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PROCESS OF LETTERPRESS PRINTING

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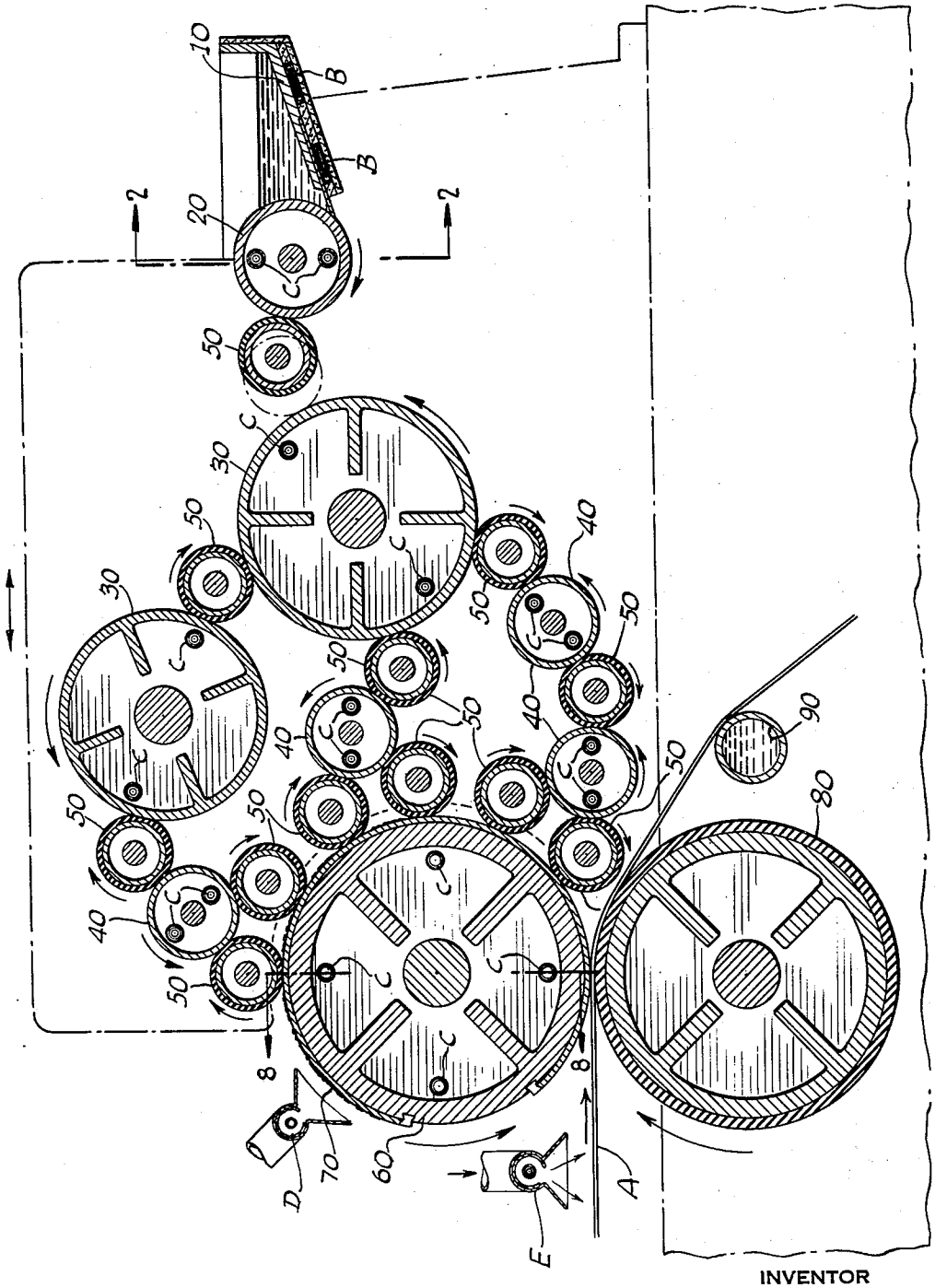

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PROCESS OF LETTERPRESS PRINTING

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This invention relates to a new and improved process of printing and, more particularly, to a new process of letter-press printing for general commercial printing work, including the printing of magazines, newspapers, books, and the like.

Letter-press printing consists in the printing of suitably fluid ink onto a sheet or web from surfaces in relief. The printing form is usually a stereotype or electrotype plate, or a type form with or without etchings bearing designs etched in relief. While various kinds of presses may be employed, rotary presses are generally used for high speed letter-press printing, as in the printing of books, magazines, newspapers and the like. In rotary letter-press operations, a supply of ink is maintained in an ink fountain at a consistency suitable for the particular printing conditions, and the ink is fed from the fountain and distributed onto the raised surfaces of the rotating printing form by a series of transfer and inking rollers. The web to be printed is passed into contact with the moving inked form to effect the printing operation. After one side of the web has been printed, that is, after the "first impression," a second printing, or second impression, is usually made on the other side of the web by continuous operation of another section of the same press. In multi-color letter-press printing, a series of impressions are made with inks of different colors, a plurality of impressions being placed in contiguous or superimposed relation on the same side of the sheet or web.

Prior to the present invention, letter-press printing has been carried out at normal press-room temperatures with printing inks which give the necessary fluidity and working consistency at such temperatures. The ink is wet when printed on the paper. Setting or drying of the print is effected either by oxidation or polymerization of an oily constituent of the ink vehicle, or by evaporation of solvents or carriers from the ink, or by absorption of the ink into the paper, or by a combination of these.

Newspaper printing, for example, is performed with inks consisting of pigment dispersed in non-drying mineral oils, which are sometimes thickened with resins or vegetable oils. When these inks are printed onto porous news stock they penetrate into the interstices of the paper by capillary attraction, thereby fixing the pigment on the fibres of the paper. The penetration of the ink causes it to spread and often to be visible from the other side of the paper, thus accounting for the characteristic appearance of newspaper print. Since news inks never become really solid they have a tendency to smear. The side of the paper first printed is marred by the printing of the reverse side, so that first impression printing is inferior to second impression printing. Smearing and marring also occur frequently during passage of the printed web over angle bars and folders, and serious troubles often are caused by off-setting of the print onto the impression roller or tympan of the press, and onto other printed matter when stacked and folded. Furthermore, the smearing tendency of newspaper print is objectionable because the ink soils the hands and clothes of readers.

For high speed letter-press printing on comparatively non-absorbent paper stock, as in the printing of magazines, it has been necessary heretofore to print with quite fluid inks, compounded from pigments, binders and volatile solvents. With this practice it is also necessary to heat the web after each impression, in order that most of the solvents may be driven off and the print dried sufficiently to permit immediate second impression or multi-color printing and handling of the printed matter without serious smearing, off-setting and damage to the print.

In very high speed work of this kind, the inks are sometimes made with solvents which are volatile only at high temperatures, and an intense heating of the printed web is carried out after each impression in order to drive off solvents, the heating being at temperatures which would inevitably burn the paper if not carried out very quickly. Such a process enables high speed printing operations but it introduces objectionable complications, difficulties and expense into printing practice. Complicated equipment must be provided for heating the print and the web; the web must be allowed to cool between impressions, necessitating additional lead over the normal of as high as 30 to 60 feet; and difficulties are encountered in obtaining proper registration of contiguous or superimposed prints due to dimensional changes in the web as caused by the heating and cooling operations and dehydration of the paper. The high heating temperatures and solvent fumes create fire and health hazards. Also, an inordinate amount of the paper stock is damaged in practice, such that wastage of paper often amounts to as much as 10%, or more, and a further expense is involved in the cost of the ink as occasioned by its high solvent and low pigment concentrations and its low covering power.

Letter-press printing processes of the kind heretofore used possess the further disadvantage that the formulae of the inks must be adjusted in accordance with the type and speed of the

press, the nature of the medium to be printed on and the ultimate use of the printed matter. This necessarily involves errors in formulating the inks and results in non-uniform printing quality. Furthermore, particularly where the drying of the print is effected by oxidation or by evaporation of volatile solvents, the workability of the ink on the press and its drying characteristics are subject to change, and this causes non-uniformities in the printing process and requires frequent adjustment of the ink formulae. Non-uniformity of operation also is caused by changing weather conditions in the press room and the variable moisture content of the paper.

The object of the present invention is to provide a new process of letter-press printing which eliminates or greatly reduces the above mentioned and other difficulties of commercial letter-press printing practice. More specific objects of the invention are: to avoid problems resulting from the formation of a wet print that must be dried or absorbed before the printed matter can be handled satisfactorily; to avoid troubles from smudging or off-setting of wet prints; to enable printed matter to be folded, stacked and assembled into books immediately when printed; to eliminate many non-uniformities in press operation and the need for frequent adjustment of ink formulae; to place printing operations under convenient and definite control; to render first impression printing of as good quality as second impression printing; to permit perfect registration of contiguous or superimposed impressions; to avoid the filling in of cuts and type and thereby to reduce work and time losses heretofore required for cleaning the printing press; and to produce printed matter of improved quality, in which cuts and type are reproduced clearly and sharply and in which there is no penetration of the ink into the paper such as would cause the ink to spread or be visible from the reverse side.

The process provided by the present invention, like other letter-press printing processes, is a process in which an ink having a fluid consistency is applied to the type or relief surfaces of a printing form and is printed onto a sheet or web from such surfaces. Unlike other processes, however, the printed ink films are set instantaneously when printed, and they are converted to a hard, smudge-resistant solid condition immediately after being printed without encountering the above-mentioned difficulties of known letter-press processes. An ink is provided which melts to a fluid consistency suitable for letter-press printing at elevated temperatures and freezes to a solid condition at temperatures above normal room temperatures. Such an ink is heated to an elevated temperature giving it a desired molten consistency for working on the press, and the inking mechanism and the printing form of the printing press also are heated to elevated temperatures. The ink in molten condition is applied to the printing surfaces of the form in thin films which adhere to the printing surfaces at elevated printing temperatures, even though the films of ink are quite fluid and the form may be moving at high speed. A sheet or web to be printed is then impressed by the inked form, the sheet or web being at ordinary press-room temperatures or at other temperatures which are low in relation to the freezing or solidifying temperature of the molten ink. In this way the ink is printed from the relief surfaces of the form onto the sheet or web in thin hot films, and the extraction of heat from these thin films into the web causes the print to set by freezing instantaneously upon leaving the printing surfaces. Further cooling of the resulting print, either by natural cooling or by artificial cooling in high speed printing work, produces a finished print, immediately after the printing operation, which is dry and rigid or hard enough to resist objectionable smearing, marring and off-setting during succeeding impressions and during the folding, stacking and assembling of the printed matter in further operation of the press.

Second impression printing on the reverse side of the same sheet or web is carried out in a manner similar to the printing of the first impression, and printed matter of high quality is produced without necessitating delay between impressions or encountering troubles from intensive heating and cooling operations on the paper, such as occur in prior processes.

Multi-color printing, also is carried out in a similar manner by using several suitable thermofluid inks of different colors and printing the different inks successively onto the same side of the sheet or web. The printing of thin molten ink films of one color over or adjacent to the solidified print of another color does not mar or destroy the quality of the previously printed impression, even though the inks of different colors may have similar melting temperatures and may be printed at similar printing temperatures.

In carrying out this process, the behavior of the molten ink on the hot printing form is different from that of the inks in other letter-press printing processes. When applied to a rotating form in its hot molten condition, the ink is found to have sufficient affinity for the heated printing surfaces to adhere evenly to them. As the ink strikes the paper, however, it adheres to the paper and sets so quickly that there is a strong tack or pull toward the paper sheet. Since the ink in contact with the heated form is kept quite molten and fluid, there is little tendency for the form to counteract the tack or pull toward the sheet. This action results in exceptionally clean printing, and it contrasts sharply with regular letter-press printing in that "fill in" of cuts and type seldom occurs. The carriage of the press and the printing form remain clean for long periods of operation and do not require washing and cleaning as in the case of other processes where evaporation of solvent or air-drying occurs on the rollers.

Another unique characteristic of the present process resides in the quality of the print that is produced on the sheet or web. The instantaneous setting of the ink produces a print that is entirely on the surface of the sheet; that is, the print lies on the top side of the top fibres of the matte. The sudden chilling and consequent case hardening of the ink when it strikes the relatively cold surface of the fibres, however, gives a surface adherence which holds the ink securely to the paper. The hardened ink has a hardness, gloss and sharpness of outline which make it distinct and unique.

This process sometimes produces another effect that is evident only by microscopic examination of the print. The pressure between the paper and, for example, the dots of a halftone plate during printing may squash the molten ink outwardly to the edges of the dots. The ink then sets on the paper so quickly that a ring in-

stead of a solid dot is printed. This effect has been obtained in known printing operations, but only by high quality printing work on expensive coated paper stock

The inks employed in the present process are materials which melt to a fluid consistency suitable for letter-press printing at elevated temperatures and become rigid, or firm, mar-resistant solids by cooling when printed. These inks are substantially free from volatile solids and other constituents which might adversely affect or change their consistency and their distributing and working qualities during the operation of the press. In general, they are materials that melt to a fluid consistency at elevated temperatures above 125° F. and are solid and non-flowing when at temperatures as low as 125° F. To be suitable for the present process they must not be soft, crayon-like or greasy. They should be very fluid at printing temperatures above 190° F. and yet not watery or non-tacky.

While various thermo-fluid inks may be compounded for use in carrying out the present process, the inks consist essentially of coloring material, either pigments or dyes, and a non-volatile vehicle imparting the above-described characteristics to the compounded ink. The nature of the color or pigment may be varied as desired. Suitable vehicles include those in which the principal constituent, e. g., more than 50% of the vehicle, is hard high-melting point base material such as resin which flows freely at temperatures above its melting point and sets rapidly to a hard consistency which imparts resistance to scuffing, rubbing and the like to the solidified print. Hydrogenated rosin ester gums, cumarone resins and hardened rosins and rosin derivatives are useful base materials. Since such hard high-melting-point materials cannot be worked satisfactorily on a letter-press when molten, because of the rapid deterioration of the rollers at elevated temperatures, they are sometimes modified by including in the ink vehicle one or more non-volatile substances, such as a minor proportion of non-volatile vegetable oil or of wax-like material, to increase the fluidity of the resin when molten. When an oil is used to increase said fluidity, a third constituent is then included in the vehicle to reduce its tack when molten and permit it to print properly. This constituent usually consists of a small proportion, preferably less than 15%, of a hard wax, such as candelilla wax or carnauba wax, that is quite fluid and free from tack when molten. This wax has the further function of protecting the ink after it is printed, by sweating or blooming from the solidifying print to furnish a hard and slippery protective coating thereon which renders it more resistant to marring.

In the practice of the present process, any suitably modified letter-press of conventional arrangement may be employed, one typical form of rotary letter-press being illustrated diagrammatically on the accompanying drawing. The drawing indicates only one section of the press, for making one impression on a continuous web, but it will be understood that another similar section is used for making a second impression on the reverse side of the web, and that several sections are used for making several impressions in multi-color letter-press printing.

As illustrated in the drawing, each press section comprises an ink fountain **10**, a fountain ball **20**, metal ink drums **30**, a series of oscillatory metal cylinders **40** and rubber composition rollers **50** for feeding and distributing the ink from the fountain to the printing form, a plate or form cylinder **60** upon which the printing form **70** is mounted, and an impression roller **80**. For convenience, the various rotary feeding and distributing elements **20**, **30**, **40** and **50** are referred to collectively as rollers. These rollers, the form cylinder **60** and the impression roller **80** rotate in the directions indicated by the arrows on the drawing, and the web A to be printed travels through the bite between the form cylinder and the impression roller in the direction indicated by an arrow.

The press is equipped with means for heating and maintaining the fountain, the rollers and the printing form at suitable elevated temperatures. This heating may be accomplished electrically, or by hot vapors, or by hot water or other liquid. An electrically heated press is illustrated schematically in the drawing, in which the fountain is heated by resistance elements B and in which each of the metal rollers **20**, **30** and **40** and the form cylinder **60** are heated by suitable electrical resistance elements C. The composition rollers **50** need not be provided with heating elements. The heating means should be capable of maintaining substantially uniform temperatures across the heated rollers, and means of any suitable known type are provided for varying the heating temperatures, whereby to control the consistency and working qualities of the ink on the press, and the character of the printing operations, by simple control of temperatures.

In high speed rotary letter-press printing according to the present process, an ink is provided for the fountain which melts to fluid consistency suitable for printing at known elevated temperatures and freezes, preferably to a hard, smudge-resistant solid condition, before cooling to room temperatures. This ink may be heated and melted beforehand, or it may be placed in the fountain in its normal solid condition and allowed to melt therein. The heating means for the metal rollers and form cylinder of the press are regulated to impart the desired elevated temperatures to the rollers and form, and the press is allowed to run idle for sufficient time to bring the metal rollers and the surfaces of the contacting composition rollers to the desired temperatures. When this has been done the press may be started in operation. The molten ink is fed from the fountain across the distributing and inking rollers of the press and applied to the heated relief surfaces or type of the form in thin films, and the web to be printed is fed through the bite between the form cylinder and the impression roller. The ink films in letter-press printing are usually less than .001" thick. Thereupon, films of fluid molten ink are printed onto the web from the relief surfaces of the form, and the ink so printed strikes and adheres to the web and freezes to a firm condition immediately when printed. The period of contact between the form and the web is so short that the web is not heated appreciably by the hot form. Thus the print sets instantaneously by absorption of heat therefrom into the paper.

The proper working temperatures for the fountain and rollers of the press are those temperatures at which the molten ink has the proper body for the speed of the press and distributes over the rollers without causing them to drag or slip. At these temperatures the molten ink does not run out of the fountain or back away from the fountain roller, or ball, while the press is

in operation. The proper printing temperature, by which is meant the temperature of the printing surfaces of the form, is not necessarily the same as the temperature of the fountain and rollers of the press; instead, it is preferred to keep the printing temperature distinctly higher. The films of molten ink on the printing surfaces should have a high degree of fluidity and the proper tackiness before being actually printed onto the web. Particularly in high speed rotary press operations, the temperature of the printing surfaces is kept from 15° to 50° F. higher than the temperature of the rollers, so that when films of the molten ink have been applied to the form they become more fluid and assume the desired printing consistency before being printed onto the web. Under these conditions, the molten ink does not "pick" the paper as it is printed, nor does it look greasy or mottled after printed.

It is also important in carrying out the present process that the temperature of the printing surfaces be as nearly uniform as practicable. Since the printing surfaces of very small area, such as the dots of a half-tone, may lose heat much more rapidly and receive heat from the form cylinder much more slowly than the surfaces of larger area, provision should be made in some cases for overcoming the non-uniformities and printing troubles which otherwise might result. This may be accomplished by supplying heat to the printing surfaces in addition to the heat supplied from the form cylinder, or by heating the surface of the web before it is contacted by the printing surfaces so that the extraction of heat into the web from the surfaces of small area will be reduced. A blast of hot air or other gas may be directed against the face of the type, either before or after the inking of the type, or the type surfaces may be heated by radiation. A tube D for directing hot air against the form is indicated in the drawing. Alternatively or in addition to such heating, the surface of the web may be heated, as by radiation or by hot air, just before the web moves into contact with the inked form. A hot air tube E is indicated for this purpose in the drawing. When the surface of the web is preheated, however, the temperature of the web is kept substantially below the solidifying temperature of the thermo-fluid ink in order to ensure instantaneous setting of the ink when printed.

When the surface of the web has been preheated, and preferably at other times in high speed printing work, the printed films on the surface of the web should be chilled or cooled artificially to hasten their complete solidification to a rigid, mar-resistant condition. This chilling operation may be carried out by passing the print in contact with a cooling roller **90** which is cooled internally by air or water.

Illustrative examples of thermo-fluid ink compositions which may be used successfully in carrying out the present process are as follows:

I. *Rotary black ink*

Constituents:	Parts by weight
Cumar resin (Cumar V-2½)	56
Blown soya bean oil	20
Carnauba wax	10
Carbon black	10
Violet toner	2
Blue toner	2
	100

Melting range, 136°–145° F.

II. *Rotary black ink*

Constituents:	Parts by weight
Hydrogenated rosin ester gum ("Stay-belite")	62
Carnauba wax	18
Carbon black	16
Toner	4
	100

Melting range, 158°–167° F.

III. *Rotary black ink*

Constituents:	Parts by weight
Rosin (N wood rosin)	62
Carnauba wax	18
Carbon black	16
Toner	4
	100

Melting range, 170°–178° F.

IV. *Rotary black ink*

Constituents:	Parts by weight
Hydrogenated rosin ester gum ("Stay-belite")	75
Paraffine wax (140°)	5
Carbon black	16
Toner	4
	100

Melting range, 156°–163° F.

V. *Rotary red ink*

Constituents:	Parts by weight
Cumar resin (Cumar V-2½)	65
Heavy-bodied China wood oil (viscosity, 30–35 poises)	20
Carnauba wax	5
Lithol red	10
	100

Melting range, 162°–176° F.

VI. *Rotary yellow ink*

Constituents:	Parts by weight
Cumar resin (Cumar V-2½)	47
Heavy-bodied China wood oil (viscosity, 30–35 poises)	15.5
Carnauba wax	7.5
Chrome yellow	30
	100

Melting range, 167°–176° F.

The melting ranges of the inks, as given in these examples, were determined by means of a Parr bar. The ink of Example V may be printed satisfactorily at printing temperatures of about 212° F. and higher; those of the other examples, at temperatures of about 200° F. and higher. Satisfactory working qualities are obtained with these inks by heating the fountain and rollers of the press to temperatures of about 185° F. These temperatures refer to typical operation of a rotary letter-press and are not to be construed as including all operable printing and working temperatures for the inks of the examples.

The process of the present invention is particularly advantageous for high speed letter-press printing. There is no problem of drying or setting a wet print, nor any troubles such as occur in processes employing an intense heating of the paper web. Second or multiple impression printing may be carried out at high speed, and the printed matter may be handled immediately after having been printed, without damaging the qual-

ity of the print. In addition, the present process is more economical than known high speed magazine printing processes. There is much less waste of paper stock, and economies may be realized in that greater printing capacity may be obtained from a given volume of ink. Further important economies are realized because press operations may be carried out with improved efficiency, there being, for example, little filling in of cuts and type and therefore a substantial reduction in press time heretofore required for clean-up work.

In newspaper printing according to the present invention an important advantage is obtained in the clarity and sharpness of the printed matter, which is distinctly superior in quality and legibility to printed matter produced by known processes on porous news stock. This advantage accrues from the manner in which the printed ink films lie on the surface of the paper, without substantial penetration into the fibres of the matte, and from the fact that no substantial part of the ink applied to the paper becomes lost by absorption or evaporation.

In the practice of the process, changes in the speed of the press or in the quality of the paper being printed do not require adjustments in the ink formula, as the working and printing qualities of the ink vary with temperatures, and the temperatures may be readily and definitely controlled by the provision of suitable temperature control means on the press. "High speed" letter-press printing, as the term is used herein, includes printing operations in which the web travels at a speed greater than 300 feet per minute.

The printing inks herein disclosed are not claimed in the present application, but all rights to claim them in other applications are reserved. Although these particular inks are suitable for use in the practice of my process, it will be understood that various other ink compositions may be found satisfactory for the same purpose. Therefore, while I have described these and other features of specific embodiments of my invention for clarity of understanding, it will be apparent that the invention is not restricted to such specific features but extends also to equivalents within the scope of the appended claims.

I claim:

1. The process of producing smudge-resistant printed publications and other printed matter by letter-press printing which comprises providing a printing ink which is solid at normal temperatures, which melts to a liquid in a range of temperatures above normal temperatures and which possesses a fluidity, cohesiveness and tackiness suitable for such printing at elevated temperatures substantially above said melting range, heating and melting said ink, heating relief printing surfaces to temperatures above said range, applying said molten ink to said heated printing surfaces in thin films, supplying to said printing surfaces relatively cold stock having sufficient heat absorbing capacity substantially instantaneously to set said molten ink films when printed thereon, and printing said thin ink films at said elevated temperatures from said printing surfaces onto said stock, thereby substantially instantaneously abstracting heat from said thin printed films into the stock and rapidly freezing the printed films in adherence to and substantially entirely on the surface of the stock.

2. The process of producing smudge-resistant printed publications and other printed matter by letter-press printing which comprises providing a printing ink which is solid at normal temperatures, which melts to a liquid in a range of temperatures above normal temperatures and which possesses a fluidity, cohesiveness and tackiness suitable for such printing at elevated temperatures substantially above said melting range, heating and melting said ink, heating relief printing surfaces to temperatures above said range, applying said molten ink to said heated printing surfaces in thin films, supplying to said printing surfaces relatively cold stock having sufficient heat absorbing capacity substantially instantaneously to set said molten ink films when printed thereon, printing said thin ink films at said elevated temperatures from said printing surfaces onto said stock, thereby substantially instantaneously abstracting heat from said thin printed films into said stock and setting the print in adherence to and substantially entirely on the surface of the stock, and further cooling and hardening the print immediately thereafter.

3. The process of producing smudge-resistant printed publications and other printed matter by letter-press printing which comprises providing a thermo-fluid printing ink which is solid at normal temperatures and which melts to a liquid in a range of temperatures substantially above normal temperatures, heating and melting said ink, heating the printing surfaces of a letter-press printing form to elevated temperatures substantially above said melting range at which thin films of said ink possess a fluidity, cohesiveness and tackiness suitable for such printing, applying said molten ink to said heated printing surfaces in thin films, supplying to said printing surfaces relatively cold stock having sufficient heat absorbing capacity substantially instantaneously to set said molten ink films when printed thereon, and printing said thin ink films at said elevated temperatures from said surfaces onto said stock, thereby substantially instantaneously abstracting heat from the printed films into the stock and freezing the printed films to a solid condition on and in adherence to the surface of the stock.

4. The process of producing smudge-resistant printed publications and other printed matter by letter-press printing which comprises providing a printing ink which is solid at normal temperatures, which melts to a liquid in a range of temperatures above 125° F. and below 185° F. and which possesses a fluidity and cohesiveness suitable for such printing at elevated temperatures above 200° F., heating and melting said ink, applying thin films of said molten ink to heated relief printing surfaces, supplying to said printing surfaces relatively cold stock having sufficient heat absorbing capacity substantially instantaneously to set said molten ink films when printed thereon, and printing said thin ink films at temperatures above 200° F. from said printing surfaces onto said stock, thereby immediately setting the ink films so printed in adherence to and substantially entirely on the surface of said stock by absorption of heat from the print into the stock.

5. The process of producing smudge-resistant printed publications and other printed matter by rotary letter-press printing which comprises providing a printing ink which is solid at normal temperatures, which melts to a liquid in a range of temperatures substantially above normal temperatures and which attains a fluidity and body suitable for such printing at elevated temperatures substantially above said melting range.

heating and melting said ink, heating said ink fountain to temperatures sufficient to keep said ink molten therein, heating the inking mechanism of the press to temperatures above said melting range at which said ink is kept liquid and distributes well on the press, heating the printing form of the press to said elevated temperatures, feeding said molten ink from said fountain across said inking mechanism and applying the same in thin films onto the relief printing surfaces of said printing form, supplying to said printing form a relatively cold web having sufficient heat absorbing capacity substantially instantaneously to set said molten ink films when printed thereon, and printing said thin ink films at said elevated temperatures from said printing surfaces onto said web, thereby immediately setting the ink films so printed in adherence to and substantially entirely on the surface of the web by absorption of heat from the print into the web.

6. The process of producing printed publications and other printed matter by rotary letter-press printing which comprises providing for the ink fountain of the printing press a printing ink which is solid at normal temperatures, which melts to a liquid in a range of temperatures substantially above normal temperatures and which attains a fluid consistency suitable for such printing at temperatures above said melting range, heating and melting said ink, heating said fountain to keep said ink therein molten and at a working consistency, heating the inking mechanism of the press to temperatures at which said ink is kept liquid and distributes well on the press, heating the relief printing surfaces of the printing form to elevated temperatures substantially higher than the temperature of the inking mechanism, at which thin films of said ink possess a fluidity and tackiness suitable for such printing, feeding said molten ink from said fountain across said inking mechanism and applying the same in thin films onto said heated relief printing surfaces, and printing said thin ink films at said elevated temperatures from said printing surfaces onto relatively cold stock.

7. A process of printing as described in claim 6, said printing surfaces being heated to a temperature about 15° to 50° F. higher than the temperature to which said inking mechanism is heated.

8. The process of producing printed publications and other printed matter by rotary letter-press printing which comprises providing for the ink fountain of the printing press a printing ink which is solid at normal temperatures, which melts to a liquid in a range of temperatures substantially above normal temperatures and which attains a fluid consistency suitable for such printing at temperatures above said melting range, heating and melting said ink, heating said fountain to keep said ink therein molten and at a working consistency, heating the inking mechanism of the press to temperatures at which said ink is kept liquid and distributes well on the press, heating the relief printing surfaces of the printing form to elevated temperatures substantially higher than the temperature of the inking mechanism, at which thin films of said ink possess a fluidity and tackiness suitable for such printing, feeding said molten ink from said fountain across said inking mechanism and applying the same in thin films onto said heated relief printing surfaces, printing said thin ink films at said elevated temperatures from said printing surfaces onto relatively cold stock, thereby substantially instantaneously setting said printed ink films by absorption of heat therefrom into said stock, and further chilling and hardening the print immediately thereafter.

9. The process of producing printed publications and other printed matter by letter-press printing which comprises heating and melting a thermo-fluid printing ink which at elevated temperatures has a fluidity, tackiness and cohesiveness suitable for such printing and which freezes to a hard, smudge-resistant solid condition in cooling to normal temperatures, said ink consisting of coloring material incorporated in a vehicle containing principally hard high-melting resin, heating a letter-press printing form to said elevated temperatures, applying said molten ink to the relief surfaces of said form in thin films, supplying to said form relatively cold stock having sufficient heat absorbing capacity substantially instantaneously to set said molten ink films when printed thereon, and printing thin fluid films of said ink at said elevated temperatures from said relief surfaces onto said stock, thereby immediately freezing the printed thin ink films on and in adherence to the surface of the stock.

10. The process of producing printed publications and other printed matter by letter-press printing which comprises heating and melting a thermo-fluid printing ink which at elevated temperatures has a fluidity, tackiness and cohesiveness suitable for such printing and which freezes to a hard, smudge-resistant solid condition in cooling to normal temperatures, said ink consisting of coloring material incorporated in a vehicle containing hard high-melting resin in a principal proportion and a smaller proportion of material that adds fluidity to the resin when the ink is molten, heating a letter-press printing form to said elevated temperatures, applying said molten ink to the relief surfaces of said form in thin films, supplying to said form relatively cold stock having sufficient heat absorbing capacity substantially instantaneously to set said molten ink films when printed thereon, and printing thin fluid films of said ink at said elevated temperatures from said relief surfaces onto said stock, thereby immediately freezing the printed thin ink films on and in adherence to the surface of the stock.

11. The process of producing printed publications and other printed matter by letter-press printing which comprises heating and melting a thermo-fluid printing ink which at elevated temperatures has a fluidity, tackiness and cohesiveness suitable for such printing and which freezes to a hard, smudge-resistant solid condition in cooling to normal temperatures, said ink consisting of coloring material incorporated in a vehicle containing hard high-melting resin in a principal proportion, a smaller proportion of material that adds fluidity to the resin when the ink is molten and a small amount of hard wax, heating a letter-press printing form to said elevated temperatures, applying said molten ink to the relief surfaces of said form in thin films, supplying to said form relatively cold stock having sufficient heat absorbing capacity substantially instantaneously to set said molten ink films when printed thereon, and printing thin fluid films of said ink at said elevated temperatures from said relief surfaces onto said stock, thereby immediately freezing the printed thin ink films on and in adherence to the surface of the stock.

12. The process of producing printed publications and other printed matter by letter-press

printing which comprises heating and melting thermo-fluid printing ink which at elevated temperatures has a fluidity, tackiness and cohesiveness suitable for such printing and which freezes to a solid condition in cooling to normal temperatures, printing thin films of such molten ink at said elevated temperatures from heated relief printing surfaces onto one side of a relatively cool sheet or web having sufficient heat absorbing capacity substantially instantaneously to set said films when printed thereon, thereby immediately freezing the printed ink films substantially entirely on the surface of said one side, then chilling the print so produced on said one side, and directly thereafter printing thin fluid films of such ink at said elevated temperatures from other heated relief printing surfaces onto the other side of said sheet or web and thereby immediately freezing the ink films so printed substantially entirely on the surface of said other side.

13. The process of producing printed publications and other printed matter by multi-color letter-press printing which comprises providing a series of thermo-fluid printing inks of different colors, each being an ink which at elevated temperatures has a fluidity, tackiness and workability suitable for such printing and which freezes to a solid condition in cooling to ordinary temperatures, heating and melting said inks, heating a series of letter-press printing forms to elevated temperatures suitable for the printing of the respective inks, applying said molten inks in thin films to the relief printing surfaces of the respective forms, one color for each form, supplying to said forms successively a relatively cold web having sufficient heat absorbing capacity substantially instantaneously to set said molten ink films when printed thereon, and printing said molten inks in thin films at said elevated temperatures from said forms successively in contiguous or superimposed relation onto the same side of said web, thereby freezing the ink films of each color on the surface of said sheet or web immediately when such ink is printed.

14. The process of producing printed publications and other printed matter by multi-color letter-press printing which comprises providing a series of thermo-fluid printing inks of different colors, each being an ink which at elevated temperatures has a fluidity, tackiness and workability suitable for such printing and which freezes to a solid condition in cooling to ordinary temperatures, heating and melting said inks, heating a series of letter-press printing forms to elevated temperatures suitable for the printing of the respective inks, applying said molten inks in thin films to the relief printing surfaces of the respective forms, one color for each form, supplying to said forms successively a relatively cold web having sufficient heat absorbing capacity substantially instantaneously to set said molten ink films when printed thereon, printing said molten inks in thin films at said elevated temperatures from said forms successively in contiguous or superimposed relation onto the same side of said web, thereby upon the printing of each color abstracting heat from the printed films into said web and setting the printed films on the surface of the web, and immediately after the printing of each color chilling the printed films to render them hard and smudge-resistant.

15. The process of producing printed publications and other printed matter which comprises feeding a paper sheet or web toward a heated printing form, heating and melting a normally solid and hard thermo-fluid printing ink, applying said molten ink to the printing elements of said form in thin films, maintaining said form at an elevated temperature sufficient to impart a fluid printing consistency to said ink films thereon, warming said paper in advance of said form to a suitable printing temperature below the freezing temperature of said ink at which said paper retains sufficient heat absorbing capacity substantially instantaneously to set said molten ink films when printed thereon, and printing said thin ink films from said elements onto said warmed paper, thereby immediately abstracting heat from the printed ink films into the paper and rapidly freezing the print in adherence to and substantially entirely on the surface of the paper.

16. The process of producing printed publications and other printed matter by letter-press printing which comprises feeding a paper sheet or web toward a heated letter-press printing form, heating and melting a normally solid and hard thermo-fluid printing ink, applying said molten ink onto relief printing surfaces of said form in thin films, maintaining said form at an elevated temperature sufficient to impart a fluid printing consistency to said ink films thereon, warming said paper in advance of said form to a suitable printing temperature below the freezing temperature of said ink at which said paper retains sufficient heat absorbing capacity substantially instantaneously to set said molten ink films when printed thereon, printing said thin ink films from said surfaces onto said warmed paper, thereby setting the printed films on the surface of said paper immediately when printed by absorption of heat therefrom into the paper, and immediately thereafter further chilling the printed films to harden the same and form a permanent, adherent, smudge-resistant print.

17. The method of printing newspapers by high speed rotary letter-press and of producing clear and sharp reproduction of reading matter and cuts on porous newspaper stock which comprises providing thermo-fluid printing ink that is solid at ordinary temperatures, melting such ink to a liquid consistency, heating the inking mechanism of the letter-press to temperatures sufficient to distribute the molten ink well thereacross, heating the printing form to temperatures sufficient to impart to the molten ink thereon a fluidity, cohesiveness and tackiness suitable for such printing, continually feeding said molten ink across said inking mechanism and applying the same in thin hot films onto the relief printing surfaces of the rotating printing form, continually supplying through a zone of contact with said rotating form a relatively cold web of porous newspaper stock having sufficient heat absorbing capacity substantially instantaneously to set said molten ink films when printed thereon, continually printing said molten ink films from said form onto said web, thereby drawing the printed films away from said surfaces and setting said films instantaneously on the surface of the web by absorption of heat therefrom into the paper web, and immediately thereafter further cooling said printed films to produce clearly- and sharply-formed, permanent, smudge-resistant, frozen printed characters lying on the surface of said web and adhering permanently thereto without substantial penetration into the fibers thereof.

18. The method of increasing efficiency and reducing press cleaning operations in the print-

ing of publications and other printed matter by rotary letter-press which comprises providing printing ink in the form of a chemically-stable thermo-fluid ink that is solid and hard at ordinary temperatures, melting such ink to a liquid consistency, heating the inking mechanism of the press to temperatures sufficient to distribute the ink well thereacross, heating the printing form to elevated temperatures sufficient to impart to said ink a fluidity and tackiness suitable for such printing, continually feeding said molten ink across said inking mechanism and applying the same in thin hot films onto the relief printing surfaces of said printing form, continually supplying to a zone of contact with said form relatively cold paper having sufficient heat absorbing capacity substantially instantaneously to set said molten ink film when printed thereon, continually printing such thin films at said elevated temperatures from said surfaces onto said paper, thereby holding lint and foreign matter away from the printing form and inking mechanism and on the paper by freezing the bases of the printed films instantaneously upon contact with the paper, drawing said films away from said surfaces and setting the same immediately on the surface of the paper by absorption of heat therefrom into the paper, and setting the printed ink films at a rate in proportion to the rate of feeding and printing the paper.

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