(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 099 639**
A1

(12) # EUROPEAN PATENT APPLICATION

(21) Application number: 83303382.2

(22) Date of filing: 10.06.83

(51) Int. Cl.^{3}: D 06 C 23/04

(30) Priority: 11.06.82 US 387627
28.10.82 US 437240
28.10.82 US 437246

(43) Date of publication of application: 01.02.84 Bulletin 84/5

(84) Designated Contracting States: AT BE CH DE FR GB IT LI LU NL SE

(71) Applicant: MILLIKEN RESEARCH CORPORATION
Iron Ore Road P.O. Box 1927
Spartanburg South Carolina 29304(US)

(72) Inventor: Reynolds, James Robert
400 Wannamaker Court
Spartanburg South CArolina 29302(US)

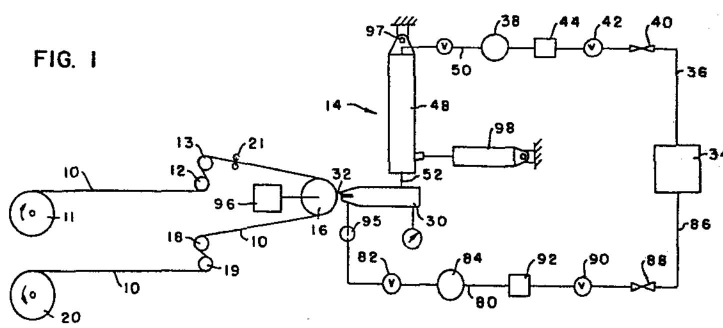
(72) Inventor: Greenway, John Michael
1000 Wendover Way
Spartanburg South Carolina 29302(US)

(74) Representative: Bass, John Henton et al,
REDDIE & GROSE 16 Theobalds Road
London WC1X 8PL(GB)

(54) **Apparatus and method for visual surface effect enhancement.**

(57) Method and apparatus for pressurized fluid stream treatment of the surface of a relatively moving textile substrate to impart visual surface changes, particularly controlled changes in visual contrast due to bubble formation within individual constituent fibers thereto. The apparatus includes a fluid discharge manifold 30 with discharge slot 32 disposed across the path of relative movement of the substrate to discharge pressurized heated fluid, such as air, in one or more narrow discrete streams into the surface of substrate 10. A temperature pre-conditioning means 2 to modify the temperature of the increasing substrate surface as well as a moisture pre-conditioning means 8 is positioned ahead of the discharge slot. Heated pressurized fluid streams strike the pre-conditioned surface of the substrate containing thermoplastic fibers which are at a pre-determined temperature and which have a controlled amount of moisture therein, causing the formation of light-reflecting bubbles within the fibers, which changes the appearance of areas of the fabric surface by enhancing the relative visual contrast level of the modified areas of the substrate compared with the untreated areas. The process may be repeated using different pre-conditioning values, resulting in areas which have a contrast level which is different from untreated and previously treated areas.

FIG. I



EP 0 099 639 A1

Croydon Printing Company Ltd.

APPARATUS AND METHOD FOR VISUAL SURFACE EFFECT ENHANCEMENT

This invention relates to improved method and apparatus for pressurized fluid stream treatment of relatively moving materials to provide visual surface effects, and particularly patterned areas having pre-selected levels of visual contrast therein, as well as to novel products produced thereby.

As used herein, the term "fluid" includes gaseous, liquid, and solid fluent materials which may be directed in a cohesive pressurized stream or streams against the surface of a substrate material. The term "gas" includes air, steam, and other gaseous or vaporous media, or mixtures thereof, which may be directed in a cohesive pressurized stream or streams. The term "substrate" is intended to define any material, the surface of which may be contacted by a pressurized stream or streams of fluid to impart a change in the visual appearance thereof. A thermally modifiable substrate is any material having a surface which may be modified in terms of shrinking, melting, or other physical change as a result of heat application.

Substrates particularly suited for pressurized heated fluid stream treatment with the method and apparatus of the present invention are textile fabric constructions, and, more particularly, textile fabrics containing thermoplastic yarn and/or fiber components wherein pressurized heated fluid stream treatment of the surface of the fabric causes thermal modification of the yarns or fibers to produce a desired surface effect or pattern therein.

As used herein, the term textile fabric is intended to include all types of continuous or discontinuous webs or sheets containing fiber or yarn components, such as knitted, woven, tufted, flocked, laminated, or non-woven fabric constructions, in which pressurized heated fluids may impart a change in the visual surface appearance of the fabric. Melt spun fibers or yarns comprise polyester, polyamide, or polyolefin components. Solution spun fibers or yarns comprise acrylonitrile, urethane, and cellulose based fibers such as rayon, cellulose acetate, and cellulose triacetate. Of these, materials comprised of polyester, polyamide, polyolefin, acrylonitrile, cellulose acetate, cellulose triacetate, and urethane, or combinations thereof, are considered thermoplastic. It is foreseen that materials not included in the above list can be shown to be thermoplastic or otherwise thermally modifiable using the method and apparatus of this invention; the above list should not, therefore, be considered exhaustive. Further, it is foreseen that other substrates which are not usually considered textile fabrics, such as sheet substrates, may be used advantageously, and are to be considered a textile material for use in connection with this invention.

In commonly assigned U. S. Patent Application Serial Number 103,329, filed December 14, 1979, and 253,135, filed April 13, 1981, apparatus and methods were disclosed for creating patterns or other visual surface effects on a variety of substrates, particularly textile substrates, using heated fluid streams. A method and apparatus for regulating the temperature of the heated fluid is found in commonly assigned U. S. Patent Number 4,323,760. Furthermore, improvements in the apparatus, in particular to the heated gas manifold described herein, are the subject of commonly assigned U. S. Patent Application Serial Numbers 227,828 and 227,838, filed January 23, 1981, and Serial Number 282,330, filed July 10, 1981. The disclosures of all these documents are hereby incorporated by reference herein.

According to the combined teachings of the above-referenced and incorporated disclosures, visual surface effects on substrate surfaces comprising thermoplastic textile materials such as nylon, polyester, acrylonitrile, etc. can be obtained by shrinking or deforming the thermoplastic fibers, as well as by re-orienting individual pile fibers in materials having a pile construction. This patterning is achieved by impinging one or more precisely defined streams of heated air or other fluid onto the substrate surface. The types of visual surface effects which can be achieved by following the above-referenced teachings include, but are not limited to, imparting a contoured or sculptured effect, e.g., imparting grooves into the substrate surface, imparting a change in the perceived color or color density in dyed substrates, and combinations of these effects. The above visual effects are the result of heat treating the fabric. Specifically, the individual fibers or yarns are either permanently shrunk or deformed by the heated air, or the fibers or yarns are permanently re-oriented and heat set, or, most commonly, the visual effects are produced by a combination of these two mechanisms.

It was found that the degree of definition and contrast observed in the treated or patterned areas on certain thermoplastic web substrates treated by the above-referenced heated air process and apparatus was not satisfactory in that the patterned areas lacked contrast. Additionally, the degree of contrast was frequently non-uniform, and not reproducible from run to run or especially from day to day. Because the desired effect was thought to be the result of heat treatment, and because the degree of shrinkage of free thermoplastic yarns was known to be a function of increasing yarn temperatures (See Figure 9), it was assumed that the individual treated yarns in those areas showing insufficient or non-uniform contrast were being insufficiently or non-uniformly heated by the heated air streams. Much experimentation was done directed to increasing the temperature of the heated air streams used to treat the substrates. Various schemes to pre-heat the substrate to some uniform temperature somewhat below the minimum temperature at which permanent effects on the substrate are produced were also considered, in the belief that overall contrast as well as contrast uniformity could be improved by increasing the degree of heat treatment of the fibers, by whatever means.

It has been found that both increasing the temperature of the heated air streams as well as directly pre-heating the substrate prior to treatment were in fact inhibiting a principal mechanism for contrast development - the formation of bubbles within the treated fibers. By pre-cooling the fibers immediately prior to exposure to the heated air streams, contrast between treated and untreated areas can be significantly improved in many instances. This is particularly true if the design of the apparatus (e.g., presence of ventilating shrouds, etc.) and the rate of substrate travel are such that significant heat build-up occurs in the general region of the heated air streams and associated apparatus, resulting in even momentary pre-heating of the substrate. Increasing the temperature of the treating air streams tends to increase the temperature in this region, and thus has the effect of incidentally pre-heating the substrate prior to the actual point of treatment by the air streams. Of course, intentional preheating of the substrate also raises the temperature of the substrate prior to the point of treatment, and can be equally effective in preventing maximum contrast. Under certain conditions, merely a moderately high ambient room temperature, e.g., 85°F., can have an adverse effect on substrate contrast if it serves to pre-heat the substrate.

It has also been determined that the moisture content of the constituent fibers at the time of treatment plays an essential role in the formation of the bubbles which are responsible in large measure for the observed visual contrast. Where, for example, a substrate containing thermoplastic fibers has been dried or stored in a relatively warm, dry place, the constituent fibers of the substrate which have been treated with a sudden stream of heated air as taught in the earlier referenced documents do not generate the expected degree of contrast when compared with untreated areas of the substrate, even if the substrate has been pre-cooled.

It has been found that by careful moisture pre-conditioning of the thermoplastic components of the substrate, the moisture level of these components can be adjusted to yield a predictable degree of bubble formation during the treatment process which results in a uniform level of visual contrast. Assuming the pre-cooling step discussed above is used as well, the degree of visual contrast may be enhanced, which is to say that bubble formation within individual thermoplastic fibers is promoted, and the contrast resulting from the overall process is thereby.

exaggerated, as well as rendered completely uniform and reproducible. It is believed that both controlled moisture pre-conditioning and controlled temperature pre-conditioning of the fibers are necessary if visual contrast due to bubble formation is to be controlled and uniformity and reproducibility of the visual contrast effects in the resulting treated area are to be maintained.

Further details of the invention will become apparent from the following detailed description of the invention, when taken together with the accompanying drawings, in which:

Figure 1 is a diagrammatic, overall, side elevation view representation of apparatus for imparting visual surface effects in a moving substrate in accordance with the present invention;

Figure 2 is an enlarged diagrammatic front elevation view of the pressurized heated fluid applicator section of the apparatus of Figure 1, illustrating an arrangement of the component parts thereof for supplying heated pressurized gas to a hot gas distributing manifold of the applicator;

Figure 3 is an enlarged schematic perspective view of a portion of the hot gas distributing manifold of

Figures 1 and 2, with portions broken away shown in section to illustrate certain of the interior components, including a shim member employed in the elongate slot of the manifold to impart a desired surface pattern to the relatively moving substrate;

Figure 4 is a schematic sectional elevation view of the heated gas distributing manifold of Figure 3, and additionally showing the use of pressurized cooler gas distribution means for selectively blocking portions of the heated gas from exiting from the manifold to produce a patterned appearance in the substrate;

Figure 5 is a schematic sectional view of a portion of the hot gas distributing manifold shown in Figure 4, taken generally along line V-V of Figure 4 and looking in the direction of the arrows;

Figure 6 is a schematic sectional elevation view of a modified form of the hot gas manifold, with shim member removed from the hot gas distributing slot of the manifold and with only the cooler gas distributing means employed to control the hot gas discharge from the slot;

Figure 7 is a schematic sectional view of portions of the manifold of Figure 6, taken generally along line VII-VII therein, and looking in the direction of the arrows;

Figure 8 is an enlarged schematic perspective view of a shim member employed with the hot gas manifold to distribute the gas in narrow spaced streams onto the surface of a substrate;

Figure 9 is a diagram of experimentally determined shrinkages for various free (i.e., untensioned or unrestrained) man-made fibers, shown as a function of fiber temperature;

Figure 10 is a photograph showing a carpet substrate comprised of nylon 6,6 fibers which has been patterned in accordance with the teachings of this invention;

Figure 11 is a photomicrograph, taken through a 65X optical microscope using direct illumination, representing fibers from the untreated, visually darker areas of the substrate of Figure 10, showing fibers which are substantially unshrunken and containing no bubbles of substantial size;

Figure 12 is a photomicrograph of the fibers of Figure 11, taken through a 65x optical microscope using transmitted illumination;

Figure 13 is a photomicrograph of a portion of the fibers of Figure 11, taken through a 200x optical microscope using transmitted illumination;

Figure 14 is a photomicrograph, taken through a 65X optical microscope using direct illumination, representing fibers from the treated area of the substrate of Figure 10 which exhibits intermediate contrast, i.e. intermediate light reflectivity compared with an adjacent untreated area, which fibers contain small quantities of bubbles;

Figure 15 is a photomicrograph, taken through a 65x optical microscope using transmitted illumination, of nylon 6,6 fibers taken from the substrate area of Figure 14;

Figure 16 is a photomicrograph, taken through a 200x optical microscope using transmitted illumination, of nylon 6,6 fibers taken from the substrate area of Figure 14;

Figure 17 is a photomicrograph, taken through a 65X optical microscope using direct illumination, representing fibers from the treated areas of the substrate of Figure 10 which exhibit high contrast, i.e., high reflectivity compared with an adjacent untreated area, which fibers contain large quantities of bubbles;

Figure 18 is a photomicrograph, taken through a 65x optical microscope using transmitted illumination, of nylon 6,6 fibers taken from the substrate of Figure 17;

Figure 19 is a photomicrograph, taken through a 200x optical microscope using transmitted illumination, of nylon 6,6 fibers taken from the substrate of Figure 17; and

Figure 20 is a block diagram schematically depicting an apparatus on which a substrate may be moisture and temperature pre-conditioned at pre-determined levels and selectively treated by a first heated fluid stream, yielding treated areas having a first level of visual contrast compared with the untreated areas, and then moisture and temperature pre-conditioned at a different pre-determined level, and selectively treated by a second heated fluid stream yielding treated areas having a second level of visual contrast compared with the untreated areas.

Referring to the drawings, Figure 1 is a schematic side elevation view of a treating apparatus which may be used in the present invention. As shown diagrammatically, an indefinite length of substrate material, such as a textile fabric 10, is continuously directed from a supply source, such as roll 11, by means of driven, variable speed feed rolls 12, 13 to a pressurized heated fluid treatment device, indicated generally at 14. As an initial step in the overall treatment process, the substrate material is processed to insure the level of moisture within the material comprising the substrate is adequate to provide a first desired contrast level. It is believed that for nylon 6,6 fibers, for example, a moisture level of at least about 2 to 3% (by weight) and preferably about 4 to 5% (by weight) or more is thought necessary for bubble formation to be at a substantial level. In thermoplastic materials or fibers such as nylon 6,6, the extent of bubble formation, and therefore the extent of the visual contrast contributed by these bubbles, is a function of the moisture content of the material -- relatively dry materials which are suddenly heated in the process described herein do not display vigorous bubble formation within constituent fibers and consequently do not display a great deal of contrast under most circumstances, even with pre-cooling, while materials which have a relatively higher moisture content at the time they are contacted by the heated fluid streams tend to produce larger quantities of bubbles, which in some cases may virtually fill the interior of at least portions of representative constituent fibers, and which result in a high degree of visual contrast. Therefore, the degree of visual contrast may be controlled by varying the relative moisture contained within the constituent fibers.

To establish a pre-determined level of moisture within the substrate material, a moisture pre-conditioning device 8 is diagrammatically depicted preceding cooling port 2. Device 8 may be any convenient means by which moisture, in the form of water or other liquids, may be applied to or withdrawn from the substrate material so that the desired amount of moisture will be uniformly distributed on the material. For example, a misting device which applies a liquid mist to the surface of substrate 10 may be employed. The mist, the substrate surface, or both may be optionally warmed during this process. Device 8 may also be comprised of a steam chamber, through which substrate 10 is directed, or a drying means such as a convection oven or the like.

It is recommended that, where moisture is applied, conditions be adjusted to allow moisture to be absorbed into the substrate material rather than merely coating the surface of the material with a layer of liquid. The latter condition tends to insulate the material from the heated fluid stream and therefore is thought to be counterproductive to the production of internal bubbles. For this reason, it is preferred that application of excess moisture, i.e., moisture substantially in excess of that necessary to produce maximum moisture retention within the material, be avoided. It is also preferred that the moisture pre-conditioning device 8 result in a substantially uniform quantity of moisture over the surface of the substrate; areas having either too little or too much moisture will tend to have reduced contrast due to the inhibiting effect such moisture levels have on bubble formation. If generation of a special effect is desired, the moisture pre-conditioning may be done selectively over portions of the substrate surface, rather than over the entire surface. The substrate may also simply be stored (i.e., with all fibers fully exposed) in an environment having carefully controlled humidity for a sufficient time to establish the desired fiber internal moisture level, and device 8 need not be employed. It is recommended that, if high contrast is desired, the internal moisture levels of the fibers be at or approaching their maximum regain levels.

Immediately prior to the entry of the substrate into the device 14, the substrate is brought past temperature pre-conditioning duct 2, which is connected via duct 3 and valve 4 to a suitable source of cooling air 6, for example, a large capacity air conditioning duct. As will be discussed later, use of this air as a temperature pre-conditioner can serve to control the formation of bubbles in fibers as well. If little or no bubble formation is desired, duct 2 may be at least partially blocked and the heated air derived from the fluid treating device may be used to pre-heat the substrate. Following this temperature pre-conditioning step, the moving fabric 10 is supported during application of heated fluid thereto by passage about a support roll 16 through which a coolant may be circulated, and the fluid treated fabric is thereafter directed by driven, variable speed take-off rolls 18, 19 to a fabric collection roll 20.

After acted upon by the moisture and temperature pre-conditioner, the fabric substrate is directed through and treated by one or more streams of heated fluid, for example, heated air, having a temperature sufficiently high to raise quickly the impinged fibers of the substrate to a temperature at which shrinkage takes place, as indicated in Figure 9. Satisfactory air temperatures within the range of about 500°F to about

900°F have been found to be satisfactory. Depending upon the desired pre-conditioning moisture and temperature levels of the substrate, representative fibers contacted by these first heated air streams will be generally at least slightly shrunken, and will be substantially devoid of bubbles, substantially filled with bubbles, or contain bubbles in some intermediate quantity. Generally speaking, the greater the quantity of bubbles present in the fibers of a given area, the greater the light reflectivity and degree of visual contrast that area will display when compared with areas wherein the fibers have substantially no bubbles.

After the substrate has been passed through the apparatus a first time and has been patterned at some pre-determined relative level of visual contrast, that same substrate may be patterned a second time, following a second pre-conditioning of the fibers at a second desired moisture and temperature level, thereby causing the heated air stream to generate a different level of bubble formation within the fibers pre-conditioned at these second levels. Of course, if desired, the temperature, velocity, etc. of the heated air stream may also be adjusted to change the character of the treated substrate fibers. The result is a substrate surface having areas exhibit a number of different visual contrast levels, depending upon the number of times a heated air stream having pre-selected characteristics is allowed to impinge upon areas which carry significantly different temperature and moisture levels. In the discussion above involving two different treatments, substrate surface areas having at least three different levels of visual contrast can be obtained - - the untreated areas, the visually significantly lighter areas resulting from a first treatment of fibers which were pre-conditioned to generate a moderate quantity of internal bubbles, and the areas resulting from a second treatment in which the pre-conditioning levels favored heavy bubble formation - - areas which would be visually the lightest of all.

If additional levels of visual contrast are desired, additional treatments using various moisture and temperature pre-conditioning levels may be employed. Multiple levels of contrast may of course also be achieved in a single treatment by selective, non-uniform pre-conditioning of various areas of the substrate, e.g., by applying moisture to the substrate surface in a pattern-wise configuration, or by applying non-uniform amounts of moisture selectively over the substrate surface. It is also foreseen that, depending upon the moisture pre-conditioning means chosen, separate temperature pre-conditioning means may be unnecessary. Evaporative effects, or the application of a chilled liquid may be sufficient to induce the desired degree of bubble formation.

Figure 20 is a block-type diagram which represents an apparatus, based upon the apparatus depicted in Figures 1-8, which can be used to automatically supply two separate heated fluid treatments, at different temperatures and pressures, if desired. Substrate 10 can receive moisture and temperature pre-conditioning at a first desired level at stations 110 and 112, followed by treatment by heated fluid treatment device 114. Following this treatment, the substrate may be immediately moved through a second set of moisture and temperature pre-conditioning stations 120 and 122 and a second heated fluid treatment device 124. The moisture and temperature levels established at each pre-conditioning station, as well as the temperature and pressure of the respective heated fluid treatment streams, may be individually determined according to the contrast levels and other visual effects desired.

Examining the apparatus of Figures 1-8 in more detail, a conventional fabric edge-guiding device 21, well known in the art, may be provided in the fabric path between feed rolls 12, 13 and the fluid treating device 14 to maintain proper lateral alignment of the fabric during its passage over support roll 16. The speed of the feed rolls 12, 13, support roll 16, and take-off rolls 18, 19 may be controlled, in known manner, to provide the desired speed of fabric travel and the desired tensions in the fabric entering, passing through, and leaving the fluid treating device 14.

As illustrated in Figures 1 and 2, pressurized fluid treating device 14 includes an elongate heated fluid discharge manifold 30 which extends perpendicularly across the path of movement of fabric 10 and has a narrow, elongate discharge slot 32 for directing a stream of pressurized heated fluid, such as air, into the surface of the fabric and at an angle generally perpendicular to the surface during its movement over support roll 16. Shrouding, such as might be necessary to ventilate the treatment area, should be designed to minimize heat build-up in the treatment area, as well as heat build-up in the vicinity of the incoming substrate. It is again noted that certain improvements in the configuration of the heated gas discharge manifold described hereinafter may be found in the commonly assigned U. S. Patent Applications referenced above and incorporated by reference herein.

Pressurized fluid, such as air, is supplied to the interior of the discharge manifold 30 by means of an air compressor 34 which is connected by air conduit line 36 to opposite ends of an elongate cool air manifold 38. Located in the air conduit line 36 to control the flow and pressure of air to manifold 38 is a master control valve 40 and an air pressure regulator valve 42. A suitable air filter 44 is also provided to assist in removing contaminants from the air passing into air manifold 38.

Pressurized air in the air manifold 38 is directed from manifold 38 to hot air discharge manifold 30 through a bank 46 of individual electric heaters, only two of which, 48, are illustrated in Figure 2. Each heater is connected by inlet and outlet conduits 50, 52 respectively, positioned in uniformly spaced relation along the lengths of the two manifolds 38, 30 to heat and distribute the air from manifold 38 uniformly along the full length of the discharge manifold 30. The bank of heaters 48 may be enclosed in a suitable insulated housing and the air outlet conduit 52 of each heater is provided with a temperature sensing device, such as a thermocouple, the position of one of which, 54, is shown in Figure 2, to measure the temperature of the outflowing air. The thermocouples are electrically connected by wiring (illustrated by line 55 in Figure 2) to a conventional electrical recorder/controller 58 where the temperature can be observed, monitored, and electric current supplied as required to individual of the heaters from a power source, generally indicated at 60, to maintain the outlet air temperatures from the heaters uniform across the discharge manifold 30. Such electrical recorder/controllers are believed to be well known and readily available in the art, and details thereof are not described herein.

As best seen in Figures 3, 4, and 6, heated air discharge manifold 30 is formed of upper and lower wall sections 62, 64 which are removably secured together by suitable fastening means, such as spaced bolts 66, to form the interior compartment 68 of the manifold as well as opposed parallel walls 70, 72 of the elongate discharge slot 32.

Prior to discharge through slot 32, heated air passing into the compartment 68 of manifold 30 from the outlet conduits 52 of the bank of heaters 48 is directed rearwardly and then forwardly in a reversing path through the manifold compartment (as indicated by the arrows) by means of a baffle plate 74 which forms a narrow elongate opening rearwardly in compartment 68 for passage of the air from the upper to the lower portion of the compartment. Baffle plate 74 thus provides for more uniform distribution of the air in the manifold compartment and further facilitates the maintenance of uniform air temperature and pressure in the manifold. Baffle plate 74 is supported in manifold compartment 68 by spacer sleeves 76 surrounding bolts 66.

As best seen in Figures 4-7, located in the wall surface 72 of lower wall section 64 of the manifold and positioned in spaced relation along the length of the discharge slot are a plurality of cool air discharge outlets 78. Each outlet is individually connected by a suitable flexible conduit 80 and solenoid valve 82 to a cool air manifold 84, which is in turn connected to air compressor 34 by conduit 86 (Fig. 2). Located in conduit 86 is a master control valve 88, air pressure regulator valve 90, and air filter 92.

As diagrammatically illustrated in Figure 2, each of the individual solenoid valves is electrically operatively connected to a suitable pattern control device 94 which sends electrical impulses to open and close selected of the solenoid valves in accordance with predetermined pattern information. Various conventional pattern control devices well known in the art may be employed to activate and deactivate the valves in desired sequence. Typically, the pattern control device may be of a type described in commonly assigned U. S. Patent No. 3,894,413.

As illustrated in Figures 4 and 6, each of the cool air discharge outlets 78 is located in the lower wall surface 72 of the manifold slot 32 to direct a pressurized discrete stream of relatively cool air transversely into the heated air discharge slot in a direction perpendicular to the passage of heated air therethrough. The pressure of the cooler air streams is maintained at a level sufficient to effectively block and stop the passage of heated air through the slot in the portion or portions into which the cold air streams are discharged. Actually, the effect is possibly due to a combination of blocking and dilution of the heated air stream, depending on the relative pressures of the respective heated and cool air streams, but the term blocking will be used for simplicity. Thus, by activation and deactivation of the individual streams of cool air by the solenoid valves 82 in accordance with information from pattern control device 94, pressurized heated air passing through the slot will be directed in one or more distinct streams to strike the moving fabric surface in a desired location, thus providing a pattern effect in the surface of the fabric 10 as it passes the discharge manifold. The cooler air which blocks the passage of the heated air passes out of the slot in place of the heated air to dissipate around or into the fabric surface without altering the thermal characteristics of the fabric or appreciably disturbing the yarns or fibers therein. Note the arrows indicating air flow in Figures 4, 6, and 7. To ensure that the cooler blocking air is maintained sufficiently cool so as not to effect or thermally modify the fabric, the ambient air may be additionally cooled prior to discharge across the manifold slot 32 by provision of a cool water header pipe 95 through which the cool air conduits 80 pass.

Although cool pressurized air blocking means, as specifically described herein, is preferred for controlling discharge of the heated pressurized gas streams, it is contemplated that other types of blocking means, such as movable baffles, or the like, may be employed in the elongate slot 32 to selectively prevent passage of the heated pressurized air into the fabric.

To avoid damage to the fabric by the presence of heated gas when the fabric feed is stopped, the hot gas manifold 30 and its heaters 48 are pivotally supported, as at 97, and fluid piston means 98 utilized to pivot the manifold and its discharge slot away from the path of the fabric 10.

Figure 3 illustrates an embodiment of the heated pressurized gas discharge manifold wherein an elongated shim member or plate 99 having a plurality of elongate generally parallel notches 100 uniformly spaced along one edge of the plate is removably positioned in the manifold compartment 68 with its notched side edge extending into the elongate discharge slot 32 to form with the walls 70, 72 of the slot a plurality of corresponding heated air discharge channels for directing narrow discrete streams of pressurized heated gas onto the surface of the moving textile fabric. As seen in Figures 3 and 4, the notches 100 of the plate extend into the heated gas manifold compartment 68 to form an elongate inlet above and below the plate into each of the discharge channels formed by the notched edges of the shim and the walls 70, 72 of the manifold slot 32. Thus, the shim plate not only serves to direct pressurized gas into narrow streams to be discharged through the spaced channels, but the edges of the shim plate defining the upper and lower openings of the narrow, elongate inlets (note Figure 4) serve to trap and filter out foreign particles which may be present in the pressurized gas, while permitting continued flow of pressurized gas around the particles and through the channels.

It can thus be understood that the discharge channels formed by the shim member and discharge slot direct a plurality of discrete, individual spaced streams onto and into the surface of the moving textile fabric to form narrow, spaced, generally parallel lines extending in the direction of movement of the fabric past the discharge manifold. For example, by maintaining the temperature and pressure of the heated gaseous streams at sufficient levels, and by an appropriate choice of air discharge channel size and substrate speed, pile fabrics containing thermoplastic pile yarns contacted by the heated gas streams may be made to longitudinally shrink and compact in the pile surface, and may be heat set to form distinct grooves in the fabric, thereby permitting patterning of the surface of the fabrics in various ways. To change the grooved pattern in the fabric, it is only necessary to loosen the manifold bolts 66 and replace an existing shim plate with another shim plate having a different groove size and/or spacing along the shim plate edge. Figure 8 illustrates another shim plate 102 having an irregular shim notch 104 spacing along the plate to provide a variation in the pattern which may be applied to the surface of the fabric web. Thus, it can be seen that various surface patterns may be applied to the moving web by the shim plates alone, and without the additional control of the streams by the cooler pressurized gas outlets described above.

The surface patterns to be imparted to the surface of the desired textile material is not limited to grooves or combinations of grooves. Relatively large areas may be thermally treated to produce a wide variety of surface effects. Figures 4 and 5 illustrate a form of the apparatus wherein shim plates are employed in combination with the pressurized cooler gas outlets in the discharge slot 32 to form more intricate or detailed pattern in the textile web. As seen in Figure 5, the discharge outlets 78 are located in the channels formed by the shim plate and slot walls 70, 72 to selectively block the channels with cool gas and thereby permit intermittent discharge of selected of the heated gas streams to produce surface patterns which may vary across the fabric as well as in the direction of movement of the fabric past the discharge manifold.

Figures 6 and 7 illustrate another form of the apparatus wherein patterning of the fabric is accomplished by use of the elongate slot 32 and pressurized cool gas outlets without the use of shim plates. As seen in Figure 7, by selectively activating the cool gas stream supply to certain of the outlets 78 in accordance with pattern information, the heated gas passage through slot 32 is blocked by the cooler gas in corresponding areas of the slot to pattern the moving fabric.

Fabric treatment may be carried out prior to dyeing to obtain subsequent differential dye uptake in the thermally modified and non-modified fibers and yarns, producing multi-tone dye effects, patterning effects, or both in pile as well as non-pile fabrics. When fabric treatment is carried out after the substrate has been dyed, a multi-tone patterning effect may also be achieved. When the patterning effect is due to the shrinking or shriveling of individual fibers and yarn segments as with non-pile fabrics and some pile fabrics, those fibers and yarn segments tend to increase in diameter, becoming shorter but thicker, and tend to lose apparent bulk in terms of crimp within the treated area. This in turn tends to increase the apparent density of dye-bearing fibers or yarns in the area of the fabric actually treated, and makes this area appear to have a color value which is more saturated, intense, or visually darker, the degree depending upon choice of operating conditions.

On selected substrates, where the heated air stream lays down or entangles fibers which normally are relatively straight and are viewed in a more-or-less "end-on" orientation, the effect can be a lightening or dilution of the color observed in the treated areas, when compared to areas on the fabric which have not been treated. It is believed the untreated fibers remain relatively upright causing the eye to see many more fibers in a substantially on-axis orientation, and causing more shadowing of the individual fibers than is found when the fibers are permanently inclined or entangled by the hot air stream, resulting in a darker color and significant contrast between treated and untreated areas.

The contrast associated with certain textile fibers, for example, nylon, is process-sensitive in a surprising way. If the substrate is cooled, say to temperature of about 70°F or below, the visual contrast is noticeably, and in many cases, dramatically improved over the contrast obtained without such cooling. In the apparatus schematically depicted in Figure 1, a large duct 2, having a width approximately the width of the web substrate being treated, is attached to an air conditioning duct. The duct 2 is positioned close to the substrate surface, immediately forward of the treatment zone, thereby cooling the substrate surface immediately prior to treatment by the heated air streams. Heat build-up in the immediate vicinity of discharge slot 32, as well as elevated ambient room temperatures (e.g., over about 85°-90°F) act to pre-heat the substrate prior to its arrival opposite slot 32, and thus contribute to contrast degradation. Means other than the cool air duct 2 of Figure 1 for cooling the substrate may be employed. If shrouds, etc. are present in the vicinity of the treatment zone, streams of compressed air, chilled rollers, or other means may be employed to prevent significant preheating of the substrate and to localize the heat generated by the manifold 30 as well as that contained in the air emerging from slot 32. Similarly, cooling support roll 16 is but one approach which has been found to cool the substrate and aid in reducing the extent of pre-heating. It is foreseen that, for some substrates, pre-cooling of the substrate to temperatures substantially below 60°F may be advantageous in terms of enhancing the visual surface effect achieved when compared with a substrate which has not been so cooled.

In order to effect satisfactory cooling of the substrate, incidental and unwanted substrate pre-heating must be overcome. Substrate pre-heating may be due to a variety of causes, among them high discharge manifold, support roll, or air stream temperatures, shrouding of the treatment area which prevents adequate circulation of cooling air and promotes heat build-up, a relatively high ambient temperature generally surrounding the apparatus, and a relatively slow substrate feed rate which results in a longer substrate exposure time to machine generated ambient heat. It has been found that if conditions are sufficient to cause a substrate such as nylon 6,6 to be pre-heated, momentarily, to merely 85°F just prior to treatment, a temperature frequently encountered even in ambient industrial environments, the contrast of the resulting product is visually significantly inferior to a similar product which has been cooled to a temperature of 65°-70°F immediately prior to treatment. A dramatic decline in contrast of the treated area can be observed when this substrate is pre-heated to temperatures in excess of about 90°-95°F. Thus, the degree of contrast generated on the substrate, which is a consequence of the quantity of bubbles generated within the fibers of the substrate, can be controlled by controlling the temperature of which the fibers are pre-conditioned immediately prior to being treated by the heated fluid streams from discharge slot 32. Of course, the actual degree of contrast development is dependent upon the type substrate as well as those factors which would influence the amount of actual incidental pre-heating which the substrate has undergone prior to the actual treatment process. For a given air stream temperature, apparatus configuration, and ambient temperature, this pre-heating effect is most pronounced if substrate feed rate is slow, as may be required in imparting the heat necessary to treat certain heavy or dense substrates.

In order to reliably control the extent of bubble formation within the substrate fibers, control of the temperature of the substrate immediately prior to the sudden heating produced by passage of the substrate under discharge slot 32, i.e., temperature pre-conditioning, is not in itself sufficient; it is also necessary to control the internal moisture level of the substrate or its constituent fibers prior to treatment, i.e., moisture pre-conditioning. Specifically, it has been found that under similar conditions, for example, where internal moisture levels of nylon 6,6 fibers are below about 2 to 3%, as may result from previous manufacturing steps or from storage in a warm, dry place, contrast levels in treated areas of the substrate containing these fibers are substantially reduced when compared with treated areas of similar substrates having internal moisture levels which are, for example, about 5%. Ideally, for maximum light reflectance or relative contrast, the substrate should be approaching its maximum, internal moisture-retaining capacity or moisture regain level. For substrates comprised of nylon 6,6, for example, the fibers should have a moisture content above about 5 to 6%, and optimally about 7% or more, by weight, in order to achieve near-maximum contrast levels. These results merely reflect the effect high fiber moisture level is believed to have in encouraging bubble formation within the fiber. As discussed above, control of moisture levels, and in particular, conditioning the substrate prior to treatment by the heated fluid streams to raise the moisture level to some pre-determined value may be achieved by a moisture pre-conditioning device 8, situated ahead of the cooling duct 2. Device 8 may comprise a misting means, a steaming means, a drying means, or other means to establish a desired moisture level within the substrate material, for example, into the fibers of a textile material. Again, it should be emphasized that the moisture must be absorbed by the material, and not merely coated or distributed on the material, thereby making the application of excessive amounts of moisture generally disadvantageous. It should also be emphasized that whatever moisture is present should be substantially evenly distributed over the desired surface of the substrate to avoid non-uniform contrast development.

As suggested above, the enhanced contrast repeatability and control which results from the combination of moisture pre-conditioning and temperature pre-conditioning the substrate just prior to treatment appears to be primarily the result of control of bubble formation within portions of the individual treated fibers. These bubbles, which generally appear within the fiber where the fiber exhibits substantial shrinkage, substantially alter the reflectivity of the outside of the fiber in the region containing the bubbles. It is theorized that the heated air, striking the cooled fibers, causes massive heat transfer into the fibers, which causes the fibers to heat to the point where internal deformation can take place, in response to pressures induced by the vaporization of trapped moisture within the fiber. Where bubbling within the fiber interior is severe, i.e., when the bubbles substantially fill the interior of a representative fiber over a portion of its length, the bubbles may deform the fiber surface and change the visual and tactile texture of the fiber or associated substrate as well.

In the case of nylon 6,6 there is a dramatic increase in the amount of light reflected from the fiber portions or sections containing low quantities of bubbles compared with untreated areas. Treated areas therefore appear to be much lighter in appearance than would otherwise be the case, as can be seen in Figure 10.

Looking first at Figures 11-13, untreated fibers of nylon 6,6 may be seen. The fibers are generally smooth-skinned, and shown no signs of internal bubbles. The nylon 6,6 fibers shown in Figure 14-16 were taken from a pile substrate which had only been treated with heated air following pre-cooling at approximately 72°F., and which showed a significant sculptured effect in the treated area, indicating shrinkage and pile re-orientation had taken place. No moisture pre-conditioning had taken place; the moisture level of the fiber was low. Only slight contrast was observed, in spite of the significant shrinkage and the pre-cooling. The photomicrographs shows this shrinkage, and also shows early development of small localized groupings of bubbles.

In Figure 17-19, the treated areas from which the nylon 6,6 fibers were taken also showed a significant sculptured effect, nearly identical in extent to the substrate of Figure 14-16. In this case, however, the treated areas of the substrate, which had been moisture pre-conditioned to a high moisture level as well as pre-cooled as before, were dramatically lighter to the eye than the area of Figures 11-13. In Figure 17, the outside surface of the fibers appears much brighter than these shown in either of Figures 11, or 14. It is believed the increased reflectivity of the fibers is due to the formation of relatively large masses of bubbles within the individual fibers. These bubbles are seen as the very dark masses which virtually fill the inside of the fiber in Figure 19. The outside surface of the Figure 17 fibers also appears to be more irregular or textured, which may contribute greatly to the fibers light reflecting characteristics.

Details of treatment procedures are described in the following examples involving the sculpturing of a carpet comprising nylon 6,6 fiber.

EXAMPLE 1

A bonded carpet with an Antron™ 3 SL (Antron™ is a trademark of DuPont) 20/2 cotton count pile and 22 denier per filament with 9 ends per inch and 7.9 folds per inch and a weight of 28 ozs./sq. yard and a pile height of one-fourth inch was processed through an apparatus similar in principle to the apparatus described herein, at a speed of 1.4 yards per minute. The temperature and pressure of the heated air in the discharge manifold was maintained at 640°F and 2.5 p.s.i.g. respectively and directed into the pile through an 0.015" continuous slit. The cold blocking air pressure, controlled via solenoid valves, was maintained at 10 p.s.i.g. The distance between the manifold discharge slot and the surface of the pile of the carpet was approximately 0.030 inch. The open end of a cooling duct connected to a central air conditioning duct was positioned adjacent to the pile carpet surface. The duct was used to maintain the pile surface at 70°F directly prior to the treatment zone. The hot air stream striking the cool pile fiber caused shrinkage and bubbles in the fiber tips which in turn resulted in good visual contrast between the treated and untreated areas, the treated areas having a lighter and greater reflectivity to light.

EXAMPLE 2

A bonded carpet as described in Example 1 was processed at the same conditions as Example 1 with the exception that the pile was pre-heated to 95°F. The fiber tips shrank, but few bubbles were present and contrast between the treated and untreated areas was poor.

EXAMPLE 3

A bonded carpet as described in Example 1 was processed through the apparatus of Example 1 at a speed of 1.4 yds. per minute. The temperature and pressure of the heated air in the discharge manifold was maintained at 790°F and 2.0 p.s.i.g. respectively, and directed onto the pile through a 0.015" continuous slit. The cold blocking air pressure controlled via solenoid valves was maintained at 10 p.s.i.g. The distance between the manifold discharge slot and the surface of the pile of the carpet was approximately 0.030 inch. Pre-cooling using the cooling duct of Example 1 maintained the pile surface at 70°F directly prior to the treatment zone. The hot air stream striking the cool pile fibers caused shrinkage and bubbles in the fiber tips which in turn resulted in good visual contrast between the treated and untreated areas.

EXAMPLE 4

A bonded carpet as described in Example 1 was processed under conditions similar to Example 3 with the exception that the pile was preheated to 95°F. The fiber tips shrank to a substantially identical degree as was found in Example 3, but few bubbles were present and contrast between the treated and untreated areas was poor.

EXAMPLE 5

A section of bonded carpet with an Antron™ 3 XL (Antron™ is a trademark of DuPont) 20/2 cotton count pile and 22 denier per filament with 9 ends per inch and 7.9 folds per inch and a weight of 28 ozs./sq. yard and a pile height of one-fourth inch is processed through an apparatus similar in principle to the apparatus described herein, at a speed of 2 yards per minute. The carpet section is moisture pre-treated by applying wet steam uniformly to the surface for 10 seconds, followed by a 20 second cooling period in an environment maintained at 75% relative humidity and 74°F, during which time cool air is blown over the surface. The temperature and pressure of the heated air in the discharge manifold is maintained at 640°F and 1.4 p.s.i.g. respectively and directed into the pile through an 0.025 inch wide continuous slit. The cold blocking air pressure, controlled via solenoid valves, is maintained at 14 p.s.i.g. The distance between the manifold discharge slot and the surface of the pile of the carpet is approximately 0.050 inch. A cooling zone established by a cool air duct connected to a hood positioned over the carpet surface is used to maintain the carpet pile surface at approximately 72°F directly prior to the treatment zone. The hot air stream striking the cool pile fiber causes shrinkage and bubbles in the fiber tips which in turn result in good visual contrast between the treated and untreated areas, the treated areas containing the bubbles having a lighter visual appearance and greater reflectivity to light.

EXAMPLE 6

A bonded carpet as described in Example 5 is processed at the same conditions as Example 5 with the exceptions that the pile is moisture pre-conditioned by pre-heating the carpet section to approximately 95°F for 3 hours, followed by storage for one day in an area maintained at 75°F and 35% relative humidity. The fiber tips shrink, but few bubbles are present and contrast between the treated and untreated areas is poor.

EXAMPLE 7

A bonded carpet section as described in Example 5 is processed through the apparatus of Example 5 at a speed of 2.0 yards per minute. The carpet section is moisture pre-treated by applying a water mist to the pile surface, raising the moisture level of the fibers to 4% by weight of the pile fibers. The temperature and pressure of the heated air in the discharge manifold is maintained at 640°F and 1.4 p.s.i.g. respectively and directed onto the pile through a 0.025 inch continuous slit. The cold blocking air pressure, controlled via solenoid valves, is maintained at 14 p.s.i.g. The distance between the manifold discharge slot and the surface of the pile of the carpet is approximately 0.050 inch. A cooling zone established by a cool air duct connected to a hood positioned over the carpet surface is used to maintain the pile surface at approximately 72°F directly prior to the treatment zone. The hot air stream striking the cool pile fibers cause shrinkage and bubbles in the fiber tips which in turn result in good visual contrast between the treated and untreated areas.

EXAMPLE 8

A section of bonded carpet with an Antron™ 3 XL (Antron™ is a trademark of DuPont) 20/2 cotton count pile and 22 denier per filament with 9 ends per inch and 7.9 folds per inch and a weight of 28 ozs./sq. yard and a pile height of one-fourth inch is processed through an apparatus similar in principle to the apparatus described herein, at a speed of 2 yards per minute. The carpet section is moisture pre-conditioned by applying wet steam uniformly to the surface for 10 seconds, followed by a 20 second temperature pre-conditioning period in an environment maintained at 75% relative humidity and 72°F, during which time air was blown over the surface or by allowing the carpet to cool for 10 minutes in a cool environment at approximately 70°F and 75% relative humidity. The temperature and pressure of the heated air in the discharge manifold is maintained at 640°F and 1.4 p.s.i.g. respectively and directed into the pile through an 0.025 inch wide continuous slot. The cold blocking air pressure, controlled via solenoid valves, is maintained at 14 p.s.i.g. The distance between the manifold discharge slot and the surface of the pile of the carpet is approximately 0.050 inch. A cooling zone established by a cool air duct connected to a hood positioned over the carpet surface is used to maintain the pile surface at approximately 72°F directly prior to the first heated fluid zone. The hot air stream striking the cool pile fiber causes shrinkage and bubbles in the fiber tips which in turn result in good visual contrast between the treated and untreated areas, the treated areas having a lighter appearance and greater reflectivity to light. The carpet section is now moisture pre-conditioned to below 3% moisture and temperature pre-conditioned to about 105°F. The carpet then passes under a second heated fluid zone, operating at the same conditions as the first heated fluid zone. The hot air stream striking the warm dry pile fiber produces few bubbles and hence low visual contrast when compared with untreated areas of the substrate. The resulting carpet shows three different levels of visual contrast in pile fibers. This example is the first listed in the following table (Table I) wherein additional examples may be found. The moisture and temperature pre-conditioning values prior to the respective heated fluid zone treatments are shown. Results on the carpet pile fibers are listed for each set of pre-conditioning values.

[illegible]AL [illegible]).	1ST PRE-CONDITIONING MOISTURE PRE-COND.	 TEMP. PRE-COND.	FIRST HEATED FLUID ZONE	FIBER CONDITION	2ND PRE-CONDITIONING MOISTURE PRE-COND.	 TEMP. PRE-COND.	SECOND HEATED FLUID ZONE	RESULTING EFFECT
1	Over 5%	72°F.	Conditions as Ex. 1	*4	Below 3%	Over 105°F.	Conditions as Ex. 1	*2
2	Below 3%	Over 105°F.	Conditions as Ex. 1	*2	Over 5%	72°F.	Conditions as Ex. 1	*4
3	Over 5%	Over 105°F.	Conditions as Ex. 1	*2	Over 5%	72°F.	Conditions as Ex. 1	*4
4	Between 3%-5%	72°F.	Conditions as Ex. 1	*3	Over 5%	72°F.	Conditions as Ex. 1	*4
5	Over 5%	90°F.	Conditions as Ex. 1	*3	Over 5%	72°F.	Conditions as Ex. 1	*4

- No shrinkage, no bubbles (low light reflectivity)
- Shrinkage, no bubbles (low to moderate light reflectivity)
- Shrinkage, few bubbles (moderately high light reflectivity)
- Shrinkage, many bubbles (high light reflectivity)

CLAIMS

1. A method for treating a moving substrate by application of pressurized heated fluid to selected surface portions thereof to alter the visual surface appearance of the substrate by creating bubbles within at least portions of said substrate, wherein uniformly heated fluid is discharged along a thin continuous band across the path of the moving substrate and onto the surface of said substrate, except at selected locations along the band wherein said discharge of fluid is blocked, thereby preventing the fluid from impinging the substrate surface at corresponding locations on said surface and causing said substrate to be impinged by separate streams of fluid flanking said locations, said surface being temperature pre-conditioned to a temperature less than 95^{o}F prior to said impinging of fluid streams onto said substrate.

2. A method according to claim 1, wherein said substrate is at a temperature less than 75^{o}F prior to contact by the heated fluid.

3. A method according to claim 2, wherein said substrate surface is cooled by a stream of chilled air impinging on said surface immediately prior to contact by the heated fluid.

4. A method according to any preceding claim, wherein said substrate is moisture pre-conditioned to establish a pre-determined moisture content within said substrate prior to contact by said impinging streams.

5. A method according to claim 4, wherein said substrate is moisture pre-conditioned by exposing said

substrate to moisture prior to said temperature pre-conditioning step.

6. A method according to claims 4 or 5, wherein said pre-determined moisture level is greater than 5%.

7. Apparatus for treating a moving substrate by application of pressurized heated fluid to selected surface portions thereof to alter the visual surface appearance of the substrate by creating bubbles therewithin, comprising means for cooling the surface of said substrate, means for directing a stream of heated fluid against the surface of the substrate, and means for supporting the substrate and bringing said substrate surface into operative relationship with said cooling means and then said stream directing means, said cooling means and said stream directing means being relatively positioned so that said substrate surface is substantially cool as said heated fluid is directed against said substrate surface.

8. Apparatus according to claim 7 further comprising means for establishing a uniform, pre-determined moisture level within said substrate, said means being relatively positioned so that said substrate carries said pre-determined moisture level as said heated fluid is directed against said substrate surface.

9. Apparatus according to claim 8, wherein said means for establishing a uniform, pre-determined moisture level comprises a steaming means.

10. Apparatus according to claim 8, wherein said means for establishing a uniform, pre-determined moisture

level comprises a misting means.

11. Apparatus according to any one of claims 7 to 10, wherein said cooling means comprises means for supplying a stream of chilled air.

12. A textile product comprising thermoplastic fibers wherein some of said fibers in certain areas are substantially longitudinally unshrunken and contain substantially no bubbles, while others of said fibers are at least partially longitudinally shrunken along portions of their lengths, said shrunken fibers having substantial internal portions of said shrunken portions occupied by bubbles.

13. A textile product comprising thermoplastic fibers wherein some of said fibers in certain areas are substantially longitudinally unshrunken and contain substantially no bubbles, while others of said fibers are at least partially longitudinally shrunken, said shrunken fibers being further differentiated by being grouped into different areas on said substrate wherein in at least one area representative ones of said shrunken fibers have little internal space occupied by bubbles, and in at least one other area representative ones of said shrunken fibers have substantially larger volumes of internal space occupied by said bubbles, the relative difference with respect to the presence of bubbles within said fibers resulting in a relative difference in reflectivity or perceived visual contrast of said fibers in said areas.

14. A product according to claims 12 or 13, wherein said thermoplastic fibers are comprised of nylon 6,6.

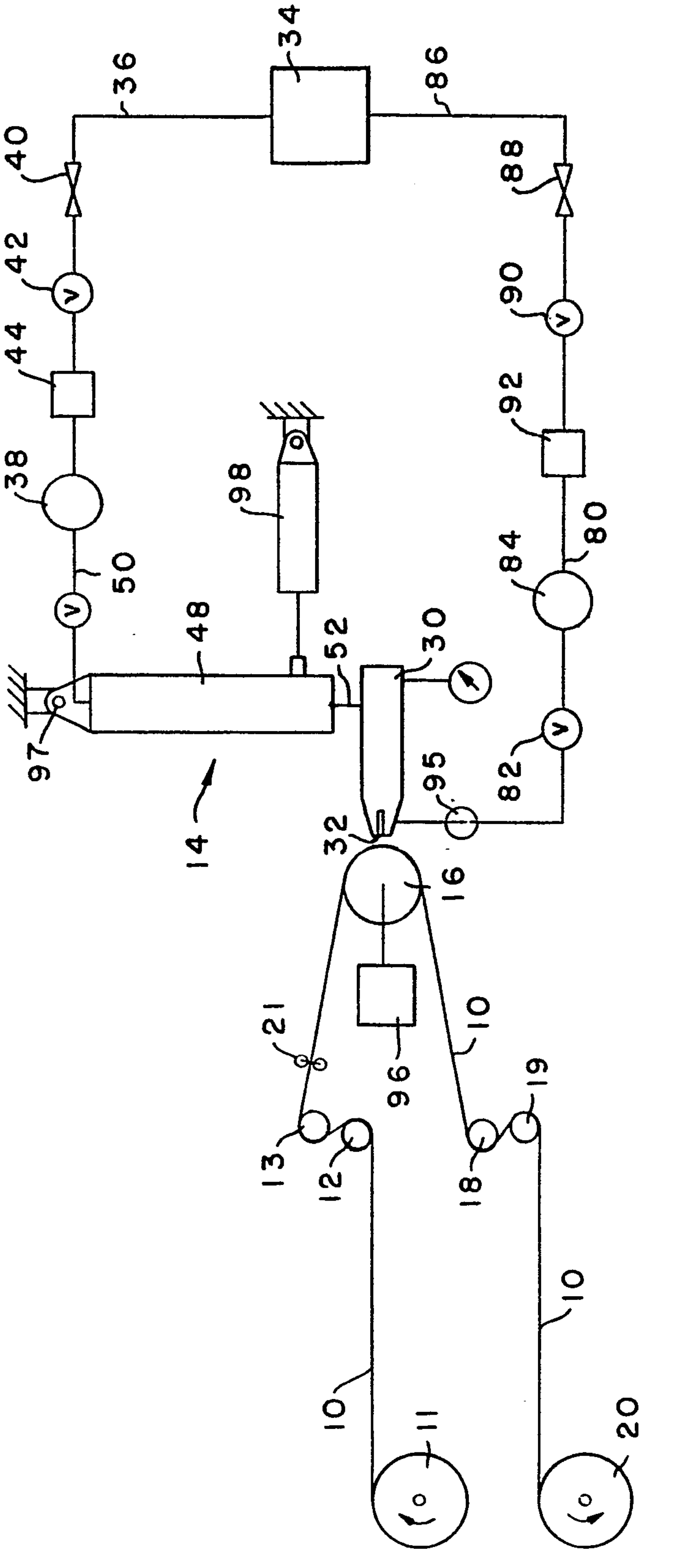

34
36
86
40
88
42
90
44
92
38
98
84
80
50
48
52
30
97
82
95
14
32
16
21
10
96
19
13
12
18
10
10
11
20

FIG. I

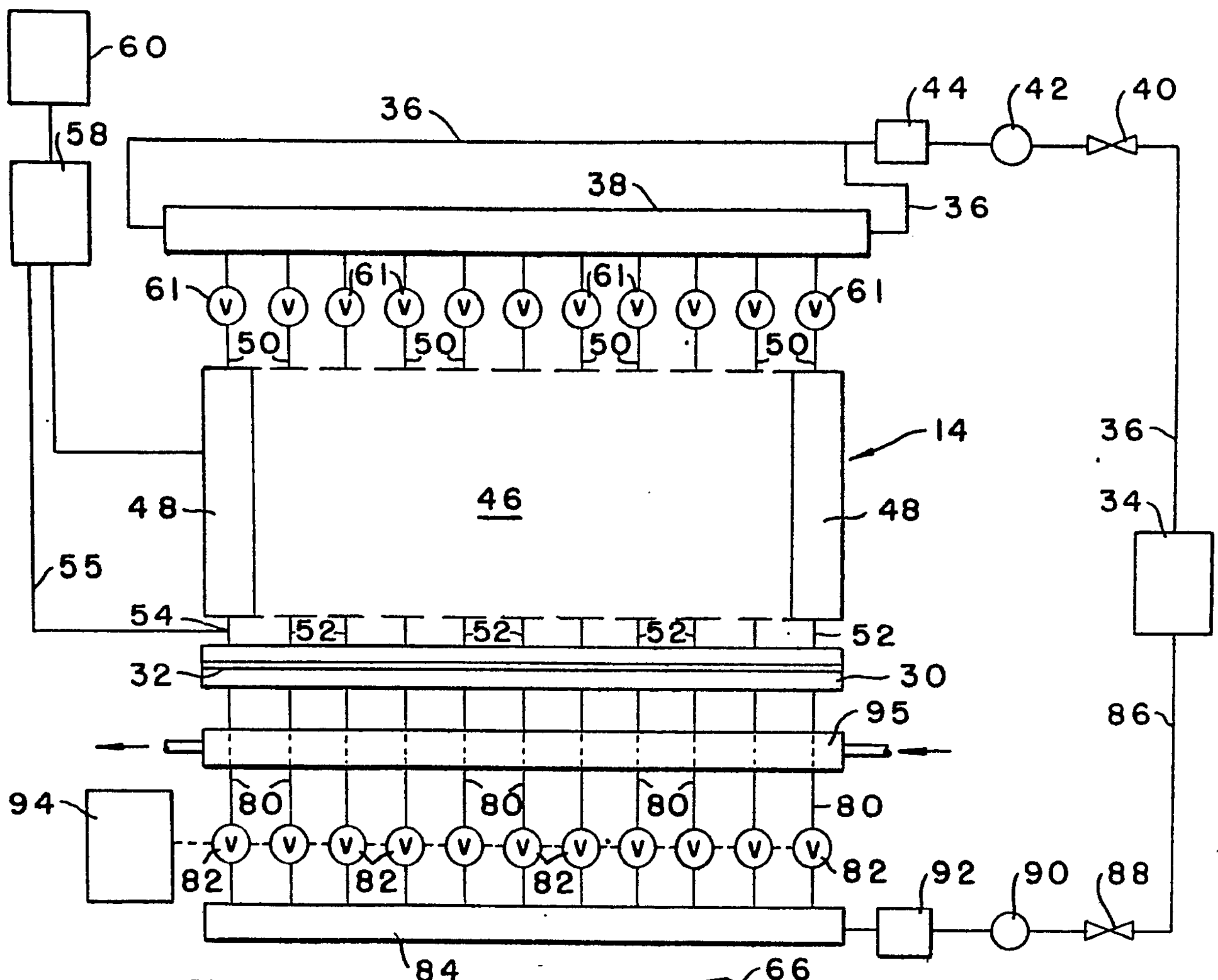


FIG. 2

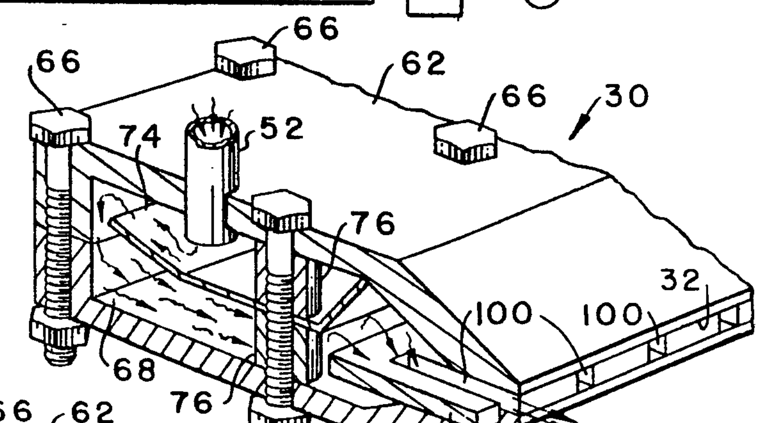


FIG. 3

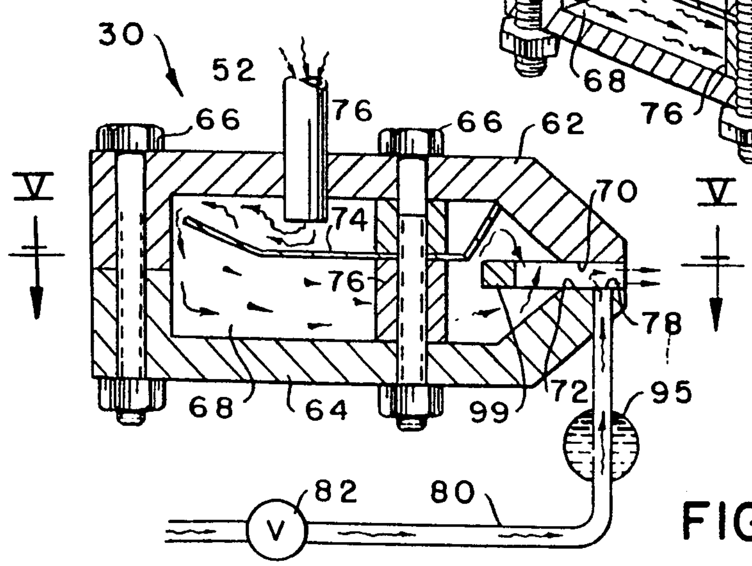


FIG. 4

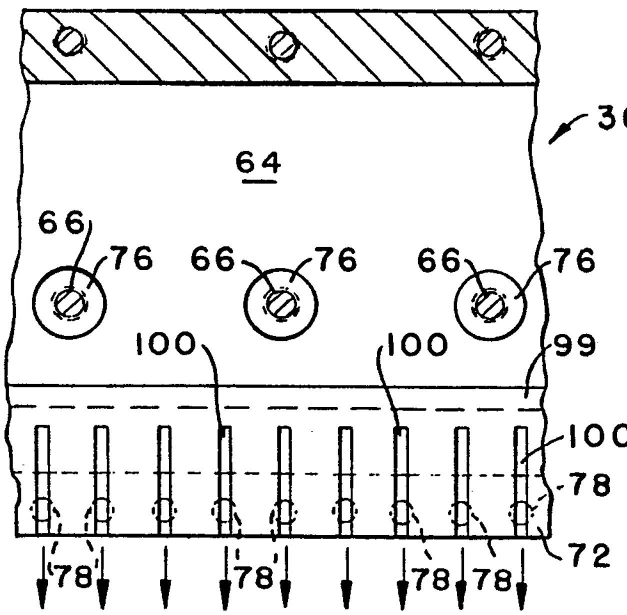


FIG. 5

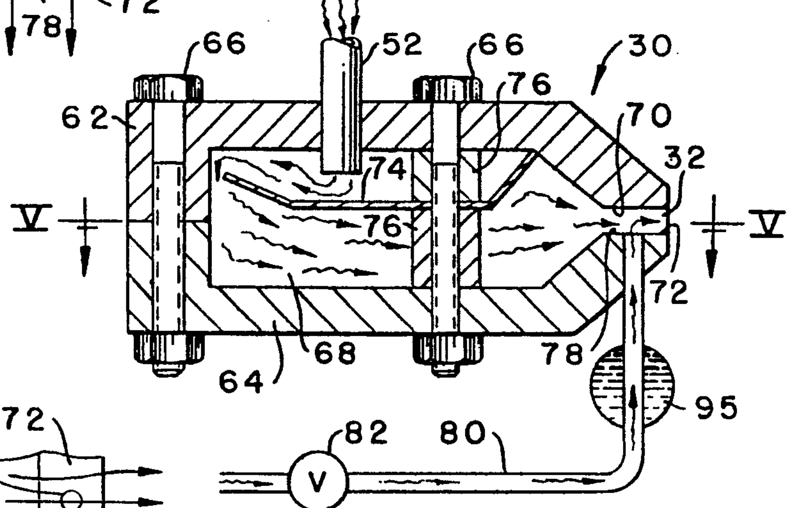


FIG. 6

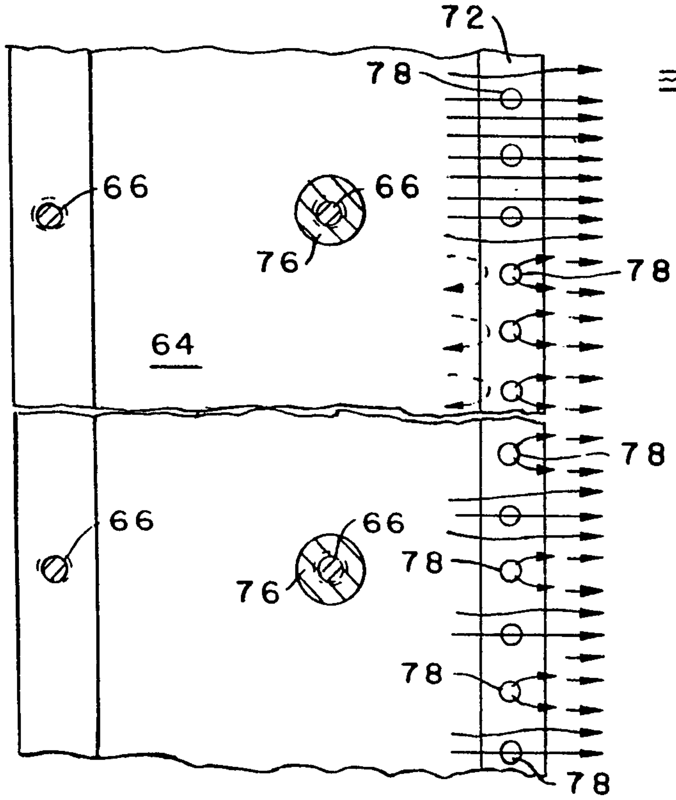


FIG. 7

FIG. 8

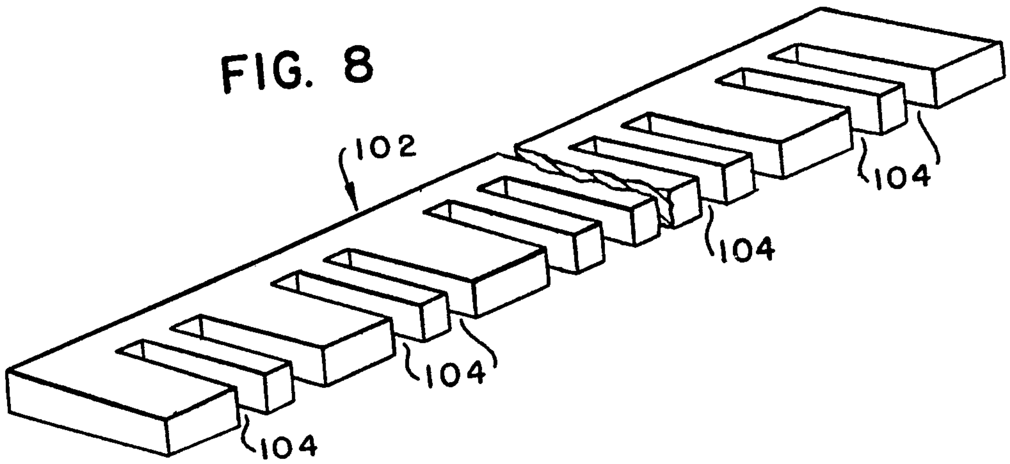


FIG. 20

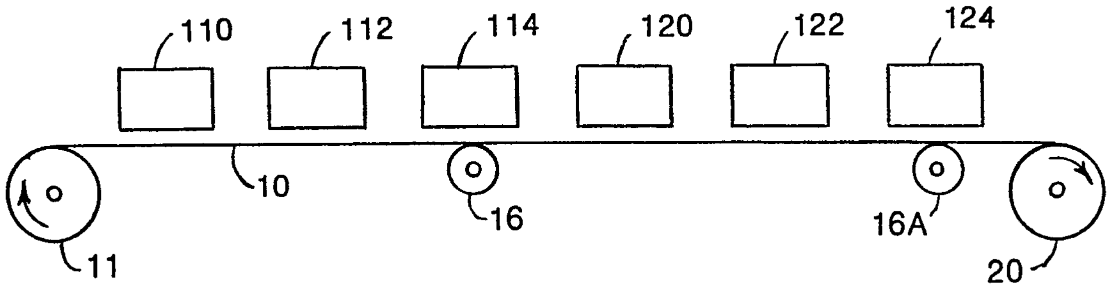
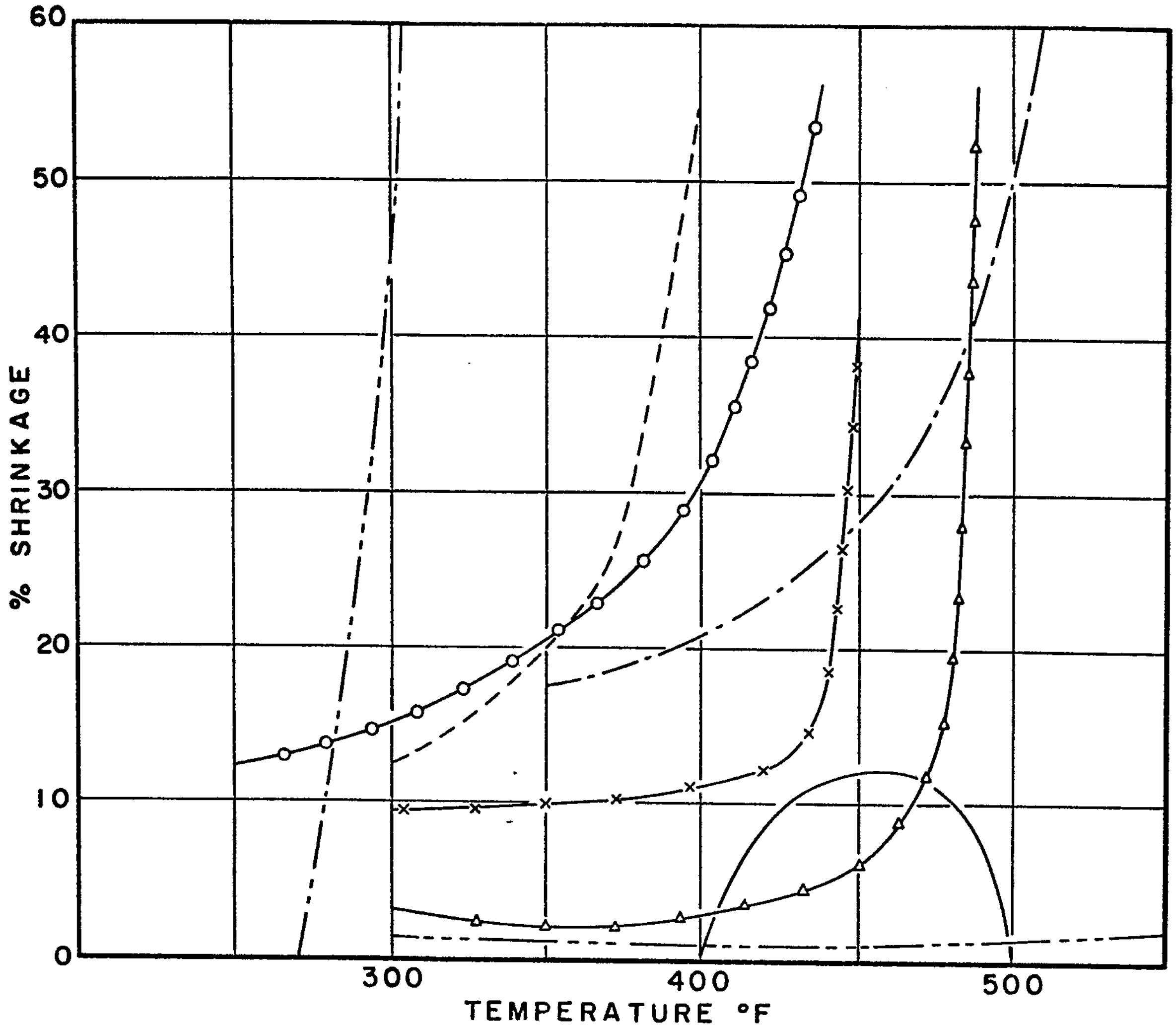


FIG. 9



POLYPROPYLENE

DACRON™ POLYESTER TYPE 56 100/54 R-02 (DUPONT)

NYLON 6 (ENKA)

ORLON™ 1/24 BLEND 152 (DUPONT)

NYLON 6/6 TYPE 74S 500/92/0 (DUPONT)

ACRILAN™ (MONSANTO)

RAYON

ACETATE 70 DENIER

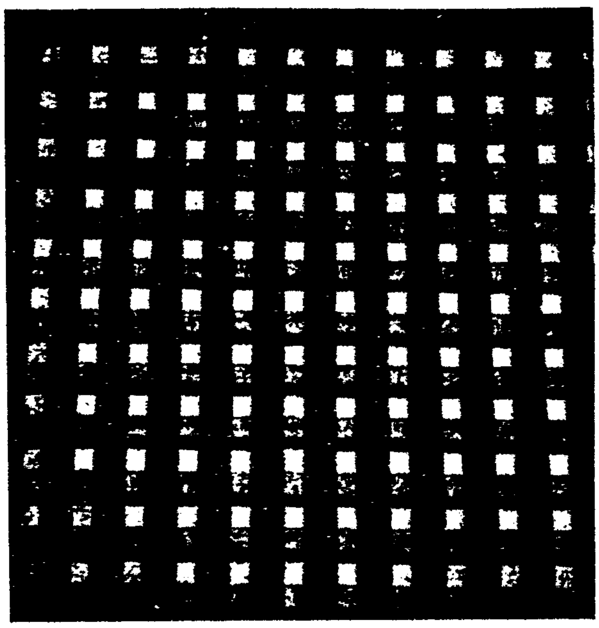


FIG.10

FIG.11

FIG.12

FIG.13

FIG.14

FIG.15

FIG.16

FIG.17

FIG.18

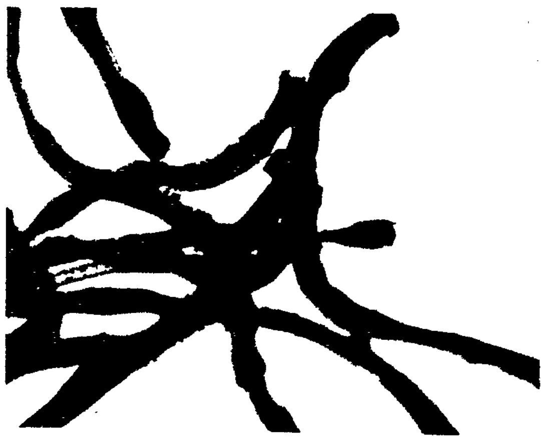


FIG.19

0099639

European Patent Office

EUROPEAN SEARCH REPORT

Application number

EP 83 30 3382

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)
			D 06 C 23/04
X	GB-A-2 065 035 (MILLIKEN RESEARCH) * Whole document * ---	1,7,12-14	
X	FR-A-2 093 468 (SCHROERS) * Whole document * ---	1,7,12,14	
X	US-A-3 635 625 (PHILLIPS) * Whole document * ---	1,7,12	
X	US-A-3 729 784 (J.P. STEVENS) * Whole document * -----	1,7,12	
			TECHNICAL FIELDS SEARCHED (Int. Cl. 3)
			D 06 C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	22-09-1983	PETIT J.P.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO Form 1503. 03.82