



(51) International Patent Classification:
B31F 1/07 (2006.01)

(21) International Application Number:
PCT/IT2009/000347

(22) International Filing Date:
30 July 2009 (30.07.2009)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
FI2008A000148 1 August 2008 (01.08.2008) IT

(71) Applicant (for all designated States except US): **FABIO PERINI S.P.A.** [IT/IT]; Via per Mugnano, I-55100 Lucca (IT).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **BENVENUTI, Angelo** [IT/IT]; Via del Chiasso, 327, I-55100 Lucca (IT). **FRACASSI, Tiziano** [IT/IT]; Via di Molina 17/0, I-55013 Lammari, Lucca (IT).

(74) Agents: **MANNUCCI, Michele** et al.; Uff. Tecn. Ing. A. Mannucci S.r.l., Via della Scala 4, I-50123 Firenze (IT).

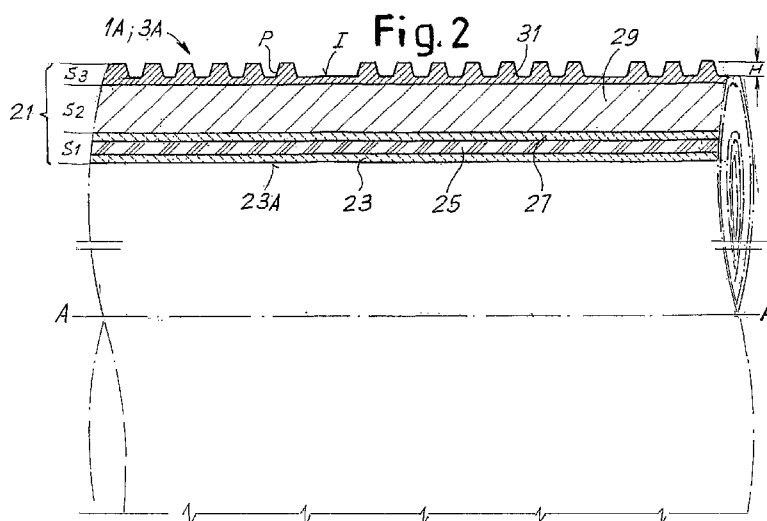
(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

(54) Title: INTERCHANGEABLE SLEEVE FOR EMBOSSED ROLLERS AND EMBOSSED UNIT COMPRISING AT LEAST ONE OF SAID SLEEVES



(57) Abstract: The sleeve (1 A;3A) comprises a multi-layer structure with at least one inner layer (23) forming an inner surface cooperating with a support element (1B; 3B); an intermediate layer (29) in carbon fibers in synthetic resin matrix and an engraved metallic outer layer (31) forming embossing protuberances (P).

"INTERCHANGEABLE SLEEVE FOR EMBOSSING ROLLERS AND EMBOSSING UNIT COMPRISING AT LEAST ONE OF SAID SLEEVES"

DESCRIPTION

Technical Field

5 The present invention relates to improvements to embossing rollers and in particular, although not exclusively, to embossing rollers for processing so called tissue paper for the production of toilet paper, kitchen towel, handkerchiefs, napkins and the like.

State of the Art

10 In the tissue paper converting industry for producing absorbent and sanitary products, such as in particular toilet paper, kitchen towel and similar products, an embossing process is often used to modify the technical - functional and aesthetic characteristics of the product. Embossing is used in particular to increase the thickness, the absorption capacity, the softness of the product, as well as to give a decorative aesthetic effect by means of patterned protuberances.

15 The embossing of the paper plies is performed by making the ply pass between a pressure roller, usually coated in a yielding material, such as synthetic rubber, natural rubber or other, and an embossing roller made of a relatively rigid material. This latter is provided on its surface with protuberances, arranged according to a pattern which is then reproduced on the processed paper material due to the effect of the permanent deformation and of the breakage of the fibers which form the material.

20 It is necessary to replace the embossing rollers in order to produce paper materials with different patterns or different technical - functional characteristics. This operation is particularly expensive and long - lasting, and it therefore requires prolonged down times, highly affecting the final cost of the product.

25 There is an increasing need for replacing the embossing rollers quite often, to meet the requirements of the market. To reduce the costs deriving from the replacement of the embossing rollers and also to reduce the cost for producing the rollers, solutions have been studied, wherein the traditional monolithic embossing roller, i.e. an embossing roller formed in a single piece with an engraved surface, is replaced by spindles or
30 tailstocks to which interchangeable sleeves are torsionally coupled, on which the embossing incisions are provided. This approach has been frequently used in the field of printing machines, but its use in the field of embossing units presents various difficulties, due to the compression stresses of the embossing rollers which are much higher

than the substantially negligible stresses which occur on the printing rollers, as during embossing the protuberances of the embossing roller must penetrate the elastically yielding thickness coating of the pressure roller so as to deform in an irreversible manner the paper passing in the embossing nip between the pressure roller and the embossing roller. Torsional stresses are also particularly high. The compression stresses and the torsional stresses cause difficulties in designing the structure of the interchangeable sleeves and in the coupling between the interchangeable sleeve and the spindle or core of the roller, or the support and rotation tailstocks.

Summary of the Invention

According to one aspect, the object of the present invention is to provide an interchangeable sleeve for embossing rollers which has better characteristics relative to the interchangeable sleeves currently known for the embossing field.

In particular, the invention provides for an interchangeable sleeve having a multi-layer structure including: at least one inner layer forming an inner surface cooperating with a support element, such as for example a tailstock or a pair of tailstocks, a core or a central spindle; an intermediate layer of carbon fibers in a synthetic resin matrix; and an engraved metallic outer layer forming embossing protuberances.

In some embodiments, the structure of the interchangeable sleeve has one or more layers of composite material, typically a synthetic resin reinforced with fibers. The fibers can be staple fibers, or woven fibers in the form of continuous yarns, or fibers in the form of mono - filament or multi - filament obtained through extrusion and therefore with a continuous structure. If not otherwise specified, in the present description and in the attached claims the term "fiber" means generally any elongated article, with a defined or not defined length, continuous or discontinuous.

Preferably, the most inner layer of the interchangeable sleeve is made of a composite material of the above mentioned type, reinforced with fibers, preferably glass fibers. With respect to other reinforcing fibers made of other materials, glass fibers allow to obtain optimum mechanical resistance and elastic characteristics. These fibers can be made of glass containing mainly silicon dioxide (SiO_2), for example with a silicon dioxide content comprised between 50 and 56%, with a high presence of calcium oxide, boron oxide, aluminum oxide, in combination or singularly. It is also possible to use fibers with a higher silicon dioxide content, for example until 65-68% with the addition of significant percentages of aluminum dioxide and / or magnesium oxide, singularly or in

combination, for example between 20 and 30% and between 9 and 12% respectively. The percentages are in weight.

In other embodiments, the fibers can be also of a different nature, for example polymeric fibers, typically aramid fibers. It is also possible to use thermoplastic fibers, polyester fibers, nylon[®] fibers or other fibers typically used for the production of composite materials with a fiber-reinforced synthetic resin matrix.

The multi - layer structure of the sleeve can also present a second layer made of composite material arranged between the inner layer and the outer layer. In some cases further intermediate layers are provided, for example made of elastomeric material, in closed - cell or open - cell foam, or the like. These layers can have for example the function of forming an adaptation or interface layer between adjacent layers having differing mechanical characteristics from one another, and thus not particularly suitable for working in direct contact one with the other. In some embodiments the intermediate layers made of elastomeric material, foam or the like give to the sleeve a greater radial compressibility so as to facilitate assembly and disassembly operations on and from a core or central spindle through for example the use of compressed air, which is injected through radial or nearly radial holes obtained in the cylindrical shell of the spindle or central core.

In a preferred embodiment of the present invention, the interchangeable sleeve comprises, from the inside to the outside:

- a first inner layer in a composite material, typically and preferably synthetic resin matrix reinforced with fibers (advantageously glass fibers) forming said inner surface;
- a layer of elastomeric material;
- a second, intermediate layer of composite material, typically and preferably synthetic resin matrix reinforced with fibers, advantageously glass fibers;
- the layer of carbon fibers in a synthetic resin matrix;
- and the metal layer engraved to form embossing protuberances.

This composition is particularly advantageous, as on one hand it allows the expansion through pneumatic systems to allow the insertion and the extraction of the sleeve onto and from a support spindle, and on the other hand it has a high resistance against compression deformation. The structure is therefore particularly adequate for the use in the manufacturing of embossing rollers which must support high pressure

stresses, and at the same time it can be used for the production of sleeves which are inserted about the support spindle forming the core of the embossing roller by radial expansion obtained by means of compressed air.

For a better adaptation of the various layers forming the sleeve, in some embodiments an intermediate layer can be provided, made in foam or foamed material and arranged between the second layer in resin reinforced with glass fibers and the layer of carbon fibers, or arranged between the layer of carbon fibers and a second carbon layer. Some materials used in the foamed (honeycomb) intermediate layer are aluminum and paper reinforced with resin.

One or the other or both the layers of resin reinforced with glass fibers can have a matrix comprised of a synthetic resin such as for example polyester, in particular and preferably an unsaturated polyester. An example of a suitable resin can be the Synolite 1862-N-1 produced by DSM Resins. In other embodiments, vinyl resins (such as for example vinyl ester), epoxy resins, phenolic resins are used.

The reinforcement fiber of the composite layer or layers can be in the form of staple fibers or also in the form of continuous filaments, for example helically wound, or also in the form of nonwoven fabrics. In some embodiments the fibers are in the form of woven fabric, although it is also possible to use knitted fabric. Particularly advantageous is the use of glass fibers in the form of woven fabric. Materials of this type are manufactured for example by Saint-Gobain Technical Fabrics America, Inc., USA.

Although the glass fibers are currently preferred and allow to obtain particular advantages in terms of static and dynamic behavior, of lightness and resistance of the interchangeable sleeve, it is also possible to use reinforcements produced with other fibers or filaments, not based on glass, but for example polymeric fibers, typically aramid fibers, for example of the type marketed under the denomination Kevlar, used for manufacturing composite materials having a synthetic resin matrix.

In some embodiments the elastomeric material forming the layer arranged between the first and the second layer of reinforced synthetic resin can be a foamed polyurethane resin. A possible suitable material is the resin marketed by the Elastogran GmbH (Germany) under the denomination Cellasto[®]. The layer in question can have a hardness comprised between 30 e 45°A (Shore degrees), preferably comprised between 35 and 40°A.

According to some embodiments, the resin matrix of the carbon fiber layer can

be produced in a two-component epoxy resin with a low polymerization temperature (for example about nearly 60°C). An example of two-component epoxy resin suitable for the purpose is the Araldite LY3505 (resin) and Aradur XB3403 (hardener), produced by "Huntsman LLC", USA. Other resins which can be used for the production of the re-
5 inforced carbon fibers layer can be chosen among the resins suitable for the production of the resins reinforced with glass fibers.

The outer metallic layer can be produced for example through electro deposition and can be constituted of copper, a copper alloy, zinc or other suitable metallic materials. In some embodiments the outer metallic layer can be obtained from a tube in a me-
10 tallic material, for example aluminum, onto which a deposition is subsequently performed, for example a Thermal Spray deposition, of copper, zinc and alloys thereof. However, the electro deposition has better characteristics as regards the porosity. The spray deposition of metallic material can be performed also directly onto the carbon fiber tube

15 Preferably, after the metallic material has been deposited, the sleeve is worked by engraving the metallic layer so as to generate the embossing protuberances. Engraving can be performed according to any one of the known techniques, provided that they are compatible with the metallic material which forms the most outer layer of the sleeve and with the embossing pattern. For example, engraving can be performed mechani-
20 cally, by chip removal, or by means of plastic deformation, or chemical removal, through acids, with a laser engraving system, or in other suitable manner. After engraving, and grinding if required, the engraved surface is subjected to a hardening treatment, for example chromium plating, or nickel electroplating (both as a mono layer or in combination), chromium oxide or carbides with Thermal Spray process, without Teflon
25 coating but with silicone oil treatment, so that all the surface, both of the protuberances and of the cavities of the obtained roller, is hardened and therefore it lasts longer.

The engraved surface can be furthermore hardened as described in EP-A-1747094 so as to make the surface less adhesive.

The various layers which form the interchangeable sleeve are advantageously
30 connected to one another in a stable manner, i.e. in an irreversible manner, contrary to what occurs in some types of rollers or interchangeable sleeves used for printing, wherein two or more cylindrical sleeves (each formed by one or more layers) are coupled in a reversible manner. In particular, joining between the various layers can be ob-

tained due to the effect of the hardening and/or the cross-linking of the synthetic materials which form the matrices of the fiber-glass-reinforced resin (resin reinforced with glass fibers) and carbon fibers in resin matrix and/or of elastomeric material. The metallic layer is anchored to the carbon fiber layer below due to the direct effect of the electro
5 deposition technique with which this layer is produced.

In some embodiments the multi-layer structure formed by the first fiber-glass-reinforced resin layer or other composite material, the elastomeric material layer and the second layer made of fiber-glass-reinforced resin or other composite material can have a thickness comprised between 2 and 15 mm, for example between 2,5 and 10 mm, preferably
10 between 3,5 and 8 mm, and more preferably between 4 and 6 mm, being understood that in the present description all the intermediate values and all the intervals of thickness among the above mentioned values are expressly included in the present description.

The layer made of carbon fibers in a synthetic resin matrix can have a thickness
15 for example between 5 and 20 mm, preferably between 7 and 15 mm and more preferably between 8 and 12 mm, for example about 10 mm. The metallic layer has a thickness which can be comprised between 1 and 16 mm, preferably between 1 and 5 mm, and more preferably between 2 and 3 mm, being understood that in both the cases, both as regards the carbon fiber layer and the metallic layer, all the intermediate values and all
20 the possible intervals between the above mentioned values are expressly included in the present description.

The height of the protuberances obtained by engraving of the metallic layer is preferably greater than 0.8 mm and preferably greater than 1.3 mm and typically comprised between 1.3 and 2.5 mm or preferably between 1.3 and 1.8 mm, according to and
25 consistently with the requirements of the embossing and the height of the embossed protuberances to be obtained on the paper ply processed by means of the sleeve in question. All the values intermediate to that mentioned above shall be understood as expressly disclosed and included in the present description, as well as all the possible intervals between said values.

30 In some embodiments, at the ends of the interchangeable sleeve two metallic rings can be mounted, one for each end, with a seat for a key. These rings have a double function:

1. they serve for making surfacing through galvanic technique, making the passage

of current on the sleeve possible;

2. they prevent the relative sliding between the interchangeable sleeve and the roller onto which the sleeve is mounted, during the stop/braking phase of the roller, thanks to keys on the roller which engage in seats for key obtained in the metallic rings.

According to a further aspect, the invention also relates to an embossing unit including a pressure roller coated with an elastically yielding material, cooperating with an embossing roller with an interchangeable sleeve as defined above. Typically, in an embossing unit according to the invention the pressure roller and the embossing roller are pressed one against the other with a linear load sufficiently high to cause the penetration of the protuberances of the sleeve forming the outer wall of the embossing roller into the elastically yielding layer with which the pressure roller is coated, so as to cause the permanent deformation of the web material which is fed in the nip between said two rollers. In some embodiments, the linear load between the two pressure and embossing rollers respectively is equal to or greater than 10 kg/cm, preferably 15 kg/cm.

Brief description of the drawings

The invention will be better understood by following the description below and the attached drawing, which shows a non-limiting practical embodiment of the invention. The various drawings are not in scale, and it must be understood that the single layers represented in the drawings are shown with thicknesses not necessary proportional to the real thicknesses. More in particular, in the drawing:

figure 1 shows a diagram of an embossing unit comprising two embossing rollers, each of which comprised of a central spindle or core and by an interchangeable sleeve;

figure 2 shows a longitudinal enlarged section of a portion of the interchangeable sleeve in one embodiment of the present invention;

figure 3 shows a longitudinal enlarged section of a portion of an interchangeable sleeve in a further embodiment of the present invention;

figure 4 shows a longitudinal enlarged section of a portion of an interchangeable sleeve in a further embodiment of the present invention;

figure 5 shows a longitudinal section of an interchangeable sleeve according to the present invention in a preferred embodiment of the invention, provided with end rings; and

figure 6 and 7 show enlarged details VI and VII of figure 5.

Detailed description of embodiments of the invention

Figure 1 schematically represents a configuration of a possible embossing -
laminating unit to which a sleeve according to the present invention can be applied. The
unit, indicated as a whole with number 2, comprises a first embossing roller 1 consti-
tuted by an interchangeable sleeve 1A inserted onto a spindle or core 1B and torsionally
and axially coupled to it. The core or spindle has, in a known manner, end pads with
which support shanks of the embossing roller 1 are integral. With the embossing roller 1
cooperates a second embossing roller 3, provided with an interchangeable sleeve 3A
mounted and torsionally and axially coupled to a spindle or core 3B. The interchange-
able sleeves 1A and 3A can be designed in the manner described below with reference
to figure 2.

Between the embossing rollers 1 and 3 a laminating nip 5 is formed, in which the
protuberances of the interchangeable sleeves 1A and 3A, which form the outer and ac-
tive cylindrical surface of the embossing rollers 1 and 3, cooperate one with the other so
as to laminate two plies V1 and V2 which have been separately embossed by the em-
bossing rollers 1 and 3 in the manner described below.

With the embossing roller 1 cooperates a first pressure roller 7, provided with an
outer elastically yielding layer 7A, made of synthetic rubber or other suitable material.
In the embossing nip between the rollers 1 and 7 the first ply V1 is fed, so as to be em-
bossed by penetration of the protuberances of the embossing roller 1 inside the elasti-
cally yielding coating 7A of the embossing roller 7. In a similar manner the embossing
roller 3 cooperates with a second pressure roller 9 provided with an elastically yielding
coating 9A so as to emboss the second ply V2 in the embossing nip 3, 9.

A glue dispenser 8 cooperates with the first embossing roller 1, which applies, in
a known manner, a glue onto some or all the protuberances produced by embossing on
the ply V1 whilst it is still engaged to the surface of the embossing roller 1. In this way
it is possible to obtain, at the exit of the laminating nip 5, a web material N formed by
the two plies V1, V2, embossed and reciprocally glued due to the effect of the reciprocal
pressure between the protuberances of the rollers 1 and 3. The two plies V1 and V2 can
be in turn formed by one or more layers. In some embodiments also further intermediate
plies can be provided, fed between the plies V1 and V2 directly in the laminating nip be-
tween the embossing rollers 1 and 3.

An embossing unit 2 of the type described above, called tip-to-tip, is known per se to those skilled in the art and does not require further explanations. It must be understood that the embossing unit to which the present invention applies can also have different configurations, for example it can be, instead of a tip-to-tip embossing unit, a nested embossing unit, or also a simple embossing unit with only one embossing roller having a respective interchangeable sleeve and only one pressure roller. It is also possible to apply the present invention to an embossing unit wherein embossing is obtained between two substantially rigid embossing rollers, one of which is provided with protuberances and the other with cavities which mesh one with the other, wherein preferably both the rollers cooperating with each other comprise an interchangeable sleeve.

Figure 2 schematically shows a section of a portion of one of the interchangeable sleeves 1A, 3A. A-A indicates the axis of the sleeve, which has a multi-layer structure 21. In some embodiments the multi-layer structure 21 has a first inner layer 23 made of glass fiber-reinforced resin, i.e. in a synthetic resin matrix reinforced with glass fibers. The layer 23 has an inner surface 23A, which cooperates with the outer surface of the core or spindle 1B, 3B of the corresponding embossing roller. The coupling between the interchangeable sleeve and the core or spindle can be obtained by mechanical coupling by manufacturing the surface 23A and the corresponding outer surface of the core or spindle 1B, 3B with a slight draft as described for example in WO-A-03045680. Alternatively, the surface 23A can be cylindrical and the core or spindle 1B, 3B can be provided with holes exiting on its cylindrical surface so as to inject compressed air between the outer surface of the core and the inner surface 23A of the interchangeable sleeve, so as to cause the radial expansion of this latter and therefore to facilitate the insertion and the extraction thereof relative to the central core, the sleeve radially narrowing and therefore blocking on the core of the roller when the feeding of compressed air ceases. In other embodiments mechanical blocking expansion systems can be provided inside the core of the roller. It is also possible to mount the interchangeable sleeve between tailstocks instead that on a central core, depending on the flexural and compression loads exerted on the sleeve during the use.

A layer 25 made of elastomeric material, for example polyurethane foam, is applied on the outer surface of the glass fiber-reinforced resin layer 23

A second layer 27 made of glass-fiber-reinforced resin, i.e. made of synthetic resin reinforced with glass fibers, is applied outside the elastomeric layer 25. The layers

23, 25, 26 are joined to each other so as to form a monolithic structure during the formation phase of the layers, for example due to the effect of the cross-linking and/or of the hardening of the resins. The overall thickness (S1) of the whole of the layers 23, 25, 27 can be advantageously in the order of 3-8 mm, for example about 5 mm.

5 On the outer surface of the layer 27 made of glass-fiber-reinforced resin a carbon fiber layer 29 is applied. More in particular, the layer 29 is made of a synthetic resin matrix into which a plurality of carbon filaments are embedded, preferably helically wound about the axis A-A of the interchangeable sleeve 1A, 3A. The manufacturing technique for producing these carbon fiber layers are known per se. Usually, the carbon fibers,
10 previously impregnated with resin in a fluid or pasty state, are wound about the outer surface of the layer 27 below, so that in the subsequent hardening phase a cylindrical block is formed constituted by the synthetic resin matrix and by the carbon fibers embedded therein. The layer 29 can be formed by helically winding one or more carbon fiber layers if necessary alternate with a winding according to right and left helices respectively,
15 so as to obtain a structure with a better mechanical behavior. The overall thickness S2 of the layer 29 can vary from few millimeters to some centimeters, for example between 5 and 25 mm, preferably between 8 and 15 mm, for example about 10 mm.

On the outer surface of the carbon fiber layer 29 a layer 31 is arranged in metallic material, typically copper or an alloy thereof, advantageously deposited by galvanic means.
20

The layer 31 in metallic material is engraved chemically, through laser, mechanically or in other suitable manner, so as to form embossing protuberances P. The protuberances P can have any suitable shape. They can be for example of simple frustum - cone or frustum-pyramid shape, or they can have a more complex path so as to define
25 decorative patterns and motifs. In some embodiments the protuberances can be of different heights. Furthermore, in some embodiments of the present invention, the protuberances can form both a background embossing pattern, if necessary with protuberances of particularly small sizes, and a decorative embossing pattern, if necessary with
30 protuberances of greater dimensions (height and/or cross dimension).

The thickness S3 of the metallic layer 31, at the protuberances P, can be comprised between 0.5 and 8 mm, preferably between 2 and 4 mm, for example in the order of 2-3 mm, whilst the protuberances P can have a height H suitable of the type of proc-

essing which must be performed on the paper material, for example a height comprised between 0.5 and 3 mm, typically of about 1-2 mm, for example 1.3-1.8 mm.

The whole outer surface of the engraved metallic layer 31 has a hardening treatment I which covers both the front surfaces of the protuberances P, and the flanks thereof, as well as the inner surfaces of the cavities between the protuberances P. The hardening can be obtained for example by chromium plating or other techniques, for example nickel electro surfacing (both as a mono layer or in combination), chromium oxide or carbides with Thermal Spray process, without Teflon coating but with silicone oil treatment.

Figure 3 shows, in an enlarged longitudinal section similar to that of figure 2, a different embodiment of the sleeve according to the present invention. The same reference numbers are used to indicate identical or equivalent parts to those in figure 2. The difference with respect to this latter is that a foam or cell layer, for example an open cell or a closed cell layer, indicated with 28, is interposed between the layer 27 made of glass-fiber-reinforced resin and the carbon fiber layer in resin matrix 29. The foam or cell layer 28 can e.g. be made of thermoset foams, such as cellular cellulose acetate (CCA), polyester, polyurethane. In other embodiments the layer 28 is made of a syntactic foam, obtained by mixing glass microspheres, epoxy resin or phenolic resin in a fluid resin with fillers and hardening agents so as to form a printable mass. Other suitable materials for the layer 28 are foams based on cross-linked PVC or linear PVC.

Figure 4 shows a longitudinal section of a different structure of a sleeve according to the invention. The same reference numbers indicate parts identical or equivalent to those in figure 3. In this case the sleeve has the following layers (from the inside to the outside): a layer 23 made of fiber glass-reinforced resin, defining the inner surface 23A; an elastomeric layer 28A; a layer 27 made of glass fiber-reinforced resin; a layer 29A made of resin reinforced with carbon fibers; a layer 28B made of foamed material for example a foam; a layer 29B made of carbon fiber-reinforced resin; an engraved metallic layer 31, for example copper.

In some embodiments the ends of the sleeve 1, 3A can be provided with metallic rings 51 (see figures 5, 6, and 7), for example made of steel or other material with high mechanical resistance and preferably electrically conductive. The rings are frontally fixed to the ends of the sleeve and have preferably one or more radially and frontally open cavities 51A (see in particular figure 7). The rings 51 can be used in order to facili-

tate the electro deposition and/or chromium plating. Furthermore, and in any case also in case of deposition of the outer layer by means of a technique different from the electro-deposition, the rings 51 have the function of blocking the sleeve on the roller, core on inner core, by means of keys which engage in the cavity 51A. This gives a greater certainty that the sleeve does not rotate relative to the core or inner roller for example in the phase of braking or stopping of the embossing roller.

The outer layer of the sleeve is described above as an engraved metallic layer, but it is also possible to use other materials with suitable physical characteristics, for the production of the outer layer and of the respective protuberances P.

It is understood that the drawing only shows an example provided by way of a practical arrangement of the present invention, which can vary in forms and arrangements without however departing from the scope of the concept underlying the invention. Any reference numbers in the appended claims are provided for the sole purpose of facilitating reading of the claims in the light of the description and the drawing, and do not in any manner limit the scope of protection represented by the claims.

Claims

1. An interchangeable sleeve for an embossing roller, with a multi-layer structure comprising at least one inner layer forming an inner surface cooperating with a supporting element; an intermediate layer of carbon fibers in a synthetic resin matrix,
5 and an outer layer forming embossing protuberances.
2. An interchangeable sleeve as claimed in claim 1, wherein said outer layer is made of engraved metal.
3. An interchangeable sleeve as claimed in claim 1 or 2, wherein said inner layer is formed by a composite material with a synthetic resin matrix reinforced with fi-
10 bers, preferable glass fibers.
4. An interchangeable sleeve as claimed in claim 1 or 2, comprising, from the inside towards the outside:
 - the first inner layer of composite material comprising a synthetic resin matrix with reinforcing fibers, forming the inner surface;
 - 15 – a layer of elastomeric material;
 - a second, intermediate layer of composite material comprising a synthetic resin matrix with reinforcing fibers;
 - the layer of carbon fibers in a synthetic resin matrix;
 - and outer layer engraved to form embossing protuberances.
- 20 5. An interchangeable sleeve as claimed in claim 4, wherein said reinforcing fibers are chosen from the group comprising: glass fibers; polymer fibers.
6. An interchangeable sleeve as claimed in claim 4 or 5, wherein said reinforcing fibers are in a form chosen from the group comprising: staple fibers; continuous filaments; fibers or filaments in the form of non-woven fabric; fibers or filaments in the
25 form of woven fabric; fibers or filaments in the form of knitted fabrics.
7. An interchangeable sleeve as claimed in one or more of the previous claims, wherein the surface of the engraved metal layer is provided with a surface hardening.
8. An interchangeable sleeve as claimed in one or more of claims 4 to 7,
30 wherein an intermediate layer of foam or cell material is inserted between said second layer of resin reinforced with fibers and said layer of carbon fibers in a resin matrix.
9. An interchangeable sleeve as claimed in one or more of claims 4 to 8, wherein at least one of said first and second layer of synthetic resin reinforced with fi-

bers comprises a matrix of synthetic resin chosen from the group comprising: polyester; vinyl ester; epoxy resins; phenolic resins; thermoplastic resins, in particular polyethylene, polystyrene, polypropylene, polyamides, nylon[®].

10. An interchangeable sleeve as claimed in one or more of claims 4 to 9,
5 wherein said elastomeric material is constituted by an open cell or closed cell foamed resin, preferably a foamed polyurethane resin.

11. An interchangeable sleeve as claimed in one or more of claims 4 to 9,
wherein said elastomeric material has a Shore hardness between 30 and 45°A (Shore degrees), preferably between 35 and 40°A.

10 12. An interchangeable sleeve as claimed in one or more of the previous claims, wherein the synthetic resin matrix of the carbon fibers layer is based on epoxy resin, preferably a two-component epoxy resin with a low polymerization temperature.

13. An interchangeable sleeve as claimed in one or more of the previous claims, wherein said layer of carbon fibers in a synthetic resin matrix comprises a distri-
15 bution of helically wound continuous carbon filaments.

14. An interchangeable sleeve as claimed in one or more of the previous claims, wherein said layer of carbon fibers comprises a structure based on carbon fibers chosen from the group comprising: a non-woven fabric; a woven fabric; a knitted fabric.

15. An interchangeable sleeve as claimed in one or more of the previous
20 claims, wherein said outer layer is made of one or more materials chosen from the group comprising: copper, zinc, aluminum and their alloys.

16. An interchangeable sleeve as claimed in one or more of the previous claims, wherein the layers of which it is composed are stably and irreversibly connected to one another.

25 17. An interchangeable sleeve as claimed in one or more of the previous claims, wherein said surface hardening comprises a chromium plating, or nickel electroplating, either as a single layer or in combination, chromium oxide or carbides with Thermal Spray process, without Teflon coating but with silicone oil treatment.

18. An interchangeable sleeve as claimed in one or more of claims 4 to 17,
30 wherein said first layer of reinforced synthetic resin, said layer of elastomeric material and said second layer of reinforced synthetic resin have a total thickness between 2.5 and 10 mm, preferably between 3.5 and 8 mm and more preferably between 4 and 6 mm.

19. An interchangeable sleeve as claimed in one or more of the previous claims, wherein said layer of carbon fibers in a synthetic resin matrix has a thickness between 5 and 20 mm, preferably between 7 and 15 mm and more preferably between 8 and 12 mm.

5 20. An interchangeable sleeve as claimed in one or more of the previous claims, wherein said metal layer has a thickness between 1 and 6 mm, preferably between 1.5 and 4 mm and more preferably between 2 and 3 mm.

 21. An interchangeable sleeve as claimed in one or more of the previous claims, wherein said protuberances have a height equal to or greater than 0.8 mm, preferably equal to or greater than 1.3 mm and more preferably between 1.3 and 1.8 mm.

10 22. An interchangeable sleeve as claimed in one or more of the previous claims, including at its ends reinforcing rings.

 23. An interchangeable sleeve as claimed in claim 22, wherein said reinforcing rings include cavities for the engagement of keys for torsional blocking.

15 24. An interchangeable sleeve as claimed in claim 22 or 23, wherein said reinforcing rings are made of metal, preferably steel, or other electrically conductive material.

 25. An embossing unit comprising a pressure roller coated in an elastically yielding material, cooperating with an embossing roller with an interchangeable sleeve
20 as claimed in one or more of the previous claims.

 26. An embossing unit as claimed in claim 25, wherein said pressure roller and said embossing roller are pressed against each other with a linear load equal to or greater than 10 kg/cm.

1/4

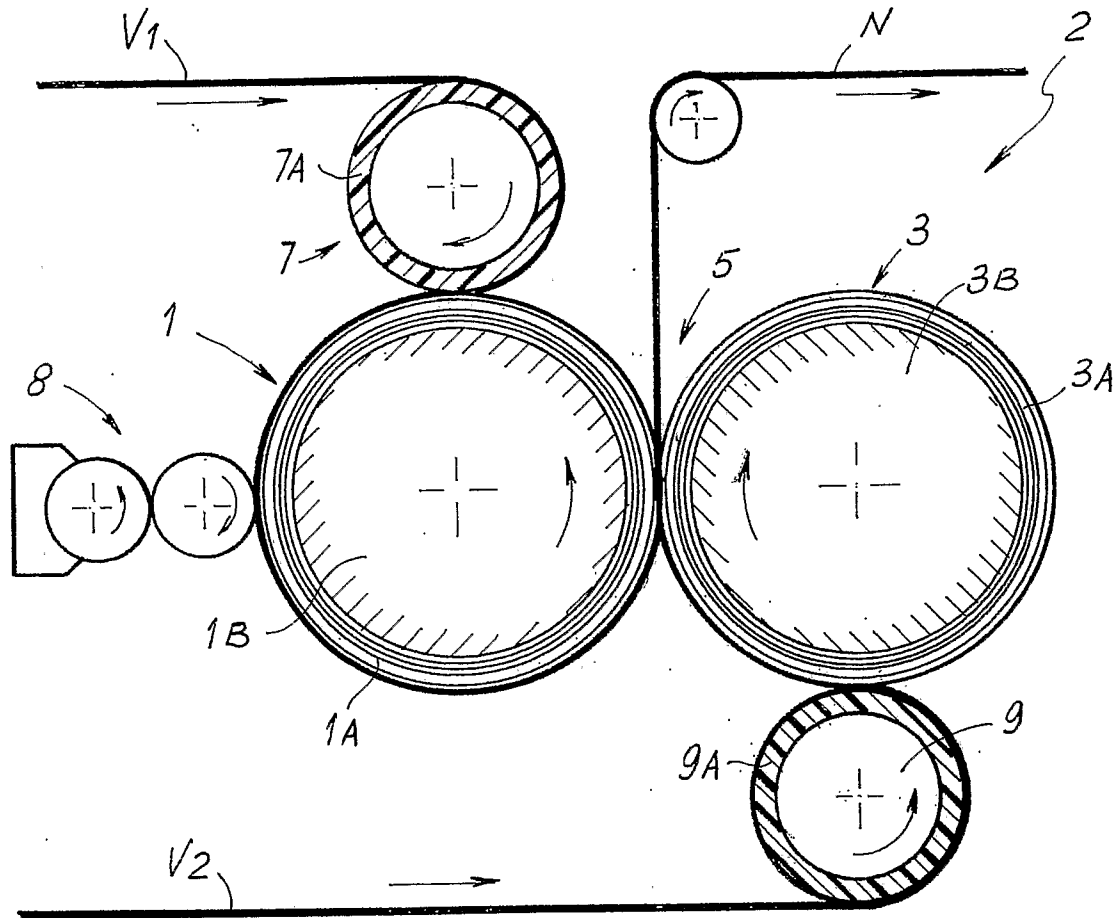


Fig. 1

2/4

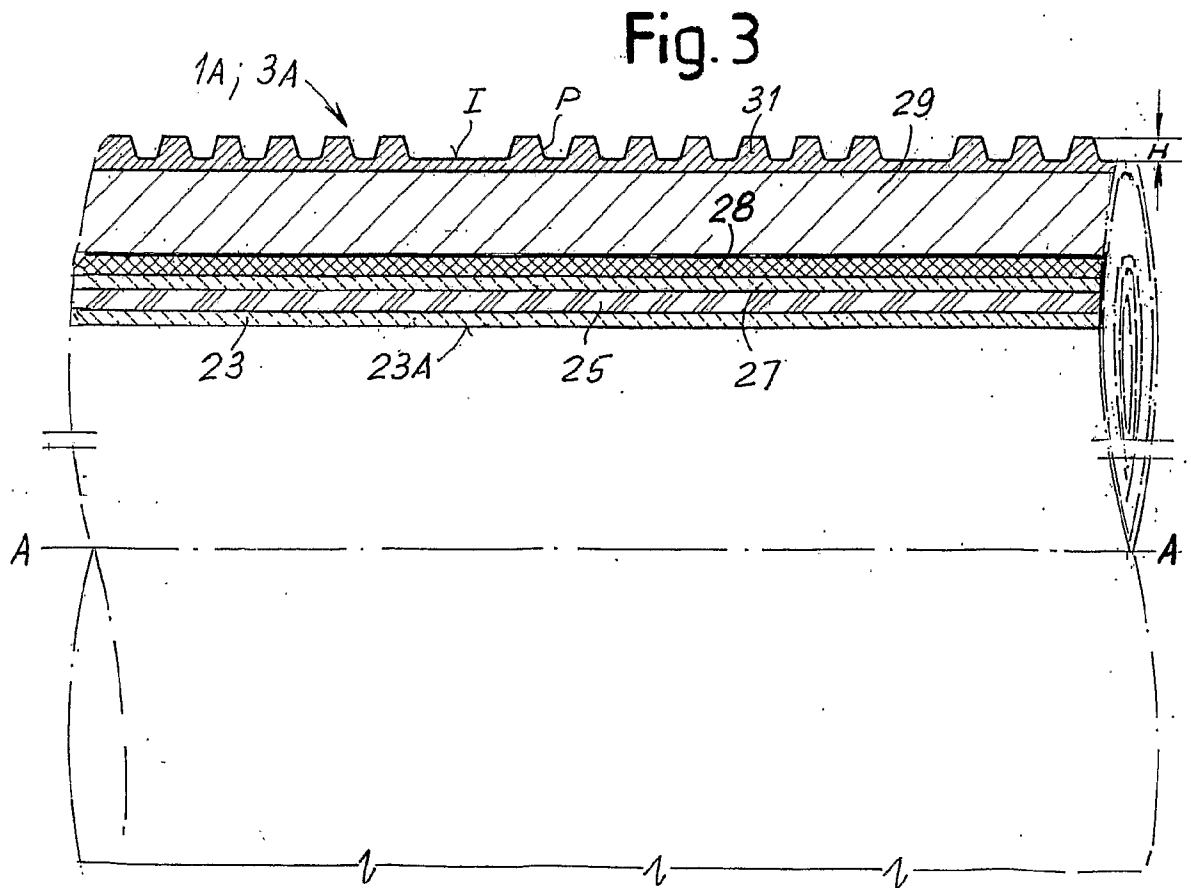
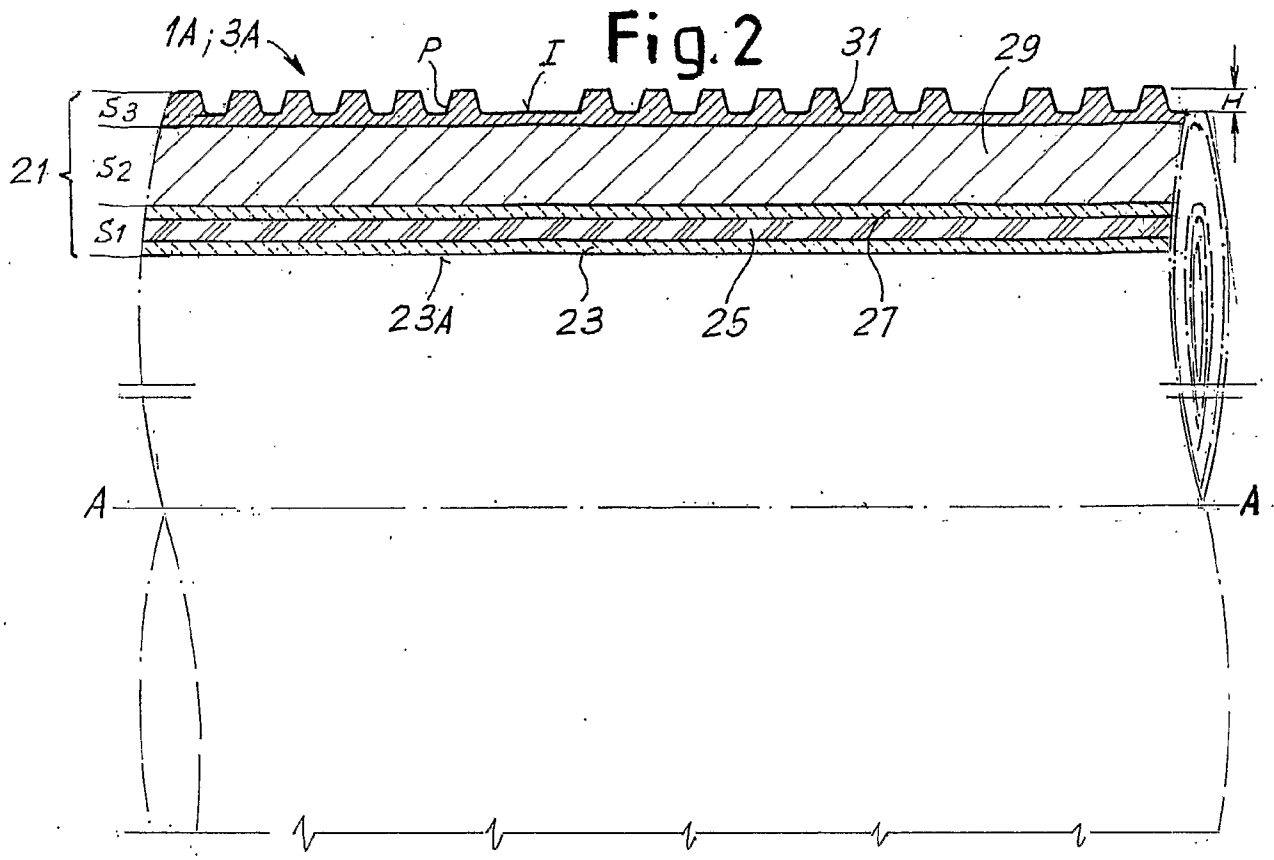
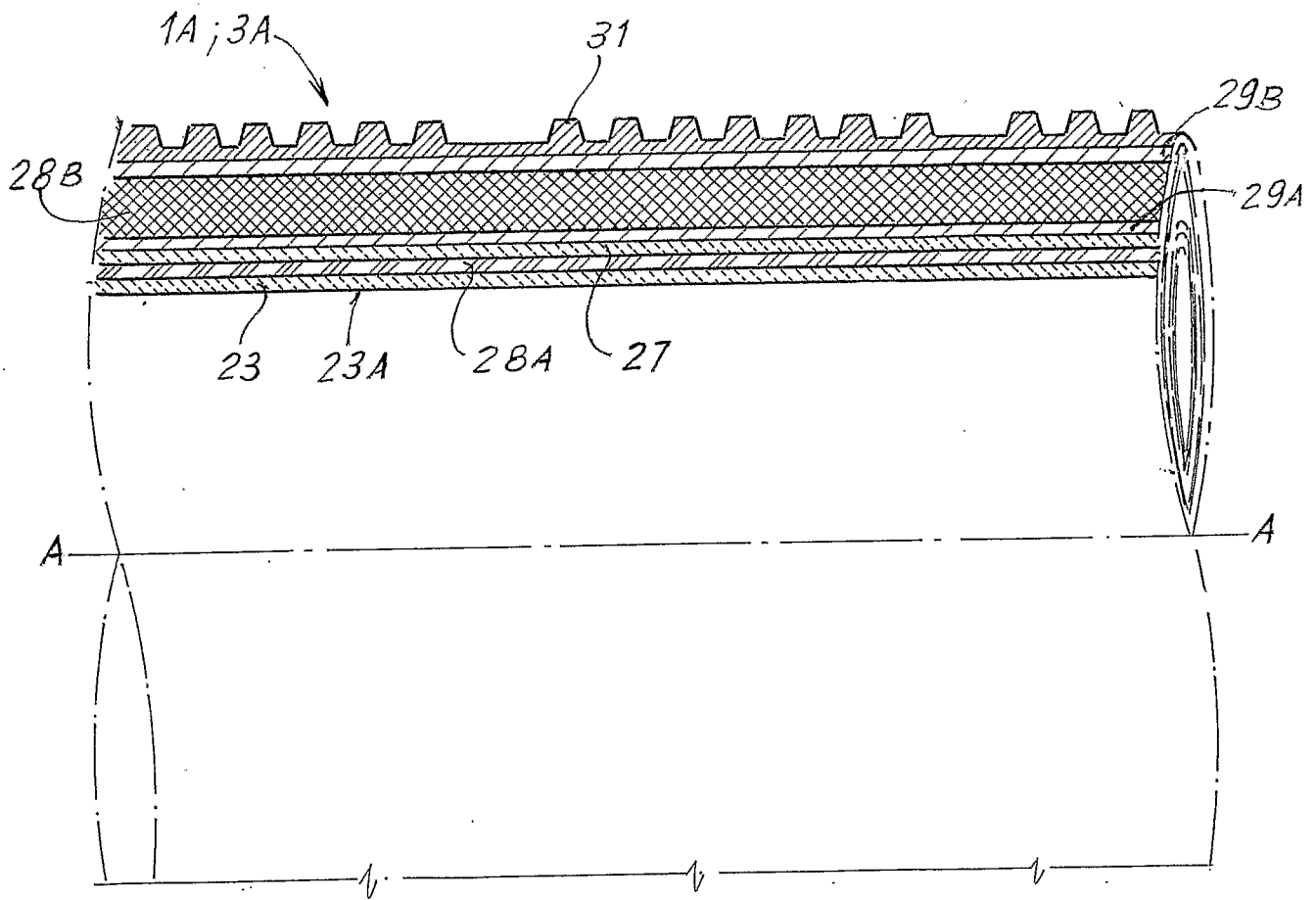


Fig. 4



4/4

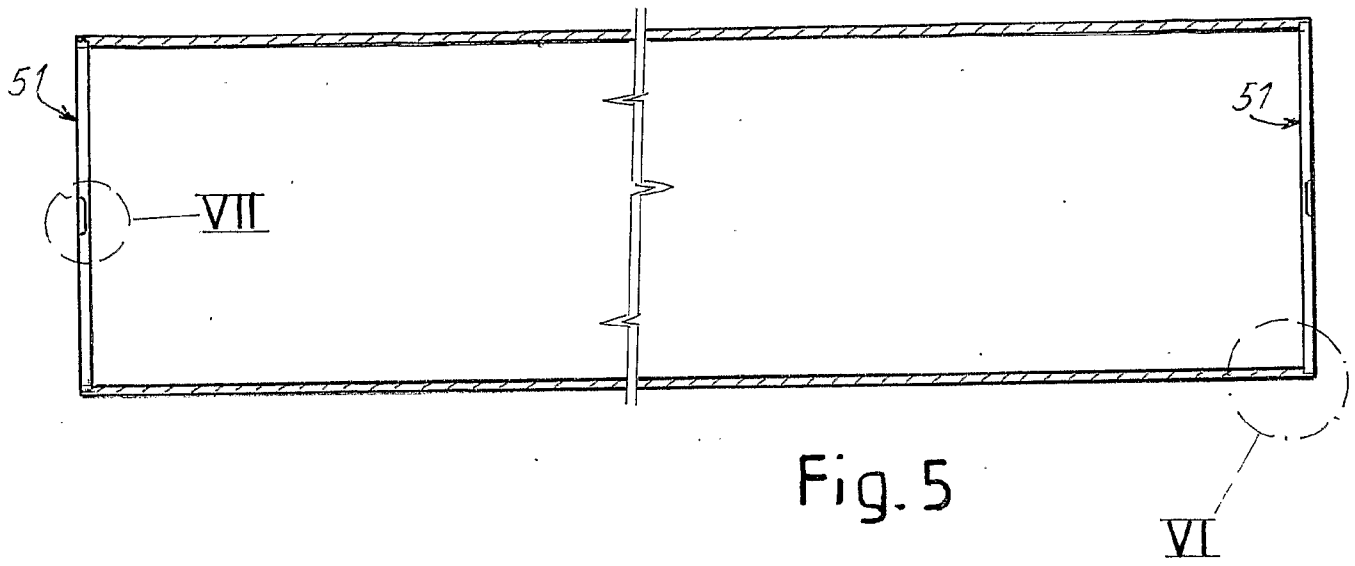


Fig. 6

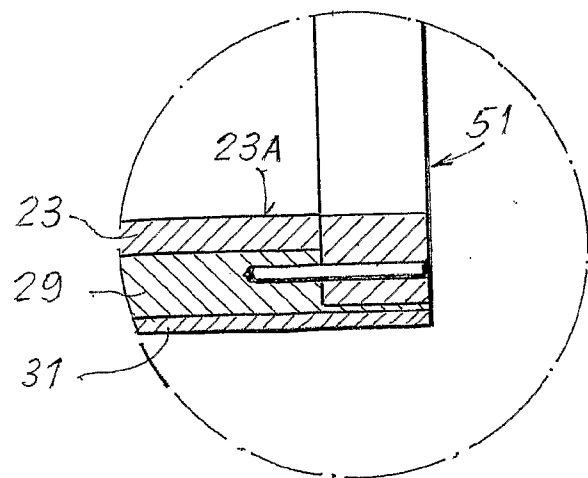
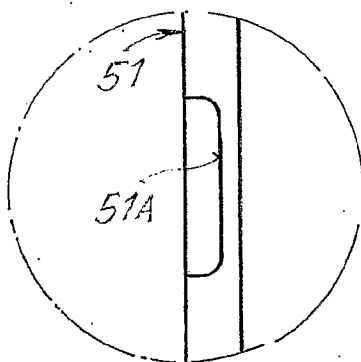


Fig. 7



INTERNATIONAL SEARCH REPORT

International application No

PCT/IT2009/000347

A. CLASSIFICATION OF SUBJECT MATTER
INV. B31F1/07

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHEDMinimum documentation searched (classification system followed by classification symbols)
B31F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2006/035470 A (PERINI FABIO SPA [IT]; DI NARDO VALTER [IT]; LORENZI FABRIZIO [IT]; GE) 6 April 2006 (2006-04-06)	1,25,26
A	page 11, line 18 - page 12, line 8; figures 6,6a	2-24



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

T later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

X document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

Y document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

& document member of the same patent family

Date of the actual completion of the international search

20 October 2009

Date of mailing of the international search report

04/11/2009

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Farizon, Pascal

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IT2009/000347

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2006035470 A	06-04-2006	AT 394213 T	15-05-2008
		BR PI0516854 A	23-09-2008
		EP 1799433 A1	27-06-2007
		US 2008115903 A1	22-05-2008