Dec. 4, 1962 R. K. REMER 3,067,056

IMPROVEMENTS IN PRINTING WITH INK COMPOSITIONS HAVING VOLATILE SOLVENTS

Filed Oct. 15, 1959 2 Sheets-Sheet 1

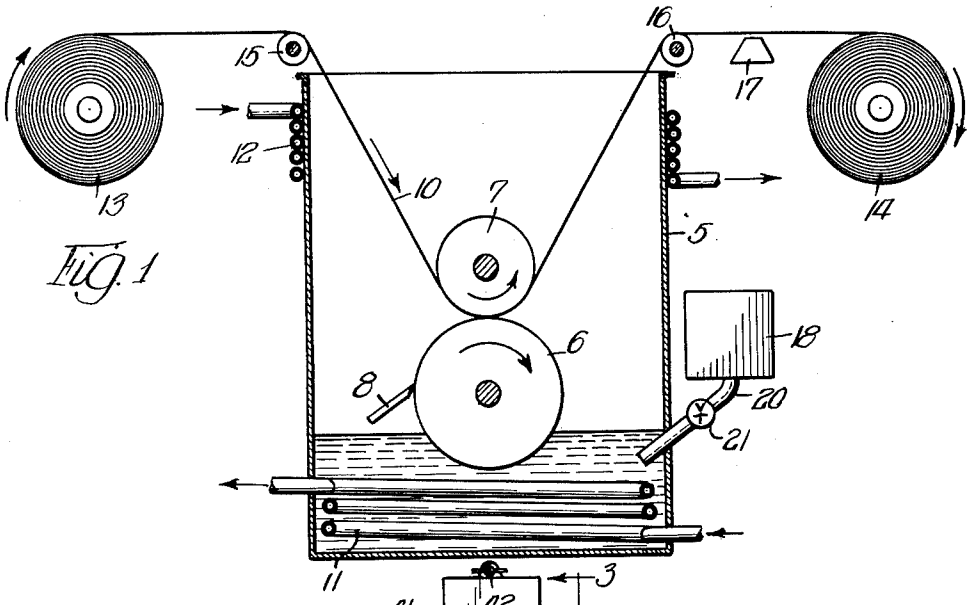


Fig. 1

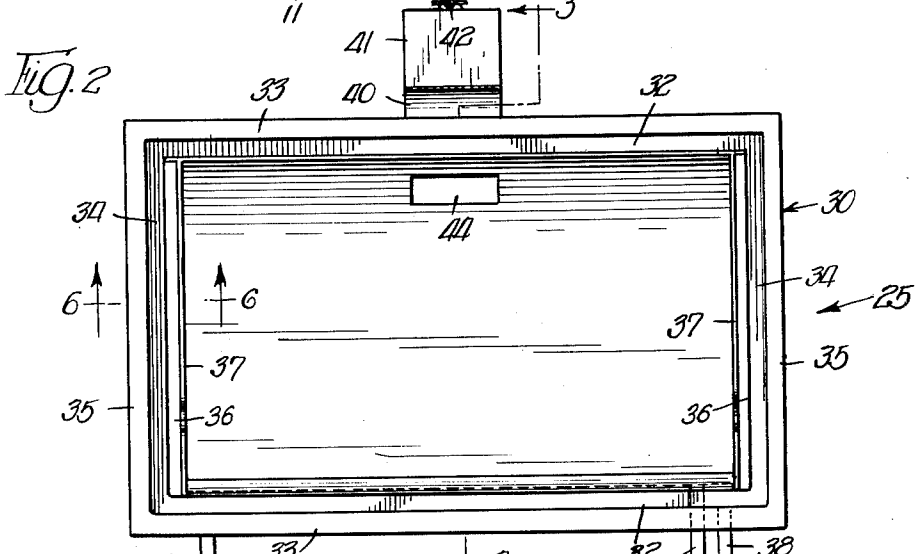


Fig. 2

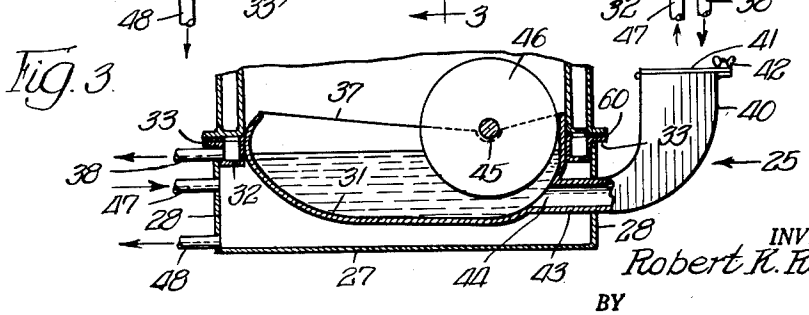


Fig. 3

INVENTOR.
Robert K. Remer,
BY
Cromwell, Greist & Warden
Attys

Dec. 4, 1962 R. K. REMER 3,067,056

IMPROVEMENTS IN PRINTING WITH INK COMPOSITIONS HAVING VOLATILE SOLVENTS

Filed Oct. 15, 1959 2 Sheets-Sheet 2

Fig. 5.

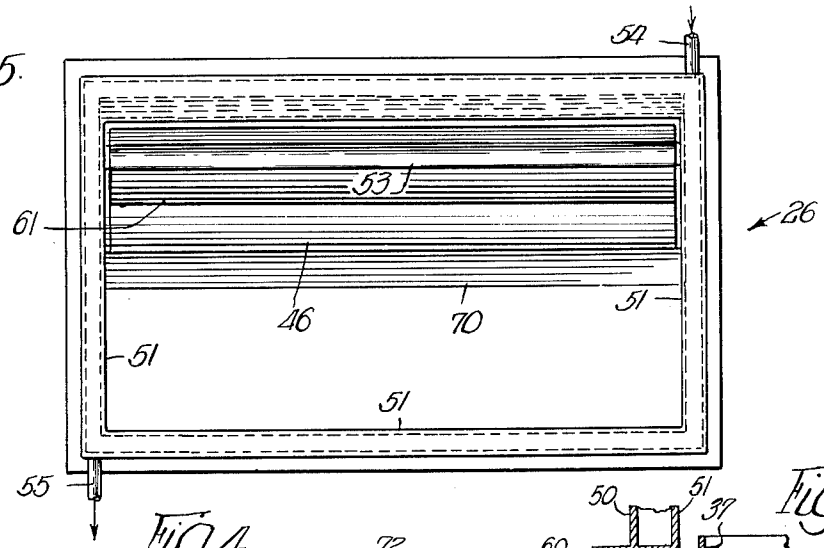


Fig. 4

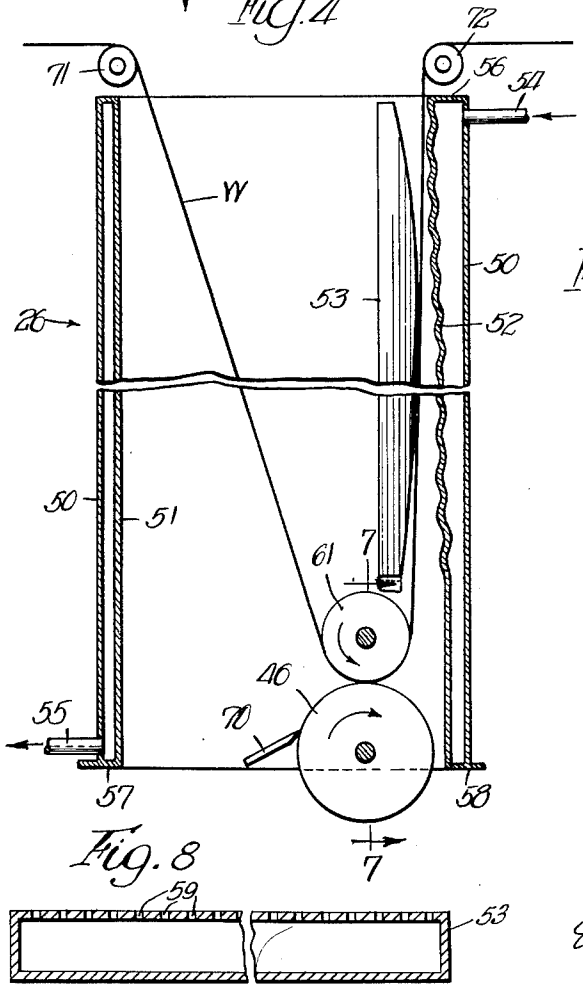


Fig. 6.

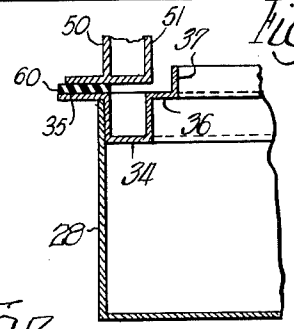


Fig. 7.

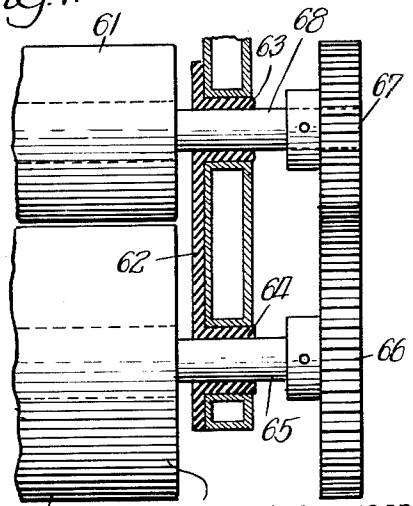


Fig. 8

ROTOGRAVURE CYLINDER

INVENTOR.

Robert K. Remer,

BY

Cromwell, Greist & Warden

Attys

United States Patent Office 3,067,056 Patented Dec. 4, 1962

3,067,056

IMPROVEMENTS IN PRINTING WITH INK COMPOSITION HAVING VOLATILE SOLVENTS

Robert K. Remer, 1014 Noyes St., Evanston, Ill.

Filed Oct. 15, 1959, Ser. No. 846,750
18 Claims. (Cl. 117—36)

My invention relates, generally, to improvements and innovations in methods and apparatus for printing web or sheet materials such as plastic films, paper, foils, non-woven fabrics, netting and textile fabrics.

According to my invention an ink is dispersed or dissolved in a chlorinated solvent which is retained in the lower portion of a tank or in a fountain. Means may be provided in the bottom of the tank or fountain for heating and controlling the temperature of the ink. The etched or mechanically knurled printing cylinder of a rotogravure printing unit is mounted in the tank or fountain so as to run in the ink bath at the proper depth. The web or sheet material being treated is passed through the intaglio or rotogravure printing unit located in the lower part of the fountain and thereby receives a metered surface deposit of the ink or coating in the form of tiny dots characteristic of intaglio or rotogravure printing. The ink may be applied as an over-all coating or in the form of a design and/or words and numerals. The volatile chlorinated solvent is immediately vaporized after deposit, leaving behind a metered deposit of the ink composition on the surface of the web. The upper portion of the tank or fountain extends above the printing unit so as to retain the vapors therein and is provided with condensing means for condensing the solvent vapors so as to recover the same and prevent them from leaving the fountain. The web or sheet leaves the top of the tank in a substantially dry, solvent-free condition.

It has been found that this particular printing or coating process is practical when the ink is applied from a rotogravure or intaglio type cylinder. Because of the type of deposit laid down on the web from such a cylinder in the form of multitudinous fine dots, it is possible to flash off and recover practically all of the chlorinated solvent used as the vehicle. When the web being printed is a fibrous or absorptive material such as paper, the chlorinated solvent still vaporizes from the tiny dots before it becomes absorbed or picked up by the web. The deposit which is applied by an etched or rotogravure cylinder is very uniform and by selecting the depth and screen size of the etching or knurling, the amount of the deposit or coating can be very closely controlled and accurately metered. The web being printed or coated travels at a fast speed which makes the process practical and economical without requiring large and expensive drying equipment and tunnels such as commonly are used in connection with rotogravure printing employing expensive volatile solvents.

An object of my invention is a method of and apparatus for continuously printing or coating a travelling web or sheet by depositing thereon a suitable ink or coating composition dispersed or dissolved in a chlorinated solvent vehicle contained in a tank or fountain, the deposit being applied by a rotogravure cylinder in such manner that the solvent quickly evaporates therefrom and is condensed in the upper portion of the tank while the web leaves the tank in a substantially solvent-free condition.

Another object of my invention is a method of and apparatus for continuously printing or coating a travelling web or sheet by passing same over a rotogravure printing cylinder running in a bath of ink or coating composition dispersed or dissolved in a chlorinated solvent vehicle and then passing the web or sheet upwardly through an upper portion of the tank or fountain wherein the solvent vapors evolved from the bath and from the deposit applied to the web or sheet are condensed and recovered while the web or sheet leaves the tank or fountain in a substantially solvent-free condition.

Another object of the invention is a method of and apparatus for printing or coating polyethylene, polyvinyl and polyester films by passing such films over a rotogravure or intaglio printing cylinder running in a bath of ink or coating composition dissolved or dispersed in chlorinated solvent vehicle in the bottom portion of a fountain, and condensing in the upper portion of the tank or fountain the solvent vapors which are evolved from the bath and from the printed or coated film whereby the film leaves the fountain in a substantially solvent-free condition.

Another object of the invention is a method of and apparatus for making carbon paper without strike through by printing and depositing a coating which will not rub off, by passing a continuously running web or sheet of paper over a rotogravure printing cylinder or coating roll running in a bath of carbon ink dispersed in a chlorinated solvent in the bottom of a fountain and passing the web or sheet of paper out through the top of the fountain which is provided with a condenser for condensing solvent vapors evolved from the bath and from the printed or coated paper which leaves the fountain in a substantially solvent-free condition.

Another object of the invention is an apparatus for printing a continuously travelling web or sheet comprising a relatively deep fountain having a rotogravure printing unit disposed in the bottom portion thereof so that the printing cylinder runs in a bath of an ink or coating composition dissolved or dispersed in a volatile solvent, with heater means in the upper portion of the fountain above the level of the bath for driving solvent off from the printed or coated web, and associated condenser means for condensing solvent vapors so that they do not escape from the fountain and may be returned to the bath or separately recovered.

Another object of the invention is a rapid method of printing on polyethylene film in one or more colors with an ink that adheres firmly to the polyethylene without any prior or separate heat-conditioning or chemical treatment of the film to make it take the ink, which method in nowise impairs the normal heat-sealing properties of the polyethylene.

Another object of the invention is polyethylene film which has been printed or decorated in one or more colors without being subjected to any heat conditioning or chemical conditioning treatment and on the surface of which the inks adhere firmly both to the surface of the film itself and one ink on top of another ink when the film is printed color-on-color.

Another object of the invention is an inexpensive method of and apparatus for rapidly producing one-time carbon paper, without wicking which is the cause of strike through, by continuously passing a web of paper over a rotogravure printing cylinder disposed in the bottom portion of a fountain containing a bath of one-time carbon ink dissolved or dispersed in chlorinated solvent, rapidly releasing solvent vapors from the deposit applied to the paper and condensing the evolved solvent in the upper portion of the fountain above the level of the bath so as to recover the same while the one-time carbon paper produced leaves the fountain in a substantially solvent-free condition.

Another object of the invention is a one-time carbon paper characterized by its excellent reproducing properties and a high resistance to rub-off or smudging.

Another object of the invention is a new and improved ink composition for printing on films having non-ab-

sorbent waxy-like surfaces such as polyethylene, polyvinyl and polyester films.

Another object of the invention is a new and improved carbon ink composition adapted to be dissolved or dispersed in a hot solvent for use in printing one-time carbon paper.

Certain other objects of the invention will in part be obvious and will in part appear hereinafter.

For a more complete understanding of the nature and scope of the invention, reference may now be had to the following detailed description thereof, wherein certain illustrative examples and embodiments are set forth.

In the accompanying drawings:

FIG. 1 is a diagrammatic view showing one type of apparatus and illustrating one method whereby my invention may be practiced;

FIG. 2 is a top plan view of a fountain which forms the bottom part of an apparatus constituting another embodiment of the invention and which has been successfully used to practice the same;

FIG. 3 is a sectional view taken on line 3—3 of FIG. 2 and showing in addition the bottom end of a condenser unit that fits on top of the fountain;

FIG. 4 is a vertical sectional view through the condenser unit which fits on top of the fountain of FIGS. 2 and 3;

FIG. 5 is a top plan view of the condensing unit shown in FIG. 4;

FIG. 6 is a detail sectional view on enlarged scale taken on line 6—6 of FIG. 2;

FIG. 7 is a fragmentary detail sectional veiw on enlarged scale on line 7—7 of FIG. 4; and

FIG. 8 is an enlarged detail section taken on line 8—8 of FIG. 4.

In FIG. 1 a fountain or tank is indicated at 5 which may be formed of suitable material such as stainless steel and in which is disposed adjacent the bottom thereof a rotogravure or intaglio printing unit comprising a printing cylinder 6, an impression cylinder or roll 7, and a doctor blade 8. Any suitable intaglio or rotogravure printing unit of known type may be used for the purpose of this invention. The printing cylinder 6 may have an over-all printing surface or it may carry a design wherein there are printing areas and non-printing areas. The cylinder 6 may be an etched cylinder or a mechanically knurled cylinder. If a knurled cylinder or an over-all etched cylinder is used and it is desired to have non-printing areas, such areas may be obtained by treating them with a film-forming material such as Teflon (tetrafluoroethylene polymer).

One or both of the cylinder 6 and 7 may be electrically heated in a well known manner by one of several commercially available electrical heater units in order to hasten the evaporation of the solvent and the setting of the coating or printed matter on the web or sheet. An electric heater element 9 of known type is shown wound on the support shaft for roll 9.

The lower portion of the printing cylinder 6 runs in a liquid bath contained in the bottom of the fountain or vessel 5 comprising an ink or coating composition dissolved or uniformly dispersed in a chlorinated solvent. A number of formulations for such a bath will be described in detail hereinafter in the examples. When a relatively heavy over-all deposit or coating is to be deposited on a web (e.g. as by a cylinder having a 35 to 65 line screen) the bath in the bottom of the fountain 5 should usually be maintained at or about its boiling temperature so that the solvent vapors will be rapidly evolved from the surface thereof and from the deposit of the bath which is applied to the travelling film or web 10 as it passes through the printing or coating unit. On the other hand, when only light over-all printing or small design areas are printed on the web 10 (e.g. as a cylinder having 165 to 200 line screen), then it usually will not be necessary to heat the ink bath above room temperature.

When heating is desired, the temperature of the bath may be controlled in any one of a number of ways such as by passing a heating fluid (gas or liquid) through a coil 11 located in the bottom of the fountain. Any fluid heating medium of suitable heat transfer and other physical characteristics may be used, such as steam, oil or Dowtherm (eutectic mixture of phenyl ether and 26.5% of diphenyl oxide having a boiling point of 258° C.). A condenser coil 12 is fitted around the upper portion of the fountain 5 so as to cool or chill the upper portion of the fountain above the printing unit so as to condense the solvent vapors evolved from the bath and from the deposit of the bath applied to the web 10 and cause the condensate to run down the side walls of the fountain on the inside. It will be understood that any suitable and known type of condenser may be used, either external or internal, and any suitable heat transfer fluid can be passed through the condenser 12 at the proper temperature and rate of flow. However, for purposes of economy cool or cold water will ordinarily be used as the condensing medium.

A supply roll of the web or sheet material to be printed is indicated at 13 and the wind-up roll of the printed or coated sheet or web material is indicated at 14. As is well understood in the art, the wind-up roll 14 will ordinarily be driven, as well as the rolls of the printing or coating unit in the fountain 5. The web or sheet 10 is guided into the fountain 5 by passage over a freely rotating guide roll 15 and passes out from the fountain over a freely rotating guide roll 16.

An ink composition suitable for dissolving or dispersing in a chlorinated solvent to make a bath to be used in the fountain 5 for printing polyethylene film is set forth in the following example:

Example 1

	Parts by weight
Chlorinated rubber (67% chlorine)	7.00
Butadiene-acrylonitril copolymer (Paracril C)	7.00
Methyl abietate (Abalyn, Hercules)	4.65
Diallyl phthalate	4.65
2,2'-methylenebis (4 - methyl-6-tert-butylphenol), antioxidant 2246, American Cyanamid	0.07
Toluidene red (pigment)	11.60

The foregoing ink formulation may be prepared in a ball mill or in a colloid mill in accordance with known ink-making techniques. Approximately 35 parts of the ink formulation are dissolved in 65 parts of chlorinated solvent, preferably trichloroethylene. Other chlorinated solvents which may be used include perchloroethylene, pentachloroethylene, ethylene dichloride, trichloromethane, dichloromethane and methylene chloride. Commercial grade chlorinated solvents may be used alone or in suitable mixtures.

When a relatively heavy over-all coating or deposit is to be applied to the web 10 by the printing cylinder 6, steam or other heating medium is passed through the heater unit 11 so as to raise the temperature of the bath to about the boiling point (e.g. 160° F. in the case of trichloroethylene) so that the lower portion of the fountain 5 surrounding the printing unit is filled with hot solvent vapors. If only printing or small-area designs are being printed, it is not necessary to heat the bath. As the printing cylinder 6 revolves in the solvent bath a film of the liquid adheres to the surface thereof which the doctor 8 removes from any non-printing areas and the excess from the printing areas in the usual manner, and thereafter the composition is transferred from the small depressions constituting the printing areas onto the undersurface of the film 10 as it passes through the bite or kiss contact between the printing cylinder 6 and the impression roll 7. The chlorinated solvent almost immediately escapes or is driven off from the film, leaving the ink set and adhered to the film. Sufficient condensing water is passed through the condenser 12 so as to chill or cool the upper portion of

the fountain 5 to the point where the solvent vapors are condensed on the inside and do not escape from the fountain. When the printed film 10 leaves the fountain 5 it is in a substantially solvent-free and dry condition and may be rewound immediately. If the ink composition is highly plasticized the final setting of the ink or coating may be hastened by means of a suitable drier indicated at 17 which may take the form of infra-red lamps, heated air blowers, or heated idler rolls.

When the apparatus is operated properly with the ink bath being heated when required, practically no solvent leaves the fountain 5, and therefore while the bath becomes gradually depleted of the ink or coating composition dissolved in the solvent as it is deposited on and carried away on the travelling web or sheet 10 very little solvent is lost. A supply or extender tank 18 is mounted on the side of the fountain 5 for containing a supplementary supply of the ink or coating composition, which preferably is dissolved in some of the chlorinated solvent so as to make up a concentrated solution. The supply tank 18 is provided with an outlet conduit 20, the bottom end of which passes through the side wall of the fountain 5 adjacent the bottom thereof, as shown. The flow of the concentrate is regulated by means of a valve indicated at 21.

If it is desired to print the film 10 in more than one color, the film 10 may be passed through additional printing units of the same type as shown in FIG. 1 so that the film is printed either in registration or in a color-on-color relationship, as is well understood in the art.

The ink formulation of Example 1 may be varied in several respects.

While the chlorinated rubber and butadiene-acrylonitril copolymer is a preferred resin combination, either of these may be used alone and other synthetic rubber polymers and copolymers and resins soluble in chlorinated solvents may be employed, e.g. styrene-isobutylene copolymer. Likewise, methyl abietate and diallyl phthalate is a preferred plasticizer combination, but other compatible plasticizers may be used. Other antioxidants may also be used as well as other pigments. Also dyes which are soluble in chlorinated solvents may be used in place of pigments, if desired.

Other films besides polyethylene that may be printed by the process described in connection with FIG. 1 include cellulose acetate, regenerated cellulose, chlorinated rubber (Pliofilm), vinylidene chloride copolymer (Saran), polyvinyl acetate and polyester films.

Another ink formulation which is particularly adapted for printing on polyethylene is the following:

Example 2

	Parts by weight
Nylon scrap (thread)	70
Cresylic acid	30
Hansa Yellow (yellow pigment)	10

The nylon is dissolved in the cresylic acid and then the pigment is milled in. Approximately 110 parts of the mixture are added to 90 parts of chlorinated solvent (trichloroethylene) so as to make up a bath suitable for use in the bottom of the fountain 5.

Still another ink-chlorinated solvent formulation for printing on polyethylene film according to the present invention is the following:

Example 3

	Parts by weight
Chlorosulfonated polymer of ethylene (Hypalon S-2)	80
Phenolic-maleic acid ester resin (Super-Beckacite 1001, Reichhold)	20
Chlorinated diphenyl (Arochlor)	20

The following is a suitable formulation for an adhesive composition for manufacturing pressure sensitive adhesive tape:

Example 4

	Parts by weight
Methyl abietate	15
Alpha-methylstyrene polymer (Dow Resin 276–V2)	15
Hydrogenated rosin (Staybelite Ester 10, Hercules)	15
Chlorinated rubber (67% chlorine)	15
2,2'-methylenebis (4-methyl-6-tertiary butylphenol), heat and light stabilizer	2

Sixty-two parts of this formulation are dissolved in 38 parts of trichloroethylene to prepare a bath suitable for use in the apparatus shown in FIG. 1 for applying a pressure sensitive adhesive coating to one side of a travelling web of plastic film such as cellophane, cellulose acetate, polyethylene or Saran. The same formulation may also be applied to advantage to a web of plastic, non-woven fabric, glass fabrics, textile fabrics or paper.

A suitable carbon ink formulation for making one-time carbon paper in the apparatus shown in FIG. 1 is shown in the following example:

Example 5

	Parts by weight
Armid O-	30
Stearamide 6%	
Oleamide 91%	
Linoleamide 3%	
Sugar cane wax	30
Chlorinated paraffin	5
Carbon black	1
Alizarin blue	1
2,2'-methylenebis (4-methyl-6-tertiary butylphenol)	1

This formulation can be ball milled or milled in a colloid mill and 68 parts of the ink can be dissolved in 32 parts of trichloroethylene to make up a bath for use in the apparatus of FIG. 1.

The following formulation is specially adapted for application to a web or sheet for depositing thereon an electrically conductive coating:

Example 6

	Parts by weight
Acetylene carbon black	25
Chlorinated paraffin	20
Methyl abietate	20
Lithium nitrate (or lithium chloride)	10

Seventy-five parts of this ink composition may be dissolved in 25 parts of chlorinated solvent to prepare a fountain bath which may be applied in the apparatus shown in FIG. 1 in accordance with the method of operation described above to provide printed circuits, printed dry cells and various electrical circuitry.

The following is an example of a magnetic coating composition which may be applied to paper or other sheet material according to the process of this invention:

Example 7

	Parts by weight
Carbonyl iron powder (or any iron oxide powder)	25
Chlorinated paraffin	25
Methyl abietate	25

Seventy-five parts of this formulation may be dissolved in 25 parts of chlorinated solvent and used as the fountain bath in the apparatus of FIG. 1. After application to a sheet or web the resulting coating may be magnetized.

The apparatus and method of the present invention may also be used advantageously for the continuous printing of metal foils such as aluminum foil. Such a foil may be passed through the apparatus shown in FIG. 1 and printed on the underside with an ink having the following formulation:

Example 8

	Parts by weight
Ethyl cellulose (low viscosity)	20
Alpha-methylstyrene polymer (Dow Resin 276–V2)	10

	Parts by weight
Methyl abietate	10
Azo Oil Blue B	5

Forty-five parts of this formulation are dissolved in 55 parts of trichloroethylene or other chlorinated solvent and used as the fountain solution in the apparatus of FIG. 1.

The following ink composition in chlorinated solvent is particularly adapted for printing on films of cellulose acetate and Mylar polyester films using the apparatus of FIG. 1:

Example 9

	Parts by weight
Ethylene dichloride	45
Methylmethacrylate (Plexiglas)	45
Glacial acetic acid	10
TiO_2 pigment	10

The apparatus shown in FIGS. 2–7 has been used to advantage in practicing the invention and it represents a preferred working embodiment of the invention. The apparatus comprises a fountain indicated generally at **25**, on top of which is mounted a condenser indicated generally at **26**. If desired, additional condenser units up to any desired weight, may be added to provide additional condensing capacity and a longer time for the printed web to be heated if desired before it leaves the apparatus.

The fountain **25** and condenser **26** may be fabricated from sheet metal of a type which will withstand chlorinated solvent and solvent vapors. The fountain **25** has a bottom **27** and side walls **28**. A rectangular frame **30** sets into the upper ends of the vertical side walls **28** and supports the bed or bottom of the fountain indicated at **31**. The frame **30** on two sides has a U-shaped cross section so as to form channels **32** as indicated in FIG. 3 having laterally projecting flanges **33** integrally formed thereon. The opposite sides of the frame **30** also have U-shaped troughs **34** (FIG. 6), laterally projecting flanges **35** and a horizontal inner flange **36** which supports a vertical flange **37**.

The U-shaped troughs or channels **32** and **34** communicate with each other around the periphery of the frame **30** for the purpose of providing a drain into which condensed solvent is collected and from which it may be drawn off through an outlet connection **38** (FIGS. 2 and 3). Referring to FIG. 6, it will be seen that the condensate first drips onto the inner horizontal flanges **36** and then runs off these flanges into the communicating troughs **34** and **32**. The gasket **60** serves to space the bottom of the condenser **26** off the flanges **36** so as to allow this draining action.

The bottom of the bed **31** is generally horizontal while the opposite ends are upwardly curved as shown in FIG. 3. Ink or coating compositions may be introduced into the fountain through an outside riser **40** having a cover **41** hinged to the top thereof and adapted to be closed by means of a wing nut **42**. The bottom end of the riser **40** communicates with a horizontal connection **43** which opens into the bed of the fountain through an opening **44**.

The top edges of the vertical flanges **37** slope downwardly from opposite ends toward the middle into semicircular recesses **45** as shown in FIG. 3. The recesses **45** serve to provide clearance for the shafts or journals on the opposite ends of a rotogravure or etched cylinder **46**.

It will be seen that the fountain **25** has a hollow construction under the floor **31** and this is for the purpose of holding a hot liquid such as oil, water or Dowtherm when it is necessary or desirable to heat the contents within the fountain as when printing an overall coating on the web W. The heating liquid may be introduced into the fountain through the connection **47** and withdrawn through the discharge connection **48**. It will be understood that instead of using a liquid, or a gas such as steam, for heating the fountain that other heating means can be used such as an electrical resistance heater or a radiant heater. If flexibility of the unit is not important the false bottom **31** may be omitted along with the connections **47** and **48**. Even though the unit has no provision for heating the ink bath, it may still be heated exteriorly and circulated by suitable pump means.

The condenser unit **26** is generally rectangular in shape and has a hollow-walled construction. The exterior walls of the condenser unit are indicated at **50**. Three of the inner walls are the same and are indicated at **51**. The fourth inner wall is different in that it is corrugated as indicated at **52** so as to provide additional condensing or cooling surface since it is adjacent this wall that the printed web or film passes upwardly on its way out of the condenser unit. The speed at which the various webs may be printed or coated may be increased by using a heater of known type which is indicated diagrammatically at **53**. This heater is juxtaposed to the corrugated wall **52** and is somewhat curved or rounded on that side and has a smooth surface over which the non-printed or non-coated side of the web W may ride and receive heat. Thus, the function of the heater **53** is to present a hot surface for heating the printed web W. Advantageously, the front surface of the heater **53** over which the web passes may be perforated with numerous pores or openings **59** as shown in FIG. 8 through which air may be blown. Air may be introduced into the heater **53** through the pipe **69** under sufficient pressure to discharge it through the openings **59**. The air may be heated when introduced and will be heated as it passes through the heater **53**. The air assists in removing residual solvent from the printed web and in setting the deposited ink. Depending on the volume and pressure, the air or other gas discharging through the openings **59** serves as an air cushion between the travelling web and heater surface.

Coolant such as cold water or brine is circulated through the condenser unit **26**, being introduced at the top adjacent one corner through the inlet **54** and being withdrawn from the bottom adjacent the opposite corner through the outlet **55**. The top and bottom ends of the hollow walls are closed off as indicated at **56** and **57** in FIG. 4. The bottom of the condenser unit is provided with a peripheral flange **58** which is dimensioned to meet or fit opposite the laterally extending flanges **33** and **35** on the frame **30** of the fountain as shown in FIG. 3 with a gasket **60** fitting therebetween.

The rotogravure roll or cylinder **46** and its impression roll **61** are located in the lower portion of the condenser **26** with the bottom of the cylinder **46** running in the fountain bath. The journals or supporting shafts on the opposite ends of the cylinders **46** and **61** project through the side walls of the condenser unit **26** through aligned sets of openings provided therein as shown in FIG. 7. On the interior of the opposite side walls of the condenser unit an integral bearing plate formed of a material such as Teflon is located as designated at **62**. Each of the Teflon plates **62** has an integral upper sleeve bearing **63** and an integral lower sleeve bearing **64**. These bearings project through the circular openings provided therefor in the opposite side walls of the condenser unit. The journals **65** on opposite ends of the rotogravure cylinder **46** carry on their outer ends a pinion gear **66** which meshes with a pinion gear **67** mounted on the outer end of the journal **68** supporting the impression roll **61**. The rotogravure cylinder **46** and impression roll **61** are driven in a known manner. A doctor blade **70** is provided for removing excess ink or coating composition from the rotogravure cylinder **46**.

The web W of material to be printed is introduced into the apparatus over a guide roll **71** and is guided out of the unit over a guide roll **72**. The web W passes between the rotogravure cylinder **46** and the impression

roll 61 so as to receive on its underside the ink or coating composition deposited thereon from the rotogravure cylinder 46.

Preferably the printing cylinder 46 is arranged to be heated such as by the insertion therein of an electrical resistance heating element 79 of known type such as a calrod heater element of suitable shape. The heater element may be used to heat the printing cylinder 46 to a temperature of 180° F., for example. The purpose in having the cylinder heated is to expel or volatilize the solvent faster from the dots which are deposited upon the web W and to cause the dots to flow and merge one with another into a continuous film. Also, heating renders the ink in the wells highly fluid and facilitates their emptying. The heater 53 in the upper portion of the condenser unit 26 may also be heated to a similar temperature, i.e. around 180° F., for example. By heating the printing cylinder 46 and using the heater 53 it is possible to operate the printing or coating machine at higher speeds, especially when air is blown through the perforated surface of the heater 53.

It is sometimes desirable that the web W be heated when printed and this may be conveniently accomplished by use of a radiant heater 80 disposed just ahead of the guide roller 71. One or more such heaters may be provided on the same, or on opposite sides of the web.

The width of the webs which are printed or coated may be varied depending upon the dimensions of the machines which are used. These machines may be used to print or coat several spaced webs of kraft paper having widths of about 1 inch, and after such webs have passed through the printing unit they may be twisted into paper cord or twine of the type that is used in manufacturing rugs, binder twine, show stitching cords and the like. Sets of twisting rolls for twisting paper into such cords are known and in use. Such sets of rolls of known type may be located within the fountains or tanks of the apparatus shown in FIG. 1 or in FIGS. 2–7.

Chlorinated solvents are used in this process for a number of reasons. They vaporize readily at low temperatures since they are low boilers, e.g. between about 104° to 160° F. Since the vapors are much heavier than air they settle rapidly into the bottom of the condenser units. These vapors condense easily and if desired for use in other formulations may be readily reclaimed by distilling and condensing. Chlorinated solvents are in the nature of "dry" solvents which do not wet or hydrate the webs even if the web happens to be a highly porous and absorptive material such as newsprint. When these chlorinated solvents are heated they have very high dissolving or suspending capacities for materials used in the ink or coating compositions including resins, fillers and pigments. Such materials dissolve or disperse readily in chlorinated solvents to a much higher or greater extent than they can be dissolved or dispersed in ordinary solvents. This high solubility and dispersibility is due to the combined solvent power and the heat. In practice, resins, fillers and pigments and other materials which are used in the inks or coating composition to be applied in accordance with the present invention are milled in the heated phase into or in the presence of hot chlorinated solvent and then the compositions may be allowed to solidify. When they are to be used, the solidified compositions may be heated and then thinned or extended as desired with additional hot chlorinated solvent. By following this procedure, it is possible to easily provide inks or coating compositions which contain up to as much as 50 to 60% solids. In the usual cold ink or coating compositions the solvent phase usually does not exceed 20% by weight.

Chlorinated solvents are non-polar and by the incorporation therein of various known anti-static chemicals or agents they will serve to change or convert the polarity of a web such as newsprint from a negative charge to a positive charge while being printed or coated in accordance with this invention. This conversion or change in electrical charge is facilitated by having the impression roll formed of Thiokol, Teflon, or silicone rubber materials which are loaded with graphite or molybdenum disulphide. By employing anti-static chemicals or agents in the chlorinated solvents and by also forming the impression roll of one of the anti-friction materials mentioned above, it is possible to eliminate or substantially prevent the wicking action normally associated with a pressure printing operation such as is involved in a rotogravure or rotogravure printing unit.

In view of the teaching contained in the foregoing examples, those skilled in the art will be able to make and use either the compositions specifically disclosed herein or probably such modified formulations as may be required for their needs without departing from the spirit and scope of the present invention.

This application is a continuation-in-part of my copending application Serial No. 624,385, filed November 26, 1956, and now abandoned, which in turn was a continuation-in-part of my prior application Serial No. 367,206, filed July 10, 1953, and now abandoned.

What is claimed as new is:

1. The method of rotogravure printing a web which comprises, conducting the web in a continuous manner in printing contact with a non-immersed portion of a rotogravure cylinder only the bottom portion of which rotates in a bath of ink dispersed in chlorinated solvent maintained at a temperature at which said solvent is rapidly volatilizing, said rotogravure cylinder being disposed in the bottom of an enclosed fountain provided with superposed condensing means and having an impression cylinder associated therewith for holding said web in said printing contact, passing the printed web upwardly through said condensing means so as to leave said fountain in a substantially solvent-free condition, and condensing said solvent at a rate sufficient to prevent escape of solvent vapor out of the top of said enclosed fountain.

2. The method of claim 1 wherein the condensed solvent is collected and removed so as not to return directly into said bath.

3. The method of claim 1 wherein the condensed solvent is returned to said bath and additional ink or coating material is added to said bath so as to make up for the amounts carried away on said web.

4. The method of claim 1 wherein said web is paper.

5. The method of claim 1 wherein said web is a film selected from the group consisting of polyethylene, polyvinyl and polyester films.

6. The method of claim 1 wherein said solvent is trichloroethylene.

7. The method of rotogravure printing a web which comprises, conducting the web in a continuous manner in printing contact with a non-immersed portion of a rotogravure cylinder only the bottom portion of which rotates in a bath of ink dispersed in chlorinated solvent maintained at a temperature at which said solvent is rapidly volatilizing, said rotogravure cylinder being disposed in the bottom of an enclosed fountain provided with superposed condensing means and having an impression cylinder associated therewith for holding said web in said printing contact, passing the non-printed side of said web over a heated surface while the printed side passes in close proximity to a condensing surface without contacting the same, and condensing said solvent at a rate sufficient to prevent escape of solvent vapor out of the top of said fountain.

8. The method of rotogravure printing polyethylene film which comprises passing polyethylene through a printing unit having the bottom portion only of the rotogravure cylinder running in an ink bath containing chlorinated solvent and heated at least approximately to boiling.

9. The method of making carbon paper comprising passing a web of paper through a printing or coating

unit running in a fountain bath containing carbon ink dispersed in a chlorinated solvent and heated at least to approximately boiling.

10. The method of printing polyethylene film comprising passing polyethylene film through a rotogravure printing unit disposed in the bottom of a fountain and running in a bath in the bottom of said fountain wherein the vehicle is chlorinated solvent and the bath is heated at least approximately to boiling, and condensing in an upper portion of said fountain solvent vapors evolved from said bath and the printed film.

11. The method of claim 10 wherein said ink bath comprises rubber base resin, coloring material and chlorinated solvent.

12. The method of claim 10 wherein said bath comprises chlorinated rubber, butadiene-acrylonitrile copolymer, methyl abietate, diallyl phthalate, and coloring material dispersed in chlorinated solvent.

13. Rotogravure printing apparatus comprising a deep fountain, a printing unit comprising a rotogravure cylinder and an impression roll disposed in the bottom of said fountain, and condenser means in the top of said fountain for condensing solvent vapors therein.

14. The apparatus of claim 13 wherein the rotogravure cylinder is heated.

15. Rotogravure printing apparatus comprising a deep enclosed fountain, a rotogravure printing unit disposed in the bottom of said fountain, heater means for heating a bath of ink or coating composition in the bottom of said fountain, condenser means in the upper portion of said fountain having at least one extended surface, stationary heater means having a heatable smooth extended surface juxtaposed to said extended condensing surface, and guide means for conducting a web after passing through said printing unit up and out of said fountain with its non-printed side passing over said heated surface.

16. In a rotogravure printing unit having a deep fountain and a rotogravure printing unit disposed in the bottom thereof, condenser means in the upper portion of said fountain providing an extended condensing surface, heater means providing an extended heater surface juxtaposed to said condensing surface, and guide means for conducting a web after passing through said printing unit up and out of said fountain with its non-printed side passing over said heater surface.

17. In a rotogravure printing unit having a deep fountain and a rotogravure printing unit disposed in the bottom thereof, condenser means in the upper portion of said fountain providing an extended condensing surface, heater means providing an extended heater surface juxtaposed to said condensing surface, guide means for conducting a web after passing through said printing unit up and out of said fountain with its non-printed side passing over said heater surface and second heater means disposed to pre-heat the web prior to printing.

18. In a rotogravure printing unit having a deep fountain and a rotogravure printing unit disposed in the bottom thereof, condenser means in the upper portion of said fountain providing an extended condensing surface, heater means providing an extended heater surface juxtaposed to said condensing surface, and guide means for conducting a web after passing through said printing unit up and out of said fountain with its non-printed side passing over said heater surface, said condenser surface being so oriented as not to overhang the path of said printed web.

References Cited in the file of this patent

UNITED STATES PATENTS

739,313	How	Sept. 22, 1903
1,236,002	Nivling	Aug. 7, 1917
1,544,675	Moller	July 7, 1925
1,740,979	Golrick	Dec. 24, 1929
1,961,827	Rutkoskie	June 5, 1934
2,223,924	Stephan	Dec. 3, 1940
2,290,200	Murch et al.	July 21, 1942
2,304,818	Grupe	Dec. 15, 1942
2,396,946	Grupe	Mar. 19, 1946
2,515,489	Borushko	July 18, 1950
2,519,321	Newman	Aug. 15, 1950
2,618,574	Pavlic	Nov. 18, 1952
2,659,340	Zinn	Nov. 17, 1953
2,675,779	Borushko	Apr. 20, 1954
2,685,572	Perkins	Aug. 3, 1954
2,837,493	Schlenker	June 3, 1958
2,936,286	Feick	May 10, 1960