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(54) A method of locating a print in a respective printing position in multi-colour silk screen printers.

(57) The invention relates to a method in multi-colour silk screen printers for adjusting print in respective print positions. This is effected by registering print material to be calibrated in a laying-on position (7"), and reading the position of the print material and storing the values obtained. The print material (7) is then printed in a first printing station, a second printing station, and so on, having knowledge of the positional settings of stepping motors (13,14,15), these positional settings being stored in a computer memory. The positions of respective prints on the print material are evaluated (10', 12') in a laying-off position or station in the printer.

The next print in line can now be printed with the minimum of discrepancy, by first establishing the position of the print material in the laying-on station, with knowledge of the positions of the earlier prints and the then prevailing positional settings of the stepping motors.

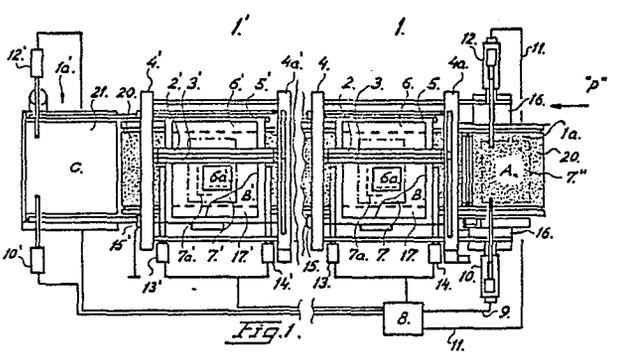

Fig.1.

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A method of locating a print in a respective printing position in multi-colour silk screen printers

TECHNICAL FIELD

The present invention relates to a method for use in silk screen printers equipped with a plurality of printing stations and adapted for multi-colour printing, such as to enable in each of said printing stations a second pattern deriving from a stencil carried first pattern to be positioned in relation to print material intended to receive said second pattern, such that subsequent to being adjusted positionally each of said second patterns will be located in a predetermined position or location in relation to said print material.

When the method is applied to a multi-colour silk screen printer, the second pattern is formed by causing a coating substance or colouring paste intended for application to said print material in respective print positions, or respective printing positions, to pass through holes in a cloth forming respective first patterns and onto the print material, for instance with aid of a squeegee.

The invention is also based on the understanding that the coordinates of each of the specific positions of respective second patterns in relation to said print material can be stored in a memory, such as to enable the coordinates of any of said positions to be compared readily with stored coordinates relating to the specific position of the pattern in relation to the print material, so as to make readily available any discrepancy with respect to size and direction.

It is also necessary to enable the coordinates of the position of said print material in the laying-on position of the print material to be established.

Although mention is made in the following description to "multi-colour silk screen printers" and "multi-colour print" it should be understood that such reference is not meant to imply that each printing station shall solely apply a "colouring paste" to form a second pattern on the print material, but that such references shall be interpreted to also include applications in which the second pattern is printed on the material with the aid of some other printing substance, such as solder paste, solder-stop varnish and similar "colourless" patterns used in the manufacture of printed circuit cards or boards.

BACKGROUND PRIOR ART

Although many different types of silk screen printers are known to the art, all such printers are constructed for the purpose of applying to print material a single specific second pattern originating from a first pattern carried by the stencil.

Silk screen printers adapted for multi-colour printing, i.e. printing in which a plurality of superposed patterns are printed on one and the same print material are to be found, but only in very limited numbers.

The present invention, however, relates to one such multi-colour silk screen printer.

Examples of silk screen printers which include a plurality of sequentially arranged printing stations provided with printing tables and stencil frames which are positioned above said tables and fitted with stencils for applying a multi-colour print to one and the same print material are found described in European Patent Application 87111078.2 and US Patent Specification 4,589,335.

In relation to the features of the method proposed in accordance with the present invention, it can also be mentioned that the US Patent Specification 4,516,495 teaches a method of positioning in one printing position a second pattern, which derives from a stencil carried first pattern, in relation to print material intended to receive said second pattern, and in which the second pattern is formed by creating conditions such that a coating substance or colouring paste intended for application to the upper surface of the print material is caused to pass through the holes or open mesh in the stencil or cloth carrying the first pattern, for instance with the aid of a squeegee used in a silk screen printer.

The previously known method proposes that the two-dimensional position of the second pattern in relation to a reference point, normally a point on the frame supporting the printer, is stored in a memory, and that subsequent to displacing the print material which is to receive said second pattern to a printing position, the relevant position of the material or a pattern previously printed thereon is evaluated such as to disclose any discrepancy that would likely occur if the second pattern were to be printed onto the print material with said material located in its prevailing position.

It is also proposed that a stencil frame carrying a stencil with the first pattern and/or a printing table and/or the print material itself is displaced in a manner such that, depending upon the size and directional sense of the positional discrepancy when the second pattern is applied to the print material in this printing position said pattern will be applied to said material in a printing position in which full or satisfactory compensation has been made with respect to the earlier identified discrepancy.

This proposed known method requires the introduction of one or more material-position reading and position establishing devices between the stencil and print material, when the print material is in a printing position, so as to enable the value and directional sense of the positional discrepancy to be evaluated, and such as to enable the print material or pattern to be displaced in a manner to compensate for the evaluated discrepancy, prior to actual printing taking place.

The standpoint of techniques set forth in US Patent Specification 4,221,165 also forms part of the known prior art. This specification teaches a silk screen printer which is provided with a plurality of gripping bars intended for gripping print material in a first position, a laying-on position or laying-on station, said print material being intended to receive print in a second position, a printing position, while being registered positionally by the gripping bars.

This enables the print material to be moved through a conveying path of precise length from the laying-on position to the printing position. The exactitude of this material conveying path is made possible by the fact that each of the gripping bars can be registered mechanically in both of said positions in relation to the chassis of the printer, or a part thereof.

It is proposed that the print material is registered positionally in the first position, not solely through mutual coaction between a first registering device and the gripping bars, but that separate means are also provided to this end, these separate means being intended for coaction with the print material in a manner such as to register the print material precisely in the first position, so that a registered gripping arm is able to collect pre-registered print material and transport said material through a precise conveying path to the printing position.

Finally, it is known from publication DE-A-26 27 155, to transport print material on an endless conveyer belt and, immediately subsequent to applying a print, to evaluate the position of the applied print and when said print is found to lie outside a desired position, to evaluate the discrepancy and to effect the necessary corrections to the position or orientation of a subsequent print.

SUMMARY OF THE INVENTION

TECHNICAL PROBLEMS

When studying the state of the prior art as expressed in the aforegoing it will be seen that in the case of a multi-colour silk screen printer one problem resides in the provision of means whereby each print applied to a print material can be used as a standard print or "template" by means of which print positions can be adjusted in a simple manner, by recording prevailing two-dimensional position values relating to the laying-on position of the print material with the aid of an optical sensing arrangement, and by storing said positional values in a computer, and by sensing and establishing positional values for respective preceding prints in relation to the chassis of the printer, or some other reference point, with the aid of a second optical sensor arrangement, such that prior to effecting a subsequent printing process, the prevailing position of respective stencils can be changed, with the aid of stepping motors, to a position in which said stencil will apply correctly oriented second patterns to the print material in said printing station when printing is continued.

It will also be seen that a technical problem relies in the realization that the steps of registering the position of the print material in the laying-on station or position, applying a plurality of sequential prints to a single print material with knowledge of the position of respective stencils, and evaluating the position of respective prints in a laying-off station or laying-off position are the only steps which need to be taken in order to subsequently adjust positionally each of the prints in order to print with minimum discrepancy solely by establishing the position of the print material in the laying-on station.

It will be also be seen that a technical problem, and also a qualified technical perception, resides in realizing the possibility of adjusting, independently of one another, the positions of each of a number of stencil frames capable of being moved selectively in two directions, with the aid of stepping motors, three stepping motors, so that said positions can be adapted to the position of the desired, prevailing second print pattern on the material when the position of said material in the laying-on position has been established.

It will be seen that in the case of a multi-colour silk screen printer a technical problem resides in the ability to increase the printing rate of the printer, preferably above the rate capable by a printer constructed in accordance with the US Patent Specification 4,516,495, without needing to depart from the requirement of a satisfactorily high degree of accuracy with respect to the positioning of each of the second patterns on the print material, particularly when the printer is used for the manufacture of printed circuit cards or boards.

It will also be seen in this latter case that a further technical problem is one of providing conditions, with the aid of simple means, which will

enable the prevailing position of print material intended for receiving a plurality of prints in the form of a plurality of mutually different second patterns in each printing station to be established, subsequent to preceding normalization or calibration, already in a laying-on position and, in response to said read position, and when necessary, to so adjust the position of a first pattern on a stencil relative to the print material that when said material has been displaced through a precise transport path to respective printing positions, a second pattern applied to said print material in said respective printing positions will haveobtain a predetermined orientation in relation to the print material.

An advantage is afforded in this respect when measures are taken which will enable the print material to be moved by a conveyer belt through a transport path of exact length within narrow tolerance limits, from a laying-onstation or location to each of a plurality of printing positions, without losing the orientation of the print material therebetween.

It will also be seen that a technical problem resides in the provision of conditions which will enable the second pattern to be given the desired, correct orientation on the print material in the event of a deviation from the aforesaid precise material-transport path.

It will also be seen that in connection with determining the position of print material in a laying-on station, a problem resides in compensating for the discrepancy which can be expected to occur in each printing position and which is caused by stretching of the first pattern on the stencil when a squeegee is moved across the stencil for the purpose of transferring the stencil pattern onto the print material and therewith form a second pattern.

It will also be seen that a further technical problem resides in the provision of conditions, with the aid of simple means, for normalizing or calibrating the positions of the various second patterns, by on the one hand moving print material in a precise manner from a first laying-on station to a respective printing position and there to apply print in the form of a second pattern, and on the other hand to simply displace or move the printed material to a second printing position.

In this respect a technical problem also resides in the provision of conditions, with the aid of simple means, which, with the aid of this information, will enable the second pattern to be printed on each subsequent print material in each printing station, subsequent to said adjustment, in a controlled and regulated fashion such that said print material will take a pre-determined position with a deviation smaller than 0.5 mm, preferably smaller than 0.03 mm, such accuracy being required when manufacturing printed circuit cards or boards.

Another technical problem, and one which requires qualified perception, is that of realizing that the accuracy afforded is strongly related to the resolution of the reading equipment or camera equipment used, and also, to a limited extent to the possibility of being able to measure the distance of the transport path travelled by the conveyor belt and the position of said belt with a high degree of accuracy.

SOLUTION

The present invention relates to a method for use in silk screen printers equipped with a plurality of printing stations and adapted for multi-colour prints, for the purpose ofadjusting in each of said printing stations the position of a second printed pattern, deriving from a first pattern carried by a stencil, in relation to print material intended to receive the second printed pattern, such that subsequent to said adjustment each of said second patterns will take a pre-determined position relative to said print material, wherein the second pattern is produced by causing printing substance to pass through the first pattern with said pattern in printing position, for instance with the aid of a squeegee, and into abutment with the print material.

The present invention relates in particular to the calibration of the positions of respective second patterns in relation to the print material.

More particularly, the present invention relates to the calibration of the positions of respective second patterns in relation to the print material, and is mainly characterized in that

a) for the purpose of effecting said adjustment the position of print material in a first registered position, a laying-on position, in relation to a reference point, for instance the chassis of the printer or a part of said chassis, is read-off and stored,

b) that the print material is moved over to a second registered position, a printing position in a first printing station, for the purpose of receiving a second pattern in said first printing station, and that the position of the stencil is established clearly and precisely, by reading and storing the positional values of three stepping motors;

c) that the print material printed with said second pattern in accordance with b) above is now moved over to a third registered position, a printing position in a second printing station, for the receipt of a second pattern applicable to said second printing station, and in that the position of the stencil is established clearly and precisely by reading and storing the positional values of three stepping motors;

d) that the print material on which two sec-

ond patterns have been printed under b) and c) above is now moved over to a fourth registered position, a third printing position in a third printing station, in which the material receives a second pattern applicable to said third printing station, and so on until all prints have been applied, and in that the position of the stencil is established clearly and precisely by reading and storing the positional values of three stepping motors;

e) that the thus printed material to which respective second patterns have been applied in a multiple of printing stations is registered in a laying-off position or station;

f) that the positions of respective second patterns on the print material are evaluated in relation to the position of the material read-off under b); and

g) that each subsequent print material, in dependence on the position of the material according to a) and in dependence on the evaluated positions of second patterns in respective printing stations, is printed in each printing station with a second pattern applied to said material with the minimum discrepancy.

In the nature of a further development, the invention also proposes that the expression minimum discrepancy implies complete compensation for an established discrepancy, or compensation which is at least satisfactory in consideration of prevailing circumstances.

It is particularly proposed that respective print materials are carried on a conveyer belt which extends through the entire printer and that the print materials are registered in said first position, by establishing the position of the conveyer belt. The transport path of the conveyer belt, up to the second registered position, is measured and the measuring result stored, wherein the material is printed with the second pattern in the first printing station according to b) above, whereafter the print material is moved over to a third registered position, a printing position in a second printing station, where said print material receives the second pattern applicable to this second printing station, and wherein the transport path through which the belt moves up to the third registered position is equal to the path previously travelled by said belt. The distance here shall be twice the previous distance. The material is here printed with its second pattern in the second printing station according to b) above.

The print material is then conveyed through a similar transport path up to a fourth registered position, in which the print material is printed with the second pattern in the third printing station, according to b) above.

The invention also relates to a silk screen printer having a plurality of printing station and in which a plurality of print materials are conveyed by a conveyer belt from a laying-on position or station to a first printing station, from there to a second printing station, and so on through all printing stations, to a laying-off position, each said printing station including a stencil provided with a respective first pattern which is transferred to the print material as a second pattern, with the aid of a squeegee arrangement.

When the positions of respective second patterns on the print material have been established in dependence on the laying-on position of the material and also in dependence on the prevailing settings of three stepping motors, the second pattern can be applied to the print material with the minimum of discrepancy and in dependence of the position of the material in the laying-on position, provided that the stencil and stencil frame are displaceably arranged in each printing station and provided that the material is transported and stopped in a specific position in the printing station, by the conveyer belt. Displacement of respective stencil frames in respective printing stations to obtain minimum discrepancy is controlled by a control unit which is common to all printing stations.

ADVANTAGES

Those advantages primarily afforded by the present invention reside in the provision of conditions which will enable the position of print material to be registered in a laying-on position in a multi-colour silk screen printer, and which, subsequent to moving one and the same print material through a transport path to respective printing positions and printing respective second patterns thereon in each printing position with the aid of known stepping motor positions, will enable the positions of respective second patterns on the print material to be evaluated in one outfeed or laying-off station and in dependence, inter alia, on the positional value of a subsequent print material in the laying-off station and the value of respective pattern positions will enable printing of subsequent print material to be effected in each printing station with minimum discrepancy.

Only one single print material passes through the multicolour printer for the purpose of obtaining a reference to the prevailing positions of the various patterns, whereafter printing of subsequent material can be effected with minimum discrepancy, solely by establishing the position of said material in the laying-on station.

The primary characteristic features of the inventive method are set forth in the characterizing clause of the following Claim 1, whereas the pri-

mary characteristic features of a multi-colour silk screen printer are set forth in the characterizing clause of the following Claim 4.

BRIEF DESCRIPTION OF THE DRAWINGS

A preferred, exemplifying embodiment of a silk screen printer adapted for carrying out the inventive method will now be described in more detail with reference to the accompanying drawing, in which:

Figure 1 is a greatly simplified, horizontal view of part of one such printer;

Figure 2 illustrates suitable markings provided on a conveyer belt for the purpose of establishing the positions of the belt and the print mate rial thereon;

Figure 3 illustrates print material in the laying-on position; and

Figure 4 illustrates the print material of Figure 3 subsequent to said material having passed through four printing stations and provided with four registering marks.

DESCRIPTION OF A PREFERRED EMBODIMENT

Figure 1 is a horizontal view of a multi-colour silk screen printer.

In Figure 1, the reference 1 identifies a first printing station, and the reference 1a identifies a laying-on arrangement coacting with said first printing station.

Arranged in the direction of material transportation "P" is a number of printing stations, each of which is operative to apply mutually different coloured prints. Normally the printer will include three or four such stations, although this number may be more or less than three or four.

The printing stations are mutually identical, although with the difference that the first printing station 1 coacts with a stencil which carries a first pattern which normally differs from the first pattern of the stencil associated with the next following printing station, this difference in successive patterns prevailing throughout the printing stations.

The illustration shown in Figure 1 has been simplified insomuch that only the first printing station 1, the laying-on arrangement 1a and the last printing station 1′ with laying-on arrangement 1a, have been shown. The number of printing stations located between these two illustrated stations will thus vary, although all of said stations will have mutually the same construction in principle.

For the sake of simplicity, those components of the last printing station 1′ have been identified with the same reference numerals as those used in connection with the first printing station, although supplemented with a prime (1 and 1′, 2 and 2′ etc.).

Thus, it will be seen that the first printing station 1 includes a squeegee arrangement 2 and an ink or paste filler 3, which are reciprocatingly movable in guides 4, 4a transversely to the transport direction "P" of the print material. Stretched in a stencil frame 5, which is movably arranged although stationarily related to the printer chassis, is a stencil 6 which carries a first pattern 6a. This first pattern 6a is transferred to or printed on print material 7, as a second pattern 7a, by means of the squeegee arrangement 2.

Thus, two slightly different patterns are concerned, namely the first pattern 6a and the second pattern 7a, these patterns differing from one another, not only because the one pattern is formed in the stencil while the other is applied or printed to the material, but also because movement of the squeegee will cause the stencil cloth to stretch and therewith distort the first pattern slightly when it is applied to the print material to form said second pattern.

The position of the second pattern 7a on the print material 7 has been exaggerated in the Figure and is shown by the side of the first pattern 6a for illustrative purposes.

The invention primarily relates to a method for use in silk screen printers of the kind having a plurality of printing stations and adapted for multi-colour printing, i.e. the application of one particular print in each of said printing stations, which will enable a second pattern 7a deriving from a first pattern 6a carried by a stencil 6 to be adjusted in relation to print material 7 intended to receive the second pattern 7a, such that the second pattern 7a will take a pre-determined position in relation to said print material 7, without needing to introduce between the stencil and printing tables in respective printing positions devices which function to determine the position of the print material.

The second pattern 7a is printed by forcing coating substance, printing paste or the like, to pass through the holes or meshes of the stencil carrying the first pattern 6a with the stencil in a printing position in the first printing station and the print material positioned therein, for example with the aid of a squeegee 2, such that said coating substance etc. is brought into abutment with the print material 7.

The determined position of the second pattern 7a has a given relationship with the position of the first pattern 6a, and the position of said first pattern 6a can be established by establishing the positional values of three stepping motors 13, 14, and 15, these positional values being stored in the memory of a central, control unit 8 preferably constructed

for the operation of the printer concerned.

The central control unit 8 is connected to a first camera arrangement 10 by an electric cable 9, and also to a second camera arrangement 12, by means of an electric cable 11. The second camera arrangement 12 functions to establish the position of the print material in the laying-on station.

Sincecentral control unit 8 forms no part of the present invention and since the principle construction of this unit with regard to silk screen printers is known to the art, the subsequent description will only deal with those functions which need to be found in the central control unit 8 in order to adjust the position of the pattern on the material in the various printing stations, in dependence on the determined position of the print material in the laying-on station, and in response hereto to guide known stepping motors 13, 14 and 15 for each stencil frame in each printing station with the minimum discrepancy.

Those who desire a more in-depth understanding of this position determining function, the manner in which discrepancies are calculated and the manner in which the stepping motors are activated are referred to the aforesaid US Patent Specification 4,610,200.

In order to obtain a better understanding of the present invention, it should be noted that by "registered position", as used in the following description and in the claims, is not necessarily meant an exact registered position in relation to the printer chassis, since this position can vary.

It is essential, however, that the two-dimensional coordinates of the position of the print material or a print previously applied thereto are established and the coordinate values stored so that an exact position can be established therefrom.

Furthermore, when a first print material, subsequent to passing through a calibrating cycle, arrives at a last registered position, an outfeed or laying-off position, it is necessary that the two-dimensional coordinates for each print can be established and the magnitude and directional sense of a discrepancy in relation a posi tion established in the laying-on station can be evaluated in this last registered position or station. Furthermore, the positional values of the stepping motors coacting with respective each stencil frames shall also be established and stored, these stepping motors having been responsible for the position in which the pattern concerned was printed.

In accordance with the present invention, and as illustrated by the exemplifying embodiment in Figure 1, for the purpose of calibrating the equipment in a first registered laying-on position "A" for the print material 7', the position of the print material is read-off by the camera arrays 10, 12 in relation to a reference, for instance the printer chassis 16, and the two-dimensional coordinates evaluated therewith are stored in the memory of the central control unit 8.

The conveyer belt 20 is now started, so as to move the print material from position "A" to a second registered position "B", namely a printing position in the first printing station, in which the second pattern 7a is applied to the print material, by movement of the squeegee 2. The distance travelled by the print material, i.e. the transport path, shall be determined exactly in this case. The manner in which this distance is determined is described in more detail hereinafter.

The positional values, or settings, of the stepping motors 13, 14 and 15 are established and stored.

In accordance with the invention, the print material 7 to which the second pattern 7a was applied in the first printing station 1 is now moved to a second printing position, along a precise transport path.

It is necessary that the printed second pattern is oriented on the material within rough tolerance limits, although naturally within those limits required by the following camera equipment 10' and 12' in order to establish the position of the pattern.

With knowledge of this information, it is now possible in the outfeed position "c" to establish the position of the print material, and the positions of the prints applied thereto in relation to the positional settings of the stepping motors, to compare, for instance, the position of the first print with the desired, correct position of the print in the first printing station, and to activate the stepping motors 13, 14 and 15 from the central control unit, such that when following print material, the position of which has been established in the laying-on position, has been transported through a precise transport path to the first printing station, the second pattern 7a can be transferred to the print material with the minimum discrepancy. Should the laying-on position be displaced, the extent of this displacement can be evaluated and all stencil frames displaced in order to minimize the discrepancy.

The aforedescribed calibration of the position of the second pattern 7a on the print material 7 can now be effected in a similar manner for each of the remaining printing stations.

In order to be able to detect the position of the transport belt and to measure the lengths of prevailing transport paths, it is proposed that the underside of the conveyer belt is provided with a scale or markings 23, as illustrated in Figure 2. This marking 23 may consist of optically detectable, individual bar codes or a magnetizable tape with a reading head located adjacent the underside of the belt, for instance in the laying-on position or station "A".

Since the distance, and therewith the exact transport path, between the laying-on position or station "A" and the first printing station is equal to the distance between the first and the second printing stations, the second and the third printing stations, etc., only one single reading head is required to evaluate the exact lengths of the transport paths travelled by the conveyer belt.

If there is a risk that the measurements of the conveyer belt measurements may change, it may be suitable to provide one such reading head at each printing station and in the close proximity of the registered position, so as to enable the momentary position of the conveyer belt in each printing station to be evaluated, so that if this position is found to deviate slightly from a position established during the calibrating process the stencil frame can be displaced to compensate also for this discrepancy.

An example of an arrangement by means of which conveyer belt movement, transportation path and position of said conveyer belt can be measured and established is found described and illustrated in European Patent Application 0 083 082.

For instance, the coordinates of a desired position of the first second pattern 7a, among a plurality of such second patterns 7a, has already been established in a known manner, it is possible with the aid of the camera equipment 10, 10′ and 12, 12′ and the computer of the central control unit 8 to establish the prevailing discrepancy and to control the stepping motors 13, 14 and 15 of the first printing station 1, so that all subsequent prints will be precisely positioned.

The illustrated embodiment includes stepping motors 13, 14 and 15 which act on a stencil frame 5 carrying the stencil 6, thereby enabling the stencil 6 and its pattern 6a to be displaced so as to bring the pattern 6a into an exact position for printing onto the material 7.

The arrangement of reading heads for establishing prevailing positions of the conveyer belt at each printing station will also enable any discrepancy occurring in the length of the transport path to be introduced as a correction factor for each printing station with respect to establishing movement of respective stencil frames to obtain minimum discrepancy.

Possible discrepancies in the transverse direction of the belt can also be evaluated and inserted as correction factors.

It is assumed here that the print material will not slide in relation to the upper surface of the conveyer belt during discontinuous movement of the belt through the printer. Non-sliding of the print material can be achieved with the aid of a so-called accompanying vacuum.

If a discrepancy between the actual position of the pattern, occurring when transferring the second pattern, and its pre-determined position is established in the printing station 1′ and remaining printing stations, the stencil frame 5′ together with the stencil 6′ carrying the first pattern 6a′, is displaced with the aid of the stepping motors 13′, 14′ and 15′ to an extent such and in a direction such as to minimize the established discrepancy. The established discrepancy and the extent to which the various stepping motors 13′, 14′ and 15′ are activated are evaluated in a known manner in the central control unit 8.

Subsequent to calibrating the positions of all second patterns on a single print material, and subsequent to displacing, when necessary, respective stencils in order to minimize the discrepancy in relation to an established correct position, and storing the extent to which respective stencils were displaced, the process of actually printing the material with multi-colour prints can be commenced with the next print material in line.

Each subsequent print material will now be registered in the first position "A" (establish the position of the material) and information concerning any discrepancy between the position of this material and the position of the material during the calibration process is transferred during transport of the print material to the second position "B" so that the stencil 6 in the first printing station can be moved to compensate for a discrepancy caused hereby, so as to be printed with the second pattern 7a in the second position "B", this pattern being applied with the minimum discrepancy, owing to the information stored in the central control unit 8 and to subsequent activation of the stepping motors in accordance therewith.

By minimum discrepancy is meant full compensation for an established discrepancy, or a degree of compensation which is considered satisfactory in view of the prevailing circumstances. When the print material is transferred to the second printing station, the stencil can also be displaced to minimize the discrepancy deriving from any discrepancy in the laying-on position.

Thus, it is necessary for the central control unit 8 to monitor the prevailing position of each print material in the laying-on station, the positional settings of the stepping motors, and to activate the stepping motors in each printing station upon arrival of the print material, so that the second pattern can always be applied with the minimum discrepancy.

Figure 1 illustrates the printer with three separate print materials 7″, 7 and 7′ resting on a conveyer belt which extends and conveys the print material through the whole of the printer. The print material 7″ is located in a registered position in the laying-on station "A". The print material 7 is lo-

cated in a registered position in the first printing station 1, whereas the print material 7′ is located in a registered position in the last printing station 1′.

By registered position in the laying-on station, is not meant that the material is forced into a given position relative to the chassis by mechanical registering means, but rather that the print material is placed in a defined position so that the stencil frame and stencil can be moved such that a pattern will be transferred to a pre-determined location on the print material.

The print material 7″ can now be conveyed by the belt 20 to the printing station 1, the print material 7 in the printing station 1 can be moved to the next printing station in line, and so on, such that the print material 7′ to which a number of colour prints have been applied, is moved onto a support surface 21 in the laying-off station 1a′.

It should be noted that the support surface 21 and the position of the print material are significant, in order to be able to establish the positions of respective prints with the aid of the camera equipment 10′ and 12′.

The camera equipment 10′ and 12′ can be moved along a guide arrangement and is arranged to stop in exact positions, corresponding to the positions of registering marks printed on the print material in respective printing stations.

The transport path between the different printing stations are mutually identical, or at least substantially identical.

Printing of respective print material in respective printing stations takes place simultaneously.

The illustrated printer thus includes a plurality of printing stations (1...1′) and a single print material to be provided with a number of prints is conveyed through the printer on a single conveyer belt 20, from a laying-on station "A" to a first printing station 1, and from there to a second printing station, etc., and finally to an outfeed or laying-off station 1a′, each said printing station including a stencil provided with a first pattern which is transferred to the print material as a printed second pattern, by means of a squeegee arrangement.

Each printing station includes stepping motors by means of which the stencil and stencil frame can be displaced, such that when applyuing print to print material transported by the conveyer belt and stopped in a specific position in said printing station, the aforesaid second pattern can be applied to said print material with the minimum discrepancy.

This displacement of respective stencil frames in respective printing stations to achieve minimum discrepancy, is controlled in respective printing stations by a control unit which is common to all printing stations, while observing the position of the print material, the laying-on position, the prevailing transport path, the position of the stencil and other parameters.

When the conveyer belt 20 stops, print material will be located in each printing station.

The position of the conveyer belt in each station can be read-off, therewith enabling the position of the print material to be established more precisely, and the stencil frame in each printing station can be displaced prior to commencing a printing operation, so as to compensate for discrepancies occurring between the actual position of the print material and its pre-determined position.

All requisite data for carrying out the aforedescribed compensations is stored in and processed by the control unit 8.

It may be suitable to include a drying station between each successive printing station, so as to dry the applied print prior to applying further print to the print material.

With regard to establishing the position of the conveyer belt (and therewith also the position of the print material), this can be effected, in the longitudinal direction by providing separate, clearly defined markings and establishing the length of the prevailing transport path with the aid of said markings.

The position of the conveyer belt laterally can be established by establishing the position of the markings with the aid of one or more reading heads.

For instance, the reading head 24 (Figure 2) can be arranged to detect one edge part, the head 25 can be arranged to detect the centre part, and the head 26 can be arranged to detect the other edge part, and therewith establish the prevailing position of the belt in a lateral direction.

The camera equipment 10, 12 may also be of simple construction, since the cameras need only detect the edges of the print material. Figure 3 illustrates the positioning of three, simple single-dimensional cameras 10, 12 and 12a.

The camera equipment 10′ and 12′ should be of a more sophisticated nature, since these cameras are required to evaluate two-dimensional positions of printed register marks.

Figure 4 illustrates three register marks and camera equipment 10′.

The register mark 41 comprises a "o" and derives from the print applied in the first printing station 1.

The register mark 42 consists of a "+" and derives from the print applied in the last printing station 1′.

The distance between these marks (41 and 42) is clearly defined and the camera equipment 10′ is arranged for movement through this distance. The camera equipment 10′ is also able to move through a distance corresponding to the distance to the

registered marks for remaining printing stations.

It will be understood that the invention is not restricted to the aforedescribed exemplifying embodiment thereof, and that modifications can be made within the scope of the inventive concept illustrated in the following claims.

Claims

1. A method for use in silk screen printers equipped with a plurality of printing stations, adapted for multi-colour printing, such as to enable in respect of each of said printing stations a second pattern deriving from a first pattern formed on a stencil to be positioned in relation to print material intended to receive said second pattern, such that subsequent to being adjusted positionally each of said second patterns will be located in a predetermined position or location in relation to said print material, wherein respective second patterns are produced by causing coating substance located in a print position to pass through the first stencil carried pattern and onto the underlying print material, e.g. with the aid of a squeegee, characterized in that

a) for the purpose of effecting said adjustment the position of print material in a first registered position, a laying-on position, in relation to a reference point, for instance the chassis of the printer or a part of said chassis, is read-off and stored,

b) that the print material is moved over to a second registered position, a printing position in a first printing station, for the purpose of receiving a second pattern in said first printing station, and that the position of the stencil is established clearlyand precisely, by reading and storing the positional values of three stepping motors;

c) that the print material printed with said second pattern in accordance with b) above is now moved over to a third registered position, a printing position in a second printing station, for the receipt of a second pattern applicable to said second printing station, and in that the position of the stencil is established clearly and precisely by reading and storing the positional values of three stepping motors;

d) that the print material on which two second patterns have been printed under b) and c) above is now moved over to a fourth registered position, a third printing position in a third printing station, in which the material receives a second pattern applicable to said third printing station, and so on until all prints have been applied, and in that the position of the stencil is established clearly and precisely by reading and storing the positional values of three stepping motors;

e) that the thus printed material to which respective second patterns have been applied in a multiple of printing stations is registered in a laying-off position or location;

f) that the positions of respective second patterns on the print material are evaluated in relation to the position of the material read-off under b); and

g) that each subsequent print material, in dependence on the position of the material according to a) and in dependence on the evaluated positions of second patterns in respective printing stations, is printed in each printing station with a second pattern applied to said material with a minimum of discrepancy.

2. A method according to Claim 1, characterized by resting the print material on a conveyer belt, which passes through the whole of the printer, and registering said material in the first position; measuring the transport distance moved by the belt to the second position; applying the second pattern to the print material in said first printing station; moving the print material to a third position, a printing position, in a second printing station and applying to said material in said station the second pattern applicable to said second printing station; and measuring the transport path travelled by the belt to the third registered position, by establishing the position of the print material in a laying-on position.

3. A method according to Claim 1, characterized by evaluating the positions of respective prints with the aid of reference patterns or marks applicable to respective prints, with respective marks being separated from adjacent marks by a predetermined distance.

4. A silk screen printer having a plurality of printing stations and a conveyer belt operative to transport print material from a laying-on station to a first printing station, and from there to a second printing station, and so on to an outfeed station or position, each printing station including a stencil which carries a first pattern and a squeegee arrangement for transferring said first pattern to print material as a second pattern, and in which respective second patterns are adjusted positionally in accordance with one of the preceding Claims characterized, by means which function to displace the stencil and stencil frame in each printing station such as to enable the second pattern to be printed on print material transported by the conveyer belt and stopped in a specific position in said printing station, with the minimum discrepancy.

5. A printer according to Claim 4, characterized by a control unit which is common to all printing stations and which is operative to control displacement of respective stencil frames in respective printing stations towards the application of print

with minimum discrepancy.

6. A printer according to Claim 4 or 5, characterized in that the arrangement is such that print material is located in each printing station when the conveyer belt stops; in that means are provided for establishing the position of the print material in said each printing station in dependence on the position of the print material in the laying-on position and the length of the transport path; and in that the stencil frame of each printing station can be displaced prior to printing, in a manner to compensate for discrepancies otherwise occurrent.

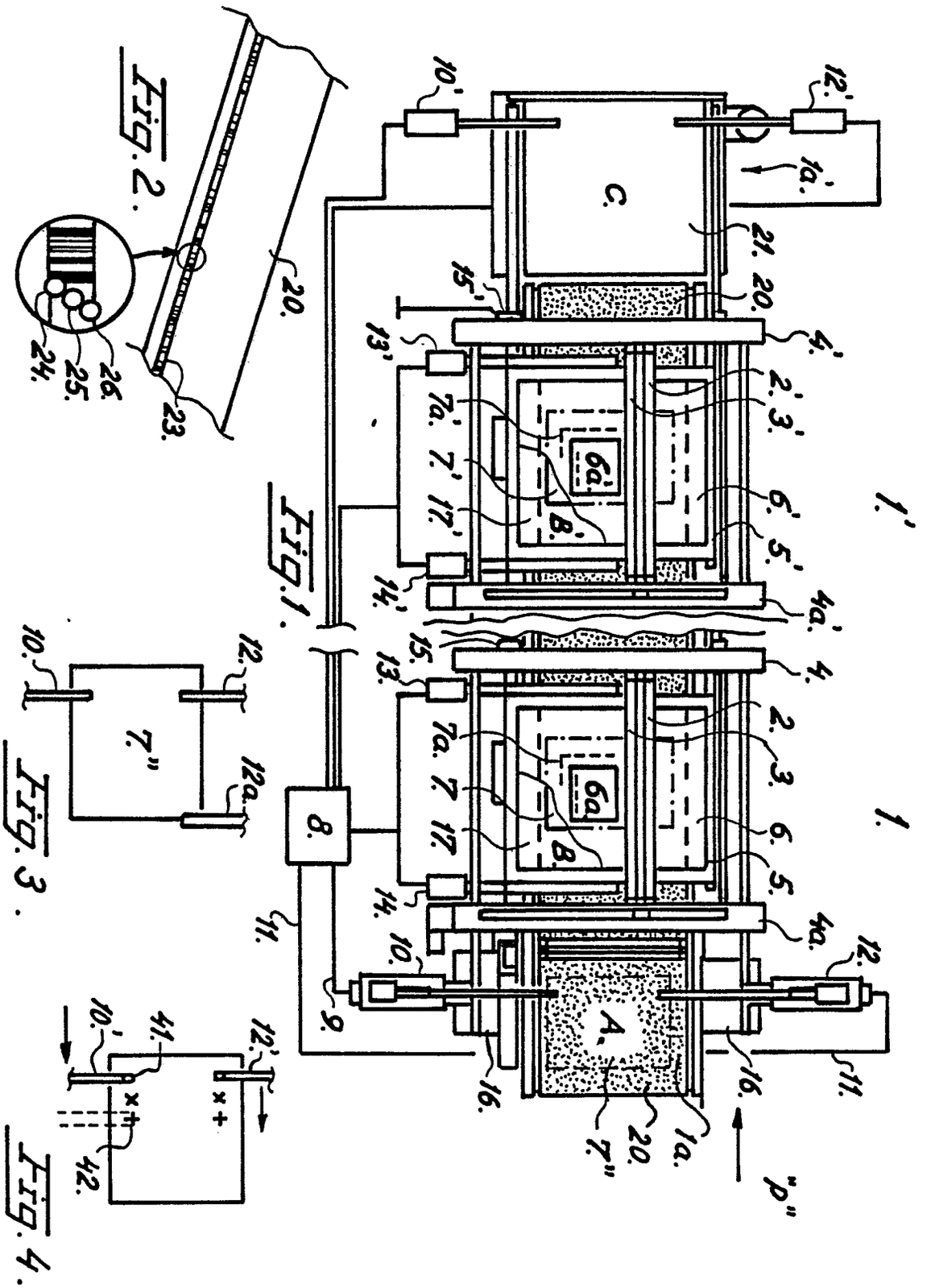

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.