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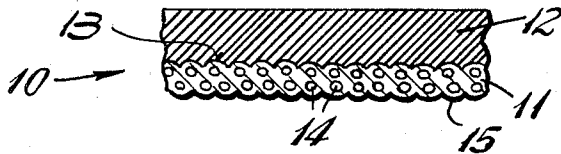
D. A. NEWMAN

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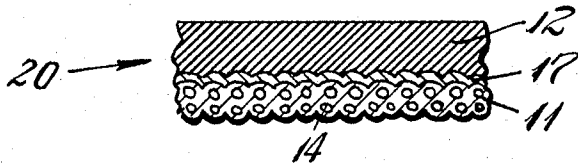
PRESSURE-SENSITIVE TRANSFER ELEMENTS AND PROCESSES

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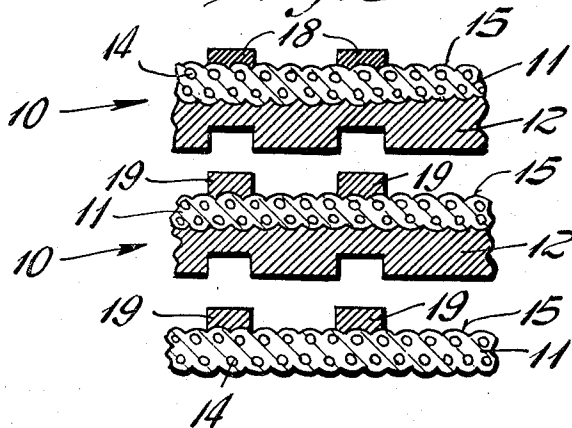
*Fig. 1*



*Fig. 2*



*Fig. 3*



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**PRESSURE-SENSITIVE TRANSFER ELEMENTS AND PROCESSES**

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10 Claims

**ABSTRACT OF THE DISCLOSURE**

Process for producing a novel pressure-sensitive transfer element such as a carbon paper or business machine ribbon which comprises the steps of applying a liquid ink composition to a foamed film foundation or to a plastic intermediate layer on a foamed film foundation, and solidifying the ink composition to cause it to bond to the irregular surface of the foundation or to the irregular surface of the undercoating which conforms to the surface of the foundation, to form a pressure-sensitive transfer element.

It is known in the transfer element art to use plastic films as foundations for carbon papers and ribbons. Such films have greater strength and durability than paper and do not absorb oils from the ink layer causing it to lose its frangibility as does paper. However, plastic film foundations present other problems not encountered with paper. Plastic films have a normally smooth surface which is not very receptive to an ink layer or retentive thereof, so that the application of an ink layer of uniform thickness is unreliable and the cracking or flaking of the ink layer from the foundation is common during use unless a separate resinous intermediate layer is used to bond the ink layer to the foundation. The intermediate layer must either be soluble in the solvent used to apply the ink layer, if a solvent coating, or must contain a high proportion of porous filler which absorbs the ink layer and permits bonding. Solvent-bonding is difficult to control whereas the incorporation of filler renders the transfer element less deformable under imaging pressure and thereby reduces the imaging quality of the transfer element.

A related disadvantage of conventional plastic film foundations is that they are not very receptive to printing inks or to pressure-applied images. Thus the rear surface of the foundation, opposite the one carrying the ink layer, is not receptive to the printing of trademarks or trade names unless a receptive resinous coating is applied first. Also transfer sheets of this type are not suitable for carbonless copy work since the rear surface of the foundation is not receptive to pressure-applied images and does not contrast in color therewith, due to the transparency of plastic films, unless a light-colored receptive layer is applied.

Among other disadvantages of plastic film foundations is their slippery nature which necessitates the application of a non-slip coating to the back surface to render the transfer sheet easier to handle and to use.

It is the object of the present invention to provide a plastic film foundation transfer element which has all of the advantages but none of the aforementioned disadvantages of conventional plastic film foundation transfer elements.

The objects and advantages of this invention will be clear to those skilled in the art in the light of the present disclosure including the drawings, in which:

FIGURES 1 to 3 are diagrammatic cross-sections, to an enlarged scale, of pressure-sensitive transfer elements

according to different embodiments of the present invention.

The present invention resides in the discovery that the disadvantages of known plastic film foundations can be overcome without destroying the other advantageous properties thereof by extruding the film as a thin foam of a synthetic thermoplastic resin which has a thickness no greater than about 3 mils and comprises a microcellular structure, at least 50% of which cells are closed, containing from about 10% up to about 90% by volume of trapped gas. Films of this type are found to have a uniformly rough surface containing a number of open pores and sealed cells which makes them very receptive to and retentive of ink coatings and pressure-applied images; such films are opaque and white or light-colored in appearance. The rough surface of such films also renders them slip-resistant and easier to handle and use.

The foamed film foundations used according to the present invention are produced by formulating a particulate expandable synthetic thermoplastic resin, preferably in bead form, and an expanding or blowing agent and then extruding the composition as a thin sheet into atmospheric pressure to cause the expanding or blowing agent to generate a gas within the film and form microcells having a diameter smaller than the film thickness. Thereafter the film is stretched to the desired thickness and set. The type and amount of the blowing agent are so controlled that at least 50% of the cells in the final foam are closed and contain from about 10% to about 90% by volume of gas trapped within the closed cells. The preferred cell diameter is from 0.5 mil and less depending on the thickness of the foamed film.

Foamed films of this type are prepared in known manner such as by means of the processes of United States Patents Nos. 3,248,462; 3,250,731 and 3,287,477, among others. The preferred synthetic thermoplastic resins are polyethylene terephthalate polyester, polyethylene, polypropylene, polystyrene, chlorinated rubber, polyvinyl chloride, polyvinyl fluoride, nylon, and the like. These materials have a solid density of from about 50 to 80 or more lbs./cu. ft.

According to the preferred embodiment of this invention, the foamed film serves as a direct foundation for a microporous ink-releasing layer of the squeeze-out type. As shown in FIG. 1, the transfer element 10 has a foamed film foundation 11 and an ink-releasing layer 12. The foamed film has uniformly uneven surfaces 13 and 15 and contains closed microcells 14 enclosing trapped gas such as air, nitrogen, carbon dioxide or the like. The ink layer 12 is firmly bonded to the uneven surface 13 of the foundation and will not separate therefrom during use.

This is particularly important in the case of solvent-applied microporous synthetic thermoplastic resinous ink layers containing pressure-exudable ink within the pores thereof. The resin structure is bonded to the foamed film due to its rough surface and is pressure nontransferable. Suitable compositions for forming the present squeeze-out ink layers are illustrated by United States Patents Nos. 2,820,717; 2,944,037; 3,037,879 and 3,117,018, among others. However, the volatile organic solvent used to apply the ink layer to the foamed film must be a non-solvent for the foamed film so that the cells in the film are undisturbed. Otherwise the foamed film loses its strength and deformability and opacity.

FIG. 2 of the drawings illustrates a second embodiment in which a transfer element 20, intended for heavy duty work such as for use as a business machine ribbon, is provided with a thin layer of synthetic thermoplastic resin as an undercoating 17 to provide an improved bond between the foamed film foundation 11 and the ink layer 12. The undercoating is generally a vinyl resin applied as a

solution in a volatile organic solvent which must be a non-solvent for the foamed film foundation, and is applied in a thickness of less than about 3 points (0.0003 inch) so that its surface 17 corresponds roughly to the surface of the foamed foundation and is more receptive to and retentive of the ink layer. If desired, the ink layer may be applied to the undercoating using a volatile organic solvent which is at least a partial solvent for the undercoating to effect solvent-bonding therewith in the manner described in United States Patent No. 3,037,879. However, care must be taken to avoid contact between the solvent and the foamed film.

FIG. 3 of the drawings illustrates the use of a number of transfer elements 10 in a carbonless copying system. The rear surface 15 of the foamed films 11 is receptive to and retentive of both typed images 18 and pressure-transferred images 19. The opaqueness of the foamed films 11 masks the color of the underlying transfer layers 12 and the white or light appearance of the films provides a good contrast with the images 18 and 19 applied thereover.

The high gas content and therefore low density of the present foamed films renders them exceptionally deformable under the effects of imaging pressure so that it is possible for a type impression to be transmitted sharply through up to eight or more transfer elements superposed in the manner shown by FIG. 3. Since no separate receptor layers are required, the superposed pack is thinner than heretofore possible with plastic film foundations and therefore a greater number of sharp clear copies can be produced. The foamed film foundations are preferably 0.5 mil thick and the ink layers 12 are preferably from 0.2 to 0.6 mil thick according to this embodiment.

The following examples are given by way of illustration and should not be considered limitative.

#### Example 1

A transfer element according to FIG. 1 is prepared by applying the following ink composition to a 0.5 mil foamed polystyrene film produced according to Example 1 of United States Patent No. 3,248,462:

Ingredients:	Parts by weight
Nylon (alcohol-soluble) -----	10
Oleic acid -----	10
Carbon black -----	1
Black toner -----	2
Nigrosine -----	3
Talc -----	7
Ethyl alcohol -----	90

The ink composition is applied to the surface of the foamed polystyrene in a thickness of about 4 mils and heat is applied to evaporate the solvent and form a solidified ink layer having a thickness of about 1.0 mil. The transfer sheet produced is light in weight and exceptionally deformable under imaging pressure so that it produces typed images of excellent sharpness. The ink layer is firmly bonded to the foundation and shows no tendency to peel or crack or transfer bodily therefrom under repeated use.

#### Example 2

A transfer element according to FIG. 2 is prepared by applying a thin layer of a 20% solution of polyvinylidene chloride in methyl ethyl ketone as an undercoating composition to a 0.5 mil foamed polypropylene film produced according to Example 1 of United States Patent No. 3,250,731. The methyl ethyl ketone is evaporated to form a dried undercoating having a thickness of about 2 points.

The following ink composition was applied over the undercoatings.

Ingredients:	Parts by weight
Vinyl chloride-vinyl acetate copolymer (Vinylite VYHH) -----	15.0
Mineral oil -----	10.0
Rapeseed oil -----	8.0
Toned carbon black -----	7.0
Blue toning paste -----	3.0
Lecithin -----	1.0
Ethyl acetate -----	36.0
Toluol -----	20.0
	100.0

The ink layer was dried by heating to an elevated temperature in a drying tunnel to remove the solvents and form an ink layer having a thickness of about 0.5 mil.

The formed transfer element is particularly useful as a continuous wide ribbon for use in calculators, adding machines and similar business machines where the additional strength and durability is important.

#### Example 3

A so-called carbonless manifolding system as shown in FIG. 3 is produced by applying the following transfer composition to a web of 0.5 mil foamed polyethylene terephthalate polyester produced in known manner.

Ingredients:	Parts by weight
Polystyrene -----	1.3
Ethyl cellulose -----	1.2
Polybutene resin -----	0.5
Lanolin -----	1.0
Clay -----	17.0
Graphite -----	2.0
Methyl isobutyl ketone -----	15.0
Toluene -----	62.0

The ingredients are uniformly mixed and applied to the web and the solvents are evaporated at elevated temperatures in a heating tunnel to form a solidified pressure-transferable layer having a thickness of about 6 points. The layer is clean to the touch and rub-resistant due to its resinous composition.

The web is then cut into sheet lengths and superposed sheets are used for the simultaneous production of multiple copies in the manner shown in FIG. 3. Up to eight or more good copies can be produced in this manner and each copy is a good record copy because of the sharpness and clarity of the images thereon and the cleanliness of the pressure-transferable imaging layer.

Other conventional donor coatings of this type are also suitable and are well known to those skilled in the art. Included among such coatings are those described in United States Patents Nos. 3,169,880; 3,186,862 and 3,243,312.

When transfer sheets are being produced for conventional carbon paper use, the pressure-transferable layer may be of the conventional wax type applied by hot melt techniques.

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

I claim:

1. The process of producing a pressure-sensitive transfer element which is exceptionally light in weight and exceptionally deformable under the effect of imaging pressure which comprises the steps of:

- (a) providing a foamed plastic film foundation having a thickness no greater than about 3 mils comprising a microcellular structure containing at least 10% by volume of gas in a cell structure containing at least 50% of closed cells, said foundation having at least one surface which is uniformly rough due to the cellular structure of the foundation,
- (b) applying a thin layer of a fluid ink composition comprising a binder material and coloring matter

5

to the side of said foundation which has the rough surface, and

(c) solidifying said ink composition to cause it to bond to said foundation due to the roughness of the surface thereof, whereby the solidified layer of ink composition resists flaking and peeling from the foundation but transfers portions thereof to a copy sheet under the effect of imaging pressure. 5

2. The process of claim 1 in which a solution comprising a resin in a volatile solvent is first applied to the rough surface of the foundation to form an undercoating layer which is sufficiently thin that its exposed surface is also rough in conformity with the roughness of the foundation, said volatile solvent being a non-solvent for said foundation, and the ink layer is applied to the exposed surface of the undercoating layer. 10 15

3. The process of claim 1 in which the applied fluid ink composition comprises a solution of a resinous binder material in a volatile solvent which is a non-solvent for said foundation, and solidification occurs through evaporation of said solvent. 20

4. The process of claim 3 in which the fluid ink composition comprises a synthetic thermoplastic binder material, an oil which is incompatible with said binder material, coloring matter and said volatile solvent, whereby the solidified ink composition comprises a pressure non-transferable microporous structure of said binder material containing within the pores thereof said oil and coloring matter as a pressure-exudable ink. 25

5. The process of claim 3 in which the fluid ink composition comprises a synthetic thermoplastic binder material, filler, coloring matter and said volatile solvent, whereby the solidified ink composition is pressure-transferable. 30

6. A pressure-sensitive transfer element which is exceptionally light in weight and exceptionally deformable under the effect of imaging pressure which comprises: 35

(a) a foamed plastic film foundation having a thickness no greater than about 3 mils comprising a microcellular structure containing at least 10% by volume of gas in a cell structure containing at least 50% of closed cells, said foundation having at least one surface which is uniformly rough due to the cellular structure of the foundation, and 40

(b) a thin pressure-transfer layer comprising a solid binder material and coloring matter bonded to the rough surface of said foundation, whereby said pressure-transfer layer resists flaking and peeling from said foundation but transfers portions thereof to a copy sheet under the effect of imaging pressure. 45 50

6

7. A transfer element according to claim 6 in which the said rough surface of the foundation carries a thin resinous undercoating, the exposed surface of which is also rough in conformity with the roughness of the foundation, and the exposed surface of the undercoating carries said pressure-transfer layer.

8. A transfer element according to claim 6 in which said pressure-transfer layer comprises a microporous structure of pressure-non-transferable synthetic thermoplastic binder material containing within the pores thereof said oil and coloring matter as a pressure-exudable ink.

9. A transfer element according to claim 6 in which said pressure-transfer layer is a frangible pressure-transferable layer comprising synthetic thermoplastic binder material, filler and coloring matter.

10. A manifolding system comprising a multiplicity of superposed sheets adapted to the simultaneous production of a multiplicity of duplicate copies under the effect of imaging pressure, said sheets comprising:

(a) a foamed plastic film foundation having a thickness no greater than about 3 mils comprising a microcellular structure containing at least 10% by volume of gas in a cell structure containing at least 50% of closed cells, said foundation having opposite surfaces which are uniformly rough due to the cellular structure of the foundation, and

(b) a thin pressure-transfer layer on one of said rough surfaces comprising a solid binder material and coloring matter, said transfer layer being bonded to said rough surface so as to resist flaking and peeling and being transferable in part to the opposite exposed rough surface of the foamed foundation of the transfer sheet superposed in contact therewith.

#### References Cited

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