This invention relates to the art of printing designs on readily stretchable fabrics, and especially to the printing of multicolor designs on knit goods and the like.

A principal object of the invention is to provide a printing machine of the multi-color rotary printing drum kind which is especially designed and adapted to print multi-color designs on stretchable fabrics such as knit goods, with maximum accuracy of color registration by preventing the fabric from being dimensionally distorted, even when complicated anti-skewing equipment is used. When the fabric is being dimensionally distorted during the printing operations, another object is to provide a printing machine of the rotary printing drum multi-color kind for printing on readily stretchable materials, such as knit goods, with permanent inks of the resistant base kind.

A further object is to provide a machine for insuring accuracy of registration of multi-color printings on readily stretchable materials such as knit goods and the like.

A feature of the invention relates to the novel organization, arrangement, and relative location and interconnection of parts, which cooperate to provide an improved multi-color printing machine for stretchable fabrics.

Other features and advantages not particularly enumerated will be apparent after consideration of the following detailed descriptions and the appended claim.

The drawing shows, by way of example, one preferred embodiment of a rotary drum multi-color fabric printing machine, for printing and registering printed designs on knitted fabrics such as sheer nylon, rayons, cotton, or wool fabrics, so as to produce a design which is substantially free from fadimg or wash-out when the goods are subjected to washing.

While the art of multi-color printing on relatively non-stretchable materials, such as paper and the like, has reached a high degree of development, the mechanisms used in that particular application have not always been found practicable for printing in multi-color on stretchable materials such as knit or woven fabrics. That is especially true where the fabrics are to be printed in multi-color in a continuous feeding operation using engraved printing rolls, as distinguished from reciprocating or linearly moving printing heads. In the latter kind of machine it is possible to hold the fabric stationary against a suitable flat backing and then to move the printing head into contact with the goods. Consequently, in that type of fabric printing, registration of the various colors can be readily achieved and the problem of dimensional distortion of the fabric is not as critical as it is where the printing is to be done by engraved rollers which continuously contact with and press against the fabric. It has been found that when using conventional engraved rollers to print multi-color designs and fabrics, the problem of color registration is exceedingly difficult to meet. One reason for this is that the fabric, not being self-supporting and in many cases for example in the case of nylons, rayons, and synthetic fibers where the fabric is extremely sleazy, unavoidably becomes dimensionally distorted. Even when complicated anti-skewing equipment is used, the accuracy of the respective multi-color registrations is not always obtained. I have found that in order to achieve completely uniform results in the multi-color printing of stretchable fabrics with resin base inks it is necessary to subject the printed fabric to a preliminary drying operation to drive off the liquid constituents of the printing ink without correspondingly shrinking or distorting the fabric and then to subject the printed design to a final heating and cooling operation to cure and set the ink and stabilize the fabric. Furthermore, in order to prevent distortion in the multi-color registrations, I have found it necessary to synchronize the various web feeding elements at the various stages so that at no point is the fabric subjected to any substantial stretch or dimensional distortion.

Accordingly, in the drawing the numeral 1 represents a roll of the stretchable fabric to be multi-color printed, such as knit goods or woven goods as received from the mill. This mill roll is supported for feed by the driving movement by gravity on a pair of inclined ways or guides 2, and the weight of the roll holds it in contact with a positively driven unwind roll 3 covered with rubber or other similar material. Preferably the ways 2 and the mill roll may be supported on any suitable tilt-able frame 4 whose angular position can be adjusted for example by a hand wheel 5. The fabric 6 from the roll 1 engages the under periphery of the rubber covered roll 3, and then passes upwardly and around the nip-forming roll 7 which is mounted as an idler roll and is arranged to press the fabric against the printing drum 8, around which the fabric passes for approximately 75 percent of the drum periphery. The idler roll 7 is preferably carried by the frame 4 so that by adjustment of the hand wheel 5 the pressure between the roll and fabric and against the drum 8 can be accurately controlled.

The printing drum 8 is driven by the printing rollers 10, 11, 12, and 13, so as to impart a uniform rotational speed to the drum 8. Drum 8 drives the idler roll 7 by its frictional engagement with web 6. Therefore, the roll 7 effects no dimensional distorting influence on the web. Furthermore, the inclined or pull roll 3 is also positively driven at a fixed speed ratio with respect to drum 8, as schematically represented by the solid-line dot-dash line symbol. This ratio is chosen so that the linear speed of movement of the web 6 is uniform throughout its length, and thus it is not subjected to any substantial tension in the direction of its length.

In order to prevent endwise slippage or skewing of the fabric 6, the surface of drum 8 is lapped by a cotton cloth which has been treated so that the knit fabric 6 is frictionally held on the drum 8 against slippage and stretching.

Located around the printing drum 8 are a series of multi-color engraved printing rolls of which four such rolls are shown, namely rolls 18-21. These engraved printing rolls are positively driven at a fixed speed so that the printing pressure on the fabric does not subject it to any drag, stretch, or other dimensional distortion. The engraved printing rolls are provided with respective ink pans or reservoirs 14-17, and with respective ink applicator rolls 18-21 and respective doctor blades 22-25. Each of the pans 14-17 is filled with a respective colored printing ink preferably of a kind which has a resinous or plastic base. Such resin base inks are well known in the printing art. A typical example of such inks may consist of vinyl acetate-chloride copolymer mixed with a suitable plasticizer such as dioctyl phthalate in a suitable solvent, for example methyl ethyl ketone, and a suitable coloring pigment.

I have found that in order to produce the best results when multi-color printing with such inks, it is necessary to subject the printed design to a preliminary controlled heat treatment. For that purpose the printed fabric, after
leaving the drum 8, is substantially directly transferred to an endless conveyor belt 26 which extends around a series of rollers 27-32. Rollers 27-32 are idle rollers, whereas roller 32 is a belt driven roller and is driven in fixed speed ratio with respect to drum 8, as indicated schematically by the dot-dash line and gearing symbol in the drawing, this ratio being chosen so that the linear movement of the fabric 6 on the conveyor 26 is the same throughout its length.

In order that no substantial unsupported span of the printed fabric exists, the roller 27 is located so that the initial end of the conveyor belt is as close as possible to the drum 8, for example within a space of a few inches. I have found that this is necessary since the slaxness and non-self-supporting properties of certain fabrics might otherwise entail undesirable sagging and distortion thereof. It will be understood, of course, that a very slight slack is desirable in the fabric between the point where it leaves the drum 8 and the point where it actually engages the conveyor belt 26.

The conveyor 26 is enclosed within a suitable oven 33 provided with a plenum chamber, whose inlet end is connected by a duct 34 to a source of dry heated air which is blown in the direction of the arrow and exits at the opposite end of the oven through an exhaust duct 35 which may be provided with an exhaust fan or the like. Thus, the liquid vehicle in the inked design on the fabric is subjected to a continuous stream of warm dry air which moves without agitation or recirculation through the plenum chamber of oven 33. It is important that the drying stream be substantially smoothly continuous as not to subject the printed fabric to any fluttering as it is passing through the oven. Furthermore, this drying stream is controlled so that the evaporation of the liquid vehicle of the printed design is gradually evaporated so as to avoid any shrinkage of the fabric. At this stage, after leaving the oven 33, the printed ink design on the fabric is neither permanent nor washable.

I have found that in order to achieve the desired degree of permanency and washability of the printed ink design, it is necessary to subject it to an ink curing operation. This is effected by passing the printed fabric in a sinuous path between and around a series of curing rolls, fifteen of which are shown in the drawings and designated 36-50. These rolls are shown mounted in a substantially vertical array in a suitable frame 51, and they are positively driven in fixed speed ratio with respect to drum 8 so that they do not disturb the desired uniformity of linear movement of the printed fabric and thus protect it against any mechanical stretching.

The roll 50 is driven from motor 9 through suitable gearing schematically illustrated, and the successive rolls 36-50 may be geared together also as schematically illustrated. All of the rolls may be of hollow construction, and the first twelve rolls, namely rolls 36-47 are steam heated, while the remaining three rolls, namely 48-50, are water cooled. It will be understood, of course, that the invention is not limited to any particular manner of heating the rolls 36-47, provided they are maintained at a temperature of approximately 300 degrees F. After the printed fabric has been subjected to the heating and cooling stages to effect curing and permanentization of the printed design, the fabric is transferred to a double drum rewind comprising for example the positively driven rewind rolls 52, 53, and the receiving roll 54 or 57. Roll 54 may be supported on suitable inclined ways 55 so as to be held by gravity in contact with the rewind roll 53. Preferably, a rubber guide roll 56 is provided between the cooling roll 50 and the rewind roll 52, it being understood that the rewind rolls 52 and 53 are driven in synchronism with the remaining rolls so as to disturb the uniform linear motion of the fabric.

One of the outstanding advantages of the machine, in addition to those already described, is the fact that if the fabric 6 has been pre-shrunk by any well known shrinking process prior to feeding it into the printing machine above described, the fabric can be printed without the necessity of further processing or pre-shrinking prior to conversion to consumer goods. Furthermore, by the use of the machine and process as described, it is possible to print piled knit fabrics with little, if any, dimensional distortion. It will be understood, of course, that the invention is not limited to the application of openwork designs since the fabric can be printed all over its surface with a single solid color. In other words, the machine, while it finds its primary utility in multi-color printing of fabrics, can also be used to apply a single over-all color coat to the fabric through the medium of an etched printing roll. By the expression “curing and setting” of the well known resin base ink, as used herein, is meant the heating of the previously dried ink to a temperature of approximately 300 degrees F., which results in what is well known as the resin ink setting or being permanently attached to the fabric, as distinguished from the preliminary heating which is done gradually merely to drive off the liquid constituents of the ink as hereinabove described.

Various changes and modifications may be made in the machine and process as disclosed without departing from the spirit and scope of the invention.

What is claimed is:

The method of printing a stretchable fabric with a permanentized resin base ink which comprises applying ink to the fabric while maintaining the fabric in a continuous uniform motion, subjecting the printed fabric to a preliminary drying heat to gradually drive off the liquid constituents of the ink and at a temperature such as to avoid any shrinkage of the fabric, but leaving the printed design non-permanent and non-washable, then passing the printed fabric in engagement with a series of heating rolls at a temperature of approximately 300 degrees F. whereby the substantially immediately adjacent areas of the fabric on its opposite faces are simultaneously heated and with substantially negligible length of the fabric between adjacent heating rolls left unsupported, whereby substantially the entire length of the fabric on both faces is uniformly heated to said temperature of approximately 300 degrees F. to render the printed design permanent and washable.

References Cited in the file of this patent

UNITED STATES PATENTS

1,315,377 McGlehan Sep. 9, 1919
1,541,806 Flick June 16, 1925
1,842,195 Pinder Jan. 19, 1932
1,867,405 Gurwitz July 12, 1932
2,098,118 Wheelwright Nov. 2, 1937
2,129,277 Jeuck Sept. 6, 1938
2,131,257 Risley Sept. 27, 1938
2,244,072 Jenkins Aug. 26, 1941
2,276,181 Foster Mar. 10, 1942
2,337,348 Prindle Dec. 21, 1943
2,358,112 Smith Sept. 12, 1944
2,434,013 Ross Jan. 6, 1945
2,656,327 Van Wirt Oct. 20, 1953