currently pending claims with proposed amendments in red.

WHAT IS CLAIMED IS:

1. An alignment method for determining a position where a second pattern in respect to a first pattern is to be formed on the basis of measurement of positions of alignment marks of the number of N associated with the first pattern formed on a substrate comprising the steps of:

(a) measuring the positions of the alignment marks of the number of N associated with the first pattern and calculating the coordinates of each of the alignment marks in reference to a result of such measurement;

(b) calculating each of the errors in the directions X and Y of the alignment marks, errors in rotational directions of the alignment marks, errors of an orthogonal degree of alignment marks, and errors of magnification in the directions X and Y of the alignment marks;

(c) calculating an initial value for getting an alignment correction coefficient under application of a method of least squares in reference to the coordinates of each of the alignment marks and the coordinates of the rational grid corresponding to each

of said alignment marks on the basis of each of said errors;

(d) calculating correction coordinates of the alignment marks under application of said initial values;

(e) calculating a difference between each of the alignment coordinates and said corrected coordinates, setting a residual to 0 when the alignment is within a reference region and calculating a residual with said difference from the alignment tolerance value other than 0;

(f) calculating a sum of squares from said residual; and

(g) calculating corrected coordinates with a value of said sum of squares being within a reference value; and

~~2. An alignment method according to claim 1 in which~~ the correction coefficients of said corrected coordinates are calculated by repeating said steps (e) to (g) by a plurality of times; and

~~3. An alignment method according to claim 1 in which~~ the correction coefficients of said corrected coordinates are calculated under application of random number elements.

~~4.~~ An alignment method according to claim 1 in which said residuals are calculated in reference to a shape of an actual lower layer pattern; and

~~5. An alignment method according to Claim 4 in which~~ the residuals are calculated with said actual lower layer pattern being a substantial circular shape.

~~6.~~ An alignment method for determining a position where a second pattern in respect to a first pattern is to be formed on the basis of measurement of positions of alignment marks of the number of N associated with the first pattern formed on a substrate comprising the steps of:

(a) measuring the positions of the alignment marks of the number of N associated with the first pattern and calculating the coordinates (X_{Mi}, Y_{Mi}) (where, i = 0, 1, 2, ... N-1. Subsequent is also similar) of each of the alignment marks in reference to a result of such measurement;

(b) under an assumption that offsets of errors in the directions X and Y of the alignment marks are defined as dx, dy, a rotation angle of an error in a rotating direction of the alignment marks is defined as θ, an orthogonal degree of layout which is an error of orthogonal degree of layout in each of the alignment

marks is defined as α, and scalings which are variation in magnification of the alignment marks in their directions X and Y are defined as S_X, S_Y, calculating initial values dx, dy, θ, α, S_X, S_Y for getting the alignment correction coefficients by a method of least squares in reference to the following equation (1) and the equation (2) on the basis of the coordinates (X_{Mi}, Y_{Mi}) of each of the alignment marks and the coordinates (X_{Li}, Y_{Li}) of the rational grid point corresponding to each of the alignment marks,

$$\begin{pmatrix} \sum_{I=0}^{N-1} X_{LI}^2 & \sum_{I=0}^{N-1} X_{LI}Y_{LI} & \sum_{I=0}^{N-1} X_{LI} \\ \sum_{I=0}^{N-1} X_{LI}Y_{LI} & \sum_{I=0}^{N-1} Y_{LI}^2 & \sum_{I=0}^{N-1} Y_{LI} \\ \sum_{I=0}^{N-1} X_{LI} & \sum_{I=0}^{N-1} Y_{LI} & \sum_{I=0}^{N-1} 1 \end{pmatrix} \begin{pmatrix} a \\ b \\ c \end{pmatrix}$$

$$= \begin{pmatrix} \sum_{I=0}^{N-1} X_{MI}X_{LI} \\ \sum_{I=0}^{N-1} X_{MI}Y_{LI} \\ \sum_{I=0}^{N-1} X_{MI} \end{pmatrix} \qquad \text{Equation (1)}$$

$$\begin{pmatrix} \sum_{l=0}^{N-1} X_{Ll}^2 & \sum_{l=0}^{N-1} X_{Ll}Y_{Ll} & \sum_{l=0}^{N-1} X_{Ll} \\ \sum_{l=0}^{N-1} X_{Ll}Y_{Ll} & \sum_{l=0}^{N-1} Y_{Ll}^2 & \sum_{l=0}^{N-1} Y_{Ll} \\ \sum_{l=0}^{N-1} X_{Ll} & \sum_{l=0}^{N-1} Y_{Ll} & \sum_{l=0}^{N-1} 1 \end{pmatrix} \begin{pmatrix} d \\ e \\ f \end{pmatrix} = \begin{pmatrix} \sum_{l=0}^{N-1} Y_{Ml}X_{Ll} \\ \sum_{l=0}^{N-1} Y_{Ml}Y_{Ll} \\ \sum_{l=0}^{N-1} Y_{Ml} \end{pmatrix}$$

$a = 1 + S_x$
$b = \alpha + \theta$
$c = dx$
$d = -\theta$
$e = 1 + S_y$
$f = dy$

Equation (2)

(c) calculating the corrected coordinates (X_{Til}, Y_{Til}) of the alignment mark under application of said initial values;

$$\begin{pmatrix} X_{Til} \\ Y_{Til} \end{pmatrix} = \begin{pmatrix} 1+S_x & \alpha \\ -\theta & 1+S_y \end{pmatrix} \begin{pmatrix} X_{Ll} \\ Y_{Ll} \end{pmatrix} + \begin{pmatrix} dx \\ dy \end{pmatrix}$$

Equation (3)

(d) calculating

$$\Delta X_{il} = X_{Mi} - X_{Til}$$

$$\Delta Y_{il} = Y_{Mi} - Y_{Til}$$

and determining the residuals E_{Xil}, E_{Yil} in each of the alignment marks in accordance with the following rule on the basis of each of the set alignment displacement tolerance values tol_X, tol_Y in the directions X and Y

which are alignment displacement values allowable in design of the device

(A) In the case that $|\Delta X_{i1}| \leqq tol_X$ and $|\Delta Y_{i1}| \leqq tol_Y$

$E_{Xi1} = 0$

$E_{Yi1} = 0$

(B) In the case that $|\Delta X_{i1}| > tol_X$ and $|\Delta Y_{i1}| > tol_Y$:

$E_{Xi1} = |\Delta X_{i1}| - tol_X$

$E_{Yi1} = |\Delta Y_{i1}| - tol_Y$

(C) In the case that $|\Delta X_{i1}| \leqq tol_X$ and $|\Delta Y_{i1}| > tol_Y$:

$E_{Xi1} = 0$

$E_{Yi1} = |\Delta Y_{i1}| - tol_Y$

(D) In the case that $|\Delta X_{i1}| > tol_X$ and $|\Delta Y_{i1}| \leqq tol_Y$:

$E_{Xi1} = |\Delta X_{i1}| - tol_X$

$E_{Yi1} = 0$

(e) calculating a residual sum of squares R_1 in reference to the following equation (4) on the basis of these residuals E_{Xi1} and E_{Yi1}

$$R_1 = \sum_{I=0}^{N-1} E_{XI1}^2 + \sum_{I=0}^{N-1} E_{YI1}^2$$

Equation (4), and

(f) calculating the correction coordinate with said residual sum of squares being within a reference value.

7. An alignment method according to claim 3 in which a reference value of said residual sum of squares is either a minimum value or a local minimum value.

8. An alignment method according to claim 3 in which said residuals are calculated in reference to a shape of the actual lower layer pattern.

9. An alignment method according to claim 5 in which residuals are calculated with said lower layer pattern being of a substantial circular shape.

10. An alignment method for determining a position where a second pattern in respect to a first pattern is to be formed on the basis of measurement of positions of alignment marks of the number of N associated with the first pattern formed on a substrate comprising the steps of:

(a) measuring the positions of the alignment marks of the number of N associated with the first pattern and calculating the coordinates (X_{Mi}, Y_{Mi}) (where, i = 0, 1, 2, ... N-1. Subsequent is also similar) of each of the alignment marks in reference to a result of such measurement;

(b) under an assumption that offsets of errors in the directions X and Y of the alignment marks are

defined as dx, dy, a rotation angle of an error in a rotating direction of the alignment marks is defined as θ, an orthogonal degree of layout which is an error of orthogonal degree of layout in each of the alignment marks is defined as α, and scalings which are variation in magnification of the alignment marks in their directions X and Y are defined as S_X, S_Y, calculating initial values dx, dy, θ, α, S_X, S_Y for getting the alignment correction coefficients by a method of least squares in reference to the following equation (1) and the equation (2) on the basis of the coordinates (X_{Mi}, Y_{Mi}) of each of the alignment marks and the coordinates (X_{Li}, Y_{Li}) of the rational grid point corresponding to each of the alignment marks,

$$\begin{pmatrix} \sum_{I=0}^{N-1} X_{LI}^2 & \sum_{I=0}^{N-1} X_{LI}Y_{LI} & \sum_{I=0}^{N-1} X_{LI} \\ \sum_{I=0}^{N-1} X_{LI}Y_{LI} & \sum_{I=0}^{N-1} Y_{LI}^2 & \sum_{I=0}^{N-1} Y_{LI} \\ \sum_{I=0}^{N-1} X_{LI} & \sum_{I=0}^{N-1} Y_{LI} & \sum_{I=0}^{N-1} 1 \end{pmatrix} \begin{pmatrix} a \\ b \\ c \end{pmatrix}$$

$$= \begin{pmatrix} \sum_{I=0}^{N-1} X_{MI}X_{LI} \\ \sum_{I=0}^{N-1} X_{MI}Y_{LI} \\ \sum_{I=0}^{N-1} X_{MI} \end{pmatrix} \qquad \text{Equation (1)}$$

$$\begin{pmatrix} \sum_{l=0}^{N-1} X_{Ll}^2 & \sum_{l=0}^{N-1} X_{Ll}Y_{Ll} & \sum_{l=0}^{N-1} X_{Ll} \\ \sum_{l=0}^{N-1} X_{Ll}Y_{Ll} & \sum_{l=0}^{N-1} Y_{Ll}^2 & \sum_{l=0}^{N-1} Y_{Ll} \\ \sum_{l=0}^{N-1} X_{Ll} & \sum_{l=0}^{N-1} Y_{Ll} & \sum_{l=0}^{N-1} 1 \end{pmatrix} \begin{pmatrix} d \\ e \\ f \end{pmatrix} = \begin{pmatrix} \sum_{l=0}^{N-1} Y_{Ml}X_{Ll} \\ \sum_{l=0}^{N-1} Y_{Ml}Y_{Ll} \\ \sum_{l=0}^{N-1} Y_{Ml} \end{pmatrix}$$

$a = 1 + S_x$
$b = \alpha + \theta$
$c = dx$
$d = -\theta$
$e = 1 + S_y$
$f = dy$

Equation (2)

(c) calculating the corrected coordinates (X_{Til}, Y_{Til}) of the alignment mark under application of said initial values;

$$\begin{pmatrix} X_{Til} \\ Y_{Til} \end{pmatrix} = \begin{pmatrix} 1+S_x & \alpha \\ -\theta & 1+S_y \end{pmatrix} \begin{pmatrix} X_{Ll} \\ Y_{Ll} \end{pmatrix} + \begin{pmatrix} dx \\ dy \end{pmatrix}$$

Equation (3)

(d) calculating

$$\Delta X_{il} = X_{Mi} - X_{Til}$$

$$\Delta Y_{il} = Y_{Mi} - Y_{Til}$$

and determining the residuals E_{Xi1}, E_{Yi1} in each of the alignment marks in accordance with the following rule on the basis of each of the set alignment displacement tolerance values tol_X, tol_Y in the directions X and Y which are alignment displacement values allowable in design of the device

(A) In the case that $|\Delta X_{i1}| \leqq tol_X$ and $|\Delta Y_{i1}| \leqq tol_Y$

$E_{Xi1} = 0$

$E_{Yi1} = 0$

(B) In the case that $|\Delta X_{i1}| > tol_X$ and $|\Delta Y_{i1}| > tol_Y$:

$E_{Xi1} = |\Delta X_{i1}| - tol_X$

$E_{Yi1} = |\Delta Y_{i1}| - tol_Y$

(C) In the case that $|\Delta X_{i1}| \leqq tol_X$ and $|\Delta Y_{i1}| > tol_Y$:

$E_{Xi1} = 0$

$E_{Yi1} = |\Delta Y_{i1}| - tol_Y$

(D) In the case that $|\Delta X_{i1}| > tol_X$ and $|\Delta Y_{i1}| \leqq tol_Y$:

$E_{Xi1} = |\Delta X_{i1}| - tol_X$

$E_{Yi1} = 0$

calculating a residual sum of squares R_1 in reference to the following equation (4) on the basis of these residuals E_{Xi1} and E_{Yi1}

$$R_1 = \sum_{i=0}^{N-1} E_{Xi1}^2 + \sum_{i=0}^{N-1} E_{Yi1}^2$$

Equation (4), and

(e) repeating the step (c) for a plurality of times with the alignment correction coefficients dx, dy, θ, α, S_X, S_Y added by random number elements Δdx, Δdy, $\Delta\theta$, $\Delta\alpha$, ΔS_X, ΔS_Y being applied as new alignment correction coefficients dx, dy, θ, α, S_X, S_Y; and

(f) calculating the corrected coordinates (X_{TiF}, Y_{TiF}) of each of the alignment marks associated with the first pattern for optically exposing the second pattern with the following equation (5) in reference to the alignment correction coefficients dx, dy, θ, α, S_X, S_Y and each of the random number elements Δdx, Δdy, $\Delta\theta$, $\Delta\alpha$, ΔS_X, S_Y when the minimum residual sum R_1 of squares is attained

$$\begin{pmatrix} X_{TiF} \\ Y_{TiF} \end{pmatrix} = \begin{pmatrix} 1+S_x+\Delta S_x & \alpha+\Delta\alpha+\theta+\Delta\theta \\ -(\theta+\Delta\theta) & 1+S_y+\Delta S_y \end{pmatrix} \begin{pmatrix} X_{Li} \\ Y_{Li} \end{pmatrix} + \begin{pmatrix} dx+\Delta dx \\ dy+\Delta dy \end{pmatrix}$$

Equation (5)

~~11~~ 8. An alignment method according to claim ~~10~~ 7, wherein the residuals E_{Xil} and E_{Yil} in each of the alignment marks in said step (d) are changed and determined in accordance with the following rule

(A') In the case that $\Delta X_{il}^2 + \Delta Y_{il}^2 \leqq tol_X^2 + tol_Y^2$

$E_{Xil} = 0$

$E_{Yil} = 0$

(B') In the case that $\Delta X_{il}^2 + \Delta Y_{il}^2 > tol_X^2 + tol_Y^2$

$E_{Xil}^2 + E_{Yil}^2 = \Delta X_{il}^2 + \Delta Y_{il}^2 - (tol_X^2 + tol_Y^2)$

q12. An alignment method for determining a position where a third pattern in respect to a first pattern and a second pattern is to be formed on the basis of measurement of positions of alignment marks of the number of N associated with the first pattern formed on a substrate comprising the steps of:

(a) measuring the positions of the alignment marks of the number of N associated with the first pattern and calculating the coordinates of each of the alignment marks in reference to a result of such measurement;

(b) measuring positions of the alignment marks of the number of N associated with the second pattern and calculating the coordinates of each of the alignment marks in reference to a result of such measurement;

(c) calculating an alignment displacement amount in each of the alignment marks;

(d) calculating an initial value for getting an alignment correction coefficient under application of a method of least squares in reference to errors in the directions X and Y of the alignment marks associated

with the first pattern, errors in rotational directions of the alignment marks associated with the first pattern, errors of an orthogonal degree of alignment marks associated with the first pattern, errors of magnification in the directions X and Y of the alignment marks associated with the first pattern, the coordinates of each of the alignment marks associated with the first pattern, and the coordinates of the rational grid corresponding to each of said alignment marks;

(e) calculating the corrected coordinates under application of said correction coefficients;

(f) calculating a difference between said corrected coordinates and said alignment mark coordinates;

(g) calculating the second alignment tolerance values in the directions X and Y in reference to the first alignment displacement tolerance value and the alignment displacement amount in each of the directions X and Y calculated at said step (f);

(h) setting the residual of each of the alignment marks associated with said first pattern 0 when it is within said second tolerance value and making a sum of squares and making a sum of squares of residuals other than said second tolerance value on the

basis of the second tolerance value calculated at said step (f); and

(i) calculating the alignment correction coordinates in which said value of sum of squares is within a reference value; and

~~13. An alignment method according to claim 12 in which~~ a reference value of said sum of squares is either a minimum value or a local minimum value; and

~~14. An alignment method according to claim 12 in which~~ each of the alignment mark residuals associated with said first pattern of said step (h) is calculated in response to a shape of the actual lower layer pattern; and

~~15. An alignment method according to claim 14 in which~~ a residual is calculated with a shape of said actual lower layer pattern being of a substantial circular shape.

10 ~~16~~. An alignment method for determining a position where a third pattern in respect to a first pattern and a second pattern is to be formed on the basis of measurement of positions of alignment marks of the number of N associated with the first pattern formed on a substrate comprising the steps of:

(a) measuring the positions of the alignment marks of the number of N associated with the first pattern and calculating the coordinates (X_{Mi}, Y_{Mi}) (where, i = 0, 1, 2, ..., N-1. Subsequent is also similar) of each of the alignment marks in reference to a result of such measurement;

(b) measuring positions of the alignment marks of the number of N associated with the second pattern and getting the coordinates (X_{Mi2}, Y_{Mi2}) of each of the alignment marks in reference to a result of such measurement;

(c) calculating alignment displacement amounts Δe_{Xi}, Δe_{Yi} at each of the alignment marks in reference to the following equations (6-1) and (6-2)

$$\Delta e_{Xi} = X_{Mi2} - X_{Mi} \qquad \text{Equation (6-1)}$$

$$\Delta e_{Yi} = Y_{Mi2} - Y_{Mi} \qquad \text{Equation (6-2)}$$

(d) under an assumption that offsets of errors in the directions X and Y of the alignment marks associated with the first pattern are defined as dx, dy, a rotation angle of an error in a rotating direction of the alignment marks associated with the first pattern is defined as θ, an orthogonal degree of layout which is an error of orthogonal degree of layout in each of the alignment marks associated with the first pattern is

defined as α, and scalings which are variation in magnification of the alignment marks in their directions X and Y associated with the first pattern are defined as S_X, S_Y, calculating the alignment correction coefficients dx, dy, θ, α, S_X, S_Y by a method of least squares in reference to the following equation (1) and the equation (2) on the basis of the coordinates (X_{Mi}, Y_{Mi}) of each of the alignment marks and the coordinates (X_{Li}, Y_{Li}) of the rational grid point corresponding to each of said alignment marks,

$$\begin{pmatrix} \sum_{I=0}^{N-1} X_{LI}^2 & \sum_{I=0}^{N-1} X_{LI}Y_{LI} & \sum_{I=0}^{N-1} X_{LI} \\ \sum_{I=0}^{N-1} X_{LI}Y_{LI} & \sum_{I=0}^{N-1} Y_{LI}^2 & \sum_{I=0}^{N-1} Y_{LI} \\ \sum_{I=0}^{N-1} X_{LI} & \sum_{I=0}^{N-1} Y_{LI} & \sum_{I=0}^{N-1} i \end{pmatrix} \begin{pmatrix} a \\ b \\ c \end{pmatrix} \cdot$$

$$= \begin{pmatrix} \sum_{I=0}^{N-1} X_{MI}X_{LI} \\ \sum_{I=0}^{N-1} X_{MI}Y_{LI} \\ \sum_{I=0}^{N-1} X_{MI} \end{pmatrix}$$

Equation (1)

$$\begin{pmatrix} \sum_{I=0}^{N-1} X_{LI}^2 & \sum_{I=0}^{N-1} X_{LI}Y_{LI} & \sum_{I=0}^{N-1} X_{LI} \\ \sum_{I=0}^{N-1} X_{LI}Y_{LI} & \sum_{I=0}^{N-1} Y_{LI}^2 & \sum_{I=0}^{N-1} Y_{LI} \\ \sum_{I=0}^{N-1} X_{LI} & \sum_{I=0}^{N-1} Y_{LI} & \sum_{I=0}^{N-1} 1 \end{pmatrix} \begin{pmatrix} d \\ e \\ f \end{pmatrix} = \begin{pmatrix} \sum_{I=0}^{N-1} Y_{MI}X_{LI} \\ \sum_{I=0}^{N-1} Y_{MI}Y_{LI} \\ \sum_{I=0}^{N-1} Y_{MI} \end{pmatrix}$$

Equation (2)

where

$a = 1 + S_X$

$b = \alpha + \theta$

$c = dx$

$d = -\theta$

$e = 1 + S_Y$

$f = dy$

(e) calculating the corrected coordinates (X_{TIl}, Y_{TIl}) of the alignment mark under application of the following equation (3) in reference to the alignment correction coefficients dx, dy, θ, α, S_X, S_Y

$$\begin{pmatrix} X_{TIl} \\ Y_{TIl} \end{pmatrix} = \begin{pmatrix} 1+S_x & \alpha \\ -\theta & 1+S_y \end{pmatrix} \begin{pmatrix} X_{LI} \\ Y_{LI} \end{pmatrix} + \begin{pmatrix} dx \\ dy \end{pmatrix}$$

Equation (3)

then, calculating

$\Delta X_{Il} = X_{MI} - X_{TIl}$

$\Delta Y_{Il} = Y_{MI} - Y_{TIl}$

then, determining alignment displacement tolerance values tol_X and tol_Y in the directions X and Y which are alignment displacement values allowable in design of the device, alignment displacement amounts Δe_{Xi}, Δe_{Yi} calculated at said step (f), new alignment displacement tolerances tol_X' and tol_Y'in the directions X and Y on the basis of said ΔX_{i1}, ΔY_{i1} in accordance with the following rule;

in the case that (x - 1) $\Delta e_{Xi} \geqq 0$ and $\Delta X_{i0} \geqq 0$:

$tol_X' = tol_X$

in the case that (x - 2) $\Delta e_{Xi} \geqq 0$ and $\Delta X_{i0} < 0$:

$tol_X' = tol_X - |\Delta e_{Xi}|$

in the case that (x - 3) $\Delta e_{Xi} < 0$ and $\Delta X_{i0} \geqq 0$:

$tol_X' = tol_X - |\Delta e_{Xi}|$

in the case that (x - 4) $\Delta e_{Xi} < 0$ and $\Delta X_{i0} < 0$:

$tol_X' = tol_X$

in the case that (y - 1) $\Delta e_{Yi} \geqq 0$ and $\Delta Y_{i0} \geqq 0$:

$tol_Y' = tol_Y$

in the case that (y - 2) $\Delta e_{Yi} \geqq 0$ and $\Delta Y_{i0} < 0$:

$tol_Y' = tol_Y - |\Delta e_{Yi}|$

in the case that (y - 3) $\Delta e_{Yi} < 0$ and $\Delta Y_{i0} \geqq 0$:

$tol_Y' = tol_Y - |\Delta e_{Yi}|$

in the case that (y - 4) $\Delta e_{Yi} < 0$ and $\Delta Y_{i0} < 0$:

$tol_Y' = tol_Y$

and determining the residuals E_{Xi1}, E_{Yi1} in each of the alignment marks associated with the first pattern on the basis of each of the tol_X', tol_Y' in accordance with the following rule,

(A) in the case that $|\Delta X_{i1}| \leqq tol_X'$ and $|\Delta Y_{i1}| \leqq tol_Y'$

$E_{Xi1} = 0$

$E_{Yi1} = 0$

(B) in the case that $|\Delta X_{i1}| > tol_X'$ and $|\Delta Y_{i1}| > tol_Y'$:

$E_{Xi1} = |\Delta X_{i1}| - tol_X'$

$E_{Yi1} = |\Delta Y_{i1}| - tol_Y'$

(C) in the case that $|\Delta X_{i1}| \leqq tol_X'$ and $|\Delta Y_{i1}| > tol_Y'$:

$E_{Xi1} = 0$

$E_{Yi1} = |\Delta Y_{i1}| - tol_Y'$

(D) In the case that $|\Delta X_{i1}| > tol_X'$ and $|\Delta Y_{i1}| \leqq tol_Y'$:

$E_{Xi1} = |\Delta X_{i1}| - tol_X'$

$E_{Yi1} = 0$

then calculating a residual sum of squares R_1 in reference to the following equation (4) on the basis of these residuals E_{Xi1} and E_{Yi1}

$$R_1 = \sum_{I=0}^{N-1} E_{XI1}^2 + \sum_{I=0}^{N-1} E_{YI1}^2$$

Equation (4), and

(g) repeating the step (e) for a plurality of times with the alignment correction coefficients dx, dy,

θ, α, S_X, S_Y added with the elements Δdx, Δdy, $\Delta\theta$, $\Delta\alpha$, ΔS_X, ΔS_Y being applied as new alignment correction coefficients dx, dy, θ, α, S_X, S_Y; and

(h) calculating the corrected coordinates (X_{TiF}, Y_{TiF}) of the alignment mark associated with the first pattern for optically exposing the third pattern in accordance with the following equation (5) on the basis of the alignment correction coefficients dx, dy, θ, α, S_X, S_Y and each of the elements Δdx, Δdy, $\Delta\theta$, $\Delta\alpha$, ΔS_X, ΔS_Y when the minimum residual sum of squares R_1 is obtained,

$$\begin{pmatrix} X_{TiF} \\ Y_{TiF} \end{pmatrix} = \begin{pmatrix} 1+S_x+\Delta S_x & \alpha+\Delta\alpha+\theta+\Delta\theta \\ -(\theta+\Delta\theta) & 1+S_y+\Delta S_y \end{pmatrix} \begin{pmatrix} X_{Li} \\ Y_{Li} \end{pmatrix} + \begin{pmatrix} dx+\Delta dx \\ dy+\Delta dy \end{pmatrix}$$

Equation (5)

11. An alignment method according to claim 1 in which the residuals E_{Xil}, E_{Yil} in each of the alignment marks associated with the first pattern in said step (e) are changed and determined in accordance with the following rule,

(A') In the case that $\Delta X_{il}^2 + \Delta Y_{il}^2 \leqq tol_X^2 + tol_Y^2$

$E_{Xil} = 0$

$E_{Yil} = 0$

(B') In the case that $\Delta X_{i1}^2 + \Delta Y_{i1}^2 > tol_X^2 + tol_Y^2$

$E_{Xi1}^2 + E_{Yi1}^2 = \Delta X_{i1}^2 + \Delta Y_{i1}^2 - (tol_X'^2 + tol_Y'^2)$