

SPECIFICATION

TITLE OF THE INVENTION

A water pressure transfer method and a water pressure transfer article

5 TECHNICAL FIELD

[0001]

This invention relates to a water pressure transfer method adapted to improve a surface property of a decorative layer formed on an article by the water pressure method or a protection layer formed on the decorative layer by
10 the water pressure transfer method.

BACKGROUND OF TECHNOLOGY

[0002]

The water pressure transfer method is the one in which a transfer film having a predetermined water-insoluble print pattern applied onto a
15 water-soluble film is sequentially supplied and floated on a water surface which flows within a transfer tub and made wet with the water and an article (a transferred body or a body to be pattern-transferred) is immersed into the water within the transfer tub while it contacts the transfer film whereby the print pattern of the transfer film is transferred onto the surface of the article
20 using the water pressure to thereby form a decorative layer. In the case where the print pattern is dried, it is required to apply an active agent to the print pattern so as to activate the ink of the print pattern in order to get the same wet state of the ink (the state where it has an adhesion) as the state of the ink immediately after being printed. In order to provide wear resistance,
25 weather resistance (including solvent resistance, chemical resistance, etc.) to the decorative layer formed by transferring the print pattern on the surface of the article, it is necessary to form a transparent surface protection layer (topcoat layer) on the decorative layer.

[0003]

In one prior art, this surface protection layer is formed by applying by spray an ultraviolet ray hardening type protection coating material onto the decorative layer after transferring the print pattern, removing the
5 water-soluble film out of the surface of the article and drying the article, and then irradiating an ultraviolet ray on the ultraviolet ray hardening type protection coating material to thereby harden the protection coating material.

[0004]

However, the method of applying the protection coating material on
10 the surface of the article by spray makes difficult the uniform application of the surface protection layer on the whole surface of the article and in addition thereto causes dirt and dust to be adhered onto the decorative layer formed by transferring the print pattern because the protection layer is applied after transferring the print pattern, water-washing and drying the article.
15 Furthermore, since the ultraviolet ray is irradiated onto the protection coating material after removing the article out of an area where the protection coating material is applied, dirt and dust tend to be adhered to the decorative layer, which causes a surface appearance to be deteriorated.

[0005]

20 In another prior art, there has been proposed a method in which water pressure transfer of the print pattern and formation of the surface protection layer are carried out at the same time (see the first patent document). This method is the one in which a transfer film with a protection layer is formed by applying a transparent or semi-transparent surface
25 protection layer of water-insoluble resin on a water-soluble film and then a water-insoluble print layer on the surface protection layer and the transfer film with the protection layer is transferred under water pressure onto an article (a body to be pattern-transferred).

[0006]

According to this method, since the surface protection layer and the print layer on the water-soluble film are simultaneously transferred on the surface of the article when it contacts the transfer film using water pressure on the water pressure transfer, this method can omit the steps of applying and hardening the protection coating material after the transfer process, which have been required in the first-mentioned conventional art, can avoid dust from adhering between the decorative layer and the surface protection layer and can have little possibility that the thickness of the surface protection layer becomes uneven.

[0007]

In this manner, this method can be advantageously used because the surface protection layer is formed at the same time when the print layer is transferred whereby the steps of operation can be simplified and in addition thereto the appearance of the decorative layer is never deteriorated and also the surface protection layer can provide wear resistance to the surface of the print layer of the article to thereby physically protect it because the surface protection layer is formed of a protecting agent such as butyl-methacrylate or ethyl-methacrylate, but since the protecting agent has low solvent resistance, when the surface protection layer is dissolved when it contacts various medicines, its surface protection function is reduced and therefore the surface protection layer disadvantageously has the low weather resistance and the poor chemical protection.

[0008]

There has been proposed another prior art that is similar to the second prior art, but is different from the latter in that the material for the surface protection layer of the second prior art is replaced by a resin to be hardened by an ultraviolet ray, etc (see the patent document 2).

[0009]

In the third prior art, since the resin hardened by the ultraviolet ray etc. is used for the surface protection layer, it will physically and chemically protect the decorative layer in an effective manner, but it has some
5 undesirable disadvantages when the adhesion of the print pattern, which is the uppermost surface of the transfer film is recovered or reproduced as described later.

[0010]

More particularly, although it is common on the aforementioned first
10 to third prior arts, an activating agent or a thinner is applied to the print pattern and also to the surface protection layer (referring to the third prior art) of the transfer film to recover the adhesion of the print pattern and the surface protection layer when the transfer should be carried out, but since the activating agent or the thinner recovers the adhesion of the print pattern by
15 using an organic solvent contained in the activating agent or the thinner, the time in which the solvent ingredient completely volatilizes and the drying condition are required to be considered as the process conditions and a bad influence may be provided to the quality of the water pressure transfer article if the solvent ingredient remains in the print pattern or the surface protection
20 layer. Furthermore, since the organic solvent is emitted into the atmosphere during the operation or inhaled by the human body, using the organic solvent for activating the print pattern or the surface protection layer causes organic air pollution or healthy injury of laborers and this becomes such a problem as should be solved immediately.

25 [0011]

As the inventors tried to directly apply such an ultraviolet ray hardening type coating material as used in the first prior art, which is also an eco-friendly coating material, they could discover the recovery of temporary

adhesion of the ink in the print pattern of the transfer film, but also find that when it tries in a continuation work during the water pressure transfer process, it becomes poor transfer due to the reduced adhesion of the print pattern. It has been discovered that as the same trial is performed using an ultraviolet ray hardening type ink which contains the same ultraviolet ray hardening resin composite as the ultraviolet ray hardening type coating material does, but contains no coloring agents, the adhesion of the ink in the print pattern can be recovered and that the transfer can be performed without reduction of the adhesion even during the transfer process.

10 [0012]

In case of the water pressure transfer, not only the ink in the print pattern has the wet state returned so as to recover the adhesion of the ink, but also the water-soluble film having the print pattern supported thereon is made also wet with the water in the transfer tub whereby both of the print pattern and the water-soluble film are required to be easily attached onto and around the surface of the article when it is forced into the water. Thus, the article should be forced underwater at the time when the harmony of the wet states of both of the print pattern and the water-soluble film is obtained and the adhesion of the print pattern also adapted to attach the print pattern onto the article should be maintained until the transfer is completed.

20 [0013]

The inventors guess that the difference between these trial results is caused by the difference between the composition of the ultraviolet ray hardening type coating material and that of the ultraviolet ray hardening type ink as the products different from their usage even though they contain the same ultraviolet ray hardening resin composite. In addition thereto, they guess that there is the difference in that the ultraviolet ray hardening type coating material contains low boiling point solvent, but the ultraviolet ray

hardening type ink generally contains less solvent, and therefore, as the ultraviolet ray hardening type coating material is applied to the print pattern, the original adhesion of the print pattern can be recovered by the solvent in the coating material, but the adhesion will be reduced due to the evaporation of the solvent when the transfer is carried out and since the ultraviolet ray hardening type ink has no solvent, any non-solvent composite will serve to recover the print pattern. This invention has been made by repeating various experiments under the aforementioned suppositions.

[0014]

There will be conceived a method of transferring a surface protection layer on an article under water pressure by using a transfer film having the surface protection layer formed by applying and drying a surface protection agent such as protection coating material or ultraviolet ray hardening resin composite on a water soluble film. However, it is also difficult to form the surface protection layer having all excellent properties of wear resistance, thermal resistance and medicine resistance by this water pressure transfer method and there occurs the same problems as the method of decorating the article by transferring the print pattern on the article when the adhesion of the surface protection layer should be recovered.

[0015]

[Patent Document 1] JP4-197699A

[Patent Document 2] JP2003-200698A

[0016]

An object of the invention is to provide a water pressure transfer method adapted to impart mechanical and chemical surface protection functions, such as wear resistance, solvent resistance, medicine resistance, weather resistance, etc., to a decorative layer itself on an article simultaneously with transfer of a print pattern.

[0017]

Another object of the invention is to provide a water pressure transfer method adapted to impart mechanical and chemical surface protection functions, such as wear resistance, solvent resistance, medicine resistance,
5 weather resistance, etc., to a surface of an article.

[0018]

Another object of the invention is to provide a water pressure transfer method adapted to impart sufficient adhesion to an ink of a print pattern of a transfer film without any organic solvent whereby such problems as air
10 pollution due to use of the organic solvent and healthy injury of laborers can be avoided.

[0019]

Further object of the invention is to provide a water pressure transfer method adapted to perform a surface treatment without any dust or dirt
15 adhering to a decorative layer on an article.

[0020]

Further object of the invention is to provide a water pressure transfer article obtained by imparting surface protection functions of mechanically and chemically protecting a decorative layer on the article simultaneously
20 with transfer of a print pattern.

[0021]

Further object of the invention is to provide a water pressure transfer article having surface protection functions imparted to a decorative layer itself on the article and having no dust attached thereto without any problem
25 of air pollution and healthy injury of laborers whereby the article has a good property.

[0022]

Further object of the invention is to provide a water pressure transfer

article having excellent surface protection properties.

[0023]

Further object of the invention is to provide a water pressure transfer article adapted to have excellent surface protection properties imparted on an
5 article without any problem of air pollution and healthy injury of laborers.

[DISCLOSURE OF THE INVENTION]

[0024]

According to a first feature of the invention, there is provided a water pressure transfer method adapted to transfer under water pressure on a
10 surface of an article a print pattern of a transfer film formed by applying the print pattern on a water-soluble film, said method comprising a step of applying an ultraviolet ray hardening resin composite on the print pattern of the transfer film, a step of forcing the article underwater together with the transfer film so as to force the print pattern
15 containing the ultraviolet ray hardening resin composite onto the surface of the article in the state where an adhesion of the print pattern is recovered by the ultraviolet ray hardening resin composite and a step of irradiating an ultraviolet ray on the article on which the print pattern containing the ultraviolet ray hardening resin composite
20 is transferred whereby the ultraviolet ray hardening resin composite is hardened.

[0025]

According to a second feature of the invention, there is provided a water pressure transfer method adapted to transfer under water pressure
25 on a surface of an article a print pattern of a transfer film formed by applying the print pattern on a water-soluble film, said method comprising a step of preparing a transfer film by applying a print pattern on a water-soluble film having an ultraviolet ray hardening resin composite previously applied

thereon, a step of forcing the article underwater together with the transfer film so as to force the print pattern containing the ultraviolet ray hardening resin composite onto the surface of the article in the state where an adhesion of the print pattern is maintained and a step
5 of irradiating an ultraviolet ray on the article on which the print pattern containing the ultraviolet ray hardening resin composite is transferred whereby the ultraviolet ray hardening resin composite is hardened.

[0026]

10 In these features of the invention, the step of irradiating the ultraviolet ray may be desirably carried out while the water-soluble film of the transfer film is in the state where it is being wound around the article, and more desirably while the article is underwater or after the article comes out of the water, but before the water-soluble film is
15 washed by water to be removed.

[0027]

According to the first and second features of the invention, since the print pattern of the transfer film is transferred onto the surface of the article after applying the ultraviolet ray hardening resin composite on or under the print pattern of the transfer film, the
20 print pattern and the ultraviolet ray hardening resin composite are simultaneously transferred on the surface of the article, which causes an operation of applying an surface protection layer on a decorative layer formed by the print pattern to be omitted and therefore, the
25 water pressure transfer can have post-process simplified.

[0028]

In case of applying the ultraviolet ray hardening resin composite on the print pattern of the transfer film, since the

ultraviolet ray hardening resin composite has the activation function of recovering the adhesion of the print pattern of the dryness state, a separate operation of activating the print pattern by an activating agent is not needed, and therefore an overall operation progress including the water pressure transfer method and the post-process gets simplified.

[0029]

Since the ultraviolet ray hardening resin composite is hardened by the ultraviolet ray in the state where the ultraviolet ray hardening resin composite permeates and is intermingled with the print pattern, the decorative layer itself has a surface protection action imparted thereto and therefore, the print pattern has the mechanically and chemically excellent surface properties..

[0030]

Since the step of irradiating the ultraviolet ray onto the ultraviolet ray hardening resin composite is carried out underwater or before water-washing for removing the water-soluble film even if the article comes out of the water, dust never adheres to the print pattern whereby the good appearance of the decorative layer can be obtained.

[0031]

According to the third feature of the invention, there is provided a method for forming an ultraviolet ray hardening type surface protection layer on an article comprising a step of coating an ultraviolet ray hardening type protection agent on a water-soluble film to form a surface protection layer transfer film, a step of transferring under water pressure the ultraviolet ray hardening type surface protection layer of the surface protection layer transfer film on the article when the surface protection layer transfer film is floated on a

water surface and the water-soluble film is made wet and a step for irradiating an ultraviolet ray on the ultraviolet ray hardening type surface protection layer transferred on the article to harden the surface protection layer.

5 [0032]

In the third feature of this invention, the surface protection layer transfer film may be formed by coating the ultraviolet ray hardening type protection agent on the water-soluble film by proper means such as printing or spray, but the ultraviolet ray hardening type protection agent should be coated by spray on the water-soluble film, in the case where the water-soluble film is floated on the water surface which should be used for water pressure transfer. In any case, the water pressure transfer is carried out while the surface protection layer has adhesion after the ultraviolet ray hardening type protection agent is coated on the water-soluble film to form the surface protection layer thereon.

[0033]

The ultraviolet ray hardening type protection agents used for the method according to the third feature of this invention may be either of an ultraviolet ray hardening type coating agent or an ultraviolet ray hardening type ink. In addition thereto, the ultraviolet ray hardening type surface protection layer on the water-soluble film may have a concavo-convex pattern for decoration formed therein by proper means. In the case where the article has the decoration applied by water pressure transfer, the surface protection layer is required to be transparent or semi-transparent.

[0034]

According to the third feature of the invention, there can be provided the surface protection layer excellent not only in mechanical surface

characteristics such as wear resistance, but also in chemical surface characteristics such as medicine resistance by using water pressure transfer technology.

[0035]

5 Especially, in this method, since the water-soluble film on which the ultraviolet ray hardening type protection agent is coated is in the form of plane, the ultraviolet ray hardening type protection agent can be uniformly coated on the upper surface of the water-soluble film by photogravure printing, screen-stencil, etc. The surface protection layer transferred on the
10 article from the thus formed surface protection layer transfer film can be uniformly applied all over the surfaces of the article and therefore, there can be obtained by the surface protection layer the product of good quality product which never deteriorates the appearance of the article.

[0036]

15 Since the water pressure transfer of the surface protection layer can be carried out following the water pressure transfer of the print pattern, for example, the surface protection layer can be inexpensively formed by simplifying the operation process without the conventional separate topcoat process.

20 [0037]

 Furthermore, since the ultraviolet ray hardening type surface protection layer can be hardened by irradiating the ultraviolet ray thereon immediately after water pressure transfer, foreign substances such as dirt or dust never adheres to the surface protection layer and therefore there can be
25 obtained the product of good appearance.

[0038]

 According to a fourth feature of the invention, there is provided a water pressure transfer method adapted to transfer on a surface of an article

a print pattern of a transfer film formed by applying the print pattern on a water-soluble film, said method comprising a step of applying a non-solvent type ultraviolet ray hardening resin composite on the print pattern of the transfer film to recover an adhesion of the print pattern by a
5 non-solvent activating agent of the non-solvent ultraviolet ray hardening type resin composite, a step of forcing the article underwater together with the transfer film so as to force the print pattern containing the ultraviolet ray hardening type resin composite onto the surface of the article and a step of irradiating an ultraviolet
10 ray on the article on which the print pattern containing the ultraviolet ray hardening type resin composite is transferred whereby the ultraviolet ray hardening type resin composite is hardened in the state where the ultraviolet ray hardening type resin is wholly united with the print pattern to form a decorative layer.

15 [0039]

According to a fifth feature of the invention, there is provided a water pressure transfer method adapted to transfer on a surface of an article a print pattern of a decorating transfer film formed by applying the print pattern on a water-soluble film, said method comprising a step of applying a
20 non-solvent type ultraviolet ray hardening resin composite on the print pattern of the decorating transfer film to recover an adhesion of the print pattern by a non-solvent activating component of the non-solvent ultraviolet ray hardening type resin composite, a step of forcing the article underwater together with the decorating transfer
25 film so as to force the print pattern containing the ultraviolet ray hardening type resin composite onto the surface of the article, a step of irradiating an ultraviolet ray on the article on which the print pattern containing the ultraviolet ray hardening type resin composite

is transferred whereby the ultraviolet ray hardening type resin composite is hardened in the state where the ultraviolet ray hardening type resin is wholly united with the print pattern to form a decorative layer and a step of transferring a layer of an ultraviolet ray hardening resin composite of a top-coating transfer film formed by applying a transparent ultraviolet ray hardening resin composite on a water-soluble film in a solid color state on the article having the decorative layer formed thereon whereby a top coat layer is formed from the ultraviolet ray hardening resin composite of the top coating transfer film.

[0040]

In the fourth and fifth features of the invention, the non-solvent activating component of the ultraviolet ray hardening resin composite for recovering the adhesion of the print pattern may be what includes a photo-polymerization monomer. Irradiating the ultraviolet ray may be preferably carried out while the water-soluble film of the decorating transfer film is wound around the article. Furthermore, the ultraviolet ray and the ultraviolet ray hardening resin composite may be replaced by an electronic line and an electronic line hardening resin composite.

[0041]

According to the fourth and fifth features of the invention, the adhesion of the print pattern can be fully recovered by the non-solvent activating component of the ultraviolet ray hardening resin composite, which may be typically and preferably the photo-polymerization monomer so that the adhesion has the same degree as the print pattern immediately after the print pattern is printed on the water-soluble film. Since the recovery of the adhesion can be made without any organic solvent, there occurs no problem of air pollution or healthy injury of laborers due to the organic solvent used.

[0042]

Since the non-solvent activating component of the ultraviolet ray hardening resin composite such as the photo-polymerization monomer is hardened in the state where it permeates the ink of the print pattern so as to be mixed with the ink and therefore in the state where the non-solvent ultraviolet ray hardening resin composite is wholly united with the print pattern, the decorative layer itself on the article has mechanical and chemical surface protection functions such as wear resistance, solvent resistance, medicine resistance and weather resistance and so on applied thereto. This is the same effects as the first and second features of the invention have.

[0043]

If the surface protection functions such as the solvent resistance imparted to the decorative layer is enough for the product (article), the decorative layer itself may be provided as the surface layer of the article, but if there is required the higher surface protection, a topcoat layer of transparent ultraviolet ray hardening resin composite applied on a water-soluble film in a solid color state may be formed on the article by using a water pressure transfer technology by the method described in the fifth feature later. This topcoat layer desirably applies depth to the surface appearance of the article and further improves the mechanical and chemical surface protection.

[0044]

Since the step of irradiating the ultraviolet ray onto the ultraviolet ray hardening resin composite is carried out underwater or before water-washing for removing the water-soluble film even if the article comes out of water, there is little chance where dust adheres to the print pattern to improve an excellent article rate whereby the article having the good appearance of the decorative layer can be

obtained.

[0045]

According to a sixth feature of the invention, there is provided a water pressure transfer method adapted to transfer on a surface of an article a print
5 pattern and a top-coating protection layer of a transfer film formed by sequentially applying the top-coating protection layer and the print pattern on a water-soluble film, said method comprising a step of applying a non-solvent type ultraviolet ray hardening resin composite on the print pattern of the transfer film to recover an adhesion of the print
10 pattern by a non-solvent activating component of the non-solvent type ultraviolet ray hardening resin composite, a step of forcing the article underwater together with the transfer film so as to force the print pattern containing the ultraviolet ray hardening type resin composite onto the surface of the article, a step of irradiating an ultraviolet ray
15 on the article on which the print pattern containing the ultraviolet ray hardening resin composite and the top-coating protection layer on the print pattern are transferred whereby the ultraviolet ray hardening type resin composite is hardened in the state where the ultraviolet ray hardening resin composite is wholly united with the print pattern and
20 with at least one portion of the top-coating protection layer.

[0046]

In the sixth feature of the invention, the non-solvent activating component of the ultraviolet ray hardening resin composite for recovering the adhesion of the print pattern may be what includes a photo-polymerization
25 monomer in the same manner as the third and fourth features of the invention. Irradiating the ultraviolet ray may be preferably carried out while the water-soluble film of the transfer film is wound around the article. Furthermore, the ultraviolet ray and the ultraviolet ray hardening resin

composite may be replaced by an electronic line and an electronic line hardening resin composite.

[0047]

5 In the sixth feature of the invention, the top-coating protection layer may be a transparent ink or an ultraviolet ray hardening resin composite and preferably a non-solvent type ultraviolet ray hardening resin composite.

[0048]

10 Since the sixth feature of the invention lies in recovering the adhesion of the print pattern by the non-solvent activating component of the non-solvent type ultraviolet hardening resin composite, there occurs no problem of air pollution or healthy injury of laborers due to the organic solvent used. Also, since the ultraviolet ray hardening resin composite and the print pattern are hardened while they are wholly united with each other, the decorative layer itself on the article has mechanical and chemical surface
15 protection functions such as wear resistance, solvent resistance, medicine resistance and weather resistance and so on applied thereto.

[0049]

The surface of the decorative layer can be fully protected by the topcoat layer transferred under water pressure on the decorative layer at the
20 same time when the latter is transferred together with the surface protection functions such as the solvent resistance and so on imparted to the decorative layer and in addition thereto, since one portion of the ultraviolet ray hardening resin composite for recovering the adhesion also permeates the top-coating protection layer, the adhesion property of the topcoat layer and
25 the decorative layer can be improved. Especially, as the topcoat layer is of ultraviolet ray hardening resin composite, the mechanical and chemical surface protection can be strengthened by the association of the ultraviolet ray hardening resin composite wholly united with the decorative layer by

being applied for recovery of the adhesion thereof and the top-coating ultraviolet ray hardening resin composite. The topcoat layer imparts the depth of the surface appearance of the article thereto.

[0050]

5 Since irradiating the ultraviolet ray on the ultraviolet ray hardening resin composite for recovery of the adhesion and the top-coating ultraviolet ray hardening resin composite may be carried out underwater or before water-washing for removing the water-soluble film even if the article comes out of water, there is little chance where dust adheres to the
10 print pattern to improve an excellent article rate whereby the article having the good appearance of the decorative layer can be obtained.

[0051]

 According to a seventh feature of the invention, there is provided a water pressure transfer method adapted to transfer on a surface of an article
15 a surface protection layer of a surface protection layer transfer film formed by applying and drying the surface protection layer on a water-soluble film, said method comprising a step of applying a ultraviolet ray hardening resin composite on the surface protection layer of the surface protection layer transfer film to recover an adhesion of the surface protection
20 layer, a step of forcing the article underwater together with the transfer film so as to force the surface protection layer containing the ultraviolet ray hardening type resin composite onto the surface of the article and a step of irradiating an ultraviolet ray on the article on which the surface protection layer containing the ultraviolet ray
25 hardening type resin composite is transferred whereby the ultraviolet ray hardening type resin composite is hardened in the state where the ultraviolet ray hardening type resin is wholly united with the surface protection layer.

[0052]

In the seventh feature of the invention, the surface protection agent may be transparent ink or coating material to be hardened by drying.

[0053]

5 According to an eighth feature of the invention, there is provided a water pressure transfer article obtained by either of the water pressure transfer methods according to the first through seventh features of the invention.

[0054]

10 The decorative layer of the water pressure transfer article obtained by the water pressure transfer methods according to the first, second and fourth through sixth features of the invention and the surface protection layer of the water pressure transfer article may be preferably adapted to be never deteriorated by a solvent resistance test in which a ten-sheet piled gauze
15 containing xylene is reciprocatively wiped on the decorative layer eight times while it is rubbed thereon.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[0055]

20 Fig. 1 is an outline view in which a water pressure transfer method used in the invention is briefly illustrated.

Fig. 2 illustrates the water pressure transfer method according to a first form of the invention in order of steps, Fig. 2A is a cross sectional view of a transfer film, Fig. 2B is a cross sectional view of the transfer film in the state where an ultraviolet ray hardening type coating material as one
25 example of an ultraviolet ray hardening resin composite is applied on the transfer film, Fig. 2C is a cross sectional view of the transfer film in the state where it is floated on a surface of water, Fig. 2D is a cross sectional view of the transfer film in the state immediately before an article for a print pattern

to be transferred thereon is forced underwater, Fig. 2E is a cross sectional of the state where an ultraviolet ray is irradiated on the article after water pressure transfer, Fig. 2F is a cross sectional view of the state where a water soluble film is water-washed and Fig. 2G is a cross sectional view of the state where the surface of the article is being dried.

Fig. 3 is an enlarged cross sectional view of a product obtained by the method of the invention.

Fig. 4 illustrates a water pressure transfer method according to a second form of the invention, Fig. 4A is a cross sectional view of the state where an ultraviolet ray hardening type coating material is applied on a water soluble film, which should get a transfer film and Fig. 4B is a across sectional view of the state where a print pattern is printed on the film of Fig. 4A.

Fig. 5 illustrates a water pressure transfer method according to a third form of the invention in order of steps, Fig. 5A is a cross sectional view of a transfer film having an ultraviolet ray hardening type surface protection layer applied thereon by printing , Fig. 5B is a cross sectional view of the state where the transfer film having the surface protection layer applied thereon is floated on a surface of water, Fig. 5C is a cross sectional view of the state immediately before an article to transfer a print pattern under water pressure is forced underwater halfway, Fig. 5D is a cross sectional of the state where the whole article is immersed into water following the state of Fig. 5C, Fig. 5E is a cross sectional view of the state where an ultraviolet ray is irradiated on the article after water pressure transfer, Fig. 5F is a cross sectional view of the state where a water soluble film is water-washed and Fig. 5G is a cross sectional view of the state where the surface of the article is being dried.

Fig. 6 is an enlarged cross sectional view of a product obtained by the

method of Fig. 5.

Fig. 7 is a cross sectional view of the surface protection layer transfer film used for the method of Fig. 5, but having a different form.

Fig. 8 illustrates a water pressure transfer method according to a fourth form of the invention in order of steps, Fig. 8A is a cross sectional view of a transfer film, Fig. 8B is a cross sectional view of the state where a non-solvent ultraviolet ray hardening resin composite is applied on the transfer film, Fig. 8C is a cross sectional view of the state where the transfer film of Fig. 8B is floated on the surface of water, Fig. 8D is a cross sectional view of the state immediately before an article to transfer a print pattern under water pressure is forced underwater, Fig. 8E is a cross sectional of the state where an ultraviolet ray is irradiated on the article after water pressure transfer, Fig. 8F is a cross sectional view of the state where a water soluble film is water-washed and Fig. 8G is a cross sectional view of the state where the surface of the article is being dried.

Fig. 9 is an enlarged cross sectional view of the product obtained by the method of Fig. 8.

Fig. 10 partially illustrates a step of applying a topcoat on the product of Fig. 9 using the water pressure transfer technology by a fifth form of the invention, Fig. 10A is a cross sectional view of a transfer film for a topcoat layer and Fig. 10B is a cross sectional view of the state immediately before the article of Fig. 3 is forced underwater in order to apply a topcoat to the article using the transfer film of Fig. 10A.

Fig. 11 is an enlarged cross sectional view of the product with the topcoat layer obtained by the method of Fig. 10.

Fig. 12 is an outline view in which a water pressure transfer method according to a sixth form of the invention is briefly illustrated.

Fig. 13 illustrates the water pressure transfer method of Fig. 12 in

order of steps, Fig. 13A is a cross sectional view of a transfer film, Fig. 13B is a cross sectional view of the state where an ultraviolet ray hardening resin composite is applied on the transfer film, Fig. 13C is a cross sectional view of the state where the transfer film of Fig. 13B is floated on the surface of water, 5 Fig. 13D is a cross sectional view of the state immediately before an article to transfer a print pattern thereon is forced underwater, Fig. 13E is a cross sectional view of the state where an ultraviolet ray is irradiated on the article after water pressure transfer, Fig. 13F is a cross sectional view of the state where a water soluble film is water-washed and Fig. 13G is a cross sectional 10 view of the state where the surface of the article is being dried.

Fig. 14 is an enlarged cross sectional view of the product obtained by the method of Fig. 13.

Fig. 15 illustrates the water pressure transfer method for a surface protection layer according to a seventh feature of the invention in order of 15 steps, Fig. 15A is a cross sectional view of a surface protection layer transfer film, Fig. 15B is a cross sectional view of the state where an ultraviolet ray hardening resin composite is applied on the surface protection layer of the transfer film, Fig. 15C is a cross sectional view of the state where the transfer film of Fig. 15B is floated on the surface of water, Fig. 15D is a cross sectional 20 view of the state immediately before an non-decorative article to transfer the surface protection layer thereon under water pressure is forced underwater, Fig. 15E is a cross sectional view of the state where an ultraviolet ray is irradiated on the article after water pressure transfer, Fig. 15F is a cross sectional view of the state where a water soluble film is water-washed and 25 Fig. 15G is a cross sectional view of the state where the surface of the article is being dried.

Fig. 16 is an enlarged cross sectional view of the product obtained by the method of Fig. 15.

Fig. 17 is an enlarged cross sectional view of the product obtained by the method identical to that of Fig. 15, but by transferring the surface protection layer under water pressure on a decorated article.

[BEST MODE OF EMBODIMENT OF INVENTION]

5 [0056]

Describing embodiments of the invention with reference to the drawings, Fig. 1 briefly illustrates a water pressure transfer method according to a first form of the invention. This water pressure transfer method is the one in which a transfer film 16 comprising a water soluble film 10 14 having a print pattern 12 applied thereon is floated on water 18 within a transfer bath not shown with the print pattern directed upside and an article 10 to have the print pattern transferred thereon under water pressure is forced underwater through the transfer film 16 whereby the water pressure transfer is accomplished.

15 [0057]

The water soluble film 14 is formed of water soluble material having a main ingredient of polyvinyl alcohol, for example, which gets wet and is softened by absorbing water. This water soluble film 14 is softened when it contacts water within the transfer tub and is wound around the article 10 to 20 be decorated whereby the water pressure transfer can be accomplished. The print pattern 12 may be applied on the water soluble film 14 by gravure printing and so on in case of general water pressure transfer. It should be noted that what is meant by the "print pattern" 12 includes plane one (one having no pattern) other than the one originally having a pattern.

25 [0058]

The method according to the first form of the invention is to apply or coat an ultraviolet ray hardening resin composite to the print pattern 12 of the transfer film 16 to permeate the print pattern 12 before transferring the

print pattern on the article under water pressure. Although, in an example described hereinafter, an ultraviolet ray hardening type coating material may be used as the ultraviolet ray hardening resin composite, an ultraviolet ray hardening type ink may be used. An example of concrete steps of the water pressure transfer method of the invention is illustrated in Fig. 2. In the form of Fig. 2, the operation begins from the state where the print pattern 12 printed on the water soluble film 14 is in a dried condition (see Fig. 2A). Although not shown, in practice, the transfer film 16 is in the form of roll obtained by previously printing the print pattern 12 on the elongated water soluble film 14 and drying the print pattern 12. The transfer film 16 may be used while being continuously fed from the film roll or by cutting it thereafter.

[0059]

In the form of Fig. 2, an ultraviolet ray hardening type coating material 20 is applied on the dried print pattern 12 of the transfer film 16 of Fig. 2A (see Fig. 2B), the transfer film 16 is floated on a water 18 within a transfer tub in the state where the print pattern 12 is activated by the ultraviolet ray hardening type coating material 20 to thereby recover the adhesion of the print pattern 12 (see Fig. 2C), thereafter an article 10 together with the transfer film 16 is forced underwater so as to force the print pattern 12 containing the ultraviolet ray hardening type coating material 20 against the surface 10S of the article (see Fig. 2D) and an ultraviolet ray 22 is irradiated on the article 10 on which the print pattern 12 containing the ultraviolet ray hardening type coating material 20 is transferred whereby the ultraviolet ray hardening type coating material 20 is hardened (see Fig. 2E). Although not shown in the drawings, the article 10 may be forced underwater while it is conveyed by a reverse triangle-like conveyer or supported by a robot arm. In some cases, the step of applying the ultraviolet ray hardening

type coating material 20 on the print pattern 12 (see Fig. 2B) and the step of floating the transfer film 16 on the water (see Fig. 2C) may be reversely carried out whereby the ultraviolet ray hardening type coating material 20 may be applied by spray on the print pattern of the transfer film 16 which is floated on the water so as to recover the adhesion of the print pattern 12.

[0060]

The ultraviolet ray hardening type coating material 20 is an ultraviolet ray hardening resin composite which serves to properly activate the dried print pattern 12 of the transfer film 16 and this may comprise an ingredient having the following composition.

- | | |
|-----------------------------------|------------------|
| (1) Oligomer | 30 - 50 weight % |
| (2) multi-functional acrylate | 10 - 30 weight % |
| (3) single functional acrylate | 10 - 40 weight % |
| (4) non-reactive additives | 1 - 20 weight % |
| (5) photopolymerization initiator | 0.5 - 5 weight % |
| (6) solvents | Remainder |

[0061]

The oligomer is an ingredient to affect the adhesion and the physical properties of the coating material and one of an acrylic oligomer, a polyester oligomer, an epoxy acrylate oligomer and an urethane acrylate oligomer may be used independently or they may be used as combined arbitrarily according to the desired characteristic.

[0062]

The single functional acrylate monomer is a reactant dilution agent and this has the function to activate the dried print pattern 12 to recover the adhesion thereof. The multi-functional acrylate monomer is a bridge formation ingredient and imparts to the coating material the chemically and mechanically excellent characteristic after its ultraviolet ray hardening to

provide weather resistance and strength to the print pattern 12 and also has further the function to activate the dried print pattern 12 to recover the adhesion thereof in the same manner as the single functional acrylate monomer.

5 [0063]

Polyacrylate such as polyacrylic acid methyl and so on is used in order to ease a contraction action of the coat layer by the bridge formation ingredient. If the contraction power of the coat layer becomes high, the adhesion of the coat layer is lowered and therefore the polyacrylate can usefully prevent this.

[0064]

Conventional acetophenone, benzophenone and so on may be used as the photopolymerization initiator and ethyl acetate, acetic acid butyl, propylene glycol mono-methyl alcohol acetate, anone (cyclohexanone), toluene, xylene, etc. may be used as the solvent.

[0065]

Although the step of applying the ultraviolet ray hardening type coating material 20 may be carried out by means of either of photogravure roll, wire bar coating and spray, since the spray applying process consumes a lot of coating materials, the photogravure roll application process or the wire bar application process may be preferable for applying the coating material.

[0066]

As the ultraviolet ray hardening type coating material 20 is applied on the print pattern 12, the dried print pattern 12 is activated by the single functional acrylate monomer or the multi-functional acrylate monomer in the ultraviolet ray hardening type coating material 20 and by the solvent etc. in addition thereto as the case may be whereby the adhesion of the ink is restored. Therefore, the ultraviolet ray hardening type coating material 20

can have the same function as the activator conventionally applied on the dried ink to thereby omit the application of the activator.

[0067]

As the ultraviolet ray hardening type coating material 20 is applied
5 on the print pattern 12, the coating material ingredient permeates into the print pattern 12 and therefore the ink ingredient and the coating material ingredient are intermingled with each other so as to be both unified. Therefore, as an ultraviolet ray 22 is irradiated so as to harden the coating material ingredient after the print pattern 12 with which the coating
10 material ingredient is intermingled is transferred onto the article 10, the mechanical strength and the chemical characteristics such as heat resistance and weather resistance will be imparted to the print pattern 12. Although Figs. 2B and 2C don't illustrate the state where the ink ingredient of the print pattern 12 and the ultraviolet ray hardening type coating material are
15 wholly unified, if these figures try to show such state, then it becomes impossible for both to be distinguished from each other and it should understand that they are conveniently indicated in the state of layers.

[0068]

After the ultraviolet ray 22 is irradiated onto the article having the
20 print pattern 20 transferred thereto, a water shower 24 is injected onto the water-soluble film 14 of the transfer film 16 to thereby wash the water-soluble film 14 as shown in Fig. 2F, whereby the water-soluble film 14 is removed out of the surface of the article 10. Thereafter, as shown in Fig. 2G, a hot wind 26 is irradiated on the surface of the article 10 on which the print
25 pattern 12 containing the ultraviolet ray hardening type coating material 20 is adhered to dry the surface of the article 10 whereby the product 10' having a decorative layer 30 is completed (refer to Fig. 3).

[0069]

The ultraviolet ray 22 is preferably irradiated while the water-soluble film 14 of the transfer film 16 is wound around the article 10 on which the print pattern 12 containing the ultraviolet ray hardening type coating material 20 is transferred and thus it is preferably carried out after the
5 article 10 is still underwater or before the water-soluble film 14 is water-washed and removed even though it comes out of the water. The ultraviolet ray 22 is irradiated by a conventional ultraviolet ray hardening equipment including light source lamps such as high-pressure mercury lamps or metal halide lamps and an irradiation machine (lamp house). The
10 ultraviolet ray 22 can be irradiated onto the article 10 while the latter is underwater because the ultraviolet ray can penetrate underwater.

[0070]

In this manner, as the ultraviolet ray 22 is irradiated while the water-soluble film 14 is wound around the article, any dirt etc. cannot be
15 adhered to the article so as to be kept being secured thereto before the print pattern 12 gets completely dry, the possibility of dirt adhesion can be reduced because the print pattern 12 is hardened when the water-soluble film 14 is removed whereby the decorative layer 30 of good appearance can be obtained easily. The irradiation of the ultraviolet ray 22 may be carried out after the
20 water-soluble film 14 is water-washed out of the article 10 in case where the irradiation of the ultraviolet ray 22 is carried out under an environment having no dust or dirt such as a tunnel like a clean room.

[0071]

(Embodiment 1)

25 In a concrete embodiment according to the first form of the invention, what makes main ingredients of FUJIHARD HH9986 U-N7 commercially available from FUJIKURA KASEI CO., LTD., Japan was used as the ultraviolet ray hardening type coating material 20 and the process was

carried out in order of the steps shown in Figs. 2A through 2G. The ultraviolet ray hardening type coating material 20 was applied or coated on the print pattern 12 of the transfer film 16 by the photogravure application process immediately before the transfer film 16 was introduced into the transfer tub. In this manner, the transfer film 16 on with the coating material was applied was floated on the water surface of the transfer tub and after activating the print pattern 12 with this ultraviolet ray hardening type coating material 20 and recovering sufficient adhesion as shown in Fig. 2D, the article 10 was underwater pushed in through the transfer film 16. After taking the article 10 out of the water following transfer, the ultraviolet ray was irradiated on the article, thereafter the article was water-cleaned and dried to obtain the water pressure transfer article 10' as shown in Fig. 3.

[0072]

As the adhesion of the thus obtained decorative layer of the water pressure transfer article (A) was tested by a cross cut tape adhesion test method (1mm cross 100 measures), it was confirmed that the article (A) had the same adhesion as the water pressure transfer article (B) having no topcoat and the water pressure transfer article (C) having the topcoat of conventional acrylic resin applied on the decorative layer. As the test of solvent resistance was conducted by reciprocatively wiping isopropyl alcohol containing rag on the article 30 times under predetermined load, it was confirmed that the water pressure transfer article (A) had solvent resistance remarkably better than the conventional water pressure transfer article (C) having the topcoat. The water pressure transfer article (B) having no topcoat had no solvent resistance, of course. Therefore, it will be noted that the water pressure transfer article according to the first form of embodiment of the invention has weather resistance as well as high mechanical strength, which is accomplished by the ultraviolet ray hardening type coating material which

permeated into the decorative layer.

[0073]

In the first form of embodiment of shown in Fig. 2, the transfer operation was performed using the transfer film 16 having the dried print pattern 12, but in the second form of embodiment shown in Fig. 4, the transfer operation may be performed by applying or coating the ultraviolet ray hardening type coating material 20 onto the water-soluble film 14, thereafter printing the print pattern 12 on the coating material 20 by non-contacting printing means such as ink jet system and introducing the transfer film 16 into the transfer tub before the print pattern 12 is dried.

[0074]

In this case, since the ink ingredient of the print pattern 12 has adhesion maintained, the ultraviolet ray hardening type coating material 20 is not required to have a function to activate the ink, but the coating material 20 permeates into the ink ingredient by printing the print pattern 12 on the coating material 20 whereby the ultraviolet ray hardening type coating material 20 and the ink ingredient are wholly unified in the same manner as the form of embodiment of Fig. 2 and therefore the decorative layer of the water pressure transfer article has the same characteristic as the form of Fig.

20 3.

[0075]

According to the first and second forms of embodiment of the invention, since the water pressure transfer of the surface of the article 10 is carried out in the state where the ultraviolet ray hardening type coating material 20 is applied on or under the print pattern 12 of the print pattern 12 of the transfer film 16, the print pattern 12 and the ultraviolet ray hardening resin composite are simultaneously transferred on the surface of the article and it will be noted that there is not required the operation for applying a

surface protection layer on the decorative layer formed by the print pattern 12 and therefore the later processes of the water pressure transfer gets simplified.

[0076]

5 Since the ultraviolet ray hardening type coating material 20 has the activation function to recover the adhesion of the dried print pattern 12, there is not required a separate operation to activate the print pattern 12 with an activating agent and therefore the overall processes of the water pressure transfer and the later possible processes are made simpler.

10 [0077]

 Since the ultraviolet ray hardening type coating material 20 is hardened by the ultraviolet ray in the state where the ultraviolet ray hardening type coating material 20 permeates into the inside of the print pattern 12 and is intermingled with the print pattern 12, a surface protection
15 action is imparted to the decorative layer itself of the article and therefore the print pattern 12 has the mechanically and chemically excellent surface properties.

[0078]

 Since the step of irradiating the ultraviolet ray is carried out
20 underwater or before the water-soluble film is water-washed and be removed even if the article comes out of water, dust, dirt, etc. never adheres to the print pattern 12, and the decorative layer of good appearance can be obtained.

[0079]

25 The same effect can be attained even if the ultraviolet ray hardening type coating material 20 may be replaced by an ultraviolet ray hardening type ink as already described.

[0080]

A water pressure transfer method (a method of forming a surface protection layer) according to a third form of embodiment of the invention is shown in Fig. 5. Although this method is typically applicable on the surface of the article following on the decoration of the article by this water pressure transfer of Fig. 2 in order to protect the surface of the decorated article 10, this method of the invention may be similarly applicable on the surface of the article decorated by other proper means, of course.

[0081]

In this method of the invention, as shown in Fig. 5, there is initially formed a surface protection layer transfer film 216 having an ultraviolet ray hardening type surface protection layer 240 formed by applying an ultraviolet ray hardening type protection agent (ultraviolet ray hardening resin composite) on a water-soluble film 214 (see Fig. 5A). Like the water-soluble film 14 of the transfer film 16 used with the first form of embodiment, the water-soluble film 214 may comprises a water-soluble material having main ingredients of polyvinyl alcohol, for example, which is made wet and softened by absorbing water.

[0082]

In case that the article 10 are decorated by water pressure transfer etc., the ultraviolet ray hardening type protection agent is an ultraviolet ray hardening type transparent coating material and this coating material may comprise ingredient having the following composition, and since this is the same ingredient as the ultraviolet ray hardening type coating material used for the first and second forms of embodiment, the detailed description will be omitted.

- | | |
|--------------------------------|------------------|
| (1) Oligomer | 30 - 50 weight % |
| (2) multi-functional acrylate | 10 - 30 weight % |
| (3) single functional acrylate | 10 - 40 weight % |

- | | |
|-----------------------------------|------------------|
| (4) non-reactive additives | 1 - 20 weight % |
| (5) photopolymerization initiator | 0.5 - 5 weight % |
| (6) solvents | Remainder |

[0083]

5 In this manner, after forming the surface protection layer transfer film 216, this transfer film 216 is floated on the surface of water 218 in the transfer tub with the surface protection layer 240 directed upward (see Fig. 5B). When the water-soluble film 214 of the transfer film 216 is made fully wet with water 218, the article 10 having the surface to be protected is forced
10 into water 218 through the surface protection layer transfer film 216 to perform the water pressure transfer of the ultraviolet ray hardening type surface protection layer 240 on the article 10 (see Figs. 5C and 5D).

[0084]

 Thereafter, an ultraviolet ray 222 is irradiated on the ultraviolet ray
15 hardening type surface protection layer 240 transferred on the article 10 to harden the surface protection layer 240 (see Fig. 5E). The water-soluble film 214 is removed by showering washing water 224 to the surface of the article 10 (see Fig. 5F). Lastly, a hot wind 226 is blown onto the surface of the article 10 to dry it (see Fig. 5G) whereby a product 210' protected by the
20 surface protection layer 240 ' is completed (see Fig. 6). In Figs. 5D and 5E, the water-soluble film 214 and the surface protection layer 240 of the transfer film 216 are not indicated while they are distinguished from each other.

[0085]

 Like the water pressure transfer for decoration of Fig. 2, irradiation of
25 the ultraviolet ray 220 is desirably carried out while the water-soluble film 214 of the transfer film 216 is wound around the article 10. This enables the ultraviolet ray hardening type coating material to be hardened without adhering dust, dirt and so on from adhering to the surface protection layer

240 of ultraviolet ray hardening type coating material and therefore the surface protection layer 240' of good appearance having no dust, dirt and so on adhered thereto can be formed.

[0086]

5 (Embodiment 2)

In a concrete embodiment according to the third form of the invention, what makes main ingredients of FUJIHARD HH9986 U-N7 commercially available from FUJIKURA KASEI CO., LTD., Japan was used as the ultraviolet ray hardening type transparent coating material and the processes were carried in order of the steps shown in Figs. 5A through 5F. The ultraviolet ray hardening type transparent coating material was applied on the water-soluble film 16 by the photogravure application process immediately before the transfer film was introduced into the transfer tub. In this manner, the transfer film having the surface protection layer formed by applying the coating material was floated on the water surface of the transfer tub with the surface protection layer directed upwardly and thereafter the article was pushed underwater through the transfer film. After taking the article out of the water following the transfer of the surface protection layer on the surface of the article, the ultraviolet ray was irradiated on the surface protection layer, finally the article was water-washed and dried to obtain the product 210' having the ultraviolet ray hardened surface protection layer 214' formed thereon as shown in Fig. 6.

[0087]

As the adhesion of the surface protection layer of the water pressure transfer article (product) (D) protected by the thus obtained transparent surface protection layer was tested by a cross cut tape adhesion test method (1mm cross 100 measures), it was confirmed that the article (D) had the same adhesion as the water pressure transfer article (B) having no topcoat and the

water pressure transfer article (C) having conventional acrylic resin applied on the decorative layer. As a test of solvent resistance was conducted by reciprocatively wiping isopropyl alcohol containing rag on the article 30 times under predetermined load, it was confirmed that the water pressure transfer article (D) had solvent resistance remarkably better than the conventional water pressure transfer article (C) having the topcoat formed thereon. The water pressure transfer article (B) having no topcoat had no solvent resistance, of course. Therefore, it will be noted that the water pressure transfer article according to the concrete embodiment of the invention has good weather resistance as well as high mechanical strength accomplished by the ultraviolet ray hardening type coating material.

[0088]

In the aforementioned form of embodiment, although the transparent coating material was used as the ultraviolet ray hardening type protection agent, a semi-transparent coating material may be used and the article may be decorated by the surface protection layer itself formed by using ultraviolet ray hardening type ink, but not coating material. In this manner, if the ultraviolet ray hardening type ink is used, then the surface protection layer results in having two functions of decoration and surface protection.

[0089]

As shown in Fig. 7, after applying the ultraviolet ray hardening type protection agent on the water-soluble film 214 to form the surface protection layer 240, proper concavo-convex pattern 240a such as grain pattern and others may be formed in the surface protection layer 240 by concavo-convex pattern processing or blast processing.

[0090]

A water pressure transfer method according to the fourth form of embodiment of the invention is shown in Fig. 8. This method is identical to

the method according to the first form of embodiment except that the material to be applied or coated on the print pattern 12 of the transfer film 16 is not the ultraviolet ray hardening type coating material 20, but non-solvent type ultraviolet ray hardening resin composite 20A and this may be carried out in the same manner as the first form of embodiment (see Figs. 8A through 8G).

[0091]

What is meant by "ultraviolet ray hardening resin" is a resin to be hardened by chemical action of an ultraviolet ray for a relatively shorter time and takes the form of ultraviolet ray hardening type coating material, ultraviolet ray hardening type ink, ultraviolet ray hardening type adhesives, etc. according to its use. These agents include (1) light polymerization pre-polymer, (2) light polymerization monomer and (3) light (optical) start agent as indispensable ingredients. What is commercially on the market as an ultraviolet ray hardening type coating material used in the first form of embodiment of the invention generally has solvents such as thinner added thereto and although some ultraviolet ray hardening ink has solvents such as alcohol added thereto, general ultraviolet ray hardening type ink has no solvents added thereto and is blended with an photopolymerization monomer to serve as a dilution agent. The "ultraviolet ray hardening resin composite", which is the object of the fourth form of embodiment of the invention is essentially blended with the photopolymerization pre-polymer, the photopolymerization monomer and the photopolymerization initiator in spite of the form of use of ultraviolet ray hardening resin and also has the form of liquid state before being hardened by ultraviolet ray irradiation without any solvent added.

[0092]

What is meant by the "ultraviolet ray hardening resin composite" to

be used with the fourth form of embodiment of the invention excludes the ultraviolet ray hardening resin composite having a solvent contained therein and is limited to the non-solvent ultraviolet ray hardening resin composite having no solvent add. This is because what recovers the adhesion of the print pattern of the transfer film is the non-solvent activation component in the non-solvent type ultraviolet ray hardening resin composite, which is typically a photopolymerization monomer. The ultraviolet ray hardening resin composite applicable to the four form of embodiment of the invention comprises the ingredient having the following composition;

- | | | |
|----|--|------------------|
| 10 | (1) Oligomer (photopolymerization pre-polymer) | 30 - 50 weight % |
| | (2) multi-functional acrylate | |
| | (photopolymerization monomer) | 10 - 30 weight % |
| | (3) single functional acrylate | |
| | (photopolymerization monomer) | 10 - 40 weight % |
| 15 | (4) photopolymerization initiator | 0.5 - 5 |
| | weight % | |
| | (5) non-reactive additives | 1 - 20 weight % |
| | [0093] | |

The photopolymerization pre-polymer is the polymer which can be further hardened by photochemical action and is called "photopolymerization unsaturated polymer", "base resin" or "photopolymerization oligomer. This pre-polymer is a basic ingredient which affects many fundamental physical properties as a coat film after being hardened and an acrylic oligomer, a polyester oligomer, an epoxy acrylate oligomer and an urethane acrylate oligomer may be used independently or arbitrarily combined. Although the degree of polymerization of photopolymerization pre-polymer is not so high as final polymer, it is not a monomer and polymerized to some extent and therefore it has the suitable viscosity and therefore a dilution agent is

required in consideration of the effectiveness of operation on its use.

[0094]

The photopolymerization monomer serves as a dilution agent for photopolymerization pre-polymer while maintaining the practical effectiveness of operation of the resin composite and itself participates in polymerization. There are a single functional monomer having a single functional group and a multi-functional monomer having two or more functional groups. The single functional monomer serves to improve adhesion to the article and to impart softness to the coat film after being hardened and the multi-functional monomer serves as a bridge formation agent which bridges pre-polymer molecules. For instance, the poly acrylate such as a poly-acrylic acid methyl is used for easing a contraction action of the coat membrane caused by bridge formation. If the contraction power of the coat membrane becomes high, the adhesion of the coat membrane is reduced, but the polyacrylate can usefully prevent this. These photopolymerization monomers serve as a dilution agent for adjusting the viscosity of the ultraviolet ray hardening resin composite and also serves as a functional ingredient (activation ingredient) for recovering the adhesion of the dried print pattern.

20 [0095]

The photopolymerization initiator serves to absorb the ultraviolet ray to start a polymerization reaction and is also called "photopolymerization start agent". Acetophenone, benzophenone, etc. may be used when the ultraviolet ray hardening reaction is a radical reaction, while diazo compound, etc. may be used when the ultraviolet ray hardening reaction is an ion reaction.

[0096]

The ultraviolet ray hardening resin composite may have a sensitizer,

a filler, an inactive organic polymer, a leveling agent, a thixotropy imparting agent, a thermal polymerization prohibition agent, etc added thereto.

[0097]

As the non-solvent type ultraviolet ray hardening resin composite 20A is applied on the print pattern 12, the photopolymerization monomer in the non-solvent type ultraviolet ray hardening resin composite 20A permeates into the dried ink of the print pattern 12 to dissolve the ink whereby the adhesion of the ink which is in the same wet state as immediately after printing the print pattern can be restored. Therefore, the non-solvent type ultraviolet ray hardening resin composite 20A can have the function equivalent to the conventionally used activating agent to thereby omit the application of the activating agent, the thinner, etc. and since each ingredient in the ultraviolet ray hardening resin composite including the photopolymerization monomer generally has the volatility far lower than the solvent etc., the degree of the recovered adhesion neither varies nor is lowered after its recovery, which enables the expectation of the stabilization of the activation, which cannot be expected in the solvent type one.

[0098]

As the print pattern 12 is transferred on the article 10 and the ultraviolet ray 22 is irradiated thereon, the ultraviolet ray hardening resin composite is hardened in the state where each ingredient of the ultraviolet ray hardening resin composite 20A such as the photopolymerization monomer permeates into the ink of the print pattern 12 whereby both of the ultraviolet ray hardening resin composite and the ink are wholly united. This imparts mechanical surface protection function such as wear resistance, etc. and chemical surface protection function such as solvent resistance, medicine resistance, etc. to the decorative layer itself. The same functions as those of the first form of embodiment are true of this. Since the photopolymerization

monomer itself participates in polymerization after the ultraviolet ray irradiation, this monomer is never separated to thereby do no badness after that.

[0099]

5 As aforementioned, both of the ultraviolet ray hardening resin composite having solvent added thereto like the commercially available common ultraviolet ray hardening type coating material used in the first form of embodiment and the non-solvent type ultraviolet ray hardening resin composite used in the fourth form of embodiment commonly impart the
10 surface protection functions to the print pattern 12 itself because of these composites wholly united with the print pattern, but the non-solvent type ultraviolet ray hardening resin composite is more preferable than the ultraviolet ray hardening resin composite having solvent added thereto for the following reasons.

15 [0100]

 Since the ultraviolet ray hardening resin is hardened by the ultraviolet ray irradiation for a short time, if the added solvent is the low boiling one having the high volatility, the solvent will fully volatilize before the article is forced underwater to thereby provide the poor transfer due to
20 shortage of the adhesion while if the added solvent is the high boiling one difficult to volatilize, the shortage of the adhesion when the article is forced underwater can be avoided, but the ultraviolet ray irradiation cannot be performed until the solvent volatilizes completely, and if the ultraviolet ray hardening type resin ingredient is hardened by the ultraviolet ray irradiation
25 in the state of inadequate volatilization of the solvent, which is in the state where the solvent is involved, there will be produced defects such as surface roughness later. Thus, if there is used the ultraviolet ray hardening resin composite having the solvent added thereto, which is either of low boiling

point or of high boiling point, there is a possibility of producing the healthy injury due to air pollution or human body suction and also of producing various problems on process or quality

[0101]

5 On the other hand, as already described partially, if the non-solvent type ultraviolet ray hardening resin composite is used, since the photopolymerization monomer can also serve as a dilution agent for the purpose of the degree adjustment of viscosity, more quantity of non-solvent ultraviolet ray hardening resin composite can be prepared in comparison with
10 the solvent containing type one. This enables the recovery of the adequate and stable adhesion only by the action of the non-solvent activation ingredient in the non-solvent type ultraviolet ray hardening resin composite, which is typically the photopolymerization monomer. Furthermore, since the ultraviolet ray hardening resin composite 20A and the print pattern 12 are
15 wholly united with each other and hardened and the photopolymerization monomer itself which has a function equivalent to the conventionally used solvent participates in polymerization, this photopolymerization monomer is never separated to thereby do no badness after that.

[0102]

20 In the fifth form of embodiment of the invention, by using the process of Fig. 10 is formed an ultraviolet hardening resin topcoat layer by a separate operation of water pressure transfer on a decorative layer obtained by transferring under water pressure the print pattern 12 activated by the ultraviolet ray hardening resin composite 20A so as to overcoat the decorative
25 layer. The operation of the topcoat application by this water pressure transfer is done by using a transfer film 116 having transparent ultraviolet ray hardening resin composite 120A formed by being applied in the state of solid color (the non-pattern state) all over the whole surface of a plain

water-soluble film 114 as shown in Fig. 10. This transfer film 116 is floated on the water surface immediately after the application of ultraviolet ray hardening resin composite 120A and at the timing when the water-soluble film 114 is made properly wet, the article 10' having the decorative layer applied thereto is forced into water 118. Thereafter, the ultraviolet ray irradiation, the water washing and the drying are performed like the steps of Fig. 8E and the succeeding figures, which are performed by the decoration operation by water pressure transfer whereby a water pressure transfer product 110' having a topcoat layer formed by being over-coated with the ultraviolet ray hardening resin topcoat layer 130 (see Fig. 11) is obtained.

[0103]

The operation of topcoat application for the water pressure transfer may be performed by using a transfer film having ultraviolet ray hardening resin composite formed by being preliminarily hardened so as not to cause blocking after applying the ultraviolet ray hardening resin composite in the state of solid color (non-pattern state) on a plain water-soluble film 14 rather than applying the ultraviolet ray hardening resin composite in the state of solid color just before floating it on the water surface. In this case, a non-solvent type ultraviolet ray hardening resin composite or an photopolymerization monomer ingredient may be applied on the preliminarily hardened ultraviolet ray hardening resin composite of the transfer film in the solid color before floating it on the water surface to thereby recover the adhesion of the ultraviolet ray hardening resin and then the steps of Fig. 8C and the succeeding figures may be performed like the operation of the water pressure transfer for decoration.

[0104]

With the topcoat layer 130 applied on the decorative layer 30 in this manner, depth is imparted to the appearance of the decorative layer 30 and in

addition thereto, the mechanical and chemical surface protection of the decorative layer 30 is further improved.

[0105]

The fourth and fifth forms of embodiment of the invention can obtain various advantages by using the non-solvent type ultraviolet ray hardening resin composite. The term "non-solvent type" in the non-solvent type ultraviolet ray hardening resin composite used by this invention does not mean that there is absolutely zero of a "solvent ingredient" but is never exclusive of one having solvent ingredient added in order to escape from the invention or having solvent ingredient used for producing the monomer or the pre-polymer, but remained if there can be obtained the function of re-adhesion of the print pattern by the non-solvent activation ingredient in the ultraviolet ray hardening resin composite, which is typically photopolymerization monomer to the necessary and full degree. Similarly, the term "non-solvent type" does not mean that there is absolutely zero of "volatility" of the photopolymerization monomer, but means that it is not as high as the solvent and therefore it may have the volatility in such a degree as can be disregarded practically. Furthermore, it should be understood that although the operation of water pressure transfer requires plant and equipment investment or a safety control, the concept of ultraviolet ray hardening resin composite may include an electronic ray hardening resin composite because the electronic ray hardening resin composite containing photopolymerization pre-polymer and photopolymerization monomer as indispensable ingredients, which can omit an photopolymerization initiator by irradiating an electronic ray of higher energy on the resin composite and hardening it has the function of activation by the photopolymerization monomer and the photopolymerization monomer itself participates in polymerization serving like the original ultraviolet ray hardening resin

composite containing the photopolymerization initiator.

[0106]

(Embodiment 3)

In a concrete example (Embodiment 3) according to the fourth form of
5 embodiment of the invention, the non-solvent type ultraviolet ray hardening
resin composite which is the ultraviolet ray hardening type ink commercially
available as "UV MAT-000 MREDIUM", the trade name of UV type screen
ink from TEIKOKU INK MANUFACTURE CO., LTD., Japan was used, and
the process was carried out in order of the steps shown in Figs. 8A through
10 8G. This non-solvent type of ultraviolet ray hardening resin composite was
applied or coated on the print pattern of the transfer film by a wire bar
coating method just before introducing the transfer film into the transfer tub.
The transfer film having the thus applied non-solvent type ultraviolet ray
hardening resin composite was floated on the water surface of the transfer
15 tub and after the print pattern recovers its adhesion with the ultraviolet ray
hardening resin composite, the article was forced underwater through the
transfer film as shown in Fig. 8D. After transfer, the article was taken out of
the water, then the ultraviolet ray was irradiated on the article and
water-washing and drying were performed to thereby obtain the water
20 pressure transfer article (product) 10' as shown in Fig. 9.

[0107]

(Embodiment 4)

In the Embodiment 4, the process was carried out in the same
manner as the Embodiment 3 except to use as the non-solvent type
25 ultraviolet ray hardening resin composite the ultraviolet ray hardening type
ink commercially available under the name "UV PAL-000 MEDIUM", the
trade name of UV type screen ink from TEIKOKU INK MANUFACTURE
CO., LTD., Japan.

[0108]

Describing the status of transfer in each of the Embodiments, the water pressure transfer could be accomplished in the same manner as the conventional method except that the operation of application of the resin composite on the transfer film was carried out with certain difficulty due to the high viscosity of the resin composite because the one on the market was used as it is.

[0109]

As the adhesion of the decorative layer of each of the water pressure transfer articles (E) obtained by the Embodiments 3 and 4 was tested by the cross cut tape adhesion test method (1mm cross 100 measures), it was confirmed that each of the articles (E) of the Embodiments had the same adhesion as the water pressure transfer article (B) having the print pattern transferred by the conventional activator, but having no topcoat and the water pressure transfer article (C) having conventional acrylic resin applied on the decorative layer.

[0110]

As a ten-sheet piled gauze containing xylene was reciprocally wiped on the surface of the product eight times while it is rubbed thereon as a solvent resistance test, it was confirmed that the product of either of the Embodiments had little damage of the decorative layer, which is not as good so the water pressure transfer article (C) having the conventional topcoat layer and showed solvent resistance as good as the conventional water pressure transfer product (C). The conventional water pressure transfer article (B) obtained by being activated by the conventional activating agent and having no topcoat applied thereon had very poor solvent resistance, which was naturally expected.

[0111]

It was confirmed from these results that with the non-solvent type ultraviolet ray hardening resin composite used although it is required to be adjusted so as to have a proper composition for the original precise transfer, the print pattern of the transfer film can be activated to the state of making the transfer possible typically by the photopolymerization monomer and that the ultraviolet ray hardening resin composite and the print pattern are hardened while they are wholly united after the irradiation of the ultraviolet ray whereby the mechanical and chemical surface protection functions such as wear resistance and solvent resistance can be imparted to the obtained decorative layer.

[0112]

There is shown in Fig. 12 a water pressure transfer method according to the sixth form of embodiment of the invention. This water pressure transfer method is the one in which the transfer film 16 having the protection layer 40 for topcoat and the print pattern 12 for decoration applied on the water-soluble film 14 is supplied and floated on the water 18 in the transfer tub not illustrated so that the print pattern 12 is directed upwards and the article 10 for the print pattern 12 to be transferred under water pressure is forced into water 18 through the transfer film 16 to thereby carry out the water pressure transfer. The water-soluble film 12 may be the same as what is used with the first, second, fourth and fifth forms of embodiment.

[0113]

Although the protection layer 40 for topcoat may be of composite such as suitable dry hardening coat material and other composites which have wear resistance and chemical resistance, it may be preferably of transparent ink or ultraviolet ray hardening resin composite and more preferably of non-solvent ultraviolet ray hardening resin composite, which is the same as the material for recovering adhesion of the print pattern 16 as described later.

This protection layer 40 may be applied on the whole surface of the water-soluble film 14 by proper application means. In general water pressure transfer, the print pattern 12 may be applied on the protection layer 40 on the water-soluble film 14 by photogravure printing and other proper means. This
5 print pattern 12 also contains a plain (non-pattern) print layer other than the pattern in a strict meaning. In case that the protection layer 40 for topcoat is formed of ultraviolet ray hardening resin composite, the print pattern 12 is applied thereon in the state of preliminary drying the resin composite and therefore the print pattern 12 may be desirably printed by an ink jet system .

10 [0114]

Also in the sixth form of embodiment, the non-solvent type ultraviolet ray hardening resin composite may be applied for recovering adhesion of the print pattern 12 of the transfer film 16. A concrete example of the water pressure transfer method according to the sixth form of embodiment is shown
15 in Fig. 13 and the protection layer 40 and the print pattern 12 applied on the water-soluble film 14 is in the state where they are dried (see Fig. 13A).

[0115]

When the water pressure transfer is carried out, the non-solvent type ultraviolet ray hardening resin composite 20A is applied on the dried print
20 pattern 12 of the transfer film 16 (see Fig. 13B). In the state where the adhesion of the print pattern 12 is recovered by the non-solvent type ultraviolet ray hardening resin composite 20A, the transfer film 16 is floated on the water 18 in the transfer tub (see Fig. 13C). Thereafter, the article 10 is forced underwater together with the transfer film 16 so that the print pattern
25 12 containing ultraviolet ray hardening resin composite 20A is engaged against the surface 10S of the article 10 (see Fig. 13D) to thereby transfer the print pattern 12 containing the ultraviolet ray hardening resin composite 20 and the protection layer 40 for topcoat and then the ultraviolet ray 22 is

irradiated on the article 10 whereby the print pattern 12 containing the ultraviolet ray hardening resin composite 20A and the protection layer 40 for the topcoat on the resin composite are hardened (see Fig. 13E). In case that the protection layer 40 is formed of the ultraviolet ray hardening resin composite, the ultraviolet ray hardening resin composite of the protection layer 40 is fully hardened together with the ultraviolet ray hardening resin composite 20A for recovery of the adhesion by this ultraviolet ray irradiation. In order to explain that the protection layer 40 is hardened together with the ultraviolet ray hardening resin composite for adhesion recovery by the step of irradiating the ultraviolet ray, the description will be made about the protection layer 40 being formed of ultraviolet ray hardening resin composite. [0116]

Although not shown, the article is practically forced underwater while it may be conveyed by a reversely triangle-like conveyer or being supported by a robot arm. In some cases, the order of the step of applying the non-solvent type ultraviolet ray hardening resin composite 20A on the print pattern 12 (see Fig. 13B) and the step of floating the transfer film on the water (see Fig. 13C) may be made reversely and the non-solvent type ultraviolet ray hardening resin composite 20A may be applied by spray on the print pattern 12 of the transfer film 16 floated on the water to thereby recover the adhesion of the print pattern.

[0117]

The "ultraviolet ray hardening resin composite" excludes the solvent containing type ultraviolet ray hardening resin composite like what is used for the fourth and fifth forms of embodiment and therefore is limited to the non-solvent type ultraviolet ray hardening resin composite having no solvent added thereto. The reason is that the recovery of adhesion of the print pattern and the protection layer for topcoat is going to be based on the

non-solvent activation component in the non-solvent type ultraviolet ray hardening resin composite that may be typically photopolymerization monomer. The ultraviolet ray hardening resin composite applicable to this invention comprises the ingredient which has the following composition.

5 Since this ingredient is the same as what is used for the fourth and fifth forms of embodiment, the detailed explanation is omitted.

(1) Oligomer (photopolymerization pre-polymer) 30 - 50 weight %

(2) multi-functional acrylate

(photopolymerization monomer) 10 - 30 weight %

10 (3) single functional acrylate

(photopolymerization monomer) 10 - 40 weight %

(4) photopolymerization initiator 0.5 - 5
weight %

(5) non-reactive additives 1 - 20 weight %

15 [0118]

As the non-solvent type ultraviolet ray hardening resin composite 20A is applied on the print pattern 12, the photopolymerization monomer that is the non-solvent activation ingredient in the non-solvent type ultraviolet ray hardening resin composite 20A permeates into the dried ink of the print
20 pattern 12 and also into at least a part of the protection layer 40 for topcoat to dissolve them whereby the adhesion which is in the same wet state as the print pattern 12 and the protection layer 40 immediately after printing the print pattern 12 and applying the protection layer 40 can be recovered. Thus, as described in the fourth and fifth forms of embodiment, the functions
25 identical to the conventional activating agent can be accomplished. The application of the activating agent, thinner, etc. can be omitted. Since each ingredient in the ultraviolet ray hardening resin composites such as the photopolymerization monomer generally has volatility far lower than the

solvent etc., the degree of adhesion recovered has neither variation nor reduction whereby the activation of the print pattern can be expected to be made stable.

[0119]

5 As the ultraviolet ray 24 is irradiated on the article after transferring the print pattern 12 thereon, each ingredient of the ultraviolet ray hardening resin composite 20A such as the photopolymerization monomer permeates into the ingredient of the ink of the print pattern 12 and the protection layer 40 for topcoat whereby the ultraviolet ray hardening resin composite 20A and
10 the ingredient of the ink of the print pattern 12 are hardened in the state where they are wholly united and also the ultraviolet ray hardening resin composite 20A and at least a part of the protection layer 40 for topcoat are hardened in the state where they are wholly united. Thus, mechanical surface protection functions such as wear resistance, etc. and chemical
15 surface protection functions such as solvent resistance, medicine resistance, etc. are imparted to the decorative layer itself and also adhesion of the protection layer 40 for topcoat to the print pattern 12 for the decorative layer can be improved. Simultaneously when the ultraviolet ray hardening resin composite 20A is hardened by the ultraviolet ray, the ultraviolet ray
20 hardening resin composite of the protection layer 40 is also hardened. In Figs. 13B and 13C, although the ink ingredient of the print pattern 12, the ingredient of the protection layer 40 for topcoat and the ultraviolet ray hardening resin composite 20A are not shown in the state where they are wholly united, it should be noted that they are shown to be conveniently in
25 the layer state because they cannot be distinguished if they try to be shown in the united state in these figures. Moreover, as already described, since the photopolymerization monomer itself participates in polymerization, it is never separated, which prevents badness thereafter due to the separation.

[0120]

Then, as shown in Fig. 13F, the water shower 24 is injected to wash the article by water to thereby remove the water-soluble film 14 of the transfer film 16 which the article is covered with. Subsequently, as shown in Fig. 13G, a hot wind 26 is blown to the article 10 to which the print pattern 12 and the protection layer 40 for topcoat containing the ultraviolet ray hardening resin composite 20A are transferred to thereby dry the surface of article 10 whereby the product 10' having the decorative layer 30 and the topcoat layer 32 is completed (see Fig. 14).

10 [0121]

Thus, when there are provided the decorative layer 30 and the topcoat layer 32, the topcoat layer 32 will impart depth to the appearance of the decorative layer 30, and will further strengthen the mechanical and chemical surface protection to the decorative layer 30.

15 [0122]

(Embodiment 5)

In a concrete example (Embodiment 5) according to the sixth form of embodiment of the invention, on the plain water-soluble film having a main ingredient of polyvinyl alcohol was applied or coated in a uniform manner all over the whole surface a mixture of what is commercially available under the trade name "KLCF IMPROVEMNET 3 MEDIUM" and an ethyl acetate by THE INTECK CO., LTD., Japan by the ratio 1:1 as the protection layer for topcoat by using a wire bar coater having a wire bar of a diameter of 12mm and wire number #8 and after naturally drying it under normal temperature atmosphere for 10 minutes, there was arbitrarily handwritten a pattern with a tip of a brush having an ink alkyd resin manufactured by THE INTECH CO., LTD., Japan and a brown ink called the trade name "KLCF IMPROVEMENT 3 BROWN" of nitrification cotton attached thereto whereby

there was obtained the transfer film having the protection layer for topcoat and the ink pattern for decoration (what corresponds to the print pattern) laminated. The water pressure transfer was carried out in order of the steps shown in Figs. 13A through 3G using the transfer film and in order to apply
5 to the ink pattern for decoration of the transfer film to recover adhesion in the ink, there was used the non-solvent type ultraviolet ray hardening resin composite which is the ultraviolet ray hardening type ink commercially available under the trade name "UV PAL-000 MEDIUM", the UV type screen ink from TEIKOKU INK MANUFACTURE CO., LTD. This non-solvent type
10 ultraviolet ray hardening resin composite was applied on the ink pattern (print pattern) of the transfer film by the wire bar coating method just before introducing the transfer film into the transfer tub. The transfer film having the non-solvent type ultraviolet ray hardening resin composite thus applied was floated on the water surface of the transfer tub. After the ink pattern had
15 adhesion recovered by this ultraviolet ray hardening resin composite, as shown in Fig. 13D, the article was forced underwater through the transfer film. After the ink pattern and the protection layer for topcoat were transferred in this manner, the article was taken out from the water, the ultraviolet ray was irradiated on the article and it was washed by water and
20 dried whereby the water pressure transfer article (product) 10' as shown in Fig. 14 was obtained.

[0123]

(EMBODIMENT 6)

The water pressure transfer was performed in the same manner as
25 EMBODIMENT 5 except that there was used what was obtained by mixing the acrylics lacquer called the trade name "PLA-ACE" manufactured by THE MUSASHI TORYO CO., LTD., Japan as the protection layer for topcoat of the transfer film and ethyl acetate by the ratio of 1:1.

[0124]

(EMBODIMENT 7)

The water pressure transfer was carried out in the same manner as EMBODIMENTS 5 and 6 except that after applying as the protection layer
5 for topcoat of the transfer film the ultraviolet ray hardening type ink called the trade name "UV PAL-000 MEDIUM" manufactured by and commercially available from THE TEIKOKU INK MANUFACTURE CO., LTD., Japan which is the same as the one being applied for the purpose of adhesion recovery (activation) of the water pressure transfer film, hardening by very
10 feeble ultraviolet ray irradiation of 1% or less of the amount of irradiation required for original hardening of the composite was carried out and stopped just before finger touching dryness, a proper pattern prepared with a paint system software by using MC-10000 of a large-sized ink jet printer MAXART series manufactured by THE SEIKO EPSON CO., LTD., Japan and six colors
15 of pigment system oiliness ink were printed on the protection layer and then they were dried under normal temperature atmosphere for 30 minutes whereby there was the transfer film having the topcoat layer and the ink pattern (corresponding to the print pattern).

[0125]

20 In either of EMBODIMENTS 5 through 7, since two layers of the ink pattern and the protection layer for topcoat were dissolved, although some more time were required for recovering the adhesion of the ink pattern than that in case of transferring the transfer film having only the ink pattern provided thereon, the water pressure transfer according to either of the
25 embodiments was carried out in good manner except for disappearance of the wrinkles of the pattern being overdue in the circumference of the portion especially having the deep color. Moreover, the water pressure transfer article (G) obtained in these embodiments had the topcoat layer applied all over the

decorative layer simultaneously with transfer and it is confirmed that the water pressure transfer article according to EMBODIMENT 5 had a little low degree of gloss compared with the water pressure transfer articles according to the EMBODIMENTS 6 and 7, but had the feeling of gloss remarkably better than that of the water pressure transfer article (E) (see EMBODIMENT 4) having no topcoat layer obtained by transferring the print pattern which the non-solvent type ultraviolet ray hardening resin composite permeated into by recovering the adhesion of the print pattern by the resin composite and also had depth of the appearance of the decorative layer imparted thereto.

[0126]

As the adhesion of the decorative layer and the topcoat layer of the water pressure transfer article obtained by each of the embodiments was tested by a cross cut tape adhesion test method (1mm cross 100 measures), it is confirmed that the article according to either of the embodiments had the same adhesion as the conventional water pressure transfer article (B) without any topcoat having the print pattern transferred by activating the print pattern by the conventional activator, the conventional water pressure transfer article (C) having the conventional acrylic resin applied on the decorative layer and the water pressure transfer article according to the EMBODIMENT 4 or 5.

[0127]

As a ten-sheet piled gauze containing xylene was reciprocatively wiped on the surface of the product eight times while it is rubbed thereon as a solvent resistance test, it was confirmed that the product of either of the EMBODIMENTS had shown the good solvent resistance equivalent to that of the conventional water pressure transfer article (F) having the topcoat layer of ultraviolet ray hardening type coating material.

[0128]

In the EMBODIMENTS 5 through 7, the water pressure transfer was carried out using the transfer film having the protection layer for topcoat and the ink pattern for decoration (print pattern) laminated and after the ink pattern was activated by applying the ultraviolet ray hardening resin composite, but since, in either of the embodiments, there is the aim in the confirmation of the recovery of adhesion of the ink pattern (print pattern) and the protection layer for topcoat, the characteristic of winding the ink pattern and the protection layer for topcoat around the pattern-transferred body (article) under water pressure and the ability to harden the ultraviolet ray hardening resin composite, the ink pattern and the topcoat layer on the pattern-transferred body by the ultraviolet ray irradiation while they are wholly united with each other, there remain the room of an improvement in a degree of surface gloss and surface smoothness and therefore it should be understood that there can be imparted more excellent surface gloss, mechanical strength, solvent resistance, etc. by consideration of coating material, ink and ultraviolet ray hardening resin composites used as the topcoat layer, these kinds and their composition ingredient.

[0129]

There is shown in Fig. 15 a water pressure transfer method according to the seventh form of embodiment of the invention. This water pressure transfer method is the one in which a surface protection layer transfer film 316 having a surface protection layer 340 for protection of a surface of an article applied on a water-soluble film 314 is supplied and floated on a water 318 in a transfer tub not illustrated so that the surface protection layer 340 is directed upwards and the article 10 for the surface protection layer 340 to be transferred under water pressure is forced into the water 318 through the transfer film 316 to thereby carry out the water pressure transfer. The

water-soluble film 312 may be the same as what is used with the first through fifth forms of embodiment.

[0130]

The surface protection layer 340 may be of a proper composite such as dry hardening coat material, transparent ink which has wear resistance and medicine resistance. The surface protection layer 340 may be applied on the whole surface of the water-soluble film 314 by proper application means such as photogravure printing means. The surface protection layer 340 may be formed of ultraviolet ray hardening resin composite.

[0131]

In the water pressure transfer method according to the seventh form of embodiment, the surface protection layer 340 applied on the water-soluble film 314 is in the dry state (see Fig. 15A), which is not different from the undried state of the surface protection layer 240 according to the third form of embodiment.

[0132]

When the water pressure transfer is carried out, the ultraviolet ray hardening resin composite 320A is applied on the dried surface protection layer 340 of the transfer film 316 (see Fig. 15B). In the state where the adhesion of the surface protection layer 340 is recovered by the ultraviolet ray hardening resin composite 320A, the transfer film 316 is floated on the water 18 in the transfer tub (see Fig. 15C) with the surface protection layer 340 upwardly directed. Thereafter, the article (undecorated article) 10 having no decoration applied is forced underwater together with the transfer film 316 so that the surface protection layer 340 containing ultraviolet ray hardening resin composite 320A is engaged against the surface 10S of the article 10 (see Fig. 15D) to thereby transfer the surface protection layer 340 containing the ultraviolet ray hardening resin composite 320A and then the ultraviolet ray

322 is irradiated on the article 10 having the surface protection layer containing ultraviolet ray hardening resin composite transferred thereon whereby the ultraviolet ray hardening resin composite 320A and the surface protection layer 340 are hardened (see Fig. 15E).

5 [0133]

As described with reference to other forms of embodiment, the article 10 is forced underwater while it may be conveyed by a reversely triangle-like conveyer or being supported by a robot arm. Similarly, the order of the step of applying the ultraviolet ray hardening resin composite 320A on the surface protection layer 340 (see Fig. 15B) and the step of floating the transfer film on the water 318 (see Fig. 15C) may be made reversely and the ultraviolet ray hardening resin composite 320A may be applied by spray on the surface protection layer 340 to thereby recover the adhesion of the surface protection layer 340.

15 [0134]

The ultraviolet ray hardening resin composite 320A applied on the surface protection layer 340 of the transfer film 316 for recovering an adhesion thereof serves to properly activate the dried surface protection layer 340 of the transfer film 316 to recover the adhesion of the surface protection layer 340 of the transfer film 316 and may be of solvent containing type ultraviolet ray hardening resin composite, which is the same as used in the first and second forms of the invention or may be of non-solvent type ultraviolet ray hardening resin composite, which is the same as used in the fourth through sixth forms of the invention. One example of the solvent containing type ultraviolet ray hardening resin composite and one example of the non-solvent type ultraviolet ray hardening resin composite are listed as follows.

[0135] (solvent containing type ultraviolet ray hardening resin composite)

- | | | |
|---|-----------------------------------|------------------|
| | (1) Oligomer | 30 - 50 weight % |
| | (2) multi-functional acrylate | 10 - 30 weight % |
| | (3) single functional acrylate | 10 - 40 weight % |
| | (4) non-reactive additives | 1 - 20 weight % |
| 5 | (5) photopolymerization initiator | 0.5 - 5 weight % |
| | (6) solvents | Remainder |
- [0136] (non-solvent type ultraviolet ray hardening resin composite)
- | | | |
|----|--|------------------|
| | (1) Oligomer (photopolymerization pre-polymer) | 30 - 50 weight % |
| | (2) multi-functional acrylate | |
| 10 | (photopolymerization monomer) | 10 - 30 weight % |
| | (3) single functional acrylate | |
| | (photopolymerization monomer) | 10 - 40 weight % |
| | (4) photopolymerization initiator | 0.5 - 5 weight % |
| 15 | (5) non-reactive additives | 1 - 20 weight % |
- [0137]

Since a mechanism that the activating components of these ultraviolet ray hardening resin composite 320A recover the adhesion of the surface protection layer 340 is the same as the ultraviolet ray hardening resin composite for recovering the adhesion in the first through third forms and in the fourth through sixth forms, the detailed description of the function of the respective composites will be omitted. In this manner, the ultraviolet ray hardening resin composite 320A is immersed into the surface protection layer 340 whereby the resin composite 320A and the surface protection layer 340 are wholly united with each other, but if Fig. 15 tries to show such state, then it becomes impossible for both to be distinguished from each other and it should understand that they are conveniently indicated in the state of layers.

[0138]

Then, as shown in Fig. 15F, a water shower 324 is injected to wash the article 310 by water to thereby remove the water-soluble film 314 of the transfer film 316 which the article 310 is covered with. Subsequently, as shown in Fig. 15G, a hot wind 326 is blown to dry the surface of the article
5 onto which the surface protection layer 340 containing the ultraviolet ray hardening resin 320A is transferred whereby the product 310 having the surface protection layer 340 transferred is completed (see Fig. 16).

[0139]

Thus, when there is applied the surface protection layer 340', the
10 mechanical and chemical protection of the article 310 will be able to be strengthened. Particularly, since the ultraviolet ray hardening resin composite for recovering the adhesion is immersed into the surface protection layer 340 whereby the surface protection layer 340 and the ultraviolet ray
15 hardening resin composite are wholly united with each other, the adhesiveness and the solvent resistance of the surface protection layer can be improved in the same manner as in the fifth form of embodiment. The surface protection layer 340' has the surface never disordered and the high feeling of gloss imparted thereto because the surface protection layer 340' is applied to the article by water pressure transfer.

20 [0140]

Although, in the method according to the seventh form of embodiment, the article 10 has no decoration applied thereto, the surface protection layer 340 may be applied to the article 10' having the decorative layer 10' (such as the article of Fig. 9 according to the Embodiment 3) by water pressure
25 transfer or other proper means. Fig. 17 shows the decorated article 310 thus surface protected.

[0141]

As described with reference to the fourth through sixth forms, the

ultraviolet ray hardening resin composite 320A for recovering the adhesion of the surface protection layer 340 may be more preferably non-solvent type ultraviolet ray hardening resin composite than solvent type ultraviolet ray hardening resin composite in consideration of less undesirable volatility of the activating component and improvement on recovery of the adhesion thereof. whereby the deterioration of the operation atmosphere is prevented.

[0142]

(Embodiment 8)

In a concrete example (Embodiment 8) according to the seventh form of embodiment of the invention, on the plain water-soluble film having a main ingredient of polyvinyl alcohol was applied or coated in a uniform manner all over the whole surface a mixture of what is commercially available under the trade name "KLCF IMPROVEMNET 3 MEDIUM" by THE INTECK CO., LTD., Japan and an ethyl acetate by the ratio 1:1 as the surface protection layer for the article by a gravure application method using a printing cylinder having #10 mesh of 60 micron and after drying it by means of a wind of normal temperature atmosphere blown for a few second to thereby obtain the surface protection layer transfer film. The water pressure transfer was carried out in order of the steps shown in Figs. 15A through 15G using the transfer film to apply the surface protection layer on the undecorated article. What includes a main ingredient of ultraviolet ray hardening coating material commercially available under the trade name of FUJIHARD HH9 from FUJIKURA KASEI CO., LTD., Japan as an ultraviolet ray hardening resin composite was used to recover the adhesion of the surface protection layer of the transfer film by application thereof on the surface protection layer. This ultraviolet ray hardening coating material was on the surface protection layer resin of the transfer film by the same method as the wire bar coating method used in Embodiment 5 just before introducing

the transfer film into the transfer tub. The transfer film having the ultraviolet ray hardening coating material thus applied was floated on the water surface of the transfer tub. After the surface protection layer had adhesion recovered by this ultraviolet ray hardening coating material, the article was forced underwater through the transfer film. After the surface protection layer was transferred on the surface of the article in this manner, the article was taken out from the water, the ultraviolet ray was irradiated on the article and it was washed by water and dried whereby the water pressure transfer article (product) 310 having the surface protection layer 340' as shown in Fig. 16 was obtained.

[0143]

(EMBODIMENT 9)

In another concrete example (Embodiment 9) according to the seventh form of embodiment of the invention, on the plain water-soluble film having a main ingredient of polyvinyl alcohol was applied or coated in the same manner as in Embodiment 8 what was obtained by mixing the acrylics lacquer called the trade name "PLA-ACE" manufactured by THE MUSASHI TORYO CO., LTD., Japan and ethyl acetate by the ratio of 1:1 as the surface protection layer of the transfer film. The water pressure transfer was carried out on the article decorated by the water pressure transfer, but having no top-coat applied, in the same manner as the method shown in Figs. 15A through 15G using the transfer film to thereby obtain the water pressure transferred article 310 shown in Fig. 17. This Embodiment is identical to Embodiment 8 except that the non-solvent type ultraviolet ray hardening resin composite of ultraviolet ray hardening type screen ink called the trade name "UV PAL-000 MEDIUM" manufactured by and commercially available from THE TEIKOKU INK MANUFACTURE CO., LTD., Japan for recovering the adhesion of the surface protection layer by its application.

[0144]

In either of EMBODIMENTS 8 and 9, the surface protection layer 340 can be transferred under water pressure in a good manner and the thus transferred surface protection layer 340 had a uniform film thickness having less surface disorder (unevenness) and good feeling of gloss. It is confirmed that the water pressure transferred article (H) obtained by EMBODIMENT 9 had a deepness imparted thereto so as to provide high class feeling by providing a uniform film thickness having less surface disorder to thereby impart a good feeling of gloss than the water pressure transferred article (G) having the surface protection layer for topcoat and the decorating print pattern transferred under water pressure in Embodiments 5 through 7. This had the feeling of gloss equivalent to that of the top-coated water pressure transferred article (C) formed by coating and drying acrylic resin on the decorative layer by conventional spray coating method.

15 [0145]

As the adhesion of the surface protection layer of the water pressure transfer article obtained by each of Embodiments 8 and 9 was tested by a cross cut tape adhesion test method (1mm cross 100 measures), it is confirmed that the adhesion onto the surface of the article (the surface of the undecorated article or the decorative layer of the decorated article) according to either of the embodiments was equivalent to that of the water pressure transfer article according to Embodiments 3 and 4.

[0146]

As a ten-sheet piled gauze containing xylene was reciprocally wiped on the surface of the product (the water pressure transfer article) eight times while it is rubbed thereon as a solvent resistance test, it was confirmed that the product of either of the Embodiments 8 and 9 had shown the good solvent resistance equivalent to that of the products according to other

Embodiments.

[0147]

In Embodiment 8, the surface protection layer was applied on the surface of the article (molded article) formed by injection mold etc., after its proper surface treatment, if necessary and it was confirmed that it had the surface finish (finish of uniform film thickness and of arranged feeling of gloss) equivalent to that of the article having the surface protection formed by a coating robot having a spray gun mounted thereon and more uniform surface protection layer having a more arranged feeling of gloss could be obtained than that of the article having the surface protection layer formed by an operator, who is not good at spar gun coating.

Embodiment 9 can be said to be an example of the repetition of the similar steps in which there was transferred under water pressure the plain print layer obtained by applying the transparent ink or transparent coating material on the decorative layer 30 of the article 10' obtained by the water pressure transfer of Embodiment 4.

[POSSIBILITY OF UTILIZATION IN INDUSTRIES]

[0148]

According to the water pressure transfer method of the invention, since the ultraviolet ray hardening resin composite is applied to the print pattern and/or the surface protection layer of the transfer film to be transferred to the article to recover the adhesion of the ink of the print pattern and the ultraviolet ray hardening resin composite permeates into the print pattern, the surface protection function is imparted to the decorative layer formed by transferring the print pattern after ultraviolet ray hardening and therefore the availability in industries can be remarkably improved.

What is claimed is;

1. A water pressure transfer method adapted to transfer under water pressure on a surface of an article (10) a print pattern (12) of a transfer film (16) formed by applying said print pattern on a water-soluble film (14), said
5 method comprising a step of applying an ultraviolet ray hardening resin composite (20) on said print pattern of said transfer film, a step of forcing said article underwater (18) together with said transfer film so as to force said print pattern containing said ultraviolet ray hardening resin composite onto the surface of said article in the state where an
10 adhesion of said print pattern is recovered by said ultraviolet ray hardening resin composite and a step of irradiating an ultraviolet ray on said article on which said print pattern containing said ultraviolet ray hardening resin composite is transferred whereby said ultraviolet ray hardening resin composite is hardened.

15 2. A water pressure transfer method adapted to transfer under water pressure on a surface of an article a print pattern of a transfer film formed by applying said print pattern on a water-soluble film, said method comprising a step of preparing a transfer film by applying said print pattern on said water-soluble film having an ultraviolet ray hardening resin
20 composite (20A) previously applied thereon, a step of forcing said article underwater together with said transfer film so as to force said print pattern containing said ultraviolet ray hardening resin composite onto the surface of said article in the state where an adhesion of said print pattern is maintained and a step of irradiating
25 an ultraviolet ray on said article on which said print pattern containing said ultraviolet ray hardening resin composite is transferred whereby said ultraviolet ray hardening resin composite is hardened.

3. A method for forming an ultraviolet ray hardening type surface protection layer on an article comprising a step of applying an ultraviolet ray hardening type protection agent on a water-soluble film (214) to form a surface protection layer transfer film (216), a step of
5 transferring under water pressure said ultraviolet ray hardening type surface protection layer (240) of said surface protection layer transfer film on said article under water pressure when said surface protection layer transfer film is floated on a water surface and said water-soluble film is made wet and a step of irradiating an ultraviolet ray on said
10 ultraviolet ray hardening type surface protection layer transferred on said article to harden the surface protection layer.

4. A water pressure transfer method as set forth in claim 3, and wherein said ultraviolet ray hardening type protection agents is an ultraviolet ray hardening type coating agent.

15 5. A water pressure transfer method as set forth in claim 3 or 4, and further comprising a step of forming a concavo-convex pattern for decoration on said ultraviolet ray hardening type surface protection layer of said the water-soluble film.

6. A water pressure transfer method adapted to transfer a print
20 pattern of a transfer film formed by applying said print pattern on a water-soluble film, said method comprising a step of applying a non-solvent type ultraviolet ray hardening resin composite on said print pattern of said transfer film to recover an adhesion of said print pattern by a non-solvent activating ingredient of said non-solvent ultraviolet ray
25 hardening type resin composite, a step of forcing said article underwater together with said transfer film so as to force said print pattern containing said ultraviolet ray hardening type resin composite onto the surface of said article and a step of irradiating an ultraviolet

ray on said article on which said print pattern containing said ultraviolet ray hardening type resin composite is transferred whereby said ultraviolet ray hardening type resin composite is hardened in the state where said ultraviolet ray hardening type resin composite is
5 wholly united with said print pattern to form a decorative layer.

7. A water pressure transfer method adapted to transfer a print pattern of a decorating transfer film formed by applying said print pattern on a water-soluble film, said method comprising a step of applying a non-solvent type ultraviolet ray hardening resin composite on said
10 print pattern of said decorating transfer film to recover an adhesion of said print pattern by a non-solvent activating ingredient of said non-solvent ultraviolet ray hardening type resin composite, a step of forcing said article underwater together with said transfer film so as to force said print pattern containing said ultraviolet ray hardening
15 type resin composite onto the surface of said article, a step of irradiating an ultraviolet ray on said article on which said print pattern containing said ultraviolet ray hardening type resin composite is transferred whereby said ultraviolet ray hardening type resin composite is hardened in the state where said ultraviolet ray
20 hardening type resin is wholly united with said print pattern to form a decorative layer and a step of transferring a layer of an ultraviolet ray hardening resin composite of a top-coating transfer film formed by applying said transparent ultraviolet ray hardening resin composite on a water-soluble film in a solid color state, on said article having
25 said decorative layer formed thereon whereby a top coat layer is formed from said ultraviolet ray hardening resin composite of said top coating transfer film.

8. A water pressure transfer method adapted to transfer a print

pattern and a top-coating protection layer of a transfer film formed by sequentially applying said top-coating protection layer and said print pattern on a water-soluble film, said method comprising a step of applying a non-solvent type ultraviolet ray hardening resin composite on said
5 print pattern of said transfer film to recover an adhesion of said print pattern by a non-solvent activating ingredient of said non-solvent ultraviolet ray hardening type resin composite, a step of forcing said article underwater together with said transfer film so as to force said print pattern containing said ultraviolet ray hardening type resin
10 composite onto the surface of said article, a step of irradiating an ultraviolet ray on said article on which said print pattern containing said ultraviolet ray hardening resin composite and said top-coating protection layer on said print pattern are transferred whereby said ultraviolet ray hardening type resin composite is hardened in the state
15 where said ultraviolet ray hardening resin is wholly united with said print pattern and with at least one portion of said top-coating protection layer.

9. A water pressure transfer method as set forth in claim 6, 7 or 8, and wherein said non-solvent activating component of said ultraviolet ray
20 hardening resin composite for recovering the adhesion of said print pattern is one including a photo-polymerization monomer.

10. A water pressure transfer method as set forth in claim 8 and wherein said protection layer for topcoat comprises transparent ink.

11. A water pressure transfer method as set forth in claim 8 and
25 wherein said protection layer for topcoat comprises ultraviolet ray hardening resin composite.

12. A water pressure transfer method as set forth in claim 11 and wherein said ultraviolet ray hardening resin composite, which is the

protection layer for topcoat is of non-solvent type.

13. A water pressure transfer method adapted to transfer under water pressure on a surface of an article a surface protection layer (340) of a surface protection layer transfer film (316) formed by applying and drying a surface protection agent on a water-soluble film (314), said method comprising a step of applying an ultraviolet ray hardening resin composite (320A) on said surface protection layer of said surface protection layer transfer film to recover an adhesion of said surface protection layer, a step of forcing said article underwater together with said transfer film so as to force said surface protection layer containing said ultraviolet ray hardening resin composite onto the surface of said article in the state where the adhesion of said surface protection layer is recovered by said ultraviolet ray hardening resin composite and a step of irradiating an ultraviolet ray on said article on which said surface protection layer containing said ultraviolet ray hardening resin composite is transferred whereby said ultraviolet ray hardening resin composite is hardened in the state where the ultraviolet ray hardening resin composite are wholly united with each other.

14. A water pressure transfer method as set forth in either of claims 13 and wherein said surface protection agent is transparent ink or dryness hardened coating material.

15. A water pressure transfer method as set forth in either of claims 13 or 14 and wherein said ultraviolet ray hardening resin composite is of non-solvent type.

16. A water pressure transfer method as set forth in either of claims 1 through 15 and wherein said step of irradiating said ultraviolet ray is carried out while said water-soluble film is wound around said article.

17. A water pressure transfer method as set forth in either of claims 1

through 16 and wherein said ultraviolet ray and said ultraviolet ray hardening resin composite to recover adhesion of said print pattern are an electronic ray and an electronic ray hardening resin composite, respectively.

18. A water pressure transfer article characterized by being obtained
5 by either of the water pressure transfer method of either of claims 1 through 17.

19. A water pressure transfer article characterized by having a decorative layer or a surface protection layer formed by the water pressure transfer method of either of claims 1 through 8 or claim 13 and said
10 decorative layer or said surface protection layer is what is never deteriorated by a solvent resistance test in which a ten-sheet piled gauze containing xylene is reciprocatively wiped on said decorative layer eight times while it is rubbed thereon.

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