Feb. 21, 1961 V. S. DE MARCHI ET AL 2,972,298

METHOD VISCOSITY CONTROL IN PRINTING

Filed June 4, 1954 2 Sheets-Sheet 1

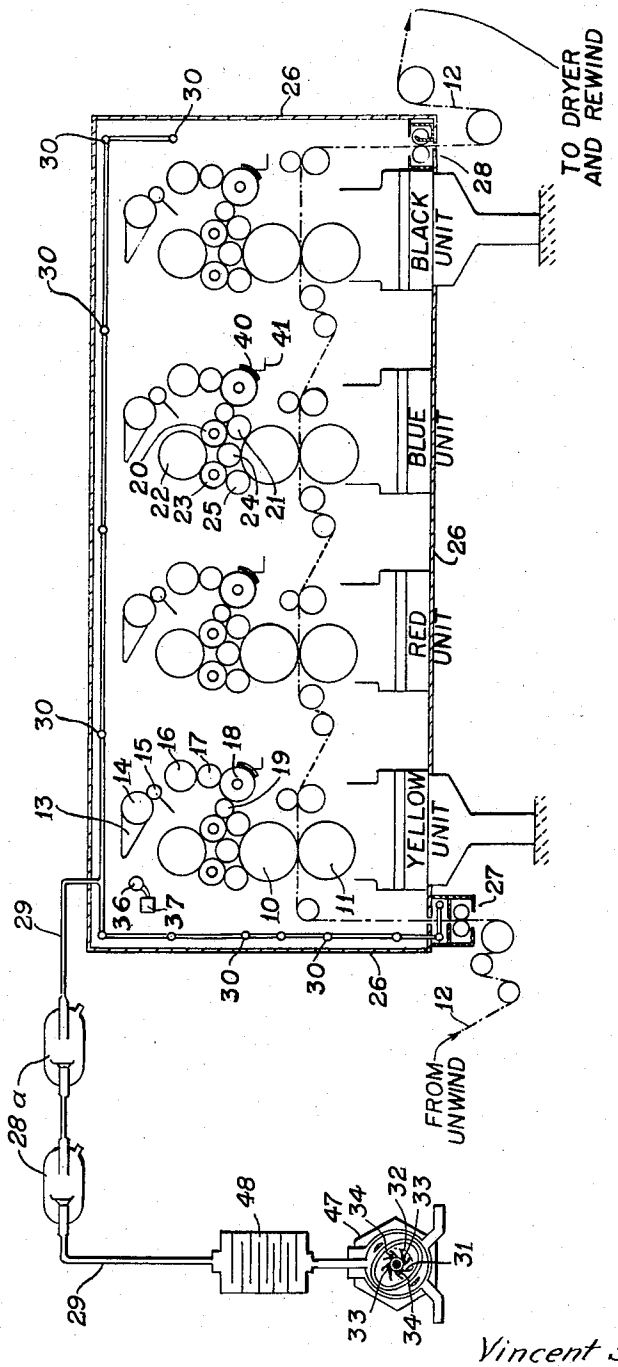


Fig. 1.

INVENTORS.
Vincent S. de Marchi
Albert E. Gessler
William Van Kirk
BY: Milton Zucker
ATTORNEY

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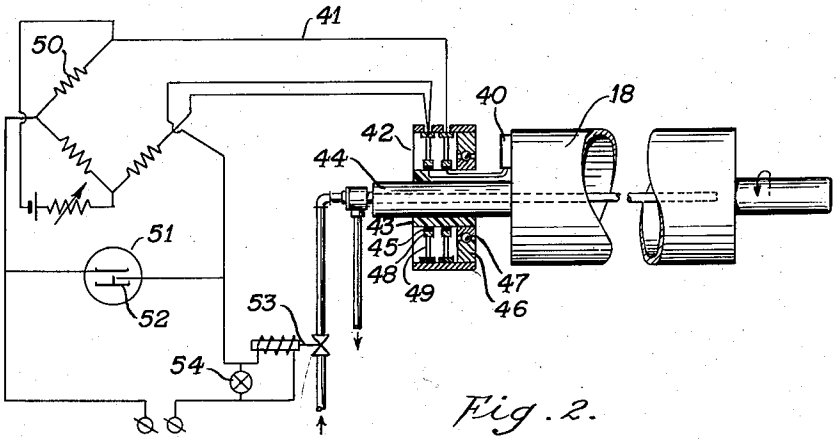


Fig. 2.

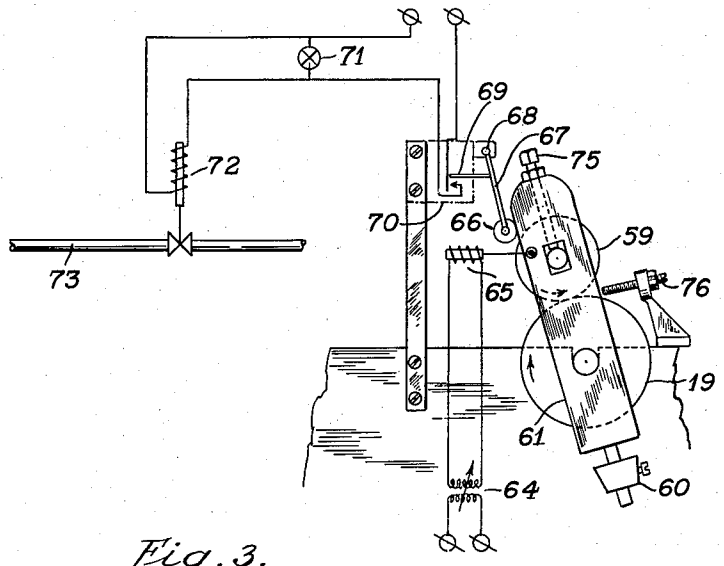


Fig. 3.

INVENTORS.
Albert E. Gessler
Vincent S. de Marchi
William Van Kirk
BY Milton Zucker ATTORNEY

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METHOD OF VISCOSITY CONTROL IN PRINTING

Vincent S. De Marchi, Jamaica, Albert E. Gessler, Scarsdale, and William Van Kirk, New Hyde Park, N.Y., assignors to Interchemical Corporation, New York, N.Y., a corporation of Ohio

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3 Claims. (Cl. 101—211)

This invention relates to typographic and lithographic printing, in particular high speed printing of magazines and the like, and aims to provide an improved method of printing at high speed with inks which set or dry rapidly. Specifically, this invention aims to provide a means for controlling ink body on the press by control of distributing roller temperatures.

Until the early 1930's, typographic or lithographic inks used for printing webs of paper were of two types. For printing of newsprint and similar absorbent stocks, mineral oil inks were used; they dried by absorption of vehicle into the paper. For super-calendered and coatad papers which were less absorbent, inks made with oxidizing oil vehicles were used. Because of the slow drying of these inks, printing speeds were low and a traveling tympan was run with the paper to prevent offset and smearing.

The advent of heat drying printing inks (see Gessler U.S. Patent No. 2,087,190) changed this picture radically, most particularly with respect to web typographic printing on papers less absorbent than news-stock, such as the super calendered and coated papers used for magazine printing. This has been done with heat drying inks, much of it at speeds well over 1,000 feet per minute, and much of it multicolor work. Such inks are characteristically based on solutions of hard thermoplastic resins in petroleum derived solvents which, at usual ambient temperatures, have vapor pressures below 0.025 mm. of mercury so that they evaporate very slowly on the press, but leave the printed films fairly rapidly when the printed paper is passed through one of the heaters with which these presses are equipped, and which bring the temperature of the web to about 300° F. to 450° F. These solvents are characteristically paraffinic in nature, with boiling ranges between 450° and 600° F., and with vapor pressures of the order of 0.05 mm. to 0.005 mm. at 95° F.—corresponding to the properties of normal paraffin hydrocarbons in the C_{14} to C_{18} range.

One difficulty with the conventional high speed printing methods is that the high temperatures necessary to dry the ink are so close to the char point of the paper as to cause a reduction of the tensile strength of the paper. Where poorer grades of paper are used, or where the paper varies in quality from place to place in the web, this reduction of strength is sometimes sufficient to cause the web to break, with consequent loss of production time, and additional substantial paper waste. Furthermore, the paper may become so brittle that trouble is encountered in folding, stapling and binding the signatures. Hence, reduction of heat has been a prime need of the industry.

Another disadvantage of heat drying inks has been that as press speeds have gone up, it has been necessary to approach their lower limit of stability on the press by using solvents near the low end of the range. As a result, on shut downs, when the ink is not being replaced continuously by fresh ink feeding down from the fountain, solvent evaporates, and the ink becomes tacky and unprintable. It has been necessary to spray the rollers with solvent after shut downs, so the press can be started without breaking the web due to excessive ink tack. This produces large quantities of paper waste, since the mixture of solvent and old ink must be removed by the paper until fresh ink works its way down from the fountain. In web offset printing, where plate scumming and stripping may occur when the ink is too thin, this necessity for spraying is a major hazard.

When heat drying inks were first introduced, press speeds of 500 feet per minute were conventional. As press builders stepped up press speeds, the necessary faster ink drying was accomplished partially by improving the ink drying ovens, and partially by changes in ink formulation. The attainment of present day speeds of 1200 to 1500 feet per minute has brought ink formulation to the practical lower limit of ink stability on the press so that mechanical progress in increasing press speeds has been held up by the problem of ink stability.

Many attempts have been made to overcome the above difficulties, including using lower boiling solvents that would evaporate faster so that the ink could be dried faster. Although such inks do dry faster, it has been impossible to use them heretofore because they evaporate too rapidly by the distribution system of the press, and cause prohibitive tacking up of the ink.

The expedient of enclosing the distribution system of the press has been suggested by a number of workers, both to reduce solvent loss by evaporation, and to prevent contamination of the atmosphere surrounding the printing press by the evaporating solvent. It has been tried with both resin-solvent based inks, and with water emulsion inks. While the enclosed system has been highly successful in gravure printing where the printing roller revolves directly in the ink fountain, it has not proved satisfactory for conventional typographic or lithographic printing.

In such printing, the ink is picked up from a fountain by a roller, and is transferred to other rollers, alternately metal and rubber, to produce eventually on the plate an even film, a few ten thousandths of an inch in thickness. Generally, between ten and twenty rollers are used. In each transfer of ink, the thin ink film is literally torn in two, part remaining on the original roller, part transferring to the next roller. The work done in splitting the film produces heat—temperatures up to 140° F. have been observed on uncooled presses, and temperatures of 90 to 100° F. can be observed on some presses even where the metal rollers are water cooled. During the splitting, the film is pulled into innumerable thin filaments of less than 1 mil diameter, and in this form is exposed, ten to twenty times, to the atmosphere around the distributing system, with a relative movement at speeds equivalent to 15 to 20 miles per hour. This extreme exposure of the film has limited conventional typographic ink vehicles to very slowly evaporating solvents, even in closed systems.

In our copending application Serial No. 421,242, filed April 6, 1954, we have disclosed a method of printing

on presses having extended distributing systems, with solvent based inks which dry so much more rapidly than present day heat drying inks that even single impressions cannot be taken from an ordinary proof press. This method permits the use of super fast inks whose vehicles comprise resin solutions in organic solvents with low boiling ranges much below previous heat drying inks and, at ordinary ambient temperatures, whose vapor pressures and rates of evaporation may be 10 to 40 times that of solvents in previous heat drying inks. These super fast inks preferably employ petroleum derived solvents with boiling ranges between 350° and 425° F. (corresponding to commercial paraffinic fractions whose principal constituents can be ideally represented as n-hendecane and n-dodecane). These inks are not printable under ordinary conditions; according to that disclosure, they are printable on such presses when the atmosphere surrounding the distributing system of the press contains a concentration of ink-solvent-vapor which is maintained in such relationship to the temperature of the ink film on the distributing system that the average ink film temperature does not exceed the dew point temperature of the solvent vapor of that atmosphere by more than a few degrees Fahrenheit, and preferably approximates that dew point temperature. We found we could maintain the relationship by feeding into the vicinity of the press distributing system air or other gas free of suspended droplets, and containing such a concentration of solvent vapor that there is a tendency toward condensation on the distributing system, rather than evaporation from the ink film. The distributing system is preferably enclosed, to preserve the atmosphere.

We have now discovered that we can control the viscosity of inks containing volatile solvents while printing on enclosed presses having extended distribution systems, by controlling the temperature of the distributing system of the press. If the viscosity is to be increased, roller temperatures are raised to a point where some solvent evaporates from the ink in its travel from the fountain to the plate cylinder; if the viscosity is to be decreased, the temperature is lowered to a point where no evaporation, or actual condensation occurs.

Our invention is particularly applicable in four color printing, where control of ink viscosity or tackiness is essential in order for the inks to "trap"—i.e.—for the first down wet ink film to accept the second ink etc. In such printing, it is essential that the inks be printed in decreasing order of tackiness, with the first down ink heaviest in body. Our method permits relative adjustment of these ink bodies on the press, so that proper tack sequence can be obtained.

To explain the invention more fully, reference should be had to the drawings, in which

Fig. 1 discloses schematically a four color press set up for the practice of our invention,

Fig. 2 shows a detail of one method for controlling roller temperatures, as shown in Fig. 1,

Fig. 3 shows a detail of a second method of controlling roller temperatures.

The press comprises 4 separate units of substantially identical design, identified in the drawing by the color which is ordinarily printed by the unit. Each unit consists of a printing cylinder **10** having a printing plate mounted on it, and an impression cylinder **11**. A web **12** of paper is fed through the press by appropriate rollers.

Each plate is inked by a distributing system which comprises a series of rollers operating between the fountain **13** and the plate. The metal fountain roller **14** takes ink from the fountain, and transfers it to a rubber ductor roller **15**, to a metal roller **16**, to a rubber roller **17**, thence to the oscillating metal ink storage roller **18** which can be water cooled. A rubber idler roller **19**, takes the ink to the final stages of the distributing system, contacting both the cooled metal roller **20** and the form roller **21** which inks the plate; roller **20** is in contact with distributing roller **22** and form roller **24**; the water cooled metal roller **23** inks both the form rollers **24** and **25**.

The entire press structure is surrounded by an enclosure **26**, preferably of some material such as glass, "Lucite," or other transparent material; this enclosure is complete except for a slit **27** through which the web enters the enclosure, and a slit **28** through which the web leaves the enclosure. The enclosure is provided with appropriate hatches and doors so that, for example, a pressman can get at any fountain from the top of the press, or so that the press can be entered from the side for the purpose of changing plates and so on.

Means are provided for running air or other gas containing solvent vapor into the press. This may comprise, for example, a saturator **47**, in which solvent vapor is mixed with air or other gas. The solvent laden air, containing droplets, is passed through a baffle chamber **48** to remove the bulk of the droplets and then through a pair of mist eliminators **28A** of the centrifugal baffle type. The solvent-vapor-containing air, free of droplets and mist, passes through a line **29** into the chamber through ports **30**, so disposed as to distribute the solvent-vapor-laden air so that dilution from fresh air, carried into the enclosure by web **12**, will be kept at a minimum. To do this, the bulk of the ports are preferably placed near the point where the web enters the enclosure, providing at such point the greatest possible amount of solvent-vapor-saturated atmosphere.

We have obtained solvent-vapor-containing air by bubbling air through a column of solvent, and by evaporating solvent into air; but a simpler way to get solvent into the air is by using as the saturator **47** a liquid sealed compressor consisting of a vaned rotor **31**, operating in a liquid seal **32** of solvent.

To pass from the inlet ports **33** to the outlet ports **34**, any gas fed into the compressor must pass through the liquid solvent, and thus it becomes substantially completely saturated with solvent vapor at the temperature and pressure in the pump chamber.

We provide means for determining the dew point of the solvent in the enclosure. For example, a water cooled etched or ground mirror **36**, with a temperature indicator **37**, can be observed. As soon as its reflectivity begins to increase on account of condensed vapor, the mirror loses its frosted appearance and the dew point temperature can then be read off on the temperature indicator. Most preferably, a photoelectric system for indicating the first increase in reflectivity (the dew point) is used in combination with a resistance thermometer or a sensitive thermocouple, attached to the surface of the mirror. All readings can be made on instruments outside the enclosure. The preferred form of the device is described and claimed in our copending application Serial No. 430,296, filed May 19, 1954 (now abandoned).

We provide a device for controlling roller temperature consisting of a resistance thermometer **40**, cemented to one of the metal rollers (e.g. **18**) of the distributing system, and connected by leads **41** through a resistance bridge circuit **50** to a combined indicating and control device **51**. Since the distributing roller **18** both rotates and vibrates laterally, it is necessary to use a slip ring assembly **42** to connect the thermometer to the wiring. An insulating sleeve **43** is rigidly attached to the shaft **44** of the roller **18**; mounted on it are silver contact slip rings **45**. A collar **46** is mounted on bearings **47**; it carries copper-graphite brushes **48** which make contact with the wires **41** through appropriate brush holders **49**.

The indicating and control device is so arranged that a control **52** can be moved to make, or break contact at any desired point, to open or close a solenoid valve **53**, which controls the passage of refrigerant into the roller **18**. A pilot light **54** indicates when water is passing into the roller.

A second type of control device is shown in Fig. 3.

This device is preferably mounted on one of the idler rollers, of the distributing system, near the form rollers (e.g. 19). A bracket 61 is pivoted on the shaft of the roller 19; the bracket carries a freely rotating roller 59 in rolling contact with the roller 19. The pressure between the two rollers can be adjusted by means of a screw 75. A counterweight 60 is provided to almost balance the weight of the roller and bracket leaving enough weight for the bracket to exert a small amount of pressure against a roller 66 attached to a lever arm 67, pivoted at 68. This in turn bears against a rod 69 bearing against a spring contact in a microswitch 70. A stop 76 is provided on the press frame to limit the clockwise motion of the bracket.

The forces acting on the bracket are dependent on press speed, pressure between the rollers 59 and 19, and the viscosity of the ink in the bight between the rollers. The bracket is connected by a piece of nylon string to the core of a solenoid 65, whose pull can be varied by changing voltage by means of a variable transformer 64. This solenoid is set so that its pull just balances the effect of press speed and pressure at the ink viscosity desired. The stop 76 prevents undue clockwise motion of the bracket while the solenoid is being adjusted for a particular set of conditions.

If ink viscosity increases during the run, the additional force moves the bracket in a clockwise direction, so that the pressure of the pin 69 in the microswitch is removed, and the spring effects closure in the switch. This opens a solenoid valve 72 to permit cooling water to enter the rollers through a pipe 73. A pilot light 71 indicates when water is passing through the rollers.

In the operation of the press, make-ready is preferably done with slow drying inks, with the press enclosure open. When the plates are properly adjusted and the make ready ink is removed the enclosure is closed, and air containing solvent vapor is blown into the press until the dew point indicator and the roller temperature indicators show the proper relationship. This may be accomplished by maintaining a temperature in the saturating compressor similar to that of the rollers. However, by cooling the rollers below the temperature of the atmosphere in the saturating compressor equilibrium can be obtained more rapidly, since complete saturation within the enclosure, at the higher temperature, is not necessary to establish the necessary dew point temperature-ink film temperature relationship. Printing is started when equilibrium is indicated.

During printing, solvent-vapor-saturated air is continuously fed into the enclosure to replace atmosphere which leaks out or is carried out by the moving web. A slight positive pressure is desirable in the enclosure. In the particular press enclosure shown, where the enclosure contains about 120 cubic feet of air, we supply solvent-vapor-saturated air from the compressor at the rate of one cubic foot per second, so that the atmosphere in the press is completely replaced about every two minutes.

As printing progresses, the press temperatures rise. The work done in splitting the ink film to distribute it manifests itself as heat. This work is proportional to the tack of the ink. In four color printing, the first ink printed must necessarily be tackiest, and the other inks become progressively less tacky. Hence, the temperature rise due to this effect is greatest on the yellow rollers in the press shown, least on the black.

At the same time, friction in the bearings produces heat, and causes the press frame to heat up. This effect may be less or greater than the effect due to the work done in ink distribution. In the specific experimental four-in-line press shown, frictional heat produced frame temperatures higher than roller temperatures on black and blue units, but lower than roller temperatures on red and yellow units.

As the temperature of the distributing systems rises, the dew point-press temperature relationship varies. Increase of the temperature in the saturating pump can maintain the relationship where only a single color is being printed, or even where two color work is being done with inks of not too dissimilar body. But in four color process work, the tack relationship is such that each distribution system will operate at a different temperature. For example, over a period of several hours in one experimental run with uncooled rollers, the black unit went up to 109° F., the blue to 112, the red to 113 and the yellow went to 119° F. Hence, it is necessary, in order to maintain the desired relationship, either to provide a separate enclosure and saturating unit for each distributing system, or, preferably, to cool the individual distributing systems at different rates.

These marked temperature rises in uncooled distributing systems are the basis for the control we can get in ink body; and it is particularly fortunate that the highest temperatures are obtainable on the rollers where the tackiest inks are desired. In adjusting the tack sequence of a set of four color inks, we are never faced with the problem of thinning down the first down color unless it is picking the paper—in such cases, the simple solution is to add solvent to the ink in the fountain. Increased tack can be obtained with the first down, or any other ink, by allowing the unit to warm up relative to the surrounding atmosphere and the other units, so that solvent will evaporate in the travel of ink from the fountain to the plate.

Where it is desired to reduce the body of the ink, the unit is cooled below the other units, so that evaporation during travel is kept lower than that of the other units, or actual condensation is allowed to occur to thin the ink out.

The foregoing description relates to a four color web press equipped with a single enclosure for all four printing units. It will be appreciated that this is illustrative and that other types of typographic or lithographic printing presses can be used in the practice of our invention. Presses are so dissimilar in design that each type of press must be enclosed with an eye to a maximum economy and utility for the particular press. In some types of web press, for example, it may be simpler and more economical to provide separate enclosures for each distributing system, rather than to enclose the whole press in a single chamber. In other cases, it may be desirable to enclose the distributing system and most of the plate, but to leave the point of impression outside of the enclosure. This eliminates the problem of the web passing through the enclosure, but involves drying of the ink on the exposed plate during shut downs, which may be easily remedied by cleaning the plate before resumption of printing.

Our method has been described as applicable to a four color system in an enclosed atmosphere, in accordance with the invention described and claimed in our copending application Serial No. 421,242 filed April 6, 1954. It is applicable, in such a system to the control of ink body in single or two-color printing as well, wherever it is desirable to change the body of an ink, within limits, to achieve the same results. Furthermore, the method is useful, in a more limited way, in four color process printing even in the absence of an enclosure, with conventional heat drying inks. Relative tack can be maintained by different rates of cooling, which controls evaporation; only the possibility of actually adding solvent by condensation is absent.

The method and apparatus become increasingly applicable in closed system printing as the volatility of the solvent increases. They are therefore particularly useful in the practice of the invention of our copending application Serial No. 430,788, filed May 19, 1954. In that application, an inert atmosphere is utilized in an enclosed system, together with solvent-vapor to retard evaporation, whereby solvents of much greater volatility can be used than those useful in the method of our application Serial No. 421,242.

Illustrative examples of inks which may be used in our system are the following:

EXAMPLE 1.—SET OF PROCESS INKS

A—Yellow ink

Benzidine yellow	15.50
Pentalyn G (pentaerythritol ester of polymerized rosin)	46.10
Aluminum stearate	0.48
Oleic acid	2.86
Paraffinic petroleum solvent-principally hendecanes and dodecanes (Boiling range 365 to 400° F., Kauri butanol value 32)	35.06
	100.00

B—Red ink

Eosine red	17.00
Pentalyn G	47.18
Aluminum stearate	0.66
Oleic acid	2.83
Paraffinic petroleum solvent-principally hendecanes and dodecanes (Boiling range 365 to 400° F., Kauri butanol value 32)	32.33
	100.00

C—Blue ink

Peacock blue	22.40
Pentalyn G	39.71
Aluminum stearate	0.66
Oleic acid	2.86
Solvent as above	34.37
	100.00

D—Black ink

Carbon black	13.98
Furnace black	3.68
Clay	19.50
Iron blue	3.03
Alkali blue in	0.56
Bodied linseed oil	0.77
Pentalyn G	26.45
Soya lecithin	1.89
Oleic acid	2.83
Solvent as above	27.31
	100.00

EXAMPLE 2.—SINGLE COLOR BLACK

Limed rosin type

Carbon black	15.80
Furnace black	4.50
Clay	9.00
Talc	4.50
Wood rosin	29.65
Hydrated lime	1.91
Gilsonite	2.81
Stearine pitch	1.56
Solvent of Example 1	30.27
	100.00

Variations can be made in the methods and apparatus described above without departing from the spirit of the invention which is set forth in the claims.

We claim:

1. In the method of multicolor printing by a process in which a plurality of different colored inks are distributed to printing plates over a plurality of extended distribution systems comprising series of rollers having cooling means to control the temperature build-up in the rollers caused by the operation of the rollers, and in which each individual ink contains a volatile organic solvent which will evaporate from the ink sufficiently rapidly under ordinary ambient conditions so as to sharply increase the tack of the ink during its passage through the distribution system, and in which method this sharp increase in tack is prevented for all the inks by maintaining about each distribution system an atmosphere with a concentration of ink solvent vapor sufficient to sharply retard evaporation of the ink solvent as the ink passes through the distribution system by continuously feeding to the space about the surface of the distributing rollers a gas substantailly saturated with ink solvent vapor, the improvement which comprises varying the rates of cooling of the individual distribution systems to vary the temperatures of the ink films thereon and to thereby change the relationships between the vapor-pressure of the solvents in the inks on the individual distribution systems and the pressures of the solvent vapor in the atmospheres about the respective distribution systems, whereby the tacks of the individual inks can be adjusted with relationship to one another.

2. The method of claim 1, in which increase of ink tack is obtained by allowing a distributing system to rise substantially above the solvent-vapor-dew point temperature of the atmosphere about the said distribution system.

3. The method of claim 1, in which decrease of ink tack is obtained by cooling a distributing system below the solvent-vapor-dew point temperature of the atmosphere about the said distribution system.

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