Aug. 16, 1955 K. S. HOOVER 2,715,363

PRINTING ON POLYETHYLENE

Filed Feb. 2, 1951

Fig. 1



Fig. 2

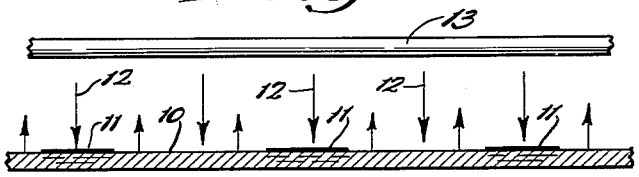


Fig. 3



Fig. 4

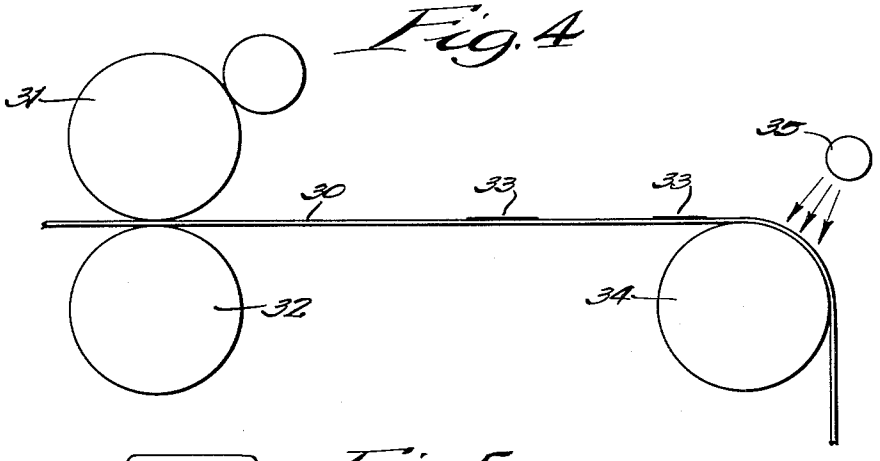
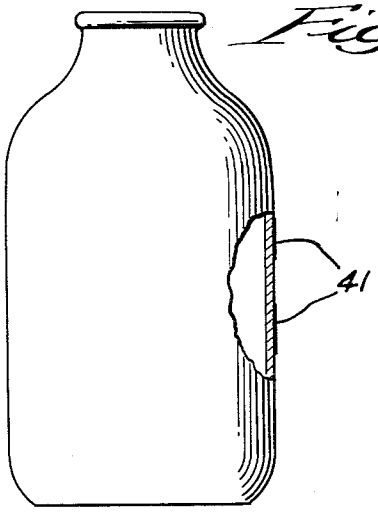


Fig. 5



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United States Patent Office 2,715,363 Patented Aug. 16, 1955

2,715,363

PRINTING ON POLYETHYLENE

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Application February 2, 1951, Serial No. 209,075

4 Claims. (Cl. 101—426)

This invention relates to a process for printing on surfaces of plastic material such, for example, as plastic films, sheet stock or molded products, and it relates particularly to printing on such plastic surfaces as are based upon polyethylene or other resinous materials of like character.

Polyethylene and other resinous materials of like character are unlike most of the other resinous materials when considering the problem of printing because the surfaces of polyethylene are so smooth as to militate against ordinary physical anchorage of the ink composition and solvent systems, which are sometimes employed to soften or etch the surface of the plastic to enable integration of the ink composition, have little, if any, effect because polyethylene is relatively inert to known solvent systems. As a result, the industry has had to be content with inadequate integration of printing or coating on polyethylene. In the past, such printed or coated surfaces have been temporary in nature because they can be easily rubbed, scratched or lifted off. A test which is often employed with printing materials of the type described makes use of an adhesive tape, such as "Scotch Tape," for testing the adherence of the printing ink to the surface. In the past, the "Scotch Tape" test has been effective to remove substantially all printing applied to surfaces of polyethylene.

It is an object of this invention to provide a method for permanently printing plastic surfaces based upon polyethylene or other resinous materials of like character.

A further object is to provide a simple and expedient method for printing on polyethylene surfaces and it is a related object to provide a printing method which may be adapted for continuous and high-speed operation.

A further object is to provide a printing process of the type described which is not deleterious or harmful to the characteristics and strength of the material upon which printing is carried out.

These and other objects and advantages of this invention will hereinafter appear and for purposes of illustration, but not of limitation, embodiments of the invention are shown in the accompanying drawing in which—

Figure 1 is a schematic sectional elevational view of an arrangement of elements in accordance with the practice of this invention;

Figure 2 is a schematic view illustrating the technique for printing plastics with the arrangement shown in Figure 1;

Figure 3 is a schematic view in section showing the printed plastic;

Figure 4 is a plan view showing continuous operation embodying features of this invention for printing plastic film; and

Figure 5 illustrates the concept employed in printing on molded plastic surfaces, such as a blown plastic bottle.

In accordance with this invention, a coating or printing ink composition in the desired arrangement is printed

or applied directly onto the surface of the polyethylene plastic to be printed and then radiant energy is directed onto the inked plastic whereby radiations are absorbed by the material in the printing ink and converted into heat. The heat generated in the ink composition is sufficient to modify the surface of the polyethylene plastic material so that the ink may become imbedded and/or integrated into the plastic surface and become a permanent part thereof.

Ink composition in sufficient quantity may be directly applied to the plastic surface by ordinary printing processes, such as by silk screen printing, printing roll, offset printing or the like, and then the plastic surface along with the printing ink thereon may be radiated at some subsequent time. The radiations are reflected or otherwise dissipated by the uninked areas and those radiations absorbed by the material in the ink composition are converted into heat. The heat thus developed reacts to soften the plastic surface contacted by the ink to permit the desired degree of integration. This is to be distinguished from the drying or setting of ink compositions onto surfaces such as plastic surfaces by exposure to elevated temperature. In the event that the ink composition has been previously dried or set on the polyethylene, in the practice of applicant's invention, it will still require the further steps described and claimed herein to effect integration of the polyethylene and the printing ink composition applied thereon. When radiation of the plastic surface follows almost immediately after application, some of the generated heat may be employed for drying or setting the ink but much more will be needed to carry the reaction an additional distance to effect proper integration of the ink with the plastic surface.

The phenomenon of heat generation by radiation absorption in ink materials in accordance with this invention may be practiced with radiations rich in infrared. These include rays having a wavelength ranging from 8,000 to 40,000 angstroms. Radiant energy capable of the phenomenon of the type described may be developed most effectively in sufficiently high concentration by an ordinary flash bulb or by a tungsten filament lamp, carbon arc lamp, photographer's flash lamp and the like. The amount of heat developed upon absorption of radiant energy in the materials of the ink composition depends chiefly upon the duration of exposure coupled with the intensity of the usable radiant energy from the light beams. The amount of heat developed also depends upon the color in the ink composition and the character of the materials of which it is formed. Satisfactory use, for example, is made with ink compositions formulated of carbon black and the like.

As previously pointed out, printing as described herein relies on integration of the ink composition with the heat-softened plastic surface, as distinguished from prior systems wherein integration is accomplished by way of solvent attack. The printed plastic produced in accordance with this invention may be handled almost immediately after printing and, therefore, the process is amenable to high-speed continuous operation. In prior systems, it was necessary to force the evaporation of solvent or to await the natural evaporation thereof before the plastic material could be handled, otherwise the ink composition would smear and offset.

In accordance with the practice of this invention, only that portion of the plastic surface which is inked becomes heated up while the remainder, which usually covers a major portion of the surface, is relatively unaffected. This is to be compared to prior thermal systems for drying or setting the ink wherein the entire surface of the plastic is necessarily exposed to elevated temperature. Such overall heating of the plastic surface is un-

desirable because, under such conditions, the plastic may become capable of flow and molecular rearrangement. If it is under molecular tension, shrinkage occurs and wrinkling and buckling are usually experienced. On the other hand, when only the inked portion of the surface is heated up to integrate the ink composition, as in the practice of this invention, the remainder of the surface, which is unaffected, substantially maintains its original character. Blemishes which might occur in the inked portions which are heated up are substantially concealed by the imbedded ink composition. It is for this reason, also, that it is preferred to employ means for developing sufficient heat substantially instantaneously so as to minimize the possibility of migration of heat to adjacent areas of the plastic material or generation of heat in areas other than that covered by the printing ink composition. This permits the production of copy having better definition.

It will be apparent that colors other than black may be printed onto plastic surfaces in the manner described so long as ingredients therein are capable of absorbing radiant energy and converting it into heat. By way of further improvement, selected dyes and catalysts may be incorporated into the ink composition for the purpose of increasing the absorption of radiant energy and accelerating the conversion of the absorbed radiant energy into heat. Organic or inorganic converters capable of changing unused light rays into heat-generating rays for the purpose of developing higher temperature in shorter time may also be incorporated.

As shown in Figure 1, ink composition **10** is printed or otherwise arranged on a polyethylene film **11**. Radiations **12** from a tungsten arc lamp **13** are directed upon the printed plastic surface, as shown in Figure 2, so that the radiations are substantially completely reflected by the uninked portions of the plastic while other radiations are absorbed by the material in the inked portion and converted into heat. The heat causes softening of the plastic surface upon which the ink is disposed and it may also cause the reduction of the ink composition to flowable condition so that the ink may flow into the softened plastic surface and become integrated therewith.

As schematically illustrated in Figure 3, the ink **15** becomes imbedded in the plastic film to impart legibility. The ink so deposited is capable of resisting all presently known tests for its physical removal.

As shown in Figure 4, a film **30** of plastic material may be fed continuously between cooperating rolls **31** and **32**, one of which is an inking roll that applies ink **33** onto the surface of the plastic, as by an offset process. The plastic film with the ink thereon is then advanced over another roll **34** during which the ink surface is radiated from a light source **35** rich in infra-red, the radiations being absorbed by material in the ink composition and converted into heat. By this technique, the ink becomes thoroughly imbedded and integrated into the surface of the plastic material and becomes a permanent part thereof. As a precaution against deleterious effects of the heat generated, the roll **34** may be cooled by water, air, or other means so as to maintain the inner surface of the plastic in non-flowable condition. Integration of the ink image with the plastic may be improved by the use of a pressure roller cooperating with the roller **34** to engage the printed side of the plastic sheet upon radiation.

Since only a very small portion of the plastic film becomes heated, the temperature developed upon radiation is relatively unimportant except for the fact that it should be sufficient to soften the surface of the plastic at the point of contact with the ink so that the ink can be imbedded herein. It has been found that temperatures in the range of 200° to 550° F. in the inked areas may be developed upon exposure of fractions of a second up to two or three seconds by the techniques described and especially by the use of a photo-flash lamp. Such temperatures are sufficient to achieve the desired results with most plastics. In the event that greater temperature is desired, the exposure of the web to radiant energy may be extended or the intensity of the light beam may correspondingly be increased.

As shown in Figure 5, ink **40** may be applied to a surface of a plastic bottle **41** blown from polyethylene or other like plastic materials, and then the plastic surface radiated by flashing of a photographer's flash lamp whereby radiations rich in infra-red are generated. The radiations are reflected by the uncoated surfaces of the plastic material and absorbed by the ink and converted into heat. The heat causes softening of the plastic surface on which the ink is disposed so that the ink may flow and secure anchorage into the wall of the bottle. In the event that the oriented nature of the plastic of which the bottle is formed tends to cause buckling of the plastic bottle responsive to the heat absorbed, cooling medium such as water may be poured into the bottle to maintain the major portion of the plastic surface at a temperature below flowable condition. Printing in this manner on blown plastic containers is an important advance because the heat generated is local in nature and affects only a small portion of the container such that the system will not set up conditions causing collapse of the bottle or the like. Other thermal systems could not be employed because the highly oriented plastic would be reduced to flowable condition to the extent that plastic deformation would take place and the product would be unsuitable for the purpose intended.

It will be apparent from the description that a new and novel means has been provided for printing on polyethylene and the like. The technique described is capable of continuous operation at high speed and involves little by way of additional equipment, so that it can be employed at distant stations and in small operations by all who desire to print on plastic surfaces. The application of pressure at point of transfer or soon thereafter will aid the integration of the ink composition with the plastic.

It will be understood that numerous changes may be made in the details of the construction, arrangement, and operation without departing from the spirit of the invention, especially as defined in the following claims.

I claim:

1. In the method of printing on polyethylene, the steps of applying ink containing infra-red ray absorbing, heat generating material in the desired image on the surface of polyethylene which is relatively non-infra-red ray absorbing, and directing radiations having high intensity of infra-red onto the ink imaged polyethylene in amount sufficient rapidly to build up a heat pattern in the inked areas which softens the underlying portion of the polyethylene to achieve anchorage of the ink image thereto while the non-imaged portions of the polyethylene remain substantially unaffected.

2. In the method of printing on polyethylene, the steps of applying ink containing infra-red ray absorbing, heat generating material in the desired image on the surface of polyethylene which is relatively non-infra-red ray absorbing, directing radiations having high intensity of infra-red onto the ink imaged polyethylene in amounts sufficient rapidly to build up a heat pattern in the inked areas which softens the underlying portion of the polyethylene to achieve anchorage of the ink image thereto while the non-imaged portions of the polyethylene remain substantially unaffected, and applying pressure to the inked surface of the polyethylene upon radiation to effect integration of the imaged ink portion with the underlying softened polyethylene material.

3. In the method of printing on polyethylene, the steps of applying ink containing infra-red absorbing, heat generating material in the desired image on the surface of polyethylene which is relatively non-infra-red ray absorbing, directing radiations having high intensity of infra-red onto the ink imaged polyethylene in amounts sufficient rapidly to build up a heat pattern in the inked areas which softens the underlying portion of the poly-

ethylene to achieve anchorage of the ink image thereto while the non-imaged portions of the polyethylene remain substantially unaffected, and cooling the opposite side of the polyethylene to limit the amount of heat penetration into the polyethylene material.

4. A printed polyethylene in which the polyethylene is printed by the method of claim 1.

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