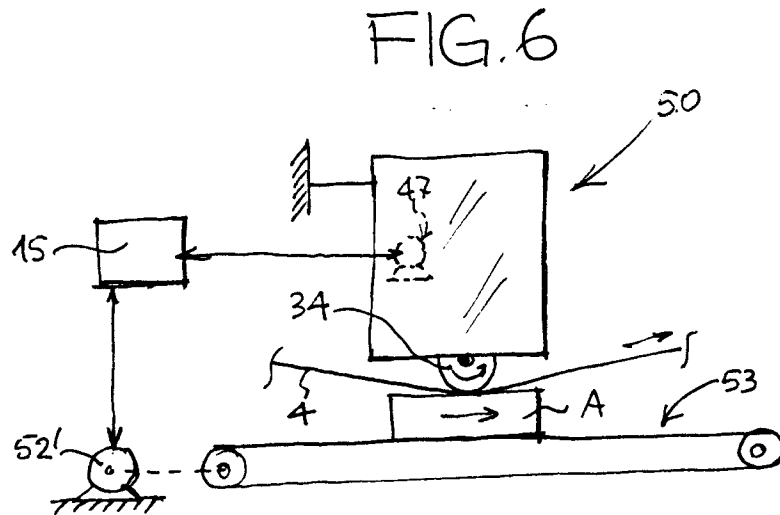
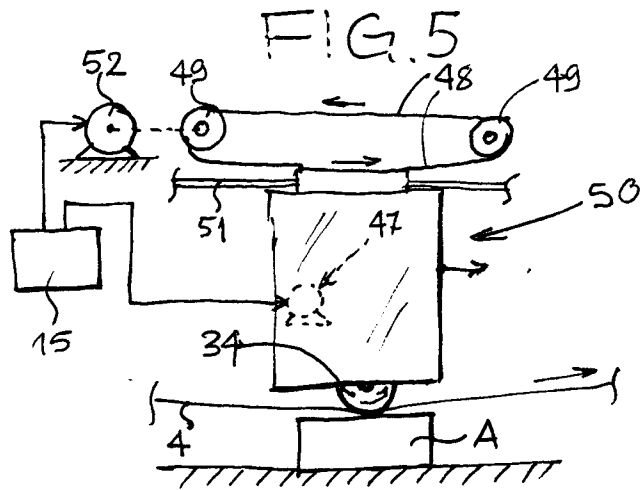


FIG. 8

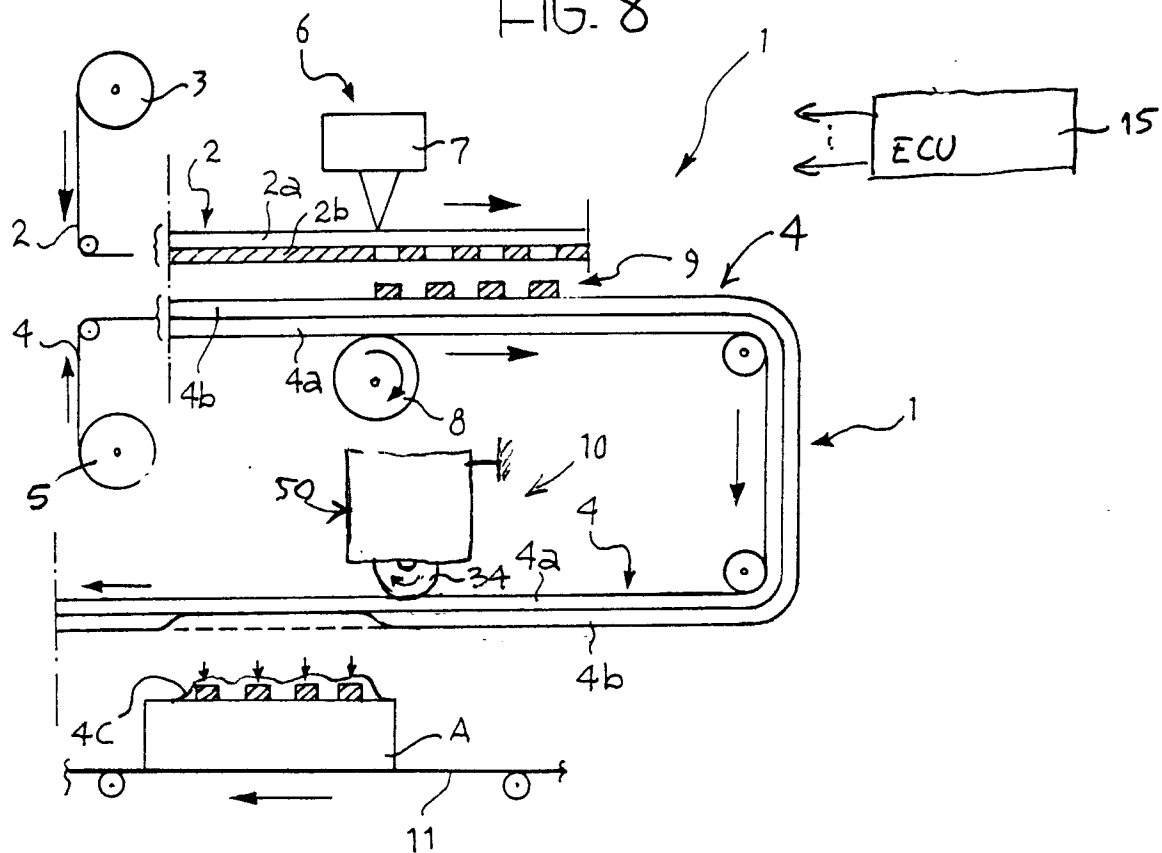


FIG. 9

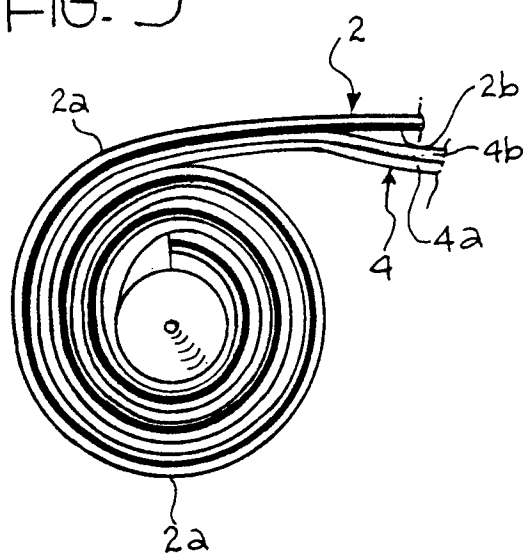


FIG. 10a

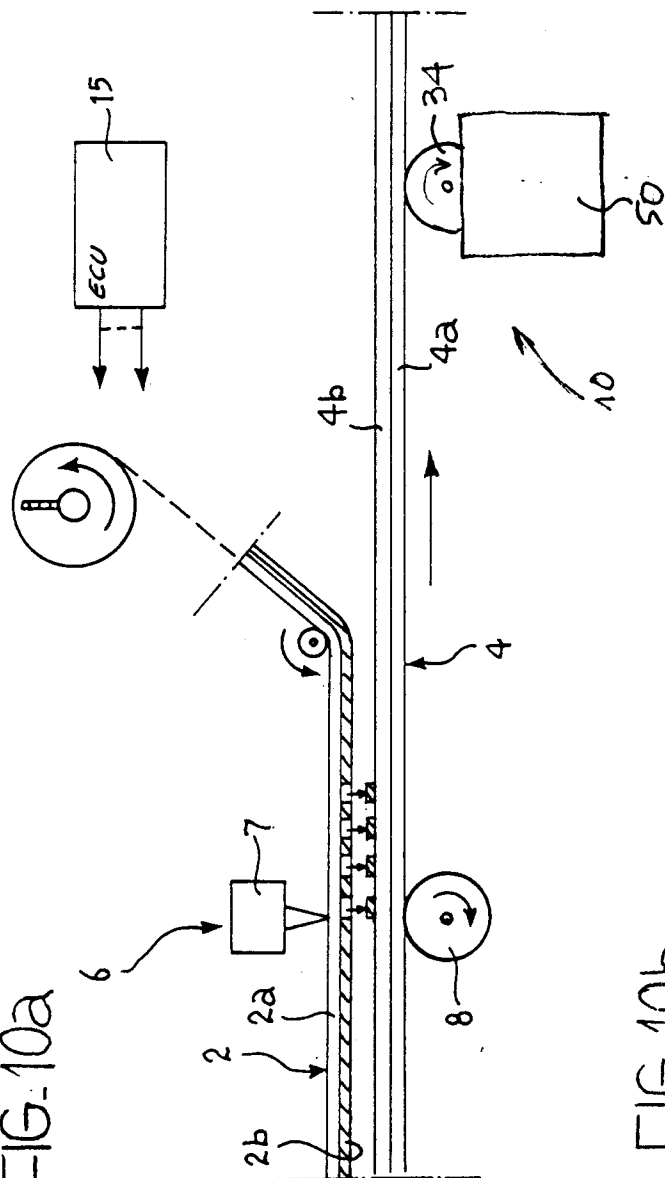


FIG-10b

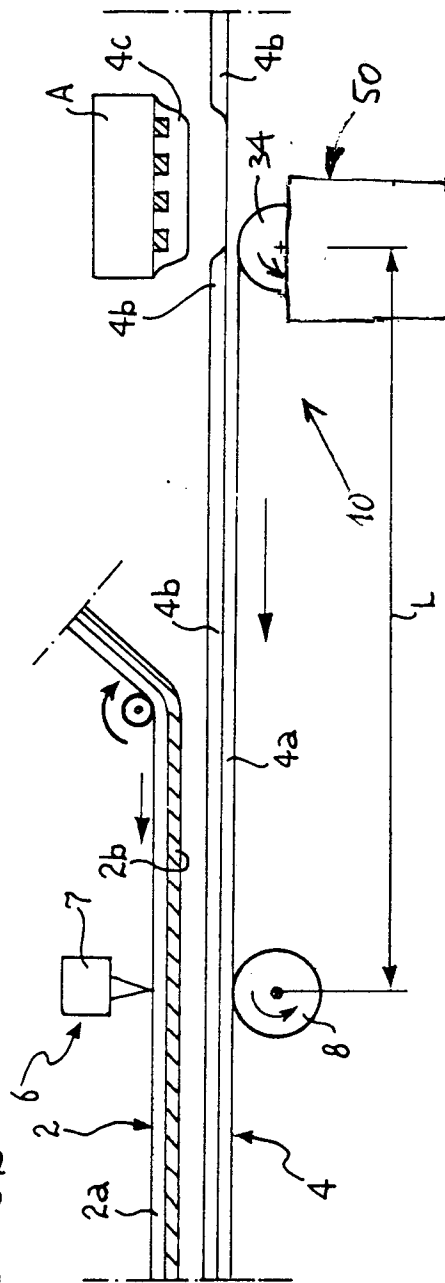


FIG. 10c

