June 13, 1972 D. A. NEWMAN ET AL 3,669,713

TRANSFER ELEMENTS AND PROCESS FOR PREPARING SAME

Filed Dec. 31, 1969

Fig. 1

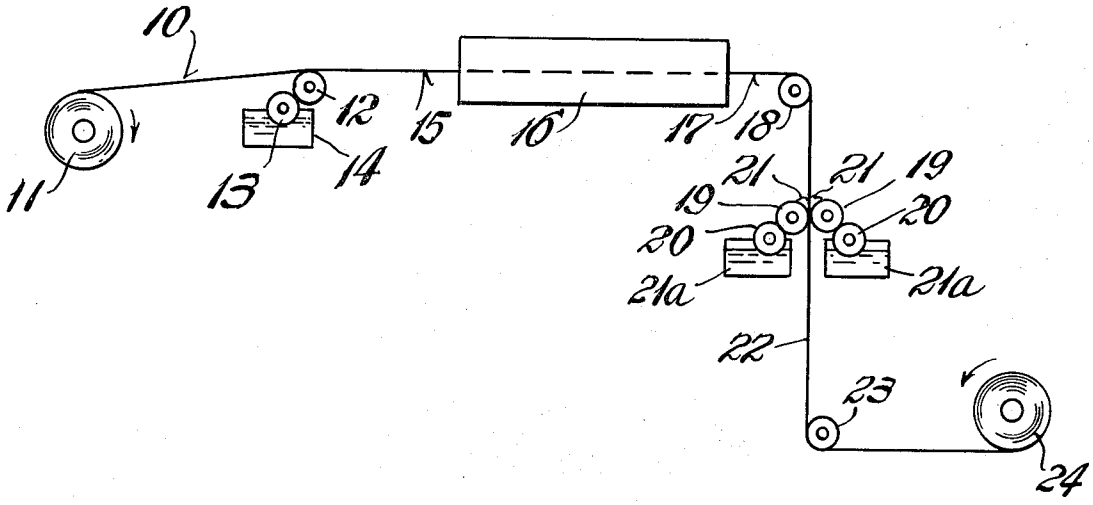


Fig. 2

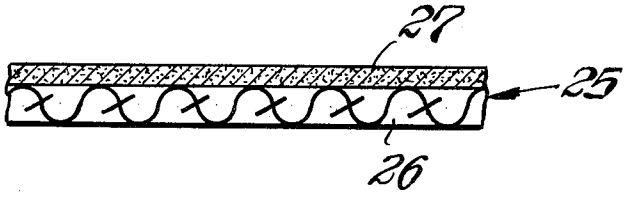
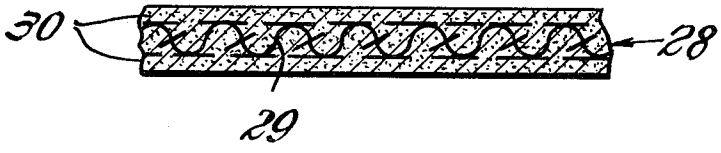


Fig. 3



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TRANSFER ELEMENTS AND PROCESS FOR PREPARING SAME

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Continuation-in-part of application Ser. No. 738,496, June 20, 1968. This application Dec. 31, 1969, Ser. No. 889,577
The portion of the term of the patent subsequent to May 6, 1986, has been disclaimed
Int. Cl. B41m 5/10
U.S. Cl. 117—36.4 8 Claims

ABSTRACT OF THE DISCLOSURE

A pressure-sensitive transfer sheet or ribbon comprising a porous fabric having on the surface thereof a sponge layer of a foamed synthetic thermoplastic resin, said fabric containing a supply of pressure-transferable ink. In use, the ink is exuded through the sponge layer, which is present at the ink-releasing surface, so that the pattern of the filaments of the fabric is not transmitted to the formed images.

This application is a continuation-in-part of parent application Ser. No. 738,496, filed June 20, 1968, now abandoned.

The present invention is concerned with the production of fabric duplicating sheets and ribbons of all types and widths but most particularly with typewriter ribbons and printing machine ribbons. The former generally are less than 1 inch in width while the latter range from 2 to 16 or more inches in width. Fabric ribbons are most commonly woven from threads of filaments of synthetic thermoplastic resin and/or natural origin but some non-woven fabrics of such materials are also used in which the filaments and/or threads are matted or randomly intertwined to form fabrics. Such fabric ribbons, whether woven or non-woven, are impregnated with a pressure-transferable liquid ink and function by exuding a portion of such ink to a copy sheet under the impact of a type face or printing head to form images on the copy sheet corresponding to the raised image on the impact element.

In order to provide duplicating ribbons which produce sharper copies, such ribbons have been reduced in caliper as much as possible. Thin ribbons conform to the raised image outline on the impact device under impact pressure so that the portion of the ribbon which contacts the copy sheet is as small as possible. Thus the formed images sharply correspond to the raised image outline and are relatively free of blurred and filled-in areas.

In satisfying these requirements, it has been found that the structure of the ink-containing fabric represents a disadvantage, particularly in the case of woven fabrics. The images produced exhibit a fabric weave imprint which represents a loss in the tone or density of the images. This is caused by the fact that the filaments, particularly those of synthetic origin, do not absorb ink but merely retain it on their surfaces and in pockets or voids between filaments and threads of filaments. Under the effects of impact pressure, the ribbon makes intimate contact with the copy sheet. Some of the filaments which are present at the surface of the ribbon make intimate contact with the copy sheet to form portions of each typed image, while other portions of each typed image are formed by contact of the copy sheet with ink-containing pockets or voids

between filaments and/or threads. The cause and effect is analogous to the fingerprinting operation. The end result is disadvantageous since it is desirable to produce typed images which have a uniform intense ink density.

The principal object of the present invention is to provide fabric duplicating sheets and ribbons which do not produce a fabric weave or fabric pattern in the images produced therewith and which produce images having uniform intense ink density.

Another object of this invention is to provide a transfer element such as a duplicating ribbon which uniformly meters ink to each copy sheet under the effect of imaging pressure and thereby prevents splattering of the large amount of ink which may be present in the ribbon, particularly during initial uses thereof.

It is an advantage of this invention that the present duplicating ribbons contain their supply of duplicating ink internally and are therefore cleaner to handle and to use than conventional fabric ribbons.

According to the present invention, it has been discovered that such novel fabric transfer elements may be produced by applying a thin sponge layer of foamed synthetic thermoplastic resin to an ink-absorbent fabric of woven or non-woven filaments, and inking the ribbon in conventional manner.

The accompanying drawing illustrates the novel elements of the present invention and a continuous process by which they can be produced. In the drawing:

FIG. 1 is a sectional view of a continuous process for producing the present transfer elements, and

FIGS. 2 and 3 are diagrammatic cross-sections, to an enlarged scale, of transfer elements produced according to two embodiments of the present invention.

The preferred methods of applying the sponge layer to the fabric substrate are (a) by applying a thin layer **15** of a pore-forming resin composition, such as a mixture of a polyisocyanate and a polyhydric material such as polyester and/or a polyglycol, to one surface of a conventional woven or non-woven ribbon fabric **10** and applying heat to react and foam the layer in conventional manner, or (b) by forming a thin layer of a pore-forming resin composition and thereafter laminating it to one surface of a conventional woven or non-woven ribbon fabric. The sponge layer may be laminated to the fabric substrate using an adhesive or solvent-bonding or heat-bonding techniques which do not result in an ink-impervious barrier between the fabric and the sponge layer.

The present invention applies to the production of duplicating fabrics based upon filaments and/or threads of filaments of synthetic and/or natural origin. The most common filaments are silk and cotton and those synthetic thermoplastic filaments formed of nylon polyamide, polyacrylonitrile (Registered Trademark Orlon), polyester fiber (Registered Trademark Dacron) and cellulose acetate rayon, but other synthetic fiber-forming materials are also used including polyvinylidene chloride, polycarbonate and the like. Woven ribbons are most commonly produced by winding a number of fine filaments together to form threads and then weaving the threads to form the fabric. Non-woven fabrics are generally produced by compacting a number of randomly dispersed filaments or threads to form a matted fabric of the desired density and caliper. Thermoplastic resin particles are often incorporated and the fabric is heated to cause the powder to melt and adhere contacting filaments to each other. The production of such ink-absorbent fabrics is well-known in the art and forms no part of the present invention.

As illustrated by FIG. 1, the uninked fabric **10** may be treated in a continuous process according to one embodiment of the present invention. The fabric is expended

from a supply roll **11** and contacted with a printing roller **12** which receives a uniformly thin supply of foam-forming composition from application roller **13** immersed in vat **14** containing such solution. The fabric carrying coating **15** is passed through a heating tunnel **16** where it is contacted with hot air to activate the blowing reaction and dry the coating to form the sponge layer **17**. The fabric is then passed over idler roller **18** and compressed between inking rollers **19**, each of which receives a constant supply of non-drying liquid ink **21** from vats **21***a* by means of application rollers **20**. The inked fabric **22** is conducted under idler roller **23** and onto take-up roll **24** for subsequent processing. If desired, ink may be applied to only the fabric side and not to the sponge side.

The duplicating element produced in this manner has the structure illustrated by FIG. 2 or FIG. 3 depending upon the structure of the fabric support. In cases where the fabric support is a dense fabric such as a conventional woven or non-woven typewriter ribbon fabric, the applied foam-forming composition is retained primarily at and near the surface of the fabric to which it is applied. The fabric is relatively impermeable to the foam-forming composition because of the density of the former and the viscosity of the latter, and the duplicating element produced has a structure as illustrated by FIG. 2 of the drawing which shows the element **25** having a fabric support **26** and the sponge layer **27**. The fabric support contains a supply of pressure-transferable ink. The sponge layer may be free of ink, where the fabric is inked separately from the sponge layer, or may contain ink. However the sponge layer preferably contains little or no ink and its empty pores function to meter ink from the fabric to a copy sheet. The inking procedure of FIG. 1 in which the element is compressed during inking causes most of the ink to be taken up by the fabric whereas the sponge layer absorbs air from the atmosphere when the compression is relaxed.

In cases where the fabric support is a loosely woven or non-woven fabric, such as cheesecloth, which consists of a very open, porous structure, the applied foam-forming composition permeates the fabric since the composition is able to flow through the fabric. The fabric is thus embedded in the foam-forming composition and the expansion of the composition during foaming insures that a porous sponge surface is formed at both surfaces of the fabric. Ribbons produced in this manner are illustrated by FIG. 3 of the drawing which shows the ribbon **28** having a fabric support **29** embedded within the sponge layer **30**, all of which contain a supply of pressure-transferable ink.

If desired, the ribbons produced according to this embodiment may have the sponge layer **30** present at only the ink-releasing surface of the fabric support **29** as well as impregnated therein. This is accomplished by applying the foam-forming composition to the open fabric while the fabric is held closely against an impermeable casting support such as a metal roller or flat glass surface, and then foaming the composition while the fabric is maintained against the support. The composition permeates the fabric and expands towards the free surface. An advantage of this procedure is that the foam-forming composition develops a relatively ink-impermeable surface adjacent the casting support so that the formed ribbon transfers only minor amounts of ink back to the type face whereby nearly the entire ink supply is preserved for transfer through the sponge layer **30** to the sheets being imaged.

The present sponge layer contains an open, interconnected cell structure and may be applied according to any of the well-known processes and using any of the well-known foam-forming compositions based on a synthetic thermoplastic binder material. The most common foam-forming compositions are those which produce foamed polyurethane layers of the open-celled or reticulated types. These are based upon compositions containing a diisocyanate, a compound containing reactive hydrogen, water and a catalyst. The reactive hydrogen compound is a difunctional polyester such as an adipic acid-ethylene glycol reaction product of about 2000 molecular weight, or a difunctional polyether condensate containing hydroxyl groups, or a difunctional polyamine. The reaction proceeds rapidly and liberates carbon dioxide which causes the foaming action. Reference is made to U.S. Pats. Nos. 2,900,278; 3,171,820 and 3,382,090 for their disclosure of materials and processes for producing polyurethane layers of the required types.

If desired, other synthetic thermoplastic resin systems may be used including the foam-forming rubbers such as chloroprene and butadiene-styrene and the pore-forming vinyl resins such as vinyl chloride, methyl methacrylate, acrylonitrile, styrene and copolymers thereof. Such resins require the presence of a small amount of a conventional gas-liberating or blowing agent which is heat-activated to produce the desired open, interconnected pores. Agents such as di-N-nitroso pentamethylene tetramine, di-N-nitroso piperazine and p, p'-oxy-bis (benzenesulfonyl hydrazide) are suitable.

The foam-forming composition is applied to one or both sides of the fabric **10** in the form of a very thin continuous coating **15** according to one embodiment. The idea is to apply the thinnest possible layer which produces a uniform continuous covering of the fabric surface, leaving the body of the fabric impregnated with the composition or free of the composition, as desired. Amounts ranging from about 0.05 pound up to about 1 pound per ream of fabric are suitable, a ream being equal to 3300 square feet of fabric surface. The coated fabric is then heated to the required temperature for a sufficient period of time to cause polymerization of the foam-forming composition and/or activation of the blowing agent. This results in an increase in the thickness of the portion of the sponge layer present on the fabric surface to the point that it has a measurable caliper which is preferably no greater than about one-sixteenth of an inch.

The foam layer **17** produced has an open, interconnected cell structure which permits free circulation of the ink and free transfer of the ink to the copy sheet without period of time to cause polymerization of the foam-form-undue filtering of the pigment of the ink from its oily vehicle. In this connection it is pointed out that the pigment of the ink has a particle size of about 5 microns so that the foam layer must contain cells having a size greater than 5 microns. The cell size should range between 6 and 50 microns and preferably is within the range of about 10 to 30 microns.

At this stage the foam-coated fabric is ready for inking. The ink comprises a conventional oil-and-pigment ink such as a mixture of oleic acid, carbon black and nigrosine black. As indicated supra, the pigment must have a particle size smaller than the cell size of the sponge layer. The ink **21** may be applied to both sides of the fabric as shown in FIG. 1 or, if desired, may be applied only to one side. A greater amount of ink can be applied to the ribbon because of the presence of the sponge layer **17** and also because the sponge layer **17** prevents the ink from splattering on the copy sheet during use. This unexpected advantage appears to be due to the open, interconnected cell structure whereby the sponge layer retains the liquid ink uniformly dispersed in the interior thereof, apparently by capillary action. There are no surface pools or reservoirs of ink at the foam surface and the foam has the ability of absorbing ink rapidly rather than permitting it to splatter onto the copy sheet under the effects of impact pressure.

The following example is given by way of illustration and should not be considered limitative.

A conventional web of woven nylon fabric prepared in accordance with Example 1 of U.S. Pat. No. 3,317,021 may be employed as the base fabric.

The uninked fabric **10** is terated according to the method of FIG. 1. The foam-forming composition present in vat **14** is as follows:

Ingredients:	Parts by weight
Toluene diisocyanate	43.0
Adipic acid-ethylene glycol polyester (molecular weight 2000)	100.0
N-ethyl morpholine	2.5
Water	3.1

The foam-forming composition is a milky liquid which is printed onto the fabric as a thin, continuous layer **15** which completely wets and covers the fabric surface. The layer is applied at a weight of about 0.25 lb./ream and may be spread and levelled after printing by means of a doctor blade, if desired. The coated web is then passed through a drying tunnel containing a continuous supply of forced hot air. The temperature within the tunnel is about 150° C. and the foaming action occurs nearly instantaneously as the ingredients react and liberate carbon dioxide gas which produces the reticulated cellular structure within the polyurethane resin formed. The porous layer **17** comprises a microsponge of polyurethane containing empty micropores which are interconnected and which are sufficiently large as to transmit pigment particles of less than 10 micron size.

Next the coated fabric is passed in the nip of inking rollers **19** which apply ink received from vats **21***a* by means of application rollers **20**. The ink may be a conventional ink comprising oleic acid as the oily vehicle and carbon black and nigrosine black colorants. The ink is initially ground in a ball mill so that the pigment particles are very fine and preferably average about 5 microns in diameter. If desired, the ribbon ink may contain dissolved dyestuff in place of solid pigment, such pigment-free ribbon inks being well-known in the art.

Finally the inked fabric is wound on take-up roll **24** for aging and subsequent processing. The inked web may be slit into ribbons of the desired width by means of heated cutter blades which fuse the cut edges.

As indicated hereinbefore, the composition of the sponge layer **15** and the method by which it is applied to the fabric support **10** are not critical so long as the layer **17** is an open sponge which will transmit the ribbon ink from the ribbon to a copy sheet under imaging pressure. Nearly any open sponge layer will accomplish this result unless preventive steps are taken to regulate the pore size to a smaller range and unless an impervious barrier is applied or formed between the fabric and the sponge.

In cases where the sponge layer **27** is produced separately from the fabric **26** and thereafter laminated thereto, caution must be taken to avoid the formation of a barrier. This may be accomplished by wetting the surface of the fabric with a small amount of a volatile liquid which is a solvent for the sponge and a non-solvent for the fabric. The surfaces are brought together and heat is applied to evaporate the solvent. Alternatively controlled heating may be used, or a small amount of a very dilute solution of an adhesive resin binder may be applied to the fabric surface to coat only the exposed fibers at the fabric surface, and the ribbon is dried immediately after the sponge layer is contacted therewith to form a discontinuous adhesive bond between the fabric and the sponge layer.

In cases where the foam-forming composition is one which is unstable at room temperature, it is preferred to apply the composition to the fabric as separate stable coreactants, which are thereafter spread together in a thin layer and reacted. Such procedures are well known in the art of forming sponge layers.

It should be understood that it is also possible to apply the sponge layer **27** to the fabric **26** after the fabric has been inked. An ink-free sponge layer is cleaner to the touch and thus is advantageous where the life span of the ribbon is of less importance than cleanliness. We have found that the foam-forming compositions have sufficient affinity for the surface of an inked fabric to remain bonded thereto during use, and also that a preformed sponge layer can be bonded to the surface of an inked fabric by the techniques listed hereinbefore. Ribbons according to this embodiment also produce images which are free of fabric weave patterns and which have good uniform tone density due to the fact that the sponge layer **27** compresses under impact and permits the ink **21** from the fabric **26** to pass through to the copy sheet.

It is also possible to produce the present transfer elements by cutting the fabric web **10** into desired widths and thereafter applying the sponge layer **17** and impregnating the elements with ink **21**. However it is preferable to process the fabric in web form and thereafter cut the coated and inked web into ribbons or sheets of the desired width.

Variations and modifications may be made within the scope of the claims and portions of the improvements may be used without others.

We claim:

1. The process of producing a pressure-sensitive ink-releasing duplicating element which comprises the steps of:

(a) providing a thin ink-absorbent fabric of filaments;

(b) bonding to at least one surface of said fabric a thin synthetic thermoplastic sponge layer containing gas-filled, ink-transmissive pores; and thereafter

(c) impregnating said fabric with a non-drying liquid ink to form a duplicating element which is capable of uniformly metering said ink from said fabric through said sponge layer to form images on a copy sheet under the effects of imaging pressure without splattering of the ink and without forming a fabric imprint in said images.

2. The process of claim **1** in which the sponge layer is formed on the fabric by applying thereto a continuous coating comprising a synthetic thermoplastic resin-forming composition which is heat-reactive to liberate a gas, and heating said coating to liberate said gas and form said thin sponge layer.

3. The process of claim **2** in which the resin-forming composition comprises a polyurethane resin-forming composition.

4. The process of claim **1** in which the sponge layer is preformed and thereafter laminated to the fabric.

5. The process of claim **1** in which the fabric is a conventional woven nylon fabric.

6. A pressure-sensitive, ink-releasing duplicating element produced according to the process of claim **1**.

7. A pressure-sensitive, ink-releasing duplicating element produced according to the process of claim **3**.

8. A pressure-sensitive, ink-releasing duplicating element produced according to the process of claim **5**.

References Cited

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MURRAY KATZ, Primary Examiner

U.S. Cl. X.R.

117—138.8; 161—190

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,669,713 Dated June 13, 1972

Inventor(s) Douglas A. Newman and Allan T. Schlotzhauer

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 4, line 44 should be deleted - it is a repetition of line 35.

Column 5, line 1, "terated" should read -- treated --.

Signed and sealed this 26th day of September 1972.

(SEAL)
Attest;

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents