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(54) **A method of reconstructing successive scans of a bar code**

Verfahren zur Wiederherstellung aufeinanderfolgender Abtastungen eines Strichcodes

Méthode de reconstruction d'un code barres à partir de balayages successifs

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(56) References cited:
EP-A- 0 436 072 **US-A- 5 387 787**

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Description

[0001] The invention relates to a method of reconstructing successive scans of a bar code.

5 **[0002]** As is known, bar codes (Fig. 2) are optical codes containing coded information made up of a plurality of rectangular elements (bars) having a dark colour (normally black) separated by light elements (spaces, normally white).

[0003] Reading devices for the said bar codes usually comprise an illumination device (e.g. a laser beam source) adapted to send an optical reading beam which moves along a scanning path intersecting the bar code and also comprise a sensor (e.g. a photodiode) which receives part of the diffused light from the portion of the scanning path illuminated by the laser spot. The sensor, in response to the radiation falling on it as a result of scanning a bar code, outputs an alternating electric signal having a wave shape which is modulated by the succession of light and dark elements in the bar code. As is known, light is absorbed by the bars and reflected by the spaces, so that the signal generated by a space has a high value owing to the large amount of incident radiation on the sensor, whereas the signal generated by a bar has a low value owing to the small amount of incident radiation on the sensor.

10 **[0004]** In this manner, a signal generated by scanning the bar code is successively binarised and has a two-level wave shape which represents the elements of the bar code and comprises a first high level when scanning a space and a second low level when scanning a bar.

[0005] Normally bar codes are examined in a scanning direction which does not coincide with the longitudinal axis of the code. The scanning direction is therefore usually at an angle to the longitudinal axis of the bar code. More particularly, when this angle exceeds a threshold value α_{max} (Fig. 2), a subset of the code elements are scanned and the binarised signal, which relates to a partial scan of the bar code, comprises a subset of the code elements.

20 **[0006]** In known devices also, relative movement occurs between the illumination device and the objects bearing the bar codes. For example the illumination device is fixed and the objects move with respect to the illumination device at a constant speed, when carried by a moving device.

[0007] For this reason, successive partial scans normally relate to scanning of various adjacent subgroups in the bar code.

25 **[0008]** Some known reconstruction devices are adapted to put together successive partial scans of the same code, made in different positions, in order to reconstruct and decode the bar code.

[0009] Reconstruction devices of this kind, which put together those elements of a partial scan which have a given inclination with respect to the longitudinal axis of the bar code, effect an omnidirectional readout of the code.

30 **[0010]** EP 0 436 072 discloses i.a. a method for decoding bar code symbols in which a bar code reader and associated components using timing information associated with the flying spot beam as it scans a bar code symbol having a succession of linear elements of different light reflectivity, produce a representation of the symbol and attempt to decode the representation of the symbol in order to produce a legitimate character message containing legitimate characters which are decodable. A first and a second representation of the bar code symbol are stored corresponding to a first and a second scan path through a first and a second portion of said symbol along with timing information representing the elapsed time between a first and a second reference time and the moment at which a predetermined bar or space of a predetermined character was crossed by the spot. The timing information is utilized in conjunction with the stored information to reconstitute the complete symbol. More in particular, a predicted time from the next start-of-scan change to the start of a character is calculated and used as a reference time to locate and decode the stored representation of a character in the next scan, where the character is the last successfully decoded character of the previous scan.

35 **[0011]** Thus, the method implements a reconstruction of the code character by character instead of element by element.

[0012] Moreover, the position of the characters of the bar code is referred to the beginning of the relevant scan. Also, one character of the code is chosen and its expected start position in a subsequent scan is calculated so that the character chosen is looked for, using a decoding algorithm, in the subsequent scan. No comparison of the elements of the two scans is carried out.

45 **[0013]** US 5,387,787 discloses a method for reading machine readable code, comprising the steps of:

- 50 - scanning the code to provide a signal representative of at least a portion of the code, and repeating scanning to obtain signals for additional portions of the code;
- successively processing each signal representative of the portion of the code obtained from each scan to provide signal identification data, including a width and position associated with each of said signals, for each successive scan of the code; and
- 55 - reconstructing the code from said signal identification data for each successive scan of the code, said reconstructing including the steps of:
 - selecting an element in a previous scan;
 - calculating the position of said element in a successive scan based upon a calculated offset, said calculated

- offset determined by the step of calculating the difference in position of features in previous scans; and
- aligning said successive scan with said previous scan by means of said calculated offset by the step of placing said selected element in said successive scan in alignment with said selected element in said previous scan;
 - verifying the alignment between said previous scan and said successive scan performed as a result of step of aligning, wherein said step of verifying further comprises the step of attempting a predetermined number of additional alignments between said previous scan and said successive scan when said previous scan and said successive scan are not aligned by said step of aligning.

[0014] Therefore, US 5,387,787 discloses a method of reconstructing successive scans of a bar code comprising a plurality of elements, each of said elements having a first or a second reflectivity and being represented by a width and a position with respect to a reference position, comprising the steps of:

- obtaining a shift amount representative of the displacement of the bar code elements between two scans successive to one another;
- performing a first scan of the bar code, determining the position and the width of the elements in the first scan with respect to a reference position;
- performing a second scan of the bar code, determining the position and the width of the elements in said second scan with respect to said reference position;
- aligning said first scan and said second scan based on said shift amount;
- carrying out a correspondence search step in order to find one reference element in said first scan and one reference element in said second scan which have substantially the same width; and
- combining the elements in said first scan with the elements in said second scan so as to generate a reconstructed scan.

[0015] The position identification data of the elements of the bar code is not referred to an absolute reference position. Also, in said alignment step, one single element of the code is chosen from said first scan and its expected position in the second scan is calculated based on the shift amount so that the single chosen element is looked for in the second scan to align the two scans based on it. The elements of the two scans are then compared, in said correspondence search step, only as far as their width is concerned.

[0016] Bar code reconstruction according to the prior art suffers therefore from inaccuracies due to the lack of taking due account of the position of the elements of the code.

[0017] The object of the invention is to provide a method of reconstructing successive partial scans of a bar code, featuring a particularly efficient omnidirectional reading of the code. Furthermore, object of the invention is to provide a method of reconstructing successive partial scans so as to efficiently manipulate the successive partial scans.

[0018] This object is achieved by the invention according to claim 1. Further advantageous embodiments are recited in the dependent claims.

[0019] The invention will now be described with reference to the accompanying drawings which illustrate a non-limitative embodiment thereof and in which:

Fig. 1 is a diagram of a device for reading bar codes, using the method according to the invention;

Fig. 2 shows a bar code;

Fig. 3a is a logic block diagram illustrating a sequence of steps of the method according to the invention;

Fig. 3b shows a detail of a block in Fig. 3a;

Fig. 3c shows a detail of a block in Fig. 3b;

Fig. 3d shows a detail of a block in Fig. 3b;

Fig. 3e shows a detail of a block in Fig. 3b;

Fig. 3f shows a detail of a block in Fig. 3b;

Fig. 3g shows a detail of a block in Fig. 3f;

Figs. 3h and 3i show details of a block in Fig. 3f;

Fig. 3j shows a detail of a block in Fig. 3f;

Fig. 3l shows a detail of a block in Fig. 3f;

5 Figs. 3m and 3n show a different embodiment with respect to Figs. 3h and 3i;

Figs. 4a and 4b show the time function of an electric signal relating to scanning of a bar code;

10 Fig. 5 illustrates scanning of the bar code of Fig. 2;

Fig. 6 shows a data structure constructed according to the invention;

Fig. 7 shows the time function of signals obtained by the method according to the invention;

15 Fig. 8 shows a step of the method according to the invention and

Fig. 9 shows a subsequent step of the method according to the invention.

20 **[0020]** In Fig. 1, reference number 1 indicates as a whole a bar code reading device comprising a reading head 5 facing a conveyor belt 6 and adapted to pick out objects 7 (e.g. packets) disposed on the belt 6 and movable in a rectilinear direction D at a constant speed with respect to the reading head 5. One surface 7a of each object 7 facing the reading head 5 bears one or more optical codes 8, more particularly bar codes of known kind (Fig. 2). Each bar code is made up of a plurality of rectangular portions (bars) having varying reflectivity, more particularly dark (normally black) portions separated by light portions (spaces, normally white). Different dark and light portions (bars and spaces) can have different widths.

[0021] The light and dark portions of the code, i.e. the bars and spaces, are the elements of the bar code. In the following description, therefore, a code "element" will mean a bar or a space of the code.

[0022] Adjacent elements of the code together form a character of the code, to which coded information is associated.

30 **[0023]** More particularly the bar code, near a first end portion thereof, has a plurality of elements which together define a code starting character, hereinafter called a START pattern (Fig. 2). Furthermore, the bar code, near a second end portion thereof, has a plurality of elements which together define an end-of-code character, hereinafter called a STOP pattern. The beginning-of-code and end-of-code characters, i.e. the START pattern and the STOP pattern, define the so-called "synchronism characters" of the code.

35 **[0024]** The reading head 5 comprises a known illumination device 17 (e.g. comprising a laser source 17a and a rotating prismatic mirror 17b adapted to reflect the laser beam produced by the source 17a), for directing a laser scanning beam F on to the optical codes 8 and scanning the codes 8.

[0025] More particularly the laser beam F moves in a substantially inclined plane and intersects the belt 6 and the objects thereon along a scanning path L on which the laser spot moves from a beginning-of-scanning position Li to an end-of-scanning position Lf.

40 **[0026]** The reading head 5 also comprises a sensor 20 (e.g. a photodiode) associated with an optical acquisition and focusing system 21 (diagrammatically represented) for picking up the diffused light radiation R in order to generate an output analog signal S(t) having an intensity proportional to the brightness of the portion of the path L which is being scanned at that moment. The analog signal S(t) is fed to an electronic unit 22 which processes the analog signal S(t) according to the invention. The unit 22 is also adapted to pick up the coded information associated with the code.

45 **[0027]** Of course, the reading device described with reference to Fig. 1 is one example of the various reading devices which could be used in association with the method according to the invention; the device 1 could be of a different kind and could e.g. comprise a lamp or LEDs for illuminating the bar codes, or a telecamera or a CCD for picking up a grey-level bidimensional image of the bar codes and of the successive processing devices, which likewise output a signal S(t) having an intensity proportional to the brightness of a portion of a scanned bar code.

50 **[0028]** Fig. 3a is a general block diagram of the operating cycle of an electronic processing unit 22.

[0029] More particularly Fig. 3a proceeds from a starting block (START) to a block 100 which acquires the analog signal S(t) generated by the sensor 20 after a complete scan of scanning path L. A "complete scan" means a scan in which the laser spot moves from the beginning-of-scanning position Li to the end-of-scanning position Lf.

55 **[0030]** The analog signal S(t) typically has an initial portion corresponding to scanning the beginning-of-scanning position Li (Fig. 1), a final portion corresponding to scanning the end-of-scanning position Lf and an intermediate section which, corresponding to a scanned bar code, comprises an alternating section (shown in Fig. 4a) formed by a sequence of zones P having a high amplitude (peaks) separated by zones V of low amplitude (valleys).

[0031] In the wave form of the alternating section of the signal S(t), a peak P represents a space whereas a valley

V represents a bar.

[0032] The analog signal $S(t)$ is then binarised in the block 100 and, corresponding to an alternating section thereof, outputs a signal $S_d(t)$ having two levels (shown in Fig. 4b) comprising a first high level HI on scanning a space and a second low level LO on scanning a bar. The high levels HI and low levels LO of the signal $S_d(t)$ are joined by substantially vertical transition fronts which separate the different-level portions of the signal $S_d(t)$ and represent the separation zone between two different elements (bar-space) of the code.

[0033] The wave form of the binarised signal $S_d(t)$ is situated on a time axis having its origin (time t_0) at the instant when scanning begins, i.e. the instant at which the laser spot illuminates the beginning-of-scanning position L_i .

[0034] The beginning-of-scanning position L_i is an absolute spatial reference to which the positions of the bar code elements are referred and consequently the instant t_0 is taken as an absolute time reference with respect to which the positions in time of the code elements represented by the signal $S_d(t)$ are measured.

[0035] More particularly the time T_p measured between the time origin t_0 and an instant t_i when a digitised signal front $S_d(t)$ is present, represents the time distance between the bar code element following the considered front and the absolute reference (t_0).

[0036] The time interval T_p represents the position of a bar code element with respect to the beginning-of-scanning position.

[0037] The time width T_c of the high-level portion HI and/or low-level portion LO of the digitised signal $S_d(t)$ represents the width of a bar code element.

[0038] For this reason, each bar code element is represented in the signal $S_d(t)$ by a time interval T_p which represents the position of the bar code element with respect to the absolute reference (time t_0 equivalent to the beginning-of-scanning position L_i) and by a time interval T_c which represents the width of the code element.

[0039] In the subsequent description, for simplicity, reference will be made to the position of the code element, meaning by this term the time distance T_p thereof, whereas by "width of the code element" the time interval T_c is meant.

[0040] In the following description also, the term FRAME will mean a set of code elements as represented by the digitised signal $S_d(t)$.

[0041] In other words, each FRAME comprises a plurality of positions and widths representing the elements of the scanned bar code.

[0042] A FRAME, for example, can be represented by a table TABF (Fig. 9) in which:

- a first line comprises a number of cells each of which contains the position, with respect to the absolute reference to (time T_p), of an element of the FRAME and therefore represents the position of a bar code element; and
- a second line comprises a plurality of cells each of which contains the width (time T_c) of the corresponding FRAME element and consequently represents the width of a bar code element.

[0043] In the following description, the term CLUSTER means a set of FRAMES grouped together by methods described hereinafter. In practice, each CLUSTER represents a storage area in which the FRAMES relating to a given bar code are stored, in the same order as the FRAMES themselves are acquired during successive scans as explained hereinafter.

[0044] In similar manner to the FRAMES, the CLUSTER elements are represented e.g. by a table TABC (Fig. 9) in which:

- a first row comprises a plurality of cells each of which contains the position, with respect to the absolute reference to (time T_p), of an element of the CLUSTER and therefore represents the position of a bar code element grouped in the CLUSTER; and
- a second row comprises a plurality of cells each of which contains the width (time T_c) of the corresponding element of the CLUSTER and therefore represents the width of a bar code element grouped in the CLUSTER.

[0045] Tables TABC and TABF can be scanned by respective pointers i and j which are able to select pairs of cells (one from the first row and another from the second row) which define a bar code element through its position and its width.

[0046] When a number of optical codes or a number of portions of optical codes are illuminated by a single scan, the signal $S_d(t)$ comprises a set of distinct different FRAMES F_1, F_2, \dots, F_n .

[0047] A FRAME contains all the elements of a bar code only when the scan occurs along a line between the longitudinal axis H of the code and a line L' (Fig. 2) having an inclination equal to α_{max} with respect to the axis H.

[0048] However, the objects 7 and the optical codes 8 thereon have an arbitrary relative arrangement with respect to the scanning path L. Consequently the scanning line normally intersects only a part of the bar code.

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[0049] For this reason, each FRAME normally relates to scanning of a subgroup of the bar code elements (not of the entire bar code). Consequently each FRAME relates to a partial scan and represents the cited subgroup of elements.

[0050] Furthermore, owing to the motion of the objects 7 with respect to the reading head 5, successive partial scans L1, L2, ... (Fig. 5) intersect adjacent portions of the code and produce successive FRAMES which relate to different subgroups of elements. Also, the invention relates to a method of reconstructing successive partial scans of bar codes starting from a general signal representing the code elements. It does not matter how the signal was generated or processed.

[0051] As will be clearer in the following description, the successive FRAMES relating to scanning of the same code are grouped in a respective CLUSTER which can be individually selected on the basis of the value taken by a pointer i.

[0052] Each CLUSTER is also marked by a first index called STATUS, which indicates the state of the CLUSTER; more particularly the index can take three values corresponding to three different situations:

- STATUS = 0 - the associated CLUSTER is empty, i.e. is not associated with any active data structure in which FRAMES can be grouped;
- STATUS = 1 - the associated CLUSTER contains a frame whereby a synchronism character, i.e. a START pattern or a STOP pattern, has been recognised for a first time; and
- STATUS = 2 - the CLUSTER contains at least two FRAMES whereby synchronism characters have been recognised.

[0053] In the following description, STATUS 1 and STATUS 2 will be called active states, whereas STATUS 0 will be called inactive state. Of course, when the algorithm is activated, the STATUS index of all the CLUSTERS will be zero. Subsequently the STATUS index of the CLUSTERS is modified (transferred to one of the two active states or set at zero) depending on the result of checks made on the CLUSTER itself or on the result of attempts to couple each CLUSTER to the extracted FRAMES as described in detail. Consequently, active CLUSTERS and inactive CLUSTERS will generally be present at every moment.

[0054] Each CLUSTER is also marked by a second index called NOMATCH which represents the number of failed attempts made to associate additional FRAMES to the same CLUSTER.

[0055] The block 100 is followed by a block 110 for cancelling the contents i of a counter in accordance with the logic operation $i = 0$.

[0056] The block 110 is followed by a block 120 which selects the i^{th} CLUSTER and checks the status of the first STATUS index associated with this i^{th} CLUSTER. More particularly the block 120 checks whether the STATUS index of the i^{th} CLUSTER is an active state, i.e.:

CLUSTER(i), STATUS = 1; or
CLUSTER(i), STATUS = 2

[0057] In the case where the check by block 120 gives a positive result (i.e. the i^{th} CLUSTER examined is in the active state), a block 130 is selected; otherwise (i^{th} CLUSTER inactive) the block 120 is followed by a block 140.

[0058] The block 130 re-selects the i^{th} CLUSTER and checks the value of the second NOMATCH index; more particularly if the NOMATCH index is equal to or above a threshold value MAX-NOMATCH, i.e. if at least MAX-NOMATCH failed attempts have been made to associate the i^{th} CLUSTER with additional FRAMES, block 130 will select a block 150 for forcing to zero the first STATUS index of the i^{th} CLUSTER which at present is active, i.e.:

CLUSTER(i), STATUS = 0

[0059] In other words, active CLUSTERS for which at least MAX-NOMATCH failed attempts have been made to associate them with new FRAMES are transferred to the inactive state, i.e. cancelled and made available for storing FRAME elements which cannot be associated with active CLUSTERS.

[0060] The block 150 is followed by block 140.

[0061] The block 140 is adapted to examine the current value i of the counter. If the value is below the maximum number of CLUSTERS present in the memory ($i < \text{MAXIMUM NUMBER OF CLUSTERS}$) the block 140 is followed by a block 160 which increases by one unit the contents i of the counter, by the logic operation $i = i + 1$, and a return is made from block 160 to block 120.

[0062] If block 140 detects that the contents i of the counter is equal to the number of CLUSTERS present in the memory ($i = \text{MAXIMUM NUMBER OF CLUSTER}$) block 140 is followed by block 170.

[0063] The preceding operations have the combined result of scanning the set of all the CLUSTERS present in the

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memory and the following operations are performed for each scanned CLUSTER:

- if the CLUSTER is marked by an inactive state index (STATUS = 0), the CLUSTER is not modified (i.e. no type of operation is performed); and
- if the CLUSTER is marked by an active state index (STATUS = 1, 2), the number of failed attempts to associate the said CLUSTER with additional frames is checked and, if the threshold value MAX-NOMATCH is exceeded, the CLUSTER is put in the inactive state by forcing to zero the STATUS index.

[0064] The block 170 is adapted in known manner to select a single FRAME F_i from the signal $S_d(t)$ relating to a complete scan.

[0065] The block 170 is followed by a block 180 adapted to count the number N_f of elements of the FRAME F_i previously selected, i.e. the number of bar code elements represented by the FRAME. If the number N_f is above a minimum number of elements defining a threshold value, the block 180 is followed by a block 190, otherwise the block 180 is followed by a block 200. The block 190 (described in detail hereinafter) selected when the FRAME F_i comprises a number of elements above the minimum number of elements is adapted to process the FRAME, i.e. is adapted to try to associate the FRAME F_i with each active CLUSTER. The block 190 is in any case followed by the block 200, which checks whether the FRAME F_i under examination is the last FRAME contained in the scan detected by the block 100. If not, a return is made from block 200 to block 170 in order to select another FRAME F_{i+1} , or otherwise (after examination of the FRAMES in the scan) a return, is made from block 200 to block 100 in order to acquire another scan. In the other scan, of course, the objects 7 will be in a different position from the preceding scan and consequently different portions of the bar code will be scanned and FRAMES will be detected relating to partial scans of the codes made in different successive positions from the positions in the preceding scan.

[0066] Fig. 3b gives a detailed view of the block 190 adapted to process the FRAME F_i extracted from the block 170. The process consists in attempting to associate the FRAME F_i with all the active CLUSTERS present in the memory.

[0067] More particularly the block 190 comprises a block 192 adapted to select a first CLUSTER. The block 192 is followed by a block 193 which checks whether the selected CLUSTER is an active CLUSTER; if so (the selected CLUSTER is active) the block 193 is followed by a block 195, otherwise (the selected CLUSTER is inactive) a block 191 is selected, which checks whether the selected CLUSTER is the last CLUSTER present in the memory. If not so (other CLUSTERS are present in the memory) the block 191 returns to block 192, otherwise (after examination of the CLUSTERS present in the memory) the block 191 selects a block 194.

[0068] The combined results of the previously-described operation is to scan all the CLUSTERS (active and inactive) and select the active CLUSTERS only. In the case of each selected active CLUSTER, an attempt is made to associate the FRAME F_i as described hereinafter.

[0069] Initially, the block 195 (described in detail hereinafter) checks whether the FRAME F_i and the selected CLUSTER intersect, i.e. whether the FRAME and the CLUSTER comprise elements which have comparable positions when superposed.

[0070] If the check of the block 195 gives a negative result (the FRAME F_i and the CLUSTER do not intersect) a return is made from block 195 to block 191. Otherwise (the FRAME F_i and the CLUSTER intersect and can be combined) the block 195 is followed by a block 196.

[0071] The block 196 modifies a state index of the FRAME, by putting it in a state indicating the use made of the FRAME. Indeed this use is made subsequently during the next attempt to combine the FRAME F_i with the various active CLUSTERS.

[0072] The block 196 is followed by a block 197 which checks whether the FRAME F_i has already been decoded; if not (no attempt has yet been made to decode the FRAME) the block 197 is followed by a block 197a which attempts this decoding. Otherwise (the FRAME has already been decoded) the block 197 is followed by a block 198. The fact that the FRAME has been successfully decoded in block 197a means that this FRAME comprises all the elements of the bar code; in that case it is of course unnecessary to reconstruct the successive partial scans. The decoded code is therefore transmitted to the exterior of the unit 22.

[0073] The block 198 (described in detail hereinafter) tries to combine the FRAME F_i with a first active CLUSTER; if the attempt has a negative result, the contents of a counter measuring the NOMATCH number of failed combination attempts made by the CLUSTER is incremented by one unit and the block 198 is followed by the block 191 and, if this was not the last cluster, by the block 192 for selecting another active CLUSTER and repeating the effort to combine the same FRAME F_i with the additional CLUSTER.

[0074] If the combination process in the block 198 has given a positive result, the block 198 is followed by a block 198a which tries to decode the CLUSTER to which the FRAME F_i has been successfully added. If the CLUSTER is successfully decoded, the decoded code is transmitted to the exterior of the unit 22. The block 198a is likewise followed by the block 191.

[0075] The block 194 checks the value of the state index of the FRAME F_i indicative of its use. If the index indicates that the FRAME F_i has been subjected to a combination attempt with at least one active CLUSTER, a transition is made from block 194 to block 200 (Fig. 3a) for selecting (block 170) an additional FRAME F_{i+1} which will be subjected to the operations in block 190 described with reference to Fig. 3b. If the state index of the FRAME indicates that the FRAME F_i has not yet been subjected to a combination attempt, the block 194 is followed by a block 194a (described in detail hereinafter) which initialises a CLUSTER by inserting the FRAME F_i into it. The block 194a is likewise followed by the block 200.

[0076] Fig. 3c shows details of the block 195 which checks whether the FRAME F_i and the selected CLUSTER intersect and are therefore superposable.

[0077] The block 195 comprises a first block 195a which checks whether the position T_{fi} (Fig. 7) of the last element in the FRAME with respect to the absolute reference (the beginning-of-scanning position corresponding to the time t_0) is lower than the position T_{cf} of the first element of the CLUSTER with respect to the absolute reference, i.e.

$$T_{fi} < T_{cf} \quad (1).$$

[0078] If the inequality (1) hereinbefore gives a positive result, the CLUSTER and the FRAME are recognised as non-superposable and a return is made from block 195a to block 191. If the inequality (1) hereinbefore gives a negative result, the block 195a is followed by a block 195b.

[0079] The block 195b checks whether the position T_{ff} of the first element in the FRAME with respect to the absolute reference is higher than the position T_{ci} of the last element in the CLUSTER with respect to the absolute reference, i.e.:

$$T_{ci} < T_{ff} \quad (2).$$

[0080] If the inequality (2) hereinbefore gives a positive result, the CLUSTER and the FRAME are recognised as non-superposable and a return is made from block 195b to block 191. If both the inequalities (1) and (2) hereinbefore give a negative result, the CLUSTER and the FRAME are recognised as superposable and the block 195b is followed by the block 196. Fig. 7 illustrates the case where both inequalities have given a negative result, when as can be seen the CLUSTER and the FRAME have a superposed zone SZ (indicated by shading) containing elements having comparable positions in the CLUSTER and in the FRAME.

[0081] Fig. 3d illustrates the blocks 197a or 198a, which try to decode the FRAME (or the CLUSTER).

[0082] The block 197a, 198a comprises an initial block 201 which checks whether the length of the FRAME (or the CLUSTER) is acceptable for a bar code, i.e. whether it contains a number of elements compatible with a bar code.

[0083] If not (the FRAME or CLUSTER has a length incompatible with the length of a bar code) the block 201 is followed by the block 198 (or 191), otherwise the block 201 is followed by a block 202. The block 202 tries to decode the FRAME (or the CLUSTER) in a manner known per se, e.g. as described in US-A-3 723 710, US-A-3 761 685 or US-A-3 838 251. Decoding the frame in block 202 is sufficient in those fortunate cases where the entire code is read from the first scans. In such cases it is impossible to couple the FRAME to the relevant CLUSTER a second time (as explained in detail hereinafter with reference to block 400 in Fig. 3g) and consequently the process does not go via the block 198a (Fig. 3b) for decoding the CLUSTER. If no decoding occurs the block 202 is followed by the block 198 (or 191), or otherwise (the FRAME or CLUSTER is decoded successfully) the block 202 is followed by a block 203. The block 203 transmits the contents of decoding the FRAME (or CLUSTER) to the exterior of the unit 22, thus decoding the bar code. The block 203 is followed by a block 204 which indicates that the FRAME (or CLUSTER) has been decoded. The block 204 is followed by block 198 (or 191). Although the FRAME (or CLUSTER) has been decoded, efforts are still made to associate the FRAME with other CLUSTERS, since the wrong code may have been decoded. Subsequently and in known manner, the true decoding of the code is chosen from among all decodings made.

[0084] Fig. 3e illustrates block 194a, which initialises a CLUSTER. Block 194a comprises an initial block 206 for checking whether there is a synchronism character in the FRAME under examination. If the check by block 206 is positive, a transition is made to a block 207, otherwise the block 206 is followed by block 200.

[0085] The block 207 copies all the elements of the FRAME inside a CLUSTER by transferring the position and width of all the FRAME elements to the CLUSTER.

[0086] The block 207 is followed by a block 208 which sets the state index of the CLUSTER at 1, i.e. STATUS = 1 in that the CLUSTER now contains a FRAME containing a synchronism character. The block 208 is followed by the block 200.

[0087] In other words, if the FRAME has not been used in any active CLUSTER, an attempt at initialisation is made by copying the FRAME in a new CLUSTER, but only if the FRAME has a synchronism character.

[0088] Fig. 3f gives a detailed view of the block 198 which tries to associate a FRAME F_i with an active CLUSTER.

[0089] The block 198 comprises an initial block 300 which controls the state index, variable between 1 and 2, of the CLUSTER. The CLUSTERS examined by block 300 are only active CLUSTERS, i.e. undoubtedly contain at least one FRAME in which a synchronism character is present. The block 300 selects a block 310 if a STATUS of 1 is detected, or a block 320 if a STATUS of 2 is detected.

[0090] Basically the block 310 is selected on examination of a CLUSTER which contains a single FRAME in which a synchronism character is present.

[0091] The block 310 checks whether the FRAME under examination contains a second synchronism character. If the check is negative, the block 310 is followed by a block 330 which cancels the CLUSTER by setting its state at zero, i.e. the CLUSTER is made inactive and the possible reconstruction is blocked. The block 330 is also followed by the block 191.

[0092] In the case of a positive check by the block 310, i.e. if the FRAME contains a second synchronism character, reconstruction begins. Therefore, reconstruction begins only after detection of two successive FRAMES each containing a synchronism character.

[0093] To this end the block 310 is followed by a block 340 (described in detail hereinafter) which checks for correspondence between the FRAME and the CLUSTER in order to check whether the FRAME and the CLUSTER belong to the same code.

[0094] The block 340 selects a block 345 if the check gives a negative result (FRAME and CLUSTER not aligned) or a block 350 if the check is positive (FRAME and CLUSTER in line), thus setting the STATUS of the CLUSTER at 2. The block 345 increases the counter defining the NOMATCH number by one unit; this block is in fact selected after a failed attempt when searching for correspondence between a FRAME and a CLUSTER. The block 345 is then followed by the block 191.

[0095] The block 340 then calculates the distance between the synchronism character of the FRAME and the corresponding synchronism character of the CLUSTER.

[0096] In this connection reference should be made to Fig. 3g, which illustrates the block 340 which calculates the distance Δ -position after successfully checking for correspondence between the FRAME and the CLUSTER, in order to check whether the FRAME and the CLUSTER relate to scanning of the same code.

[0097] The block 340 comprises an initial block 400 which checks whether the number of elements in the FRAME is greater than the number of elements in the CLUSTER. If this is not so, an error situation is detected and the block 400 is followed by block 345 and 191; otherwise the block 400 is followed by block 410. Of course, in the fortunate case in which the entire bar code has already been read in the preceding scan and the present scan also relates to all the elements of the code, the check made in block 400 will prevent coupling between the actual FRAME and the CLUSTER and the situation will be as described hereinbefore with reference to block 197a in Fig. 3b.

[0098] The block 410 calculates the number f of code elements which are superposed in the FRAME and in the CLUSTER, i.e. which have the same position with respect to the absolute reference and the same width, by making the comparison (Fig. 8) starting from the first element of the FRAME and from the first element of the CLUSTER (corresponding to the left or FORWARD).

[0099] The block 410 is followed by a block 420 which calculates the number r of elements which are superposed in the FRAME and in the CLUSTER, i.e. which have the same position with respect to the absolute reference and the same width, starting the comparison from the last element of the FRAME and from the last element of the CLUSTER (corresponding to the right or REVERSE).

[0100] Referring to Fig. 8, the CLUSTER contains the code elements detected in the scan marked L1, whereas the FRAME contains the code elements found by the scan marked L2.

[0101] The block 420 is followed by a block 430 which checks whether the number r is equal to the number f . If the numbers r and f are equal, an uncertainty situation is detected (the number of superposable elements on the right corresponds to the number of superposable elements on the left) and consequently the code is not reconstructed. The block 430 is followed by blocks 345 and 191. If the numbers r and f are different, the block 430 is followed by a block 450 which checks whether the number f is greater than the number r . If the number f is greater than the number r a block 460f is selected, otherwise (f is less than r) a block 460r is selected.

[0102] The block 460f checks whether the number f of superposable elements starting from the left is greater than a threshold value MINMATCH; if f is less than the threshold (i.e. when there are a limited number of elements which are superposed in the FRAME and in the CLUSTER), an error is detected, reconstruction does not begin and consequently blocks 345 and 191 are selected. If f is greater than the MINMATCH threshold (i.e. if there are a sufficient number of superposed elements in the FRAME and in the CLUSTER) the block 460f selects a block 470f which stores the superposition condition starting from the left (or FORWARD direction) of the bar code with respect to the reading head. The block 470f is followed by a block 480f which calculates the value Δ -position as the difference between the position of the first element in the FRAME and the position of the first element in the CLUSTER (see Fig. 7).

[0103] Reconstruction of the code therefore begins and the block 480f is followed by a block 350 (Figs. 3f and 3g) which puts the STATUS index at two (STATUS = 2) indicating the beginning of reconstruction. The situation in fact

means that two successive superposable FRAMES have been detected and both have a synchronism code; the term Δ -position has also been calculated on the basis of these two first FRAMES.

[0104] The block 460r checks whether the number r of superposable elements starting from the right is greater than a threshold value MINMATCH. If r is less than the threshold (i.e. if there are a limited number of corresponding elements in the FRAME and in the CLUSTER) an error is detected, reconstruction does not begin and the blocks 345 and 191 are selected. If r is above the MINMATCH threshold (i.e. when there is a sufficient number of superposed elements in the FRAME and in the CLUSTER) the block 460r selects a block 470r which stores the superposition condition starting from the right (BACKWARDS or REVERSE direction) of the bar code with respect to the reading head. The block 470r is followed by a block 480r which calculates the value Δ -position as the difference between the position of the last element in the FRAME and the position of the last element in the CLUSTER.

[0105] Reconstruction of the code therefore begins and the block 480r is also followed by the block 350 which sets the state index at two.

[0106] Returning to Fig. 3f, the block 350 which, as already stated, sets the first STATUS index of the CLUSTER at 2 indicating the beginning of reconstruction, is followed by a block 355 which associates the FRAME with the CLUSTER by copying the FRAME elements in the CLUSTER.

[0107] The block 355 is followed by a block 380 which recalculates the position of the CLUSTER by disposing it in the position provided for the subsequent scan (due to the movement of the conveyor belt 6 (Fig. 1) and based on the measured displacement of the CLUSTER with respect to the just-associated FRAME. The block 380 (described in detail in Fig. 31) applies the Δ -position displacement to all elements of the CLUSTER, i.e. a new position is calculated for each element of the CLUSTER by summing the Δ -position term at the present position. For each element in the CLUSTER, therefore, the block 380 makes the following transformation:

$$\text{NEW POSITION OF CLUSTER ELEMENT} = \text{PRESENT POSITION OF CLUSTER ELEMENT} + \Delta\text{-position}$$

[0108] To this end, note that the belt 6 moves at a substantially constant speed (e.g. 3 metres per second) with respect to the reading head; the mirror 17b also rotates at high speed, e.g. sufficient for 1000 scans per second. The time between one scan and the next is very short, equal to 1/1000 of a second in the present case. During this time interval the speed of the belt is practically constant, in that substantial variations in speed would require very high acceleration (of the order of several tens of g) which are obviously unobtainable or unimaginable in the case of a conveyor-belt device.

[0109] Consequently the position to be taken by the CLUSTER in order to be comparable with a FRAME detected in a subsequent scan is approximated with high accuracy by the block 380 (Fig. 31), which subjects the elements in the CLUSTER relating to the last scan to a displacement (Δ -position) which is estimated on the assumption of a constant velocity between the last scan contained in the CLUSTER and the subsequent scan which will give rise to the next FRAME.

[0110] The block 380 is then followed by the block 198a.

[0111] The block 320 (described in detail hereinafter) reached when reconstruction is begun, STATUS = 2, checks whether the FRAME F_i and the CLUSTER analysed by block 300 can be associated. The CLUSTER taking part in the operations of block 320 is a CLUSTER which contains two FRAMES each comprising a synchronism character; the block 320 is normally selected during the third or fourth scan of the bar code.

[0112] If the association attempted by block 320 is unsuccessful, block 320 is followed by a block 360 which increases by one unit the counter which defines the number NOMATCH; the block 360 is then followed by the block 191.

[0113] If the association attempt by block 320 is successful, the block 320 is followed by a block 365 (described in detail hereinafter) which corrects the calculation of the distance Δ -position between the FRAME and the CLUSTER previously calculated in block 340 (Fig. 3g).

[0114] Block 365 is followed by a block 370 (similar to block 355) which, after the operations performed by block 320, associates the new FRAME elements in the CLUSTER. The operations of block 370 will be described in detail hereinafter.

[0115] Blocks 355 and 370 are followed by block 380, which in turn is followed by block 198a.

[0116] Figs. 3h and 3i illustrate details of the block 320, which tries to associate the FRAME F_i with the CLUSTER under examination.

[0117] The block 320 comprises an initial block 500 (Fig. 3h) which checks whether the bar code has made a FORWARD movement (block 470f, Fig. 3g) or a REVERSE movement (block 470r, Fig. 3g) with respect to the reading head. In the first case (FORWARD movement) a block 510 is selected and in the second case (REVERSE movement) a block 520b is selected (Fig. 3i).

[0118] Block 510 selects the last-but-one element in the CLUSTER, defined by the value i_c of a pointer in Table TABC and the last-but-one element of the FRAME, defined by the value j_n of a pointer in Table TABF (Fig. 9). In the

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description hereinafter, for brevity, the term "element ic in the CLUSTER" is used to identify the element in the CLUSTER which is defined by the pointer value ic and "element jn in the FRAME" is used to identify the element of the FRAME which is defined by the pointer value jn .

5 **[0119]** The block 510 is followed by a block 520 which checks whether the position of element ic of the CLUSTER with respect to the absolute reference is approximately equal to the position of the element jn of the FRAME with respect to the same absolute reference.

[0120] In the negative case (the positions of ic and jn do not coincide) the block 520 is followed by the block 530. Otherwise (the positions of ic and jn substantially coincide) the block 520 is followed by a block 540.

10 **[0121]** The block 530 checks whether the position of element ic in the CLUSTER is higher than the position of element jn in the FRAME.

[0122] If so (the position of element ic in the CLUSTER is higher than the position of the element jn in the FRAME) a block 555 is selected; otherwise a block 550 is selected. Fig. 9 illustrates the case regarding selection of the block 550 when the position of element jn of the FRAME is higher than the position of element ic of the CLUSTER.

15 **[0123]** The block 550 decrements by one unit the value of jn , i.e. performs the operation $jn = jn - 1$, in order to select a FRAME element having a lower position than the preceding one. correspondingly, the block 555 decrements by unity the value of ic , i.e. performs the operation $ic - 1$, in order to select a CLUSTER element having a lower position than the preceding one.

[0124] Blocks 555 and 550 are both followed by a block 560 which checks whether the values ic and jn (previously modified by the respective blocks 555 and 550) are now below a threshold value MINMATCH, i.e.:

20
$$ic < MINMATCH$$

or

25
$$jn < MINMATCH$$

30 **[0125]** If at least one of the inequalities hereinbefore is satisfied, block 560 is followed by block 360 (Figs. 3h and 3f) which detects an error situation and increases the number NOMATCH which describes the number of failed attempts at coupling between CLUSTERS and FRAMES.

[0126] If neither inequality of block 560 is satisfied, a return is made from block 560 to block 520, which re-checks the position of the elements ic of the CLUSTER and jn of the FRAME; the check is made by a different element of the CLUSTER or FRAME from the element used in the preceding check step.

35 **[0127]** The block 540 is selected when the elements ic and jn of the CLUSTER and of the FRAME have substantially the same position. In the example in Fig. 9 this happens when the pointer jn moves from the position from the right to the position on the left at which jn corresponds to an element (a space in the illustrated example) in the FRAME having the same position with respect to the absolute reference as the element (space) in the CLUSTER marked by ic .

[0128] Block 540 performs the following operations:

- 40
- select a plurality of CLUSTER elements starting from the element marked ic in the REVERSE direction towards elements ($ic-1$, $ic-2$, ... $ic-n$) preceding the said element ic . "Preceding elements" with respect to a given element mean elements having a lower position than the given element;
 - 45 • select a plurality of FRAME elements starting from the element marked jn in the REVERSE direction towards elements ($jn-1$, $jn-2$, ... $jn-m$) preceding the considered element; and
 - calculate the number $A(ic,jn)$ of superposable elements by comparing at least MINMATCH selected elements in the CLUSTER and in the FRAME, starting from ic and jn . "Superposable elements" means a continuous sequence of elements of the FRAME and of the CLUSTER in which each element of the FRAME of the sequence corresponds to a respective element of the CLUSTER having the same position and the same width.
- 50

[0129] Block 540 is followed by a block 580 which checks whether the number $A(ic, jn)$ is greater than the number MINMATCH, i.e.:

55
$$A(ic,jn) > MINMATCH$$

[0130] If so ($A(ic,jn) > MINMATCH$) the block 580 is followed by blocks 365 and 370 (Fig. 3f), otherwise ($A(ic,jn) < MINMATCH$) block 580 is followed by block 530 for a new attempt to check superposability starting from a FRAME element ic or a CLUSTER element jn adjoining the element last considered, since the check for identity of position made in block 520 is only approximate and the calculation and check of the number of superposable elements (based

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on blocks 540 and 580) may have been made on bar code elements which are distant by only one position.
[0131] If so, i.e. if the check shows that the FRAME and CLUSTER can be successfully coupled, a move is made (Fig. 3f) to block 365 (which recalculates the value Δ -position) and to block 370 (Fig. 3f) which copies the FRAME elements following jn in the CLUSTER starting from the element ic .

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[0132] The operations illustrated with reference to Fig. 3i are similar to those illustrated in Fig. 3h, but in this case the operations relate to the REVERSE direction of motion whereas the operations illustrated with reference to Fig. 3h are for the FORWARD direction of advance.

[0133] Block 520b (Fig. 3i) sets the values of ic and jn at zero, i.e. $ic = jn = 0$.

15

[0134] Block 520b is followed by a block 590 which checks whether the position of the CLUSTER element ic detected with respect to the absolute reference is approximately the same as the position of the FRAME element jn detected with respect to the absolute reference.

[0135] If not (i.e. if the positions of the elements associated with ic and jn do not coincide) block 590 is followed by block 600, otherwise (the position of the elements associated with ic and jn substantially coincide) block 590 is followed by a block 610.

20

[0136] Block 600 checks whether the position of element ic in the CLUSTER is higher than the position of the FRAME element jn . If so (position of CLUSTER element $ic >$ position of FRAME element jn), a block 620 is selected, otherwise, a block 630 is selected.

25

[0137] The block 620 increases the value of jn by one unit, i.e. performs the operation $jn = jn + 1$, in order to select a FRAME element having a higher position than the preceding one. Similarly block 630 increases the value of ic by one unit, i.e. performs the operation $ic = ic + 1$, in order to select a CLUSTER element having a higher position than the preceding one.

[0138] Blocks 620 and 630 are both followed by a block 640 which checks whether the values of ic and jn (previously modified by the blocks 630 and 620 respectively) are now greater than the number of elements in the CLUSTER or in the FRAME, respectively minus a threshold value $MINMATCH$, i.e.:

30

$$ic > \text{number of elements in the CLUSTER} - MINMATCH$$

or

35

$$jn > \text{number of elements in the FRAME} - MINMATCH$$

[0139] If at least one of the inequalities hereinbefore is satisfied, block 640 is followed by block 360 (Figs. 3i and 3f) which detects an error situation and increases the $NOMATCH$ number, which describes the number of failed attempts at coupling CLUSTER and FRAME.

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[0140] If none of the inequalities is satisfied in block 640, block 640 is followed by block 590 which re-checks the position of the elements associated with ic and jn . The check is made on a different CLUSTER element or FRAME element from that used in the preceding check step.

45

[0141] The block 610 is selected when the elements associated with ic and jn have substantially the same position and performs the following operations:

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- it selects a plurality of CLUSTER elements starting from the element marked ic and in the FORWARD direction towards elements ($ic+1, ic+2, \dots ic+n$) which follow the last element ic . "Elements which follow a given element" mean elements having a higher position than the given element.
- it selects a plurality of FRAME elements starting from the element marked jn and in the FORWARD direction towards elements ($jn+1, jn+2, \dots jn+m$) following the last element jn and
- it calculates the number $A(ic,jn)$ of superposable elements by comparing at least $MINMATCH$ selected elements of the CLUSTER and the FRAME.

55

[0142] Block 610 is followed by a block 660 which checks whether the number $A(ic,jn)$ is greater than the number $MINMATCH$, i.e. :

$A(ic,jn) > MINMATCH$

5 **[0143]** If so, ($A(ic,jn) > MINMATCH$), the block 660 is followed by blocks 365 and 370; if not ($A(ic,jn) < MINMATCH$), block 660 is followed by block 600.

[0144] In the positive case, i.e. where the FRAME and CLUSTER can be successfully coupled, a move is made to block 365 (Fig. 3f) which recalculates the value Δ -position and to the block 370 and the FRAME elements preceding jn are copied in the CLUSTER, starting from the element ic .

10 **[0145]** Element ic is therefore a reference element with respect to which the CLUSTER and the FRAME are aligned. Block 370 also carries out a "junction" step between the FRAME and the CLUSTER in which all the FRAME elements disposed on a given side with respect to the reference element are copied in the CLUSTER. More particularly in the FORWARD case (Fig. 3h) from the reference element in the forward direction (i.e. towards elements having a higher position) the FRAME elements are selected and copied in the CLUSTER, whereas from the reference point in the backward direction (i.e. towards elements having a lower position) the CLUSTER elements are retained.

15 **[0146]** The operations performed by block 320 define a correspondence search step in which a selection is made (blocks 510 and 520b) of a check start element (denoted by the pointer value ic), of the CLUSTER; a selection is made (blocks 510 and 520b) of a check start element (denoted by pointer value jn) of the FRAME and a corresponding check step is carried out (blocks 520 and 590) to check whether the position of the check start element in the CLUSTER with respect to the absolute reference is approximately the same as the position of the check start element of the FRAME with respect to the absolute reference.

20 **[0147]** If the correspondence check step gives a negative result, an iterative modification step is carried out (by blocks 530, 555, 550, 560; 600, 620, 630, 640) in order to select subsequent CLUSTER or FRAME elements adjoining the check start element. The iterative modification step is carried out by other CLUSTER or FRAME elements until the correspondence check step arrives at a positive result (output to blocks 540 and 610). In such cases, a possible coupling between FRAME and CLUSTER is initially detected. Initially the coupling is detected in the case of a single element of the FRAME or the CLUSTER. In order however to recognise the coupling with greater reliability, a series of further operations are performed in the method according to the invention, including the following:

- 30 - selecting (blocks 540, 610) a plurality of CLUSTER elements starting from the reference element which satisfies the correspondence check step in a predetermined direction (i.e. in the REVERSE or the FORWARD direction), starting from the reference element towards elements remote from the reference element;
- 35 - selecting (blocks 540, 610) a plurality of FRAME elements starting from the reference element (jn) which satisfies the correspondence check step and in a predetermined direction (the said REVERSE and FORWARD directions) starting from the reference element towards elements remote from the reference element;
- calculating (blocks 540, 610) the number of superposable elements among those selected in the CLUSTER and in the FRAME and
- 40 - detecting (blocks 580 and 660) that the correspondence search step has given a positive result when the number of superposable elements has a predetermined relation to (more particularly is greater than) the reference MINMATCH.

45 **[0148]** In this manner, coupling between FRAME and CLUSTER is recognised with greater reliability in that FRAME elements and CLUSTER elements are compared together.

[0149] Note that the correspondence search operations start from the last-but-one element of the FRAME or the CLUSTER. The last FRAME or CLUSTER element is not selected, since it may provide information which is insufficiently reliable, e.g. because of noise.

50 **[0150]** The last-but-one element is chosen because (see Fig. 8, scan L2) the last element may be only partly crossed by the scanning line, with the result that its width is uncertain.

[0151] In this way, the reliability of the correspondence search algorithm is improved.

[0152] Fig. 3j shows the block 365, which recalculates the distance Δ -position between the FRAME and the CLUSTER. The distance Δ -position is calculated for the first time by block 340. More particularly, the block 365 recalculates the distance Δ -position as the difference between the position of FRAME element jn and CLUSTER element ic .

55 **[0153]** As can be seen, therefore, the term Δ -position is initially calculated a first time in block 340 at the beginning of the coupling operations and is successively refined by calculation in block 365.

[0154] Fig. 3m illustrates a variant of that described with reference to Fig. 3h. For simplicity, only the parts differing from those previously illustrated will be described.

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[0155] In the variant shown, block 540 comprises a block 540a which performs the following operations:

- it selects a plurality of CLUSTER elements starting from the element denoted by ic in the backward (REVERSE) direction towards elements ($ic-1, ic-2, \dots ic-n$) preceding element ic . "Elements preceding a given element" means elements having a lower position than this element.
- it selects a plurality of FRAME elements starting from the element denoted by jn in the backward (REVERSE) direction towards element ($jn-1, jn-2, \dots jn-m$) preceding this element and
- it calculates the number $A(ic,jn)$ of superposable elements by comparing at least MINMATCH selected elements of the CLUSTER and of the FRAME starting from ic and jn . "Superposable elements" means a continuous sequence of elements of the FRAME and of the CLUSTER in which each FRAME element of the sequence corresponds to a respective CLUSTER element having the same position and the same width.

[0156] The block 540a is followed by block 540b, which performs the following operations:

- it selects a plurality of CLUSTER elements starting from the element denoted by $ic-1$ in the backward (REVERSE) direction towards elements ($ic-2, ic-3, \dots ic-n$) preceding element $ic-1$;
- it selects a plurality of FRAME elements starting from the element denoted by jn in the backward (REVERSE) direction towards elements ($jn-1, jn-2, \dots jn-m$) preceding this element and
- it calculates the number $B(ic-1,jn)$ of superposable elements by comparing at least MINMATCH selected elements of the CLUSTER and of the FRAME.

[0157] The block 540b is followed by the block 540c which performs the following operations:

- it selects a plurality of CLUSTER elements starting from the element denoted by $ic+1$ in the backward (REVERSE) direction towards elements ($ic, ic-1, \dots ic-n$) preceding element $ic+1$;
- it selects a plurality of FRAME elements starting from the element denoted by jn in the backward (REVERSE) direction towards elements ($jn-1, jn-2, \dots jn-m$) preceding this element and
- it calculates the number $C(ic+1,jn)$ of superposable elements by comparing at least MINMATCH selected elements of the CLUSTER and of the FRAME.

[0158] The block 540c (the last step in block 540) is followed by a block 570 which searches for the largest number Mb among the numbers $A(ic,jn), B(ic-1,jn), c(ic+1,jn)$ which have previously been calculated in blocks 540a, 540b and 540c.

[0159] The block 570 is followed by a block 580 which checks whether the previously-extracted number Mb is greater than a threshold value MINMATCH; if the check made by block 580 has given a negative result ($Mb < \text{MINMATCH}$) a return is made to block 520; if not ($Mb > \text{MINMATCH}$) a move is made from block 580 to block 365.

[0160] If it is found that the FRAME and CLUSTER have been successfully coupled, therefore, block 365 (recalculating the value Δ -position) and block 370 are selected (Fig. 3f), block 370 copying the FRAME elements following jn in the CLUSTER starting from the element $ic, ic+1$ or $ic-1$ depending on whether the selected greatest number is $A(ic, jn), B(ic-1, jn)$ or $C(ic+1, jn)$.

[0161] Fig. 3n shows a variant of that described with reference to Fig. 3i. For simplicity, only parts differing from those previously illustrated will be described.

[0162] In the variant shown, block 610 comprises a block 610a which performs the following operations:

- it selects a plurality of CLUSTER elements starting from the element denoted by ic in the FORWARD direction towards elements ($ic+1, ic+2, \dots ic+n$) following the last element ic . "Elements following a given element" means elements having a higher position than the given element.
- it selects a plurality of FRAME elements starting from the element denoted by jn in the FORWARD direction towards elements ($jn+1, jn+2, \dots jn+m$) following the last element jn ; and
- it calculates the number $A(ic,jn)$ of superposable elements by comparing at least MINMATCH selected elements

of the CLUSTER and of the FRAME.

[0163] The block 610a is followed by block 610b which performs the following operations:

- 5 • it selects a plurality of CLUSTER elements starting from the element denoted by $ic-1$ in the FORWARD direction towards elements ($ic, ic+1, \dots ic+n$) following element $ic-1$;
- it selects a plurality of FRAME elements starting from the element denoted by j_n in the FORWARD direction towards elements ($j_{n+1}, j_{n+2}, \dots j_{n+m}$) following element j_n and
- 10 • it calculates the number $B(ic-1, j_n)$ of superposable elements by comparing at least MINMATCH selected elements of the CLUSTER and of the FRAME.

[0164] The block 610b is followed by block 610c which performs the following operations:

- 15 • it selects a plurality of CLUSTER elements starting from the element denoted by $ic+1$ in the FORWARD direction towards elements ($ic+2, ic+3, \dots ic+n$) following element $ic+1$;
- it selects a plurality of FRAME elements starting from the element denoted by j_n in the FORWARD direction towards elements ($j_{n+1}, j_{n+2}, \dots j_{n+m}$) following element j_n and
- 20 • calculates the number $C(ic+1, j_n)$ of superposable elements by comparing at least MINMATCH selected elements of the CLUSTER and of the FRAME.

25 **[0165]** The block 610 is followed by a block 650 which searches for the largest number M_f from among the numbers $A(ic, j_n), B(ic-1, j_n), C(ic+1, j_n)$ previously calculated by the blocks 610a, 610b and 610c.

[0166] Block 650 is followed by a block 660 which checks whether the number M_f extracted by the previous block 650 is greater than the number MINMATCH, i.e.:

30
$$M_f > \text{MINMATCH}$$

[0167] If so ($M_f > \text{MINMATCH}$), block 660 is followed by blocks 365 and 370; if not ($M_f < \text{MINMATCH}$) block 660 is followed by block 600.

35 **[0168]** In the positive case, i.e. where the FRAME and CLUSTER have been successfully coupled, a move is made to block 365 (Fig. 3f) which recalculates the value Δ -position and to block 370, which copies the FRAME elements preceding j_n in the CLUSTER starting from element $ic, ic+1$ or $ic-1$ depending on whether the selected largest number was $A(ic, j_n), B(ic-1, j_n)$ or $C(ic+1, j_n)$.

40 **[0169]** Obviously, numerous modifications and variants can be made to the method described and illustrated here, all coming within the scope of the invention as defined in the accompanying claims. In particular it is stressed that the present method, instead of being of the continuous kind and continually scanning and processing the code even after transmission of the decoded code (as described with reference to Fig. 3d, blocks 203, 204), can comprise interruption of the algorithm, setting the CLUSTER to zero and reactivation starting from block 100 only after manual actuation or after recognition of a subsequent code (e.g. after a period of scans without FRAMES). In such cases however it is

45 advisable to insert a check that the number of elements in the FRAME or CLUSTER is equal to a given number of elements, so as to ensure that the code has actually been completely read.

[0170] Also the algorithm can be modified by inserting some checks. In particular, each CLUSTER can be associated with an additional indicator (a zero scan counter) which is incremented after any scan which does not result in updating of the CLUSTER. In such cases the reading of the zero scan counter is checked after every scan (e.g. at the initial block 100), if the reading exceeds a given threshold value, the STATUS index of the CLUSTER is set at zero, thus making the CLUSTER available. This operation, however, is not strictly necessary since scans are rarely without elements, owing to the noise which exists even in the intervals between one bar code and the next. The noise however enables CLUSTERS to be opened and subsequently closed by setting the STATUS index of the CLUSTERS at zero, thus making them available for subsequent scans of effective code elements.

55

Claims

1. A method of reconstructing successive scans of a bar code (8) in the presence of a relative movement between the bar code (8) and a scanning path, the bar code (8) comprising a plurality of elements, each of said elements having a first or a second reflectivity and being represented by a width (Tc) and a position (Tp) with respect to an absolute reference position (To, Li), comprising the steps of:

a0) obtaining a shift amount (Δ -position) representative of the displacement, in a scanning direction, of the bar code elements between two scans successive to one another;

a) performing (100) a first scan of the bar code, determining the position (Tp) and the width (Tc) of the elements in the first scan with respect to said absolute reference position (To, Li) ;

b) recalculating (380), based on said shift amount (Δ -position), the position of said elements in said first scan with respect to said absolute reference position (To, Li) as the position which said elements will take with respect to said absolute reference position (To, Li) in a subsequent scan;

c) performing (100) a second scan of the bar code, determining the position (Tp) and the width (Tc) of the elements in said second scan with respect to said absolute reference position (To, Li);

d) carrying out a correspondence search step (510-530, 550-560; 520b, 590, 600, 620-640) in order to find (520, 590) at least one reference element in said first scan and at least one reference element in said second scan which both have substantially the same position (Tp) with respect to said absolute reference (To, Li) and substantially the same width (Tc); and

e) combining (370) the elements in said first scan with the elements in said second scan so as to generate a reconstructed scan.

2. A method according to claim 1, **characterised by** the steps of:

bb) recalculating (380), based on said shift amount (Δ -position), the position of said elements in said reconstructed scan with respect to said absolute reference position (To, Li) as the position which said elements (To, Li) will take with respect to said absolute reference position (To, Li) in a subsequent scan;

cc) performing (100) a further scan of the bar code, determining the position (Tp) and the width (Tc) of the elements in said further scan with respect to said absolute reference position (To, Li);

dd) carrying out a subsequent correspondence search step (510-530, 550-560; 520b, 590, 600, 620-640) to find (520, 590) at least one reference element in said reconstructed scan and at least one reference element in said further scan which both have substantially the same position (Tp) with respect to said absolute reference position (To, Li) and substantially the same width (Tc); and

ee) updating (370) the elements in the reconstructed scan by combining them with the elements in said further scan.

3. A method according to claim 2, **characterised by** the steps of :

bb1) recalculating (380), based on said shift amount (Δ -position), the position of the elements in the reconstructed scan with respect to said absolute reference position (To, Li) as the position which said elements, after updating in step ee) will take with respect to said absolute reference position (To, Li) in a subsequent scan and

iteratively repeating said steps cc), dd), ee) and bb1) as long as (180) said further scan comprises at least a predetermined number of elements.

4. A method according to claim 3, **characterised in that** only said step cc) is iteratively repeated as long as said further scan comprises a number of elements less than the predetermined number.

5. A method according to claim 2, **characterised by** the steps of :

bb1) recalculating (380), based on said shift amount (Δ -position), the position of the elements in the reconstructed scan with respect to said absolute reference position (To, Li) as the position which said elements, after updating in step ee), will take with respect to said absolute reference position (To, Li) in a subsequent scan; attempting (198a) to decode said reconstructed scan; and iteratively repeating the steps cc), dd), ee) and bb1) as long as said step of attempting to decode gives a negative result.

- 5
6. A method according to any of the preceding claims, **characterised in that** said correspondence search step d) (510-530, 550-560; 520b, 590, 600, 620-640) is followed by a coupling check step f) (540, 570, 580; 610, 650, 660) for checking that at least a predetermined number (MINMATCH) of elements in said first scan and said second scan has substantially the same position (T_p) with respect to the absolute reference position (T_o) and substantially the same width (T_c).
- 10
7. A method according to claim 6, **characterised in that** said coupling check step f) (540, 570, 580; 610, 650, 660) is carried out by comparing (540, 610) at least a defined minimum set (560, 640, MINMATCH) of elements in said first scan with a minimum defined set (560, 640, MINMATCH) of elements in said second scan.
- 15
8. A method according to claim 6 or 7, **characterised in that** in said coupling check step f) a calculation (540; 610) is made of the number $A(ic,jn)$ of superposable elements in said first and said second scan.
- 20
9. A method according to claim 8, **characterised in that** said superposable elements are defined by a continuous sequence of elements in said first scan and said second scan having substantially the same position with respect to the absolute reference position and substantially the same width.
- 25
10. A method according to any of claims 6-9, **characterised in that** said step e) of combining (370) the elements in said first scan with the elements in said second scan is carried out when said coupling check step f) (540, 570, 580; 610, 650, 660) has given a positive result.
- 30
11. A method according to any of the preceding claims, **characterised in that** said correspondence search step d) (510-530, 550-560; 520b, 590, 600, 620-640) comprises the steps of:
- 35
d1) selecting (510; 520b) a check start element (ic) among the elements in said first scan and a check start element (jn) among the elements in said second scan;
d2) carrying out a correspondence check step (520; 590) in order to check whether the position of the check start element in the second scan (520; 590) with respect to the absolute reference position is approximately the same as the position of the check start element in the first scan with respect to the absolute reference position;
if said correspondence check step d2) (520; 590) has given a negative result, carrying out an iterative modification step d3) (530, 555, 550, 560; 600, 620, 630, 640) to select further elements in the second scan or in the first scan adjacent to said check start element; the iterative modification step d3) is carried out with further elements until said correspondence check step d2) arrives at a positive result (520; 590) and said reference element is found.
- 40
12. A method according to claim 11, **characterised in that** said check start element comprises a last-but-one element in the first and in the second scan.
- 45
13. A method according to any of the preceding claims, **characterised in that** said correspondence search step d) is followed by a matching step g) (540a,b,c; 610a,b,c) for selecting a plurality of elements in said first scan and a plurality of elements in said second scan having better reciprocal superposability, said selected plurality of elements of the first and of the second scan being used in said step e) to generate said reconstructed scan.
- 50
14. A method according to claim 13, **characterised in that** said matching step g) comprises at least the steps of:
- 55
g1) selecting (540a, 610a) a first plurality of elements in the first scan starting from the reference element (ic) in the first scan and a second plurality of elements in the second scan starting from the reference element (jn) in the second scan;
g2) calculating a first quantity (A) as an indication of superposition of elements in the first plurality and of elements in the second plurality;
g3) selecting (540b, 610b) a third plurality of elements in the first scan starting from a first element ($ic-1$) in the first scan near to the reference element (ic) in the first scan;
g4) calculating a second quantity (B) indicating superposition of said elements in the second and in the third plurality;
g5) comparing the first and second quantities and selecting (570, 650) said first and second plurality if said first quantity indicates better superposability than said second quantity and

g6) comparing said first and second quantity and selecting (570, 650) said second and said third plurality if said second quantity indicates better superposability than said first quantity.

5 15. A method according to claim 14, **characterised by** the further steps of:

g7) selecting (540c, 610c) a fourth plurality of elements in the first scan starting from a second element (ic+1) in the first scan near to the reference element (ic) in the first scan;

g8) calculating a third quantity (C) indicating superposition of said elements in the second and in the fourth plurality and

10 g9) comparing said first, second and third quantity and selecting (570, 650) said second and fourth plurality if said third quantity indicates better superposability than said first and second quantity.

15 16. A method according to claim 15, **characterised in that** said first and second element (ic-1, ic+1) in said first scan are adjacent to said reference element (ic) in said first scan on two different sides thereof.

20 17. A method according to any of claims 14-16, **characterised in that** said quantities comprise the number of elements in said first and said second scan which have substantially the same position with respect to the absolute reference position and substantially the same width and **in that** said steps for comparing said quantities comprise a search for the quantity which has the maximum value.

25 18. A method according to any of claims 6-17, **characterised in that** said step e) of combining (370) the elements in the first scan with the elements in the second scan comprises the steps of:

e1) selecting a first side of said reference element in said first scan comprising said elements in said first scan having substantially the same position and the same width as the elements in the second scan;

e2) maintaining those elements in the first scan which are disposed on said first side and

e3) adding to said first scan those elements in said second scan which are disposed on the side opposite said first side in order to generate said reconstructed scan.

30 19. A method according to any of the preceding claims, **characterised in that** said step a) for carrying out (100) a first scan is preceded by the steps of:

h) carrying out (100) a preliminary scan of said bar code by determining the position (Tp) and the width (Tc) of the elements in said preliminary scan with respect to said absolute reference position (To, Li) and associating the elements in said preliminary scan with a current area (FRAME); and

35 i) associating (191, 194a) the elements in said current area (FRAME) with at least one of a plurality of loading areas (CLUSTERS).

40 20. A method according to claim 19, **characterised in that** said association step i) comprises the steps of:

i1) selecting (192) a loading area among said plurality of loading areas;

i2) checking (193) whether the selected area is already occupied;

i3a) if said selected area has not already been occupied, investigating (191, 192) whether a subsequent loading area exists;

45 i4a) if a subsequent loading area exists, returning to said step i2) and

i4b) if no subsequent loading area exists, copying (207) said elements in said current area into one of said unoccupied loading areas, performing a new scan, associating the elements in the last performed scan with said current area and returning to said step i1).

50 21. A method according to claim 20, **characterised in that** said step i4b) comprises, before said step of copying (207), the step of searching for synchronism characters (206) between said elements in said current area (FRAME); if the search for synchronism characters in said current area gives a positive result and synchronism characters are found, a condition of presence of the first synchronism (208) is stored and said step of copying (207) is carried out; if the search for synchronism characters in said current area gives a negative result and no synchronism characters are found, said step of carrying out h) a preliminary scanning is returned to.

55 22. A method according to claim 21, **characterised in that** said step i2) of checking (193) whether said selected area is already occupied comprises the step of checking whether said condition of presence of the first synchronism

has been stored; if said condition of presence of the first synchronism is detected, the following step is carried out:

5 i5) searching (310) for a synchronism character among the elements in said current area;
i6a) if said step i5) of searching (310) gives a positive result and a synchronism character is found in said
current area, the following steps are carried out: copying (355) the elements in said current area into said
loading area; storing (350) a coupling condition; performing (100) a new scan, associating (170) the elements
in the last performed scan with said current area (FRAME) and returning to said step i1) ;
i6b) if said search (310) step i5) gives a negative result and no synchronism character is found in said current
area, cancelling (330) said condition of presence of a first synchronism and returning to said step h).

10 **23.** A method according to claim 22, **characterised in that** said step i6a) of copying (355) and storing (350) is preceded
by the steps of:

15 i7) a coupling check (340) to verify whether the elements in said current area and the elements in said loading
area can be coupled;
i8a) if said elements in said current area and the loading area can be coupled, carrying out the steps i6a) of
copying (355) and storing (350) a coupling condition;
i8b) if said elements in said current area and the loading area cannot be coupled, updating (345) a failed-
attempts counter.

20 **24.** A method according to claim 23, **characterised in that** said coupling check (340) step i7) comprises the steps of:

25 i7-1) checking (400) whether the number of elements in said current area has a predetermined relation to the
number of elements in the loading area;
i7-2a) if said checking (400) step i7-1) gives a positive result, calculating (410, 420) the number of superposable
elements between said loading area and said current area;
i7-3) checking (460f, 460r) whether the number of superposable elements exceeds a predetermined threshold
value;
i7-4a) if said step i7-3) gives a positive result, carrying out the step i6a) for coupling (355) and storing (350) a
coupling condition;
i7-4b) if said step i7-3) gives a negative result, carrying out the step i8b) for updating (345) the failed attempts
counter;
i7-2b) if said step i7-1) of checking (400) gives a negative result, said step i8b) of updating (345) the failed
attempts counter is carried out.

35 **25.** A method according to claim 24, **characterised in that** the step i8b) of updating (345) the failed attempts counter
is followed by the steps of checking (130) whether said failed attempts counter (NOMATCH) exceeds a predeter-
mined threshold value (MAX-NOMATCH) and if the result is positive, storing an unoccupied loading area condition
(150); then returning to said step h).

40 **26.** A method according to any of claims 20-25, **characterised in that** if the result of the step i2) of checking (193)
indicates that said selected area is already occupied, the following steps are carried out:

45 i3b) superposability check (195) between the elements in said loading area and the elements in said current
area;
i9a) if said superposability check step i3b) gives a positive result, the elements in said current area are coupled
(355; 370) with the elements in said storage area;
i9b) if said superposability check step i3b) gives a negative result, a return is made to said step i1) for selecting
(192) a loading area among said plurality of loading areas.

50 **27.** A method according to claim 26, **characterised in that** said correspondence search step d) (510-530, 550-560;
520b, 590, 600, 620-640) is followed by the steps of:

55 j) coupling checking (540, 570, 580; 610, 650, 660) to check whether at least a predetermined number (MIN-
MATCH) of elements in said current area and in said loading area have substantially the same position (Tp)
with respect to the absolute reference (To) and substantially the same width (Tc);
k) if said coupling check step j) gives a negative result, updating (360) a failed-attempts counter (NOMATCH) ;
l) checking (130) whether said failed-attempts counter (NOMATCH) exceeds a predetermined threshold value

(MAX-NOMATCH) and, if the result is positive, storing (150) an unoccupied loading area condition.

28. A method according to any of claims 22-27, **characterised in that** said step i2) also comprises the step i2-1) of checking (300) the presence of said coupling condition and, if said coupling condition is detected, carrying out a correspondence search step i2-2) between the elements in said current area and the elements in said loading area.

29. A method according to any of claims 22-28, **characterised in that** said preliminary scan, said further scan, said first scan, said second scan and any new scan each comprise the steps of:

a1) performing (100) a complete scan from a beginning-of-scanning position (Li) to an end-of-scanning position (Lf);

a2) selecting (170) a plurality of adjacent code elements;

a3) associating (170) the plurality of adjacent elements with the current area;

a4) processing (190) said elements in the current area;

a5) investigating (200) whether other successive code elements exist in said complete scan;

a6a) if other adjacent code elements exist, selecting (170) said other adjacent code elements and repeating said steps a3), a4) and a5) and

a6b) if no other adjacent code elements exist, repeating said step a1).

30. A method according to any of the preceding claims, **characterized in that** said correspondence search step d) is preceded by a step m) of determining the direction of superposition, comprising the steps of:

m1) determining (410) the number of elements in a third and a fourth scan which can be superposed starting from a predetermined element in said third and fourth scan and moving in a first direction;

m2) determining (420) the number of elements in said third and fourth scan which can be superposed starting from a different predetermined element and moving in a second direction opposite the first direction;

m3) setting (470f) a first direction indicator (FORWARD) if the number of elements determined in said step m1) is greater than the number of elements determined in said step m2); and

m4) setting (470r) a second direction indicator (REVERSE) if the number of elements determined in said step m2) is greater than the number of elements determined in said step m1).

31. A method according to claim 30, **characterised in that** said steps m1) and m2) of determining the number of superposable elements comprise a search for elements having substantially the same position with respect to said absolute reference position and substantially the same width, in said third and fourth scan starting from the first and last element respectively in said first and said second direction.

32. A method according to claim 30 or 31, **characterised in that** said correspondence search step d) is followed by the step of: n) determining (365, 380) the position which the elements in said third scan will take during a subsequent scan, said step n) of determining comprising the steps of:

n1) recalculating (365) said shift amount (Δ -position) as the absolute position difference between the elements in the third scan and the corresponding elements in said fourth scan;

n2) summing (380) the absolute position of said elements in the third scan and said calculated difference.

33. A method according to claim 32, **characterised in that** when said first indicator (FORWARD) is set, the position difference between the first element in the third scan and the first element in the fourth scan is calculated in step n1) whereas when said second indicator (REVERSE) is set, the position difference between the last element in the third scan and the last element in said fourth scan is determined in step n1).

34. A method according to any of claims 22-26, **characterised in that** the step i6a) also comprises the steps of:

o1) recalculating (480) said shift amount (Δ -position) as the absolute position difference between the elements in said loading area and the corresponding elements in said current area;

o2) determining (380) the position which the elements in said loading area will take during a subsequent scan as the sum of the absolute position of said elements in said loading area and said calculated difference.

35. A method according to any of the preceding claims, **characterised in that** the step e) is followed by the steps of:

oo1) recalculating (480) said shift amount (Δ -position) as the absolute position difference between the elements in said reconstructed scan and the corresponding elements in said second scan;
oo2) determining (380) the position which the elements in said reconstructed scan will take during a subsequent scan as the sum of the absolute position of said elements in said reconstructed scan and said calculated difference.

5
36. A method according to any of the preceding claims, **characterised in that** said step d) of correspondence search (510-530, 550-560; 520b, 590, 600, 620-640) is preceded by a step p) of checking the superposability (195) of said elements in said first and said second scan.

10
37. A method according to claim 36, **characterised in that** said step p) for checking superposability (195) comprises the steps of:

15
p1) checking (195a) whether the position of the last element in said second scan is not lower than the position of the first element in said first scan;
p2) checking (195b) whether the position of the first element in said second scan is not higher than the position of the last element in said first scan;
p3a) if the steps p1) and p2) of checking both give a positive result, the correspondence search step d) is carried out and
20
p3b) if at least one of said steps p1) and p2) of checking gives a negative result, carrying out (100) a further step of scanning the bar code.

25
38. A method according to claim 36 or 37, **characterised in that** if the superposability (195) check step p) has given a positive result, the following steps are carried out:

q) decoding (202) the elements in said second scan and
r) transmitting the result of the decoding step q) to the exterior.

30
39. A method according to any of the preceding claims, **characterised in that** after said step e) of combining (370) the elements in said first scan with the elements in said second scan, the following steps are carried out:

s) decoding (202) the elements in said reconstructed scan and
t) transmitting the result of said decoding step s) to the exterior (203).

35
40. A method according to any of the preceding claims, **characterised in that** said absolute reference position (T_o , L_i) is external to the bar code (8).

40 Patentansprüche

45
1. Verfahren zum Rekonstruieren aufeinanderfolgender Abtastungen eines Strichcodes (8) bei Vorhandensein einer Relativbewegung zwischen dem Strichcode (8) und einem Abtastweg, wobei der Strichcode (8) mehrere Elemente umfaßt, wobei jedes dieser Elemente eine erste oder eine zweite Reflektivität aufweist und durch eine Breite (T_c) und eine Position (T_p) in bezug auf eine absolute Referenzposition (T_o , L_i) dargestellt wird, mit folgenden Verfahrensschritten:

a0) Erhalten einer Verschiebungsgröße (Δ -Position), die repräsentativ für die Verschiebung der Strichcodeelemente in einer Abtastrichtung zwischen zwei aufeinanderfolgenden Abtastungen ist;
a) Ausführen (100) einer ersten Abtastung des Strichcodes, Bestimmen der Position (T_p) und der Breite (T_c) der Elemente in der ersten Abtastung in bezug auf die absolute Referenzposition (T_o , L_i);
50
b) Neuberechnen (380) der Position der Elemente in der ersten Abtastung in bezug auf die absolute Referenzposition (T_o , L_i), gestützt auf die Verschiebungsgröße (Δ -Position), als die Position, welche die Elemente in bezug auf die absolute Referenzposition (T_o , L_i) in einer nachfolgenden Abtastung annehmen werden;
c) Ausführen (100) einer zweiten Abtastung des Strichcodes, Bestimmen der Position (T_p) und der Breite (T_c) der Elemente in der zweiten Abtastung in bezug auf die absolute Referenzposition (T_o , L_i);
55
d) Ausführen eines Korrespondenz-Suchschrittes (510-530, 550-560; 520b, 590, 600, 620-640), um wenigstens ein Referenzelement in der ersten Abtastung und wenigstens ein Referenzelement in der zweiten Abtastung, die beide im wesentlichen dieselbe Position (T_p) in bezug auf die absolute Referenzposition (T_o , L_i)

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und im wesentlichen dieselbe Breite (T_c) haben, zu finden; und

e) Kombinieren (370) der Elemente in der ersten Abtastung mit den Elementen in der zweiten Abtastung, um eine rekonstruierte Abtastung zu erzeugen.

5 2. Verfahren nach Anspruch 1, **gekennzeichnet durch** folgende Verfahrensschritte:

bb) Neuberechnen (380) der Position der Elemente in der rekonstruierten Abtastung in bezug auf die absolute Referenzposition (T_o , L_i), als die Position, welche die Elemente in bezug auf die absolute Referenzposition (T_o , L_i) in einer nachfolgenden Abtastung haben werden, gestützt auf die Verschiebungsgröße (Δ -Position);

10 cc) Ausführen (100) einer weiteren Abtastung des Strichcodes, Bestimmen der Position (T_p) und der Breite (T_c) der Elemente in der weiteren Abtastung in bezug auf die absolute Referenzposition (T_o , L_i);

dd) Ausführen eines nachfolgenden Korrespondenz-Suchschrittes (510-530, 550-560; 520b, 590, 600, 620-640) um wenigstens ein Referenzelement in der rekonstruierten Abtastung und wenigstens ein Referenzelement in der weiteren Abtastung zu finden, die beide im wesentlichen dieselbe Position (T_p) in bezug auf die absolute Referenzposition (T_o , L_i) und im wesentlichen dieselbe Breite (T_c) haben; und

15 ee) Aktualisieren (370) der Elemente in der rekonstruierten Abtastung **durch** Kombinieren dieser mit den Elementen in der weiteren Abtastung.

20 3. Verfahren nach Anspruch 2, **gekennzeichnet durch** die folgenden Verfahrensschritte:

bb1) Neuberechnen der Position der Elemente in der rekonstruierten Abtastung in bezug auf die absolute Referenzposition (T_o , L_i) als die Position, welche diese Elemente nach der Aktualisierung im Schritt ee) in bezug auf die absolute Referenzposition (T_o , L_i) in einer nachfolgenden Abtastung annehmen werden, gestützt auf die Verschiebungsgröße (Δ -Position); und

25 iteratives Wiederholen der Schritte cc), dd), ee) und bb1), solange (180) die weitere Abtastung wenigstens eine vorgegebene Anzahl von Elementen umfaßt.

30 4. Verfahren nach Anspruch 3, **dadurch gekennzeichnet, daß** nur der Schritt cc) iterativ wiederholt wird, solange die weitere Abtastung einer Anzahl Element umfaßt, die geringer ist als die vorgegebene Anzahl.

5. Verfahren nach Anspruch 2, **gekennzeichnet durch** die folgenden Schritte:

bb1) Neuberechnen der Position der Elemente in der rekonstruierten Abtastung in bezug auf die absolute Referenzposition (T_o , L_i), gestützt auf die Verschiebungsgröße (Δ -Position), als die Position, welche diese Elemente nach dem Aktualisieren in Schritt ee) in bezug auf die absolute Referenzposition (T_o , L_i) in einer nachfolgenden Abtastung annehmen werden;

Versuchen (198a), die rekonstruierte Abtastung zu decodieren; und

iteratives Wiederholen der Schritte cc), dd), ee) und bb1), solange der Schritt des Versuchs zu decodieren ein negatives Ergebnis erzielt.

6. Verfahren nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, daß** dem Korrespondenz-Suchschritt d) (510-530, 550-560; 520b, 590, 600, 620-640) ein Kopplungs-Prüfschritt f) (540, 570, 580; 610, 650, 660) folgt, um zu prüfen, daß wenigstens eine vorgegebene Anzahl (MINMATCH) von Elementen in der ersten Abtastung und der zweiten Abtastung im wesentlichen dieselbe Position (T_p) in bezug auf die absolute Referenzposition (T_o und im wesentlichen dieselbe Breite (T_c)) hat.

7. Verfahren nach Anspruch 6, **dadurch gekennzeichnet, daß** der Kopplungs-Prüfschritt f) (540, 570, 580; 610, 650, 660) ausgeführt wird, indem wenigstens eine definierte minimale Gruppe (560, 640, MINMATCH) von Elementen in der ersten Abtastung mit einer definierten minimalen Gruppe (560, 640, MINMATCH) von Elementen in der zweiten Abtastung verglichen wird.

8. Verfahren nach Anspruch 6 oder 7, **dadurch gekennzeichnet, daß** in dem Kopplungs-Prüfschritt f) eine Berechnung (540; 610) der Anzahl $A(i_c, j_n)$ überlagerbarer Elemente in der ersten und der zweiten Abtastung durchgeführt wird.

9. Verfahren nach Anspruch 8, **dadurch gekennzeichnet, daß** die überlagerbaren Elemente durch eine kontinuierliche Folge von Elementen in der ersten Abtastung oder zweiten Abtastung mit im wesentlichen derselben Position

in bezug auf die absolute Referenzposition und im wesentlichen derselben Breite definiert werden.

5 10. Verfahren nach einem der Ansprüche 6-9, **dadurch gekennzeichnet, daß** der Schritt e) des Kombinierens (370) der Elemente in der ersten Abtastung mit den Elementen in der zweiten Abtastung ausgeführt wird, wenn der Kopplungs-Prüfschritt f) (540, 570, 580; 610, 650, 660) ein positives Ergebnis ergeben hat.

11. Verfahren nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, daß** der Korrespondenz-Suchschritt d) (510-530, 550-560; 520b, 590, 600, 620-640) die folgenden Schritte umfaßt:

10 d1) Auswählen (510; 520b) eines Prüf-Startelementes (ic) unter den Elementen in der ersten Abtastung und eines Prüf-Startelementes (jn) unter den Elementen in der zweiten Abtastung;
d2) Durchführen eines Korrespondenz-Prüfschrittes (520; 590), um zu überprüfen, ob die Position des Prüf-Startelementes in der zweiten Abtastung (520; 590) in bezug auf die absolute Referenzposition ungefähr gleich der Position des Prüf-Startelementes in der ersten Abtastung in bezug auf die absolute Referenzposition ist;

15 wenn der Korrespondenz-Prüfschritt d2) (520; 590) ein negatives Ergebnis ergab, Ausführen eines iterativen Modifikationsschrittes d3) (530, 555, 550, 560; 600, 620, 630, 640), um weitere Elemente in der zweiten Abtastung oder in der ersten Abtastung auszuwählen, die dem Prüf-Startelement benachbart sind; wobei der iterative Modifikationsschritt d3) mit den weiteren Elementen ausgeführt wird, bis der Korrespondenz-Prüfschritt d2) zu einem positiven Ergebnis (520; 590) kommt und das Referenzelement gefunden wurde.

20 12. Verfahren nach Anspruch 11, **dadurch gekennzeichnet, daß** das Prüf-Startelement ein vorletztes Element in der ersten und in der zweiten Abtastung umfaßt.

25 13. Verfahren nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, daß** dem Korrespondenz-Suchschritt d) ein Abgleichschritt g) (540a, b, c.; 610a, b, c) zum Auswählen mehrerer Elemente in der ersten Abtastung und mehrere Elemente in der zweiten Abtastung mit einer besseren reziproken Überlagerbarkeit folgt, wobei die ausgewählten mehreren Elemente der ersten und der zweiten Abtastung in dem Schritt e) zum Erzeugen der rekonstruierten Abtastung verwendet werden.

30 14. Verfahren nach Anspruch 13, **dadurch gekennzeichnet, daß** Abgleichschritt g) wenigstens die folgenden Schritte umfaßt:

35 g1) Auswählen (540a, 610a) einer ersten Mehrzahl von Elementen in der ersten Abtastung beginnend bei dem Referenzelement (ic) in der ersten Abtastung und einer zweiten Mehrzahl von Elementen in der zweiten Abtastung beginnend bei dem Referenzelement (jn) in der zweiten Abtastung;

g2) Berechnen einer ersten Größe (A) als eine Angabe der Überlagerung von Elementen in der ersten Mehrzahl und Elementen in der zweiten Mehrzahl;

40 g3) Auswählen (540b, 610b) einer dritten Mehrzahl von Elementen in der ersten Abtastung beginnend bei einem ersten Element (ic-1) in der ersten Abtastung, das in der Nähe des Referenzelementes (ic) in der ersten Abtastung liegt;

g4) Berechnen einer zweiten Größe (B), welche die Überlagerung der Elemente in der zweiten und in der dritten Mehrzahl angibt;

45 g5) Vergleichen der ersten und der zweiten Größe und Auswählen (570, 650) der ersten und der zweiten Mehrzahl, wenn die erste Größe eine bessere Überlagerbarkeit angibt als die zweite Größe; und

g6) Vergleichen der ersten und der zweiten Größe und Auswählen (570, 650) der zweiten und der dritten Mehrzahl, wenn die zweite Größe eine bessere Überlagerbarkeit angibt als die erste Größe.

50 15. Verfahren nach Anspruch 14, **gekennzeichnet durch** die weiteren Schritte:

g7) Auswählen (540c, 610c) einer vierten Mehrzahl von Elementen in der ersten Abtastung beginnend bei einem zweiten Element (ic+1) in der ersten Abtastung, das in der Nähe des Referenzelementes (ic) in der Abtastung liegt;

55 g8) Berechnen einer dritten Größe (C), welche die Überlagerung der Elemente in der zweiten und der vierten Mehrzahl angibt; und

g9) Vergleichen der ersten, der zweiten und der dritten Größe und Auswählen (570, 650) der zweiten und der vierten Mehrzahl, wenn die dritte Größe eine bessere Überlagerbarkeit angibt als die erste und die zweite Größe.

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16. Verfahren nach Anspruch 15, **dadurch gekennzeichnet, daß** das erste und das zweite Element ($ic-1$, $ic+1$) in der ersten Abtastung neben dem Referenzelement (ic) in der ersten Abtastung, auf jeweils zwei verschiedenen Seiten desselben liegen.
- 5 17. Verfahren nach einem der Ansprüche 14-16, **dadurch gekennzeichnet, daß** die Größen die Anzahl der Elemente in der ersten und in der zweiten Abtastung umfassen, welche im wesentlichen dieselbe Position in bezug auf die absolute Referenzposition haben und im wesentlichen dieselbe Breite haben, und daß der Schritt zum Vergleichen der Größen eine Suche nach der Größe mit dem maximalen Wert umfaßt.
- 10 18. Verfahren nach einem der Ansprüche 6-17, **dadurch gekennzeichnet, daß** der Schritt e) des Kombinierens (370) der Elemente in der ersten Abtastung mit den Elementen in der zweiten Abtastung die folgenden Schritte umfaßt:
- e1) Auswählen einer ersten Seite des Referenzelementes in der ersten Abtastung, welche die Elemente in der ersten Abtastung umfaßt, die im wesentlichen dieselbe Position und dieselbe Breite wie die Elemente in der zweiten Abtastung haben;
- 15 e2) Aufrechterhalten dieser Elemente der ersten Abtastung, die auf dieser ersten Seite angeordnet sind; und
e3) Addieren der Elemente der zweiten Abtastung, die auf der ersten Seite gegenüberliegenden Seite angeordnet sind, zu der ersten Abtastung, um die rekonstruierte Abtastung zu erzeugen.
- 20 19. Verfahren nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, daß** dem Schritt a) zum Ausführen (100) einer ersten Abtastung die folgenden Schritte vorangehen:
- h) Ausführen (100) einer vorläufigen Abtastung des Strichcodes, wobei die Position (T_p) und die Breite (T_c) der Elemente in der vorläufigen Abtastung in bezug auf die absolute Referenzposition (T_o , L_i) bestimmt werden, und Zuordnen der Elemente in der vorläufigen Abtastung zu einem aktuellen Bereich (FRAME); und
- 25 i) Zuordnen (191, 194a) der Elemente in dem aktuellen Bereich (FRAME) zu wenigstens einem von mehreren Ladebereichen (CLUSTERS).
- 30 20. Verfahren nach Anspruch 19, **dadurch gekennzeichnet, daß** der Zuordnungsschritt i) die folgenden Schritte umfaßt:
- i1) Auswählen (192) eines Ladebereichs aus den mehreren Ladebereichen;
- i2) Überprüfen (193), ob der ausgewählte Bereich bereits besetzt ist;
- i3a) wenn der ausgewählte Bereich noch nicht besetzt wurde, Untersuchen (191, 192), ob ein nachfolgender Ladebereich vorhanden ist;
- 35 i4a) wenn ein nachfolgender Ladebereich vorhanden ist, Zurückkehren zum Schritt i2); und
i4b) wenn kein nachfolgender Ladebereich vorhanden ist, Kopieren (207) der Elemente in dem aktuellen Bereich in einen der nicht besetzten Ladebereiche, Ausführen einer neuen Abtastung, Zuordnen der Elemente in der zuletzt ausgeführten Abtastung zu dem aktuellen Bereich und Zurückkehren zu dem Schritt ii).
- 40 21. Verfahren nach Anspruch 20, **dadurch gekennzeichnet, daß** der Schritt i4b) vor dem Schritt des Kopierens (207) einen Schritt umfaßt, bei dem nach Synchronitätszeichen (206) zwischen den Elementen in dem aktuellen Bereich (FRAME) gesucht wird; wenn die Suche nach den Synchronitätszeichen in dem aktuellen Bereich ein positives Ergebnis ergibt und Synchronitätszeichen gefunden werden, eine Bedingung, die das Vorhandensein der ersten Synchronität (208) angibt, gespeichert wird und der Schritt des Kopierens (207) ausgeführt wird; wenn die Suche nach Synchronitätszeichen in dem aktuellen Bereich ein negatives Ergebnis liefert und keine Synchronitätszeichen gefunden werden, zu dem Schritt des Ausführens h) einer vorläufigen Abtastung zurückgekehrt wird.
- 45 22. Verfahren nach Anspruch 21, **dadurch gekennzeichnet, daß** der Schritt i2) des Überprüfens (193), ob der ausgewählte Bereich bereits besetzt ist, einen Schritt umfaßt, bei dem überprüft wird, ob die Bedingung, welche das Vorhandensein der ersten Synchronität angibt, gespeichert wurde; wenn diese Bedingung des Vorhandenseins der ersten Synchronität erfaßt wird, die folgenden Schritte ausgeführt werden:
- i5) Suchen (310) nach einem Synchronitätszeichen unter den Elementen in dem aktuellen Bereich;
- 55 i6a) wenn der Schritt i5) der Suche (310) ein positives Ergebnis liefert und ein Synchronitätszeichen in dem aktuellen Bereich gefunden wird, die folgenden Schritte ausgeführt werden: Kopieren (355) der Elemente in dem aktuellen Bereich in den Ladebereich; Speichern (350) einer Kopplungsbedingung; Ausführen (100) einer neuen Abtastung, Zuordnen (170) der Elemente in der zuletzt ausgeführten Abtastung zu dem aktuellen Be-

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reich (FRAME) und Zurückkehren zu dem Schritt i1);
i6b) wenn die Suche (310) im Schritt i5) ein negatives Ergebnis liefert und kein Synchronitätszeichen in dem aktuellen Bereich gefunden wird, Löschen (330) der Bedingung, welche das Vorhandensein einer ersten Synchronität angibt, und Zurückkehren zu dem Schritt h).

5
23. Verfahren nach Anspruch 22, **dadurch gekennzeichnet, daß** dem Schritt i6a) des Kopierens (355) und Speicherns (350) die folgenden Schritte vorangehen:

10
i7) eine Kopplungs-Überprüfung (340) zum Verifizieren, ob die Elemente in dem aktuellen Bereich und die Elemente in dem Ladebereich gekoppelt werden können; i8a) wenn die Elemente in dem aktuellen Bereich und dem Ladebereich gekoppelt werden können, Ausführen der Schritte i6a) des Kopierens (355) und Speicherns (350) einer Kopplungsbedingung;
i8b) wenn die Elemente in dem aktuellen Bereich und dem Ladebereich nicht gekoppelt werden können, Aktualisieren (345) eines Fehlversuchszählers.

15
24. Verfahren nach Anspruch 23, **dadurch gekennzeichnet, daß** die Kopplungs-Überprüfung (340) im Schritt i7) folgende Schritte umfaßt:

20
i7-1) Überprüfen (400), ob die Anzahl der Elemente in dem aktuellen Bereich eine vorgegebene Beziehung zu der Anzahl der Elemente in dem Ladebereich hat;

i7-2a) wenn die Überprüfung (400) im Schritt i7-1) ein positives Ergebnis liefert, Berechnen (410,420) der Anzahl der überlagerbaren Elemente zwischen dem Ladebereich und dem aktuellen Bereich;

25
i7-3) Überprüfen (460f, 460r), ob die Anzahl der überlagerbaren Elemente einen vorgegebenen Schwellwert überschreitet;

i7-4a) wenn der Schritt i7-3) ein positives Ergebnis liefert, Ausführen des Schritts i6a) zum Koppeln (355) und Speichern (350) einer Kopplungsbedingung;

30
i7-4b) wenn der Schritt i7-3) ein negatives Ergebnis liefert, Ausführen des Schritts i8b) zum Aktualisieren (345) des Fehlversuchszählers;

i7-2b) wenn der Schritt i7-1) des Überprüfens (400) ein negatives Ergebnis liefert, Ausführen des Schritts i8b) des Aktualisierens (345) des Fehlversuchszählers.

35
25. Verfahren nach Anspruch 24, **dadurch gekennzeichnet, daß** dem Schritt i8b) des Aktualisierens (345) des Fehlversuchszählers die folgenden Schritte folgen: Überprüfen (130), ob der Fehlversuchszähler (NOMATCH) einen vorgegebenen Schwellwert (MAX-NOMATCH) überschreitet, und wenn das Ergebnis positiv ist, Speichern einer Bedingung, die zu einem nicht besetzten Ladebereich gehört (150); dann Zurückkehren zum Schritt h).

40
26. Verfahren nach einem der Ansprüche 20-25, **dadurch gekennzeichnet, daß** dann, wenn das Ergebnis des Schritts i2) der Überprüfung (193) angibt, daß der ausgewählte Bereich bereits besetzt ist, die folgenden Schritte ausgeführt werden:

i3b) eine Überlagerbarkeits-Überprüfung (195) zwischen den Elementen in dem Ladebereich und den Elementen in dem aktuellen Bereich;

45
i9a) wenn die Überlagerbarkeits-Überprüfung im Schritt i3b) ein positives Ergebnis liefert, Koppeln der Elemente in dem aktuellen Bereich mit den Elementen in dem Speicherbereich (355; 370);

i9b) wenn die Überlagerbarkeits-Überprüfung im Schritt i3b) ein negatives Ergebnis liefert, Zurückkehren zum Schritt i1), um unter den mehreren Ladebereichen ein Ladebereich auszuwählen (192).

50
27. Verfahren nach Anspruch 26, **dadurch gekennzeichnet, daß** dem Korrespondenz-Suchschritt d) (510-530, 550-560; 520b, 590, 600, 620-640) die folgenden Schritte folgen:

j) eine Kopplungs-Überprüfung (540, 570, 580; 610, 650, 660), um zu überprüfen, ob wenigstens eine vorgegebene Anzahl (MINMATCH) von Elementen in dem aktuellen Bereich und in dem Ladebereich im wesentlichen dieselbe Position (Tp) in bezug auf die absolute Bezugsposition (To) und im wesentlichen dieselbe Breite (Tc) haben;

55
k) wenn der Kopplungs-Prüfschritt j) ein negatives Ergebnis liefert, Aktualisieren (360) eines Fehlversuchszählers (NOMATCH);

l) Überprüfen (130), ob der Fehlversuchszähler (NOMATCH) einen vorgegebenen Schwellwert (MAX-NOMATCH) überschreitet, und wenn das Ergebnis positiv ist, Speichern (150) einer Bedingung, die einen nicht

besetzten Ladebereich angibt.

5 28. Verfahren nach einem der Ansprüche 22-27, **dadurch gekennzeichnet, daß** der Schritt i2) auch den Schritt i2-1) umfaßt, bei dem das Vorhandensein einer Kopplungsbedingung geprüft wird (300), und wenn die Kopplungsbedingung erfaßt wird, ein Korrespondenz-Suchschritt i2-2) zwischen den Elementen in dem aktuellen Bereich und den Elementen in dem Ladebereich ausgeführt wird.

10 29. Verfahren nach einem der Ansprüche 22-28, **dadurch gekennzeichnet, daß** die vorläufige Abtastung, die weitere Abtastung, die erste Abtastung, die zweite Abtastung und jede neue Abtastung folgende Schritte umfassen:

a1) Ausführen (100) einer vollständigen Abtastung von einer Anfangsabtastposition (Li) zu einer Endabtastposition (Lf);

a2) Auswählen (170) mehrerer benachbarter Codeelemente;

a3) Zuordnen (170) der mehreren benachbarten Elemente zu dem aktuellen Bereich;

15 a4) Verarbeiten (190) der Elemente in dem aktuellen Bereich;

a5) Untersuchen (200), ob weitere aufeinanderfolgende Codeelemente in der vollständigen Abtastung vorhanden sind;

a6a) wenn weitere benachbarte Codeelemente vorhanden sind, Auswählen (170) der weiteren benachbarten Codeelemente und Wiederholen der Schritte a3), a4) und a5); und

20 a6b) wenn kein weiteres benachbartes Codeelement vorhanden ist, Wiederholen des Schritts a).

25 30. Verfahren nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, daß** dem Korrespondenz-Suchschritt d) ein Schritt m) vorausgeht, in dem die Richtung der Überlagerung ermittelt wird, mit folgenden Verfahrensschritten:

m1) Ermitteln (410) der Anzahl der Elemente einer dritten und einer vierten Abtastung, welche beginnend von einem vorgegebenen Element in der dritten und in der vierten Abtastung überlagert werden können, und Bewegen in einer ersten Richtung;

30 m2) Ermitteln (420) der Anzahl der Elemente in der dritten und in der vierten Abtastung, welche beginnend von einem anderen vorgegebenen Element überlagert werden können, und Bewegen in einer zweiten Richtung, die zur ersten Richtung entgegengesetzt ist;

m3) Einstellen (470f) eines ersten Richtungszeigers (FORWARD), wenn die Anzahl der in dem Schritt m1) ermittelten Elemente größer ist als die Anzahl der im Schritt m2) ermittelten Elemente; und

35 m4) Einstellen (470r) eines zweiten Richtungszeigers (REVERSE), wenn die Anzahl der in dem Schritt m2) ermittelten Elemente größer ist als die Anzahl der im Schritt m1) ermittelten Elemente.

40 31. Verfahren nach Anspruch 30, **dadurch gekennzeichnet, daß** die Schritte m1) und m2) des Ermitteln der Anzahl der überlagerbaren Elemente eine Suche nach Elementen mit im wesentlichen derselben Position in bezug auf die absolute Referenzposition und im wesentlichen derselben Breite in der dritten und der vierten Abtastung in der ersten bzw. in der zweiten Richtung beginnend bei dem ersten bzw. dem letzten Element umfaßt.

45 32. Verfahren nach Anspruch 30 oder 31, **dadurch gekennzeichnet, daß** dem Korrespondenz-Suchschritt d) folgender Schritt folgt: n) Ermitteln (365, 380) der Position, welche die Elemente in der dritten Abtastung während einer nachfolgenden Abtastung annehmen werden, wobei der Schritt n) folgende Schritte umfaßt:

n1) Neu berechnen (365) der Verschiebungsgröße (Δ -Position) als die absolute Positionsdifferenz zwischen den Elementen in der dritten Abtastung und den korrespondierenden Elementen in der vierten Abtastung;

n2) Summieren (380) der Absolutposition der Elemente in der dritten Abtastung und der berechneten Differenz.

50 33. Verfahren nach Anspruch 32, **dadurch gekennzeichnet, daß** dann, wenn der erste Zeiger (FORWARD) eingestellt wird, die Positionsdifferenz zwischen dem ersten Element in der dritten Abtastung und dem ersten Element in der vierten Abtastung in dem Schritt n1) berechnet wird, während dann, wenn der zweite Zeiger (REVERSE) eingestellt wird, die Positionsdifferenz zwischen dem letzten Element in der dritten Abtastung dem letzten Element in der vierten Abtastung im Schritt n1) bestimmt wird.

55 34. Verfahren nach einem der Ansprüche 22-26, **dadurch gekennzeichnet, daß** der Schritt i6a) auch die folgenden Schritte umfaßt:

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o1) Neuberechnen (480) der Verschiebungsgröße (Δ -Position) als die absolute Positionsdifferenz zwischen den Elementen in dem Ladebereich und den korrespondierenden Elementen in dem aktuellen Bereich;
o2) Ermitteln (380) der Position, welche die Elemente in dem Ladebereich während einer nachfolgenden Abtastung annehmen werden, als die Summe der Absolutposition der Elemente in dem Ladebereich und der berechneten Differenz.

35. Verfahren nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, daß** dem Schritt e) die folgenden Schritte folgen:

oo1) Neuberechnen (480) der Verschiebungsgröße (Δ -Position) als die absolute Positionsdifferenz zwischen den Elementen in der rekonstruierten Abtastung und den korrespondierenden Elementen in der zweiten Abtastung;

002) Ermitteln (380) der Position, welche die Elemente in der rekonstruierten Abtastung während einer nachfolgenden Abtastung annehmen werden, als die Summe der absoluten Position dieser Elemente in der rekonstruierten Abtastung und der berechneten Differenz.

36. Verfahren nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, daß** dem Schritt d) der Korrespondenz-Suche (510-530, 550-560; 520b, 590, 600, 620-640) ein Schritt p) vorangeht, in dem die Überlagerbarkeit (195) dieser Elemente in der ersten und der zweiten Abtastung geprüft wird.

37. Verfahren nach Anspruch 36, **dadurch gekennzeichnet, daß** der Schritt p) der Überprüfung der Überlagerbarkeit (195) die folgenden Schritte umfaßt:

p1) Überprüfen (195a), ob die Position des letzten Elements in der zweiten Abtastung nicht niedriger ist als die Position des ersten Elements in der ersten Abtastung;

p2) Überprüfen (195b), ob die Position des ersten Elements in der zweiten Abtastung nicht höher ist als die Position des letzten Elements in der ersten Abtastung;

p3a) wenn die Schritte p1) und p2) des Überprüfens beide ein positives Ergebnis liefern, Ausführen des Korrespondenz-Suchschrittes d); und

p3b) wenn wenigstens einer der Schritte p1) und p2) des Überprüfens ein negatives Ergebnis liefert, Ausführen (100) eines weiteren Schritts, in dem der Barcode abgetastet wird.

38. Verfahren nach Anspruch 36 oder 37, **dadurch gekennzeichnet, daß** dann, wenn der Schritt p) des Überprüfens der Überlagerbarkeit (195) ein positives Ergebnis liefert, die folgenden Schritte ausgeführt werden:

q) Decodieren (202) der Elemente in der zweiten Abtastung; und

r) Übertragen des Ergebnisses des Decodierschrittes q) nach außen.

39. Verfahren nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, daß** nach dem Schritt e) des Kombinierens (370) der Elemente in der ersten Abtastung mit den Elementen in der zweiten Abtastung die folgenden Schritte ausgeführt werden:

s) Decodieren (202) der Elemente in der rekonstruierten Abtastung; und

t) Übertragen des Ergebnisses des Decodierschrittes s) nach außen (203).

40. Verfahren nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, daß** die absolute Referenzposition (T_0 , L_i) außerhalb des Strichcodes (8) liegt.

Revendications

1. Procédé pour reconstituer un code à barres (8) à partir de balayages successifs en présence d'un mouvement relatif entre le code à barres (8) et un trajet de balayage, le code à barres (8) comprenant plusieurs éléments, chacun de ces éléments ayant une première et une deuxième réflectivité et étant représenté par une largeur (T_c) et une position (T_p) par rapport à une position de référence absolue (T_0 , L_i), comprenant les étapes suivantes :

(a0) obtenir une valeur de décalage (Δ -position) représentative du déplacement, dans une direction de balayage, des éléments du code à barres entre deux balayages successifs l'un à l'autre ;

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a) effectuer (100) un premier balayage du code à barres, déterminer la position (T_p) et la largeur (T_c) des éléments dans le premier balayage par rapport à la position de référence absolue (T_o , L_i) ;
b) recalculer (380), sur la base de la valeur de décalage (Δ -position), la position de ces éléments dans le premier balayage par rapport à la position de référence absolue (T_o , L_i) comme étant la position que ces éléments prendront par rapport à la position de référence absolue (T_o , L_i) dans un balayage suivant ;
c) effectuer (100) un deuxième balayage du code à barres, déterminer la position (T_p) et la largeur (T_c) des éléments dans le deuxième balayage par rapport à la position de référence absolue (T_o , L_i) ;
d) accomplir une étape de recherche de correspondance (510-530, 550-560 ; 520b, 590, 600, 620-640) de façon à trouver (520, 590) au moins un élément de référence dans le premier balayage et au moins un élément de référence dans le deuxième balayage qui ont tous deux sensiblement la même position (T_p) par rapport à la référence absolue (T_o , L_i) et sensiblement la même largeur (T_c) ; et
e) combiner (370) les éléments dans le premier balayage avec les éléments dans le deuxième balayage de façon à générer un balayage reconstitué.

2. Procédé selon la revendication 1, **caractérisé par** les étapes suivantes :

bb) recalculer (380), sur la base de la valeur de décalage (Δ -position), la position desdits éléments dans le balayage reconstitué par rapport à la position de référence absolue (T_o , L_i) comme étant la position que ces éléments vont prendre par rapport à la position de référence absolue (T_o , L_i) dans un balayage suivant ;
cc) effectuer (100) un autre balayage du code à barres, déterminer la position (T_p) et la largeur (T_c) des éléments dans cet autre balayage par rapport à la position de référence absolue (T_o , L_i) ;
dd) accomplir une étape suivante de recherche de correspondance (510-530, 550-560 ; 520b, 590, 600, 620-640) de façon à trouver (520, 590) au moins un élément de référence dans ledit balayage reconstitué et au moins un élément de référence dans ledit autre balayage qui ont tous deux sensiblement la même position (T_p) par rapport à la référence absolue (T_o , L_i) et sensiblement la même largeur (T_c) ; et
ee) actualiser (370) les éléments dans le balayage reconstitué en les combinant avec les éléments dans ledit autre balayage.

3. Procédé selon la revendication 2, **caractérisé par** les étapes suivantes :

bb1) recalculer (380), sur la base de la valeur de décalage (Δ -position), la position desdits éléments dans le balayage reconstitué par rapport à la position de référence absolue (T_o , L_i) comme étant la position que ces éléments, après actualisation à l'étape ee) vont prendre par rapport à la position de référence absolue (T_o , L_i) dans un balayage suivant ; et

- répéter itérativement les étapes cc), dd), ee) et bb1) aussi longtemps (180) que ledit autre balayage comprend au moins un nombre prédéterminé d'éléments.

4. Procédé selon la revendication 3, **caractérisé en ce qu'on** répète itérativement seulement l'étape cc) tant que ledit autre balayage comprend un nombre d'éléments inférieur au nombre prédéterminé.

5. Procédé selon la revendication 2, **caractérisé par** les étapes suivantes :

bb1) recalculer (380), sur la base de la valeur de décalage (Δ -position), la position desdits éléments dans le balayage reconstitué par rapport à la position de référence absolue (T_o , L_i) comme étant la position que ces éléments, après actualisation à l'étape ee), vont prendre par rapport à la position de référence absolue (T_o , L_i) dans un balayage suivant ; essayer (198a) de décoder le code reconstitué ; et répéter itérativement les étapes cc), dd), ee) et bb1) aussi longtemps que l'étape d'essayer de décoder donne un résultat négatif.

6. Procédé selon l'une quelconque des revendications précédentes, **caractérisé en ce que** ladite étape d) de recherche de correspondance (510-530, 550-560 ; 520b, 590, 600, 620-640) est suivie par une étape f) de vérification de couplage (540, 570, 580 ; 610, 650, 660) pour vérifier qu'au moins un nombre prédéterminé (MINMATCH) d'éléments dans le premier balayage et le deuxième balayage a sensiblement la même position (T_p) par rapport à la position de référence absolue (T_o) et sensiblement la même largeur (T_c).

7. Procédé selon la revendication 6, **caractérisé en ce que** l'étape f) de vérification de couplage (540, 570, 580 ; 610, 650, 660) est accomplie en comparant (540, 610) au moins un jeu minimum défini (560, 640, MINMATCH) d'éléments dans le premier balayage avec un jeu défini minimum (560, 640, MINMATCH) d'éléments dans le

deuxième balayage.

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8. Procédé selon la revendication 6 ou 7, **caractérisé en ce que** dans l'étape f) de vérification de couplage, on calcule (540, 610) le nombre $A(i_c, j_n)$ d'éléments superposables dans le premier et deuxième balayage.
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9. Procédé selon la revendication 8, **caractérisé en ce que** les éléments superposables sont définis par une séquence continue d'éléments dans le premier balayage et le deuxième balayage ayant sensiblement la même position par rapport à la position de référence absolue et sensiblement la même largeur.
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10. Procédé selon l'une quelconque des revendications 6 à 9, **caractérisé en ce que** l'étape e) de combiner (370) les éléments dans le premier balayage avec les éléments dans le deuxième balayage est effectuée lorsque l'étape f) de vérification de couplage (540, 570, 580 ; 610, 650, 660) a donné un résultat positif.
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11. Procédé selon l'une quelconque des revendications précédentes, **caractérisé en ce que** l'étape d) de recherche de correspondance (510-530, 550-560 ; 520b, 590, 600, 620-640) comprend les étapes suivantes :
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- d1) choisir (510 ; 520b) un élément de départ de vérification (i_c) parmi les éléments dans le premier balayage et un élément de départ de vérification (j_n) parmi les éléments dans le deuxième balayage ;
- 30
- d2) accomplir une étape de vérification de correspondance (520 ; 590) de façon à vérifier si la position de l'élément de départ de vérification dans le deuxième balayage (520 ; 590) par rapport à la position de référence absolue est approximativement la même que la position de l'élément de départ de balayage dans le premier balayage par rapport à la position de référence absolue ; si l'étape de vérification de correspondance d2) (520 ; 590) a donné un résultat négatif, accomplir une étape d3) de modification itérative (530, 555, 550, 560 ;
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- 600, 620, 630, 640) pour choisir d'autres éléments dans le deuxième balayage ou dans le premier balayage à côté dudit élément de départ de vérification ; l'étape d3) de modification itérative est accomplie avec d'autres éléments jusqu'à ce que l'étape de vérification de correspondance d2) aboutisse à un résultat positif (520 ; 590) et que l'élément de référence soit trouvé.
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12. Procédé selon la revendication 11, **caractérisé en ce que** l'élément de départ de vérification comprend un avant-dernier élément dans le premier et le deuxième balayage.
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13. Procédé selon l'une quelconque des revendications précédentes, **caractérisé en ce que** l'étape de recherche de correspondance d) est suivie par une étape d'adaptation g) (540a,b,c ; 610a,b,c) pour choisir plusieurs éléments dans le premier balayage et plusieurs éléments dans le deuxième balayage ayant une meilleure superposabilité réciproque, lesdits plusieurs éléments sélectionnés du premier et du deuxième balayage étant utilisés dans l'étape e) pour générer le balayage reconstitué.
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14. Procédé selon l'une quelconque des revendications précédentes, **caractérisé en ce que** l'étape d'adaptation (g) comprend au moins les étapes suivantes :
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- g1) choisir (540a, 610a) une première pluralité d'éléments dans le premier balayage à partir de l'élément de référence (i_c) du premier balayage et une deuxième pluralité d'éléments dans le deuxième balayage à partir de l'élément de référence (j_n) du deuxième balayage ;
- g2) calculer une première quantité (A) en tant qu'indication de superposition d'éléments dans la première pluralité d'éléments et d'éléments dans la deuxième pluralité d'éléments ;
- g3) choisir (540b, 610b) une troisième pluralité d'éléments dans le premier balayage à partir d'un premier élément (i_{c-1}) dans le premier balayage près de l'élément de référence (i_c) du premier balayage ;
- g4) calculer une deuxième quantité (B) indiquant la superposition desdits éléments dans la deuxième et la troisième pluralité ;
- g5) comparer la première et la deuxième quantité et choisir (570, 650) la première et la deuxième pluralité si la première quantité indique une meilleure superposabilité que la deuxième quantité et
- g6) comparer la première et la deuxième quantité et choisir (570, 650) la deuxième et la troisième pluralité si la deuxième quantité indique une meilleure superposabilité que la première quantité.
15. Procédé selon la revendication 14, **caractérisé par** les étapes supplémentaires suivantes :
- g7) choisir (540c, 610c) une quatrième pluralité d'éléments dans le premier balayage à partir d'un deuxième

élément (ic+1) du premier balayage près de l'élément de référence (ic) du premier balayage ;
g8) calculer une troisième quantité (C) indiquant la superposition desdits éléments dans la deuxième et la quatrième pluralité ;
g9) comparer la première, la deuxième et la troisième quantité et choisir (570, 650) la deuxième et la quatrième pluralité si la troisième quantité indique une meilleure superposabilité que la première et la deuxième quantité.

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16. Procédé selon la revendication 15, **caractérisé en ce que** le premier et le deuxième élément (ic-1, ic+1) dans le premier balayage sont adjacents à l'élément de référence (ic) du premier balayage de deux cotés différents de celui-ci.

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17. Procédé selon l'une quelconque des revendications 14 à 16, **caractérisé en ce que** les dites quantités comprennent le nombre d'éléments dans le premier et le deuxième balayage qui ont sensiblement la même position par rapport à la position de référence absolue et sensiblement la même largeur, et **en ce que** les étapes pour comparer ces quantités comprennent une recherche de la quantité ayant la valeur maximum.

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18. Procédé selon l'une quelconque des revendications 6 à 17, **caractérisé en ce que** l'étape e) de combiner (370) les éléments dans le premier balayage avec les éléments dans le deuxième balayage comprend les étapes suivantes :

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e1) choisir un premier coté de l'élément de référence dans le premier balayage comprenant lesdits éléments dans le premier balayage ayant sensiblement la même position et la même largeur que les éléments dans le deuxième balayage ;

e2) maintenir les éléments dans le premier balayage qui sont disposés dudit premier coté et

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e3) ajouter au premier balayage les éléments du deuxième balayage qui sont disposés du coté opposé au premier coté de façon à générer le balayage reconstitué.

19. Procédé selon l'une quelconque des revendications précédentes, **caractérisé en ce que** l'étape a) pour effectuer (100) un premier balayage est précédée par les étapes suivantes:

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h) effectuer (100) un balayage préliminaire du code à barres en déterminant la position (Tp) et la largeur (Tc) des éléments dans le balayage préliminaire par rapport à la position de référence absolue (To, Li) et associer les éléments de ce balayage préliminaire avec une aire courante (FRAME) et ;

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i) associer (191, 194a) les éléments de l'aire courante (FRAME) avec au moins l'une de plusieurs aires de chargement (CLUSTERS)

20. Procédé selon la revendication 19, **caractérisé en ce que** l'étape d'association i) comprend les étapes suivantes :

i1) choisir (192) une aire de chargement parmi lesdites plusieurs aires de chargement ;

i2) vérifier (193) si l'aire choisie est déjà occupée ;

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i3a) si l'aire choisie n'a pas déjà été occupée, rechercher (191, 192) s'il existe une aire de chargement suivante ;

i4a) s'il existe une aire de chargement suivante, retourner à l'étape i2) et

i4b) s'il n'existe pas d'aire de chargement suivante, copier (207) lesdits éléments de l'aire courante dans l'une desdites aires de chargement inoccupées, effectuer un nouveau balayage, associer les éléments du dernier balayage effectué avec l'aire courante et revenir à l'étape i1).

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21. Procédé selon la revendication 20, **caractérisé en ce que** l'étape i4b) comprend, avant l'étape de copier (207), l'étape de chercher des caractères de synchronisme (206) entre lesdits éléments de l'aire courante (FRAME) ; si la recherche de caractères de synchronisme dans l'aire courante donne un résultat positif et que des caractères de synchronisme sont trouvés, une condition de présence du premier synchronisme (208) est enregistrée et l'étape de copier (207) est effectuée ; si la recherche de caractères de synchronisme dans l'aire courante donne un résultat négatif et qu'aucun caractère de synchronisme n'est trouvé, on retourne à l'étape d'effectuer (h) un balayage préliminaire.

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22. Procédé selon la revendication 21, **caractérisé en ce que** l'étape i2) de vérifier (193) si l'aire choisie est déjà occupée comprend l'étape de vérifier si ladite condition de présence du premier synchronisme a été enregistrée ; si la condition de présence du premier synchronisme est détectée, l'étape suivante est effectuée :

i5) rechercher (310) un caractère de synchronisme parmi les éléments de l'aire courante ;

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i6a) si l'étape (15) de recherche (310) donne un résultat positif et qu'un caractère de synchronisme est trouvé dans l'aire courante, les étapes suivantes sont effectuées : copier (355) les éléments de l'aire courante dans ladite aire de chargement ; enregistrer (350) une condition de couplage ; effectuer (100) un nouveau balayage, associer (170) les éléments du dernier balayage effectué avec l'aire courante (FRAME) et revenir à l'étape i1) ;
i6b) si l'étape i5) de recherche (310) donne un résultat négatif et qu'aucun caractère de synchronisme n'est trouvé dans l'aire courante, supprimer (330) ladite condition de présence d'un premier synchronisme et revenir à l'étape h).

23. Procédé selon la revendication 22, **caractérisé en ce que** l'étape 6a) de copier (365) et enregistrer (350) est précédée par les étapes suivantes :

i7) une vérification de couplage (340) pour vérifier si les éléments dans l'aire courante et les éléments dans l'aire de chargement peuvent être couplés ;

i8a) si les éléments dans l'aire courante et l'aire de chargement peuvent être couplés, effectuer les étapes 6a) de copier (355) et enregistrer (350) une condition de couplage ;

i8b) si les éléments dans l'aire courante et l'aire de chargement ne peuvent pas être couplés, actualiser (345) un compteur de tentatives infructueuses.

24. Procédé selon la revendication 23, **caractérisé en ce que** l'étape i7) de vérification ce couplage (340) comprend les étapes suivantes :

i7-1) vérifier (400) si le nombre d'éléments dans l'aire courante présente une relation prédéterminée avec le nombre d'éléments dans l'aire de chargement ;

i7-2a) si l'étape i7-1) de vérification (400) donne un résultat positif, calculer (410, 420) le nombre d'éléments superposables entre l'aire de chargement et l'aire courante ;

i7-3) vérifier (460f, 460r) si le nombre d'éléments superposables dépasse une valeur seuil prédéterminée ;

i7-4a) si l'étape i7-3) donne un résultat positif, effectuer l'étape i6a) pour coupler (355) et enregistrer (350) une condition de couplage ;

i7-4b) si l'étape i7-3) donne un résultat négatif, effectuer l'étape i8b) d'actualiser (345) le compteur de tentatives infructueuses ;

i7-2b) si l'étape i7-1) de vérification (400) donne un résultat négatif, effectuer l'étape i8b) d'actualiser (345) le compteur de tentatives infructueuses.

25. Procédé selon la revendication 24, **caractérisé en ce que** l'étape i8b) d'actualiser (345) le compteur de tentatives infructueuses est suivie par les étapes de vérifier (130) si le compteur de tentatives infructueuses (NOMATCH) dépasse une valeur seuil prédéterminée (MAX-NOMATCH) et si le résultat est positif, enregistrer une condition d'aire de chargement inoccupée (150) ; puis revenir à l'étape h).

26. Procédé selon l'une quelconque des revendications 20 à 25, **caractérisé en ce que** si le résultat de l'étape i2) de vérifier (193) indique que l'aire choisie est déjà occupée, les étapes suivantes sont effectuées :

i3b) vérification de superposabilité (195) entre les éléments dans l'aire de chargement et les éléments dans l'aire courante ;

i9a) si l'étape de vérification de superposabilité (i3b) donne un résultat positif, les éléments dans l'aire courante sont couplés (355 ; 370) avec les éléments dans l'aire de stockage ;

i9b) si l'étape de vérification de superposabilité (i3b) donne un résultat négatif, on revient à l'étape i1) pour choisir (192) une aire de chargement parmi les plusieurs aires de chargement.

27. Procédé selon la revendication 26, **caractérisé en ce que** l'étape de recherche de correspondance (d) (510-530, 550-560 ; 520b, 590, 600, 620-640) est suivie par les étapes suivantes :

j) vérifier le couplage (540, 570, 580 ; 610, 650, 660) pour vérifier si au moins un nombre prédéterminé (MIN-MATCH) d'éléments dans l'aire courante et dans l'aire de chargement ont sensiblement la même position (Tp) par rapport à la référence absolue (To) et sensiblement la même largeur (Tc) ;

k) si l'étape de vérification de couplage (j) donne un résultat négatif, actualiser (360) un compteur de tentatives infructueuses (NOMATCH) ;

l) vérifier (130) si le compteur de tentatives infructueuses (NOMATCH) dépasse une valeur seuil prédéterminée (MAX-NOMATCH) et, si le résultat est positif, enregistrer (150) une condition d'aire de chargement inocc-

cupée.

- 5 28. Procédé selon l'une quelconque des revendications 22 à 27, **caractérisé en ce que** l'étape (i2) comprend également l'étape i2-1) de vérifier (300) la présence de la condition de couplage et, si la condition de couplage est détectée, effectuer une étape de recherche de correspondance (i2-2) entre les éléments dans l'aire courante et les éléments dans l'aire de chargement.
- 10 29. Procédé selon l'une quelconque des revendications 22 à 28, **caractérisé en ce que** ledit balayage préliminaire, ledit autre balayage, ledit premier balayage, ledit deuxième balayage et tout nouveau balayage comprennent chacun les étapes suivantes :
- 15 a1) effectuer (100) un balayage complet à partir d'une position de début de balayage (Li) jusqu'à une position de fin de balayage (Lf) ;
a2) choisir (170) un ensemble d'éléments de code adjacents ;
a3) associer (170) l'ensemble d'éléments adjacents avec l'aire courante ;
a4) traiter (170) ces éléments dans l'aire courante ;
a5) rechercher (200) s'il existe d'autres éléments de code successifs existant dans le balayage complet ;
a6a) s'il existe d'autres éléments de code adjacents, choisir (170) ces autres éléments de code adjacents et répéter les étapes a3), a4) et a5) et
20 a6b) s'il n'existe pas d'autres éléments de code adjacents, répéter l'étape a1).
- 25 30. Procédé selon l'une quelconque des revendications précédentes, **caractérisé en ce que** l'étape de recherche de correspondance d) est précédée par une étape m) de déterminer la direction de superposition, comprenant les étapes suivantes :
- 30 m1) déterminer (410) le nombre d'éléments dans un troisième et un quatrième balayage qui peuvent être superposés à partir d'un élément prédéterminé dans le troisième et le quatrième balayage et en se déplaçant dans une première direction ;
m2) déterminer (420) le nombre d'éléments dans le troisième et le quatrième balayage qui peuvent être superposés à partir d'un élément prédéterminé différent et en se déplaçant dans une deuxième direction opposée à la première direction ;
35 m3) positionner (470) un indicateur de première direction (FORWARD) si le nombre d'éléments déterminé dans l'étape m1) est plus grand que le nombre d'éléments déterminé dans l'étape m2) ; et
m4) positionner (470) un indicateur de deuxième direction (REVERSE) si le nombre d'éléments déterminé dans l'étape m2) est plus grand que le nombre d'éléments déterminés dans l'étape m1).
- 40 31. Procédé selon la revendication 30, **caractérisé en ce que** les étapes m1 et m2) de déterminer le nombre d'éléments superposables comprend une recherche d'éléments ayant sensiblement la même position par rapport à la position de référence absolue et sensiblement la même largeur, dans le troisième et le quatrième balayage à partir du premier et du dernier élément respectivement dans la première et la deuxième direction.
- 45 32. Procédé selon la revendication 30 ou 31, **caractérisé en ce que** l'étape de recherche de correspondance d) est suivie par l'étape suivante :
- 50 n) déterminer (356, 380) la position que les éléments dans le troisième balayage vont prendre pendant un balayage ultérieur, cette étape n) de déterminer comprenant les étapes suivantes :
n1) recalculer (365) la valeur de décalage (Δ -position) comme étant la différence de position absolue entre les éléments dans le troisième balayage et les éléments correspondants dans le quatrième balayage ;
n2) sommer (380) la position absolue des éléments dans le troisième balayage et la différence calculée.
- 55 33. Procédé selon la revendication 32, **caractérisé en ce que** lorsque le premier indicateur (FORWARD) est positionné, la différence de position entre le premier élément dans le troisième balayage et le premier élément dans le quatrième balayage est calculée dans l'étape n1) alors que lorsque le deuxième indicateur (REVERSE) est positionné, la différence de position entre le dernier élément dans le troisième balayage et le dernier élément dans le quatrième balayage est déterminée dans l'étape n1).
34. Procédé selon l'une quelconque des revendications 22 à 26, **caractérisé en ce que** l'étape i6a) comprend également les étapes suivantes :

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o1) recalculer (480) la valeur de décalage (Δ -position) comme étant la différence de position absolue entre les éléments dans l'aire de chargement et les éléments correspondants dans l'aire courante ;
o2) déterminer (380) la position que les éléments dans l'aire de chargement vont prendre dans un balayage ultérieur comme étant la somme de la position absolue de ces éléments dans l'aire de chargement et de la différence calculée.

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35. Procédé selon l'une quelconque des revendications précédentes, **caractérisé en ce que** l'étape e) est suivie par les étapes suivantes :

oo1) recalculer (480) la valeur de décalage (Δ -position) comme étant la différence de position absolue entre les éléments dans le balayage reconstitué et les éléments correspondants dans le deuxième balayage ;
oo2) déterminer (380) la position que les éléments dans le balayage reconstitué vont prendre dans un balayage ultérieur comme étant la somme de la position de ces éléments dans le balayage reconstitué et de la différence calculée.

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36. Procédé selon l'une quelconque des revendications précédentes, **caractérisé en ce que** l'étape d) de recherche de correspondance (510-530, 550-560 ; 520b, 590, 600, 620-640) est précédée par une étape p) de vérifier la superposabilité (195) de ces éléments dans le premier et le deuxième balayage.

37. Procédé selon la revendication 36, **caractérisé en ce que** l'étape b) de vérifier la superposabilité (195) comprend les étapes suivantes :

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p1) vérifier (195a) si la position du dernier élément dans le deuxième balayage n'est pas inférieure à la position du premier élément dans le premier balayage ;

p2) vérifier (195a) si la position du premier élément dans le deuxième balayage n'est pas supérieure à la position du dernier élément dans le premier balayage ;

p3a) si les étapes de vérification p1) et p2) donnent toutes les deux un résultat positif, l'étape de recherche de correspondance (d) est accomplie et ;

p3b) si l'une au moins des étapes de vérification p1) et p2) donne un résultat négatif, effectuer (100) une autre étape de balayage du code à barres.

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38. Procédé selon la revendication 36 ou 37, **caractérisé en ce que** si l'étape (p) de vérification de superposabilité (195) a donné un résultat positif, les étapes suivantes sont effectuées :

q) décoder (202) les éléments dans le deuxième balayage et
r) transmettre le résultat de l'étape de décodage (q) à l'extérieur.

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39. Procédé selon l'une quelconque des revendications précédentes, **caractérisé en ce qu'**après l'étape e) de combiner (370) les éléments dans le premier balayage avec les éléments dans le deuxième balayage, les étapes suivantes sont effectuées :

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s) décoder (202) les éléments dans le balayage reconstitué et

t) transmettre le résultat de l'étape de décodage (s) à l'extérieur (203).

40. Procédé selon l'une quelconque des revendications précédentes, **caractérisé en ce que** la position de référence absolue (T_0 , L_i) est extérieure au code à barres (8).

45

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55

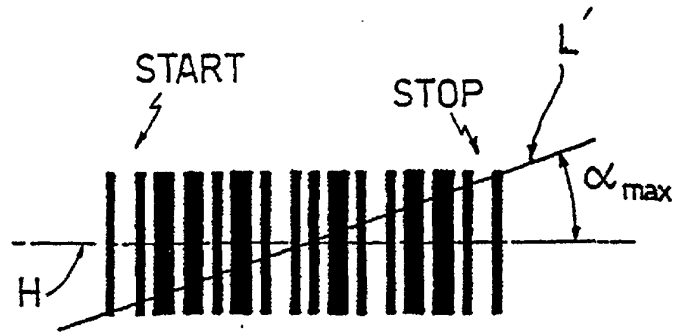


Fig.2

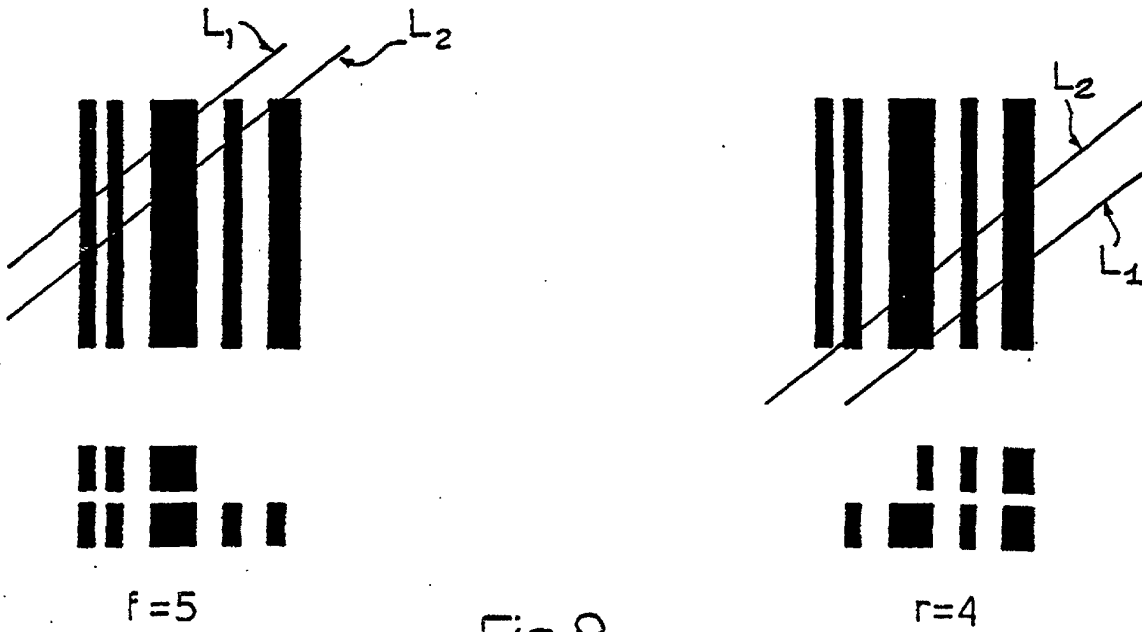


Fig.8

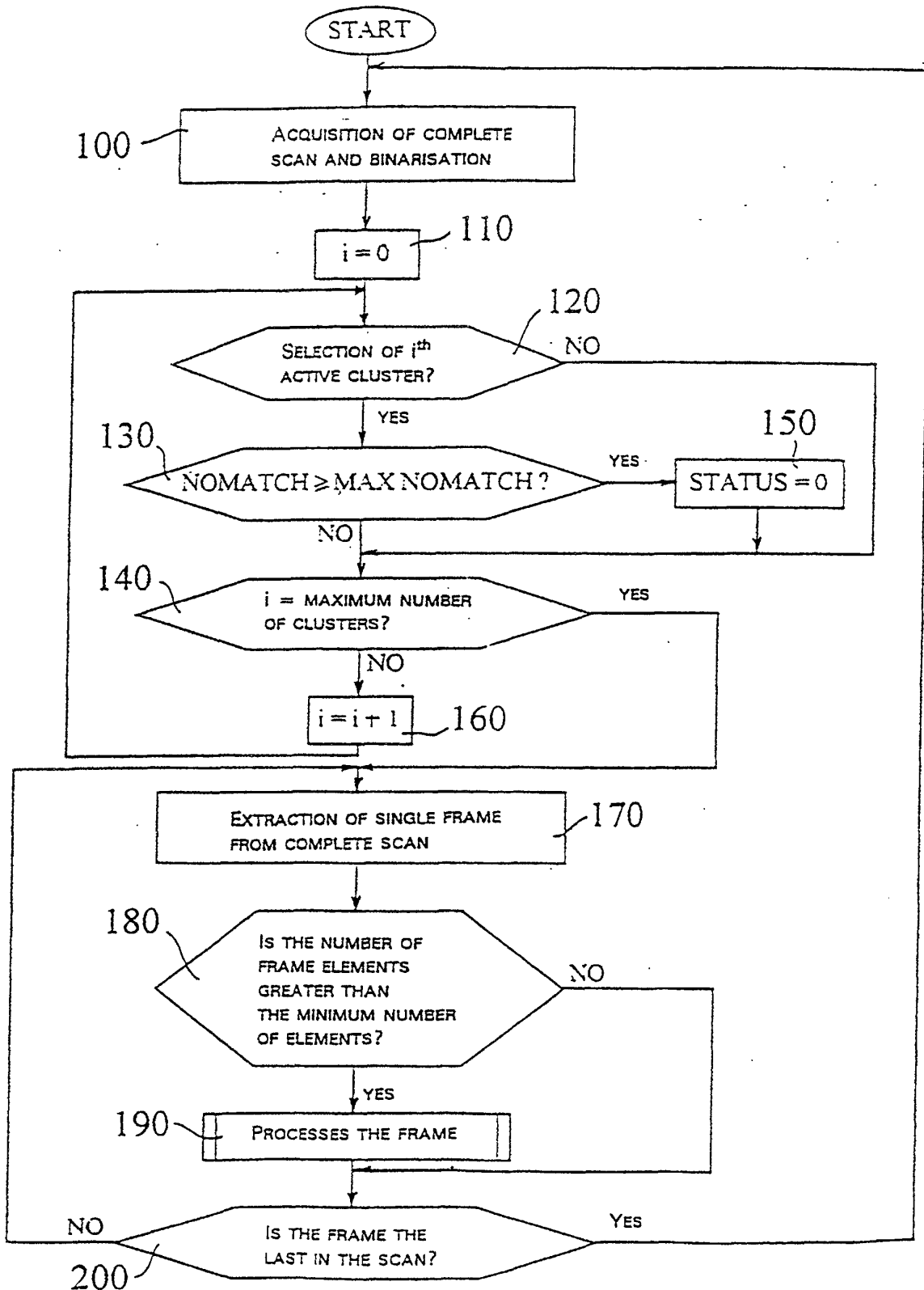


Fig. 3a

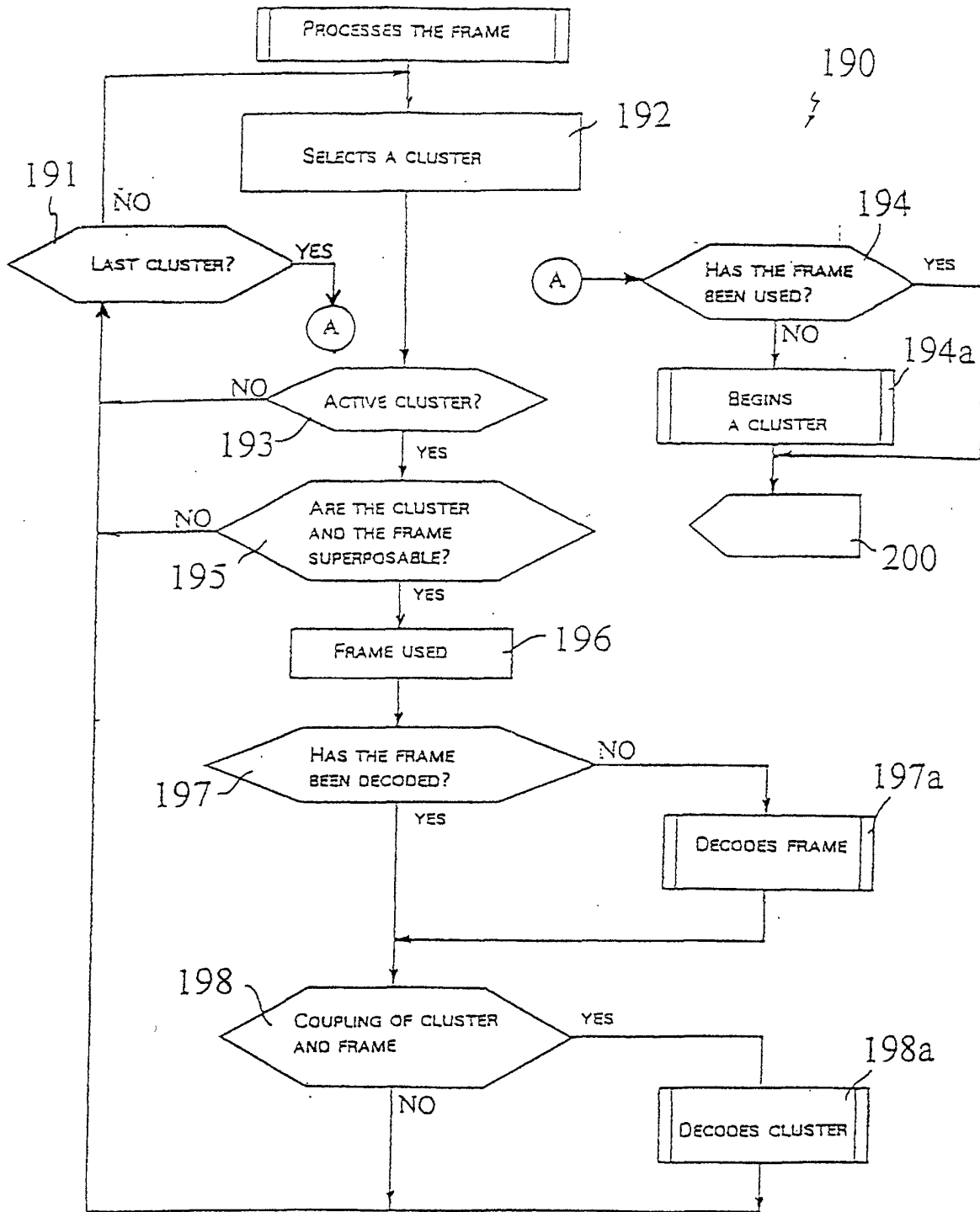


Fig. 3b

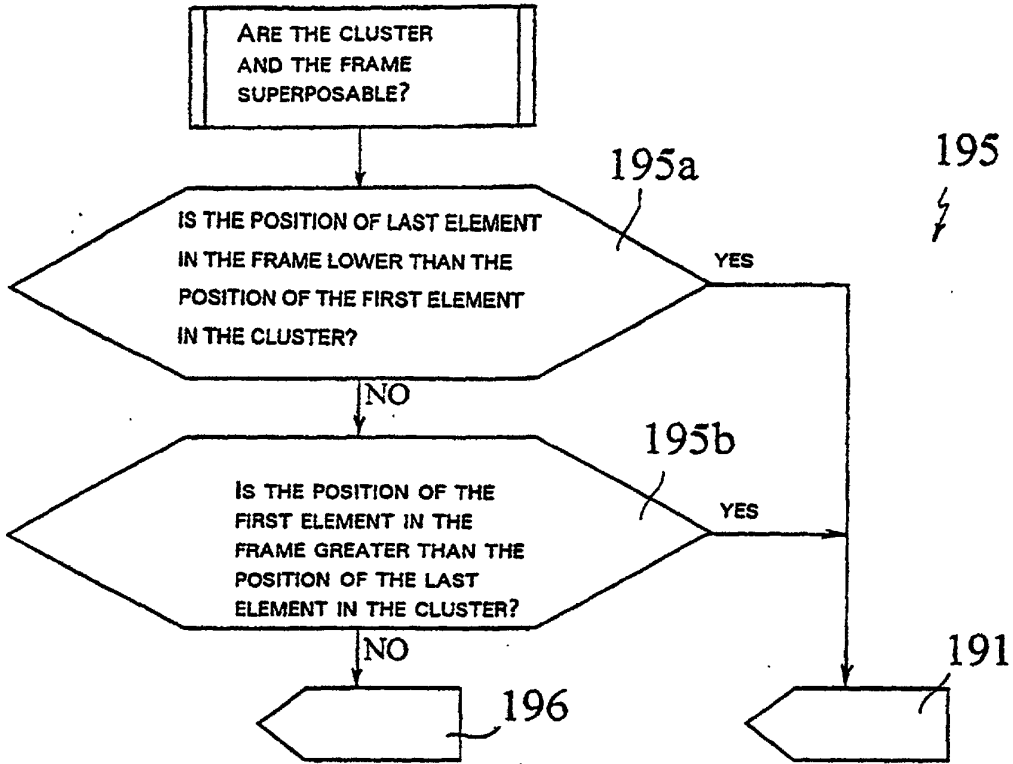


Fig. 3c

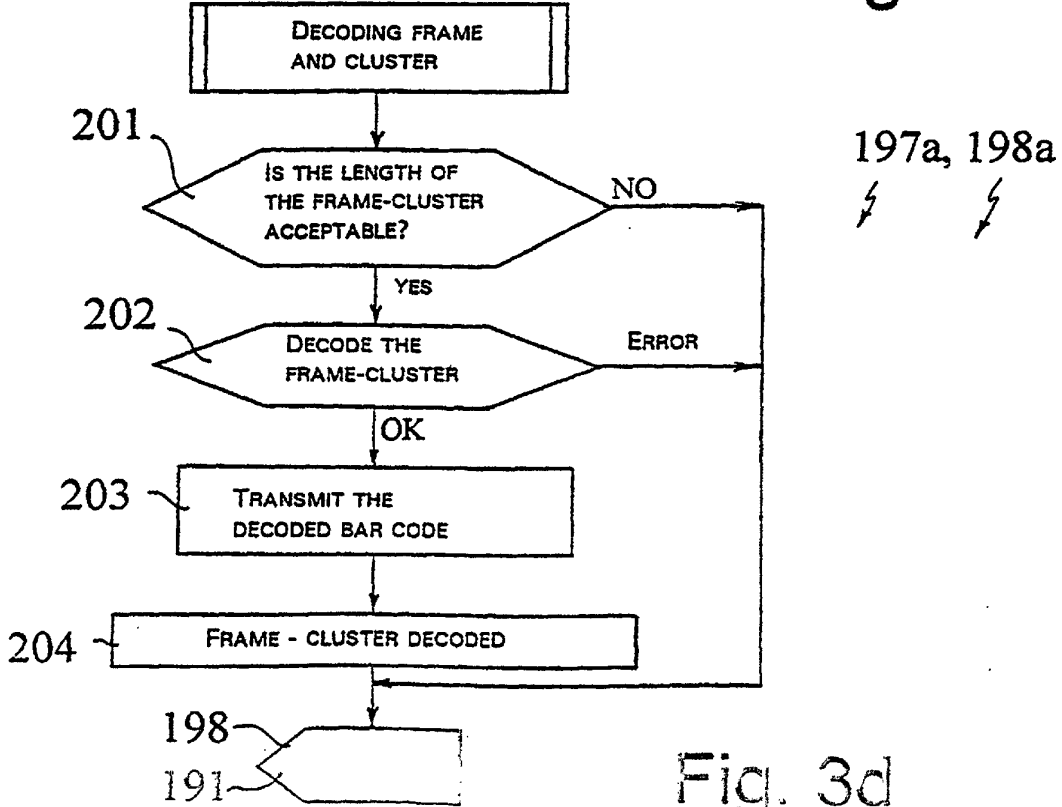


Fig. 3d

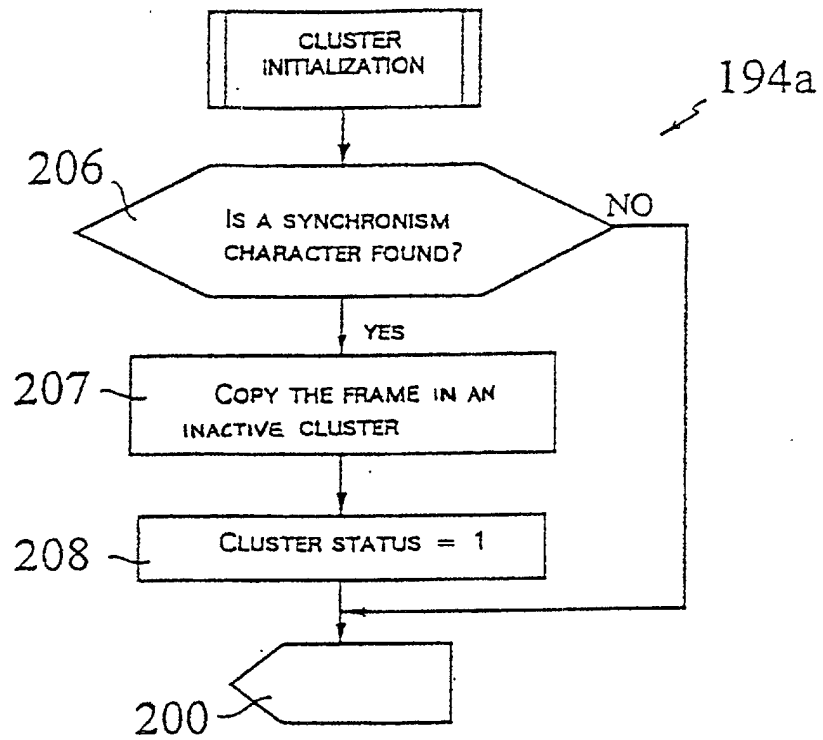


Fig. 3e

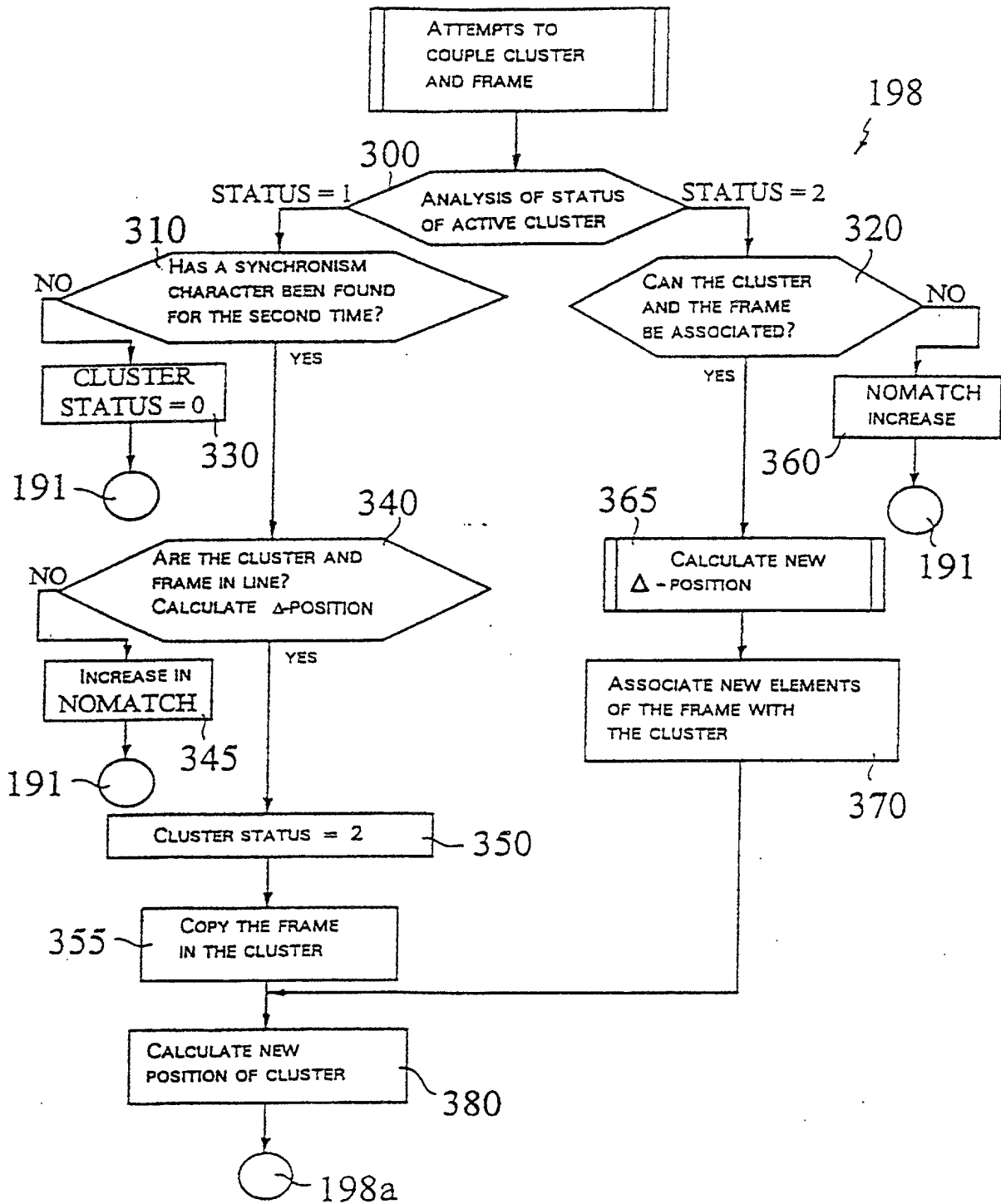


Fig. 3f

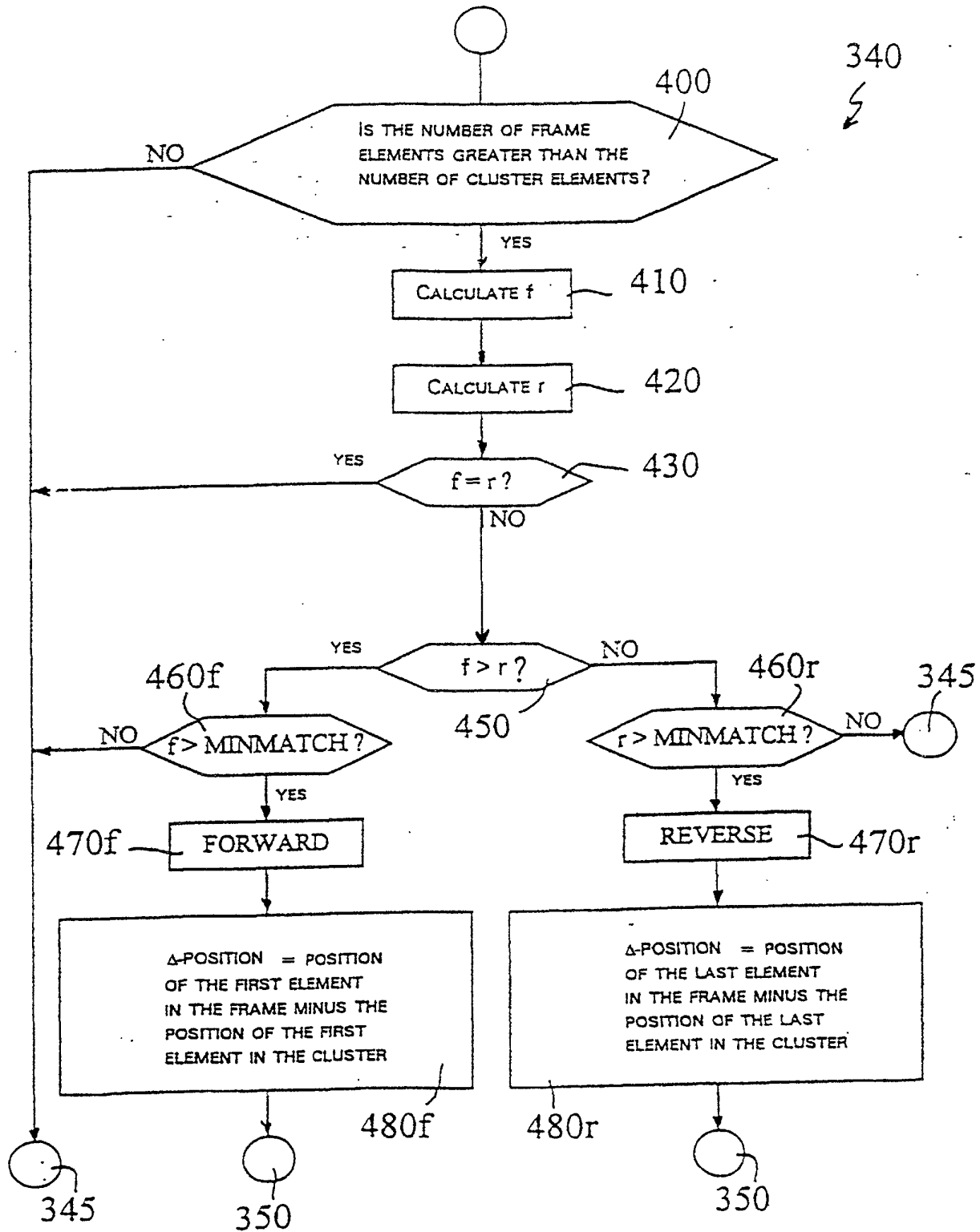


Fig. 3g

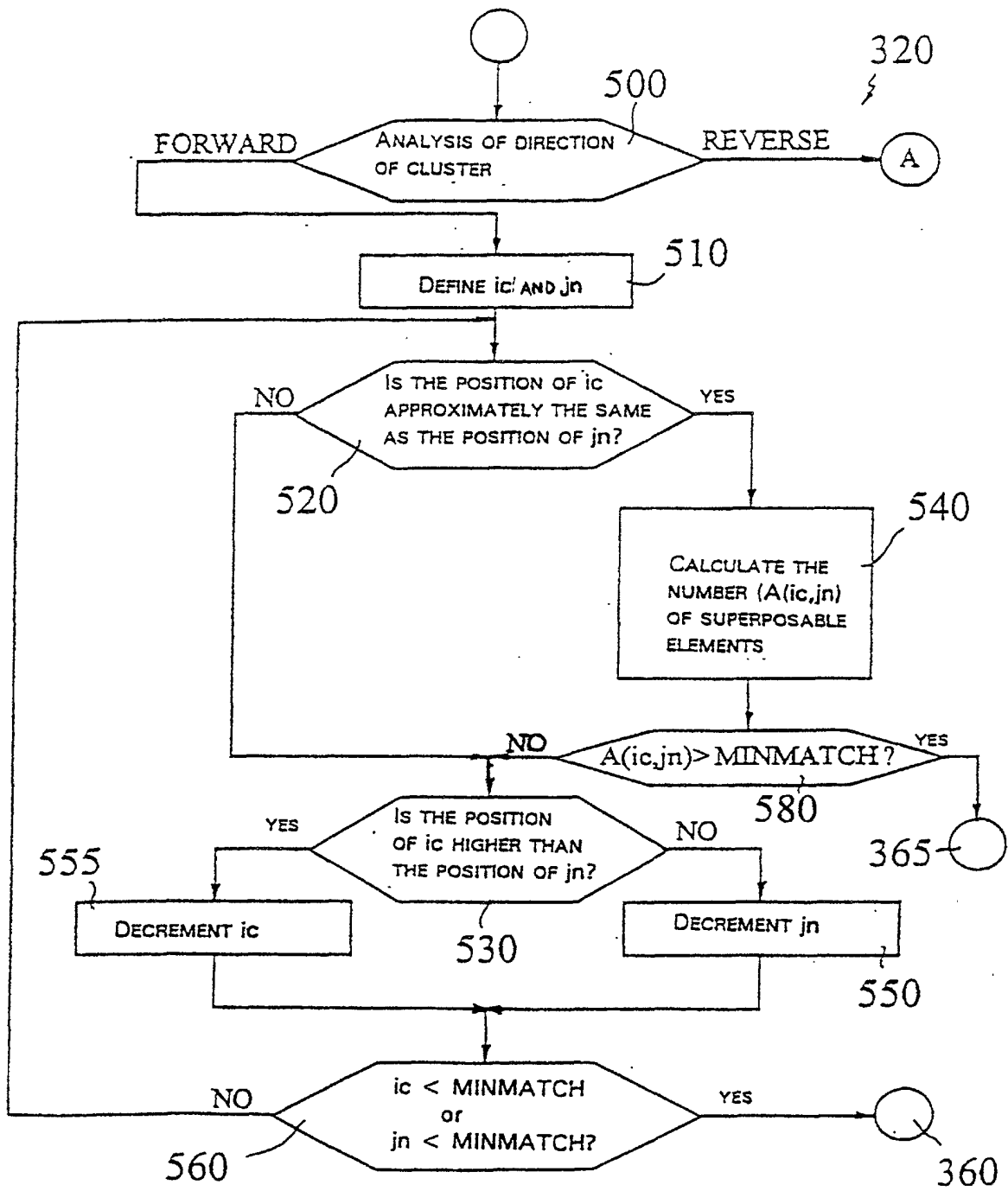


Fig. 3h

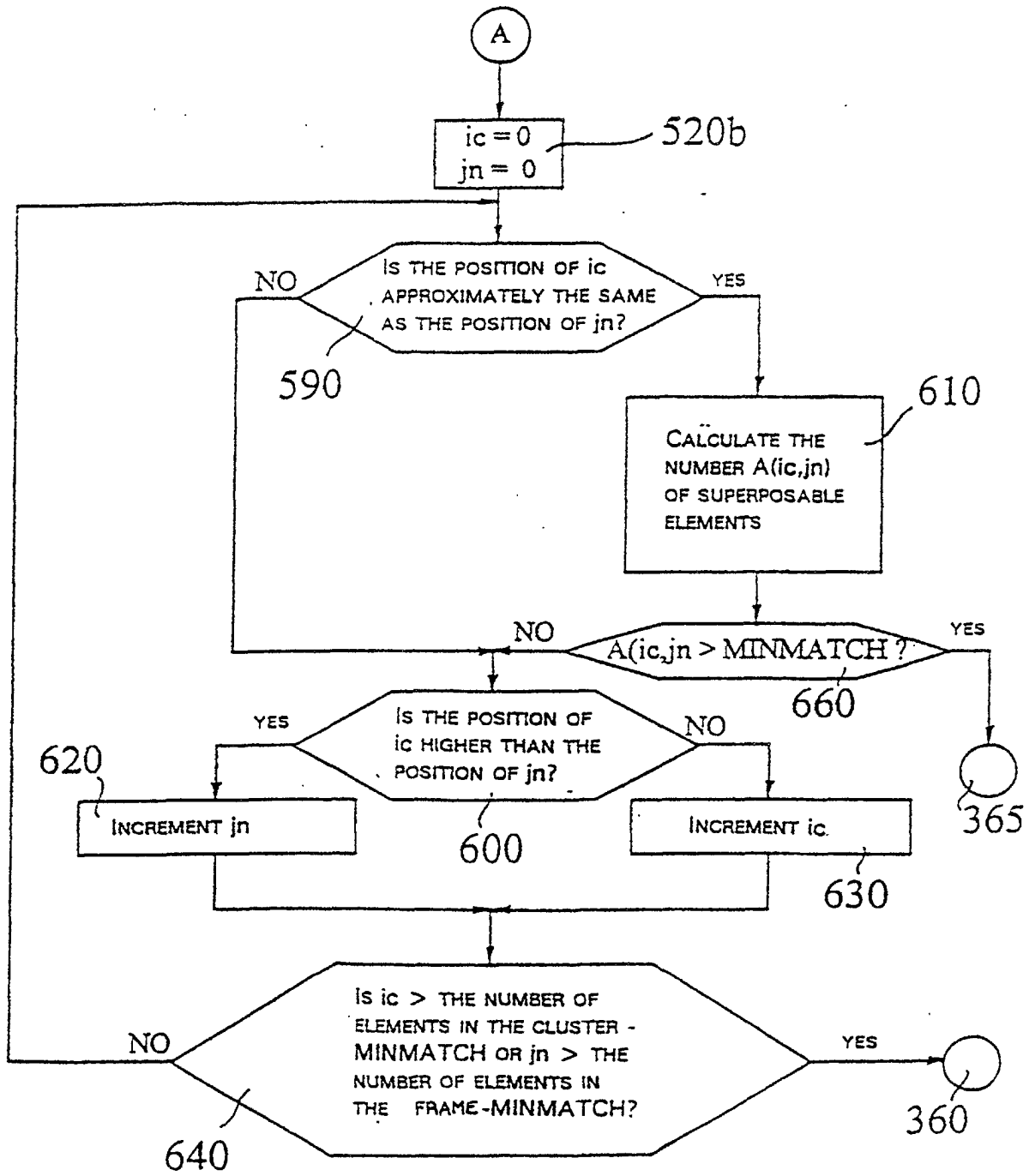


Fig. 3i

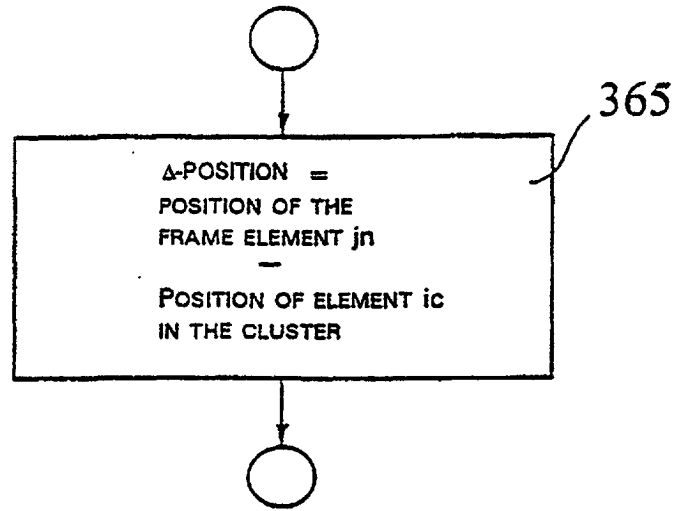


Fig. 3j

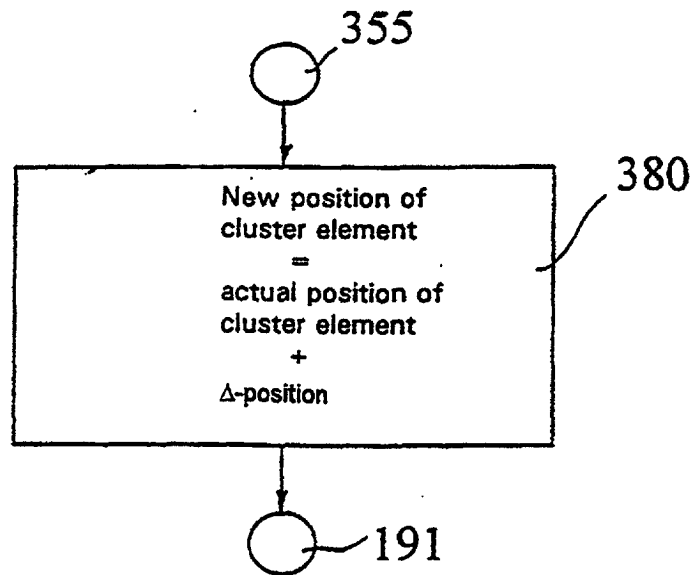


Fig. 3l

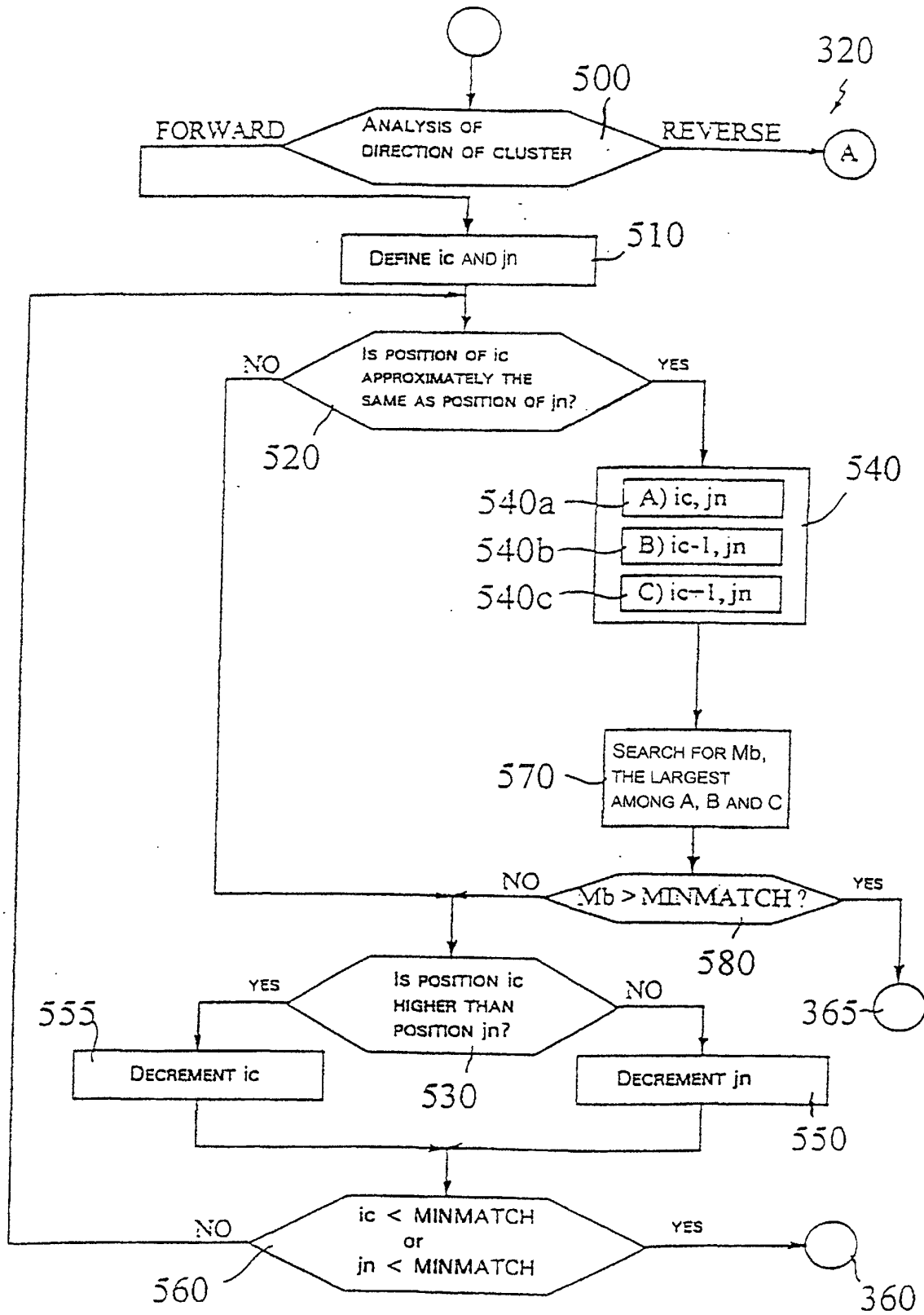


Fig. 3m

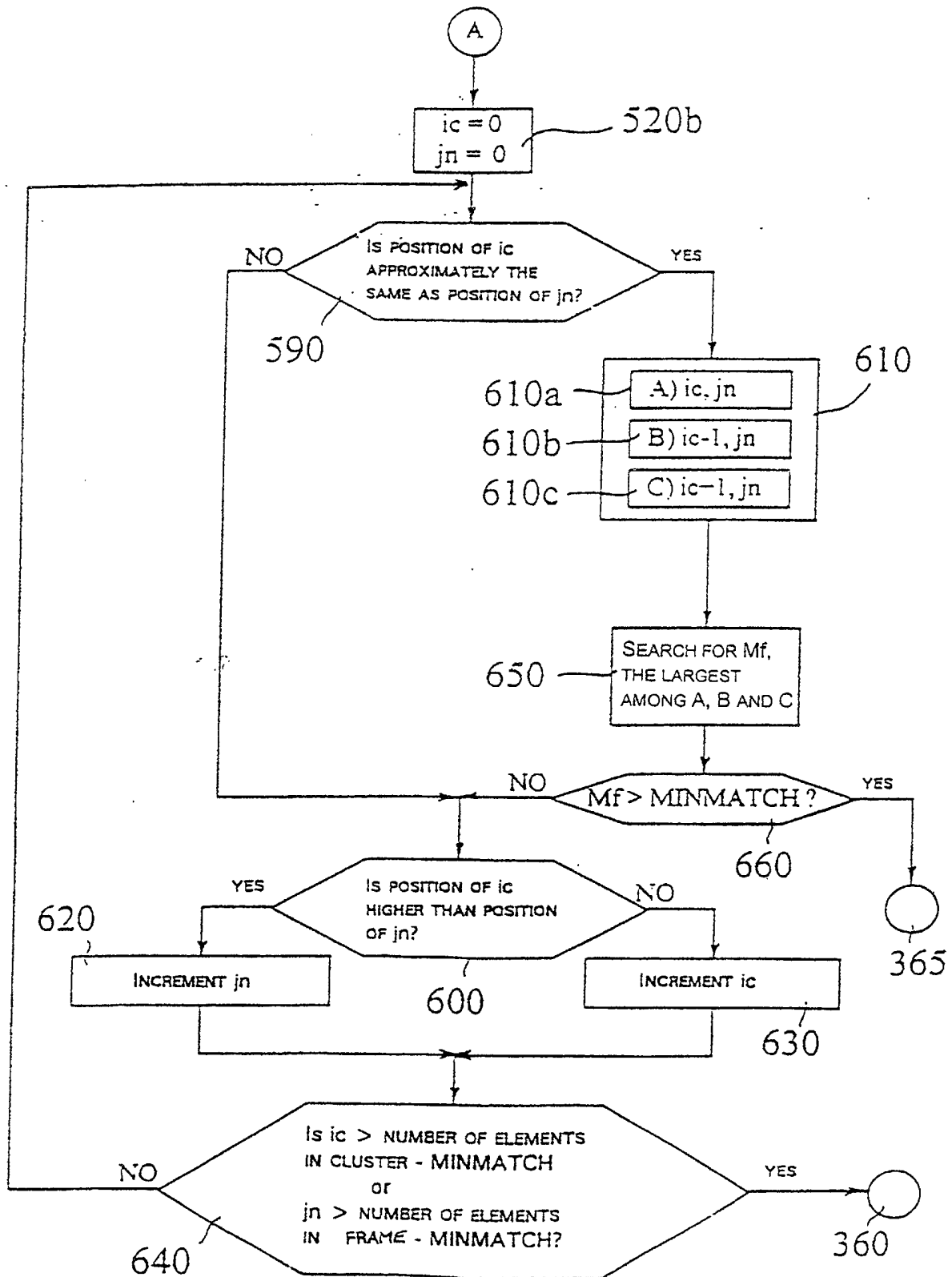


Fig. 3n

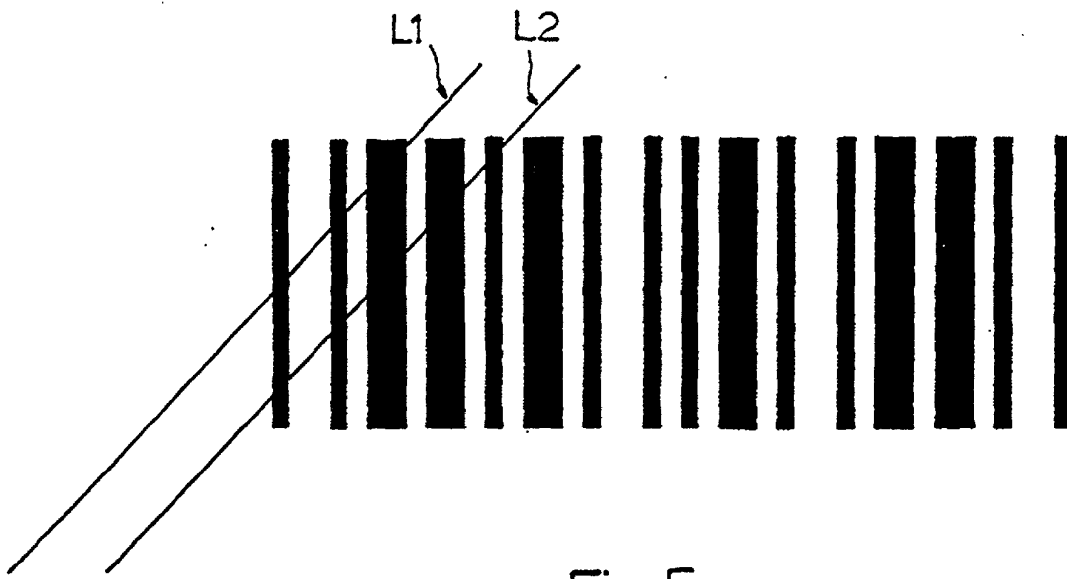


Fig. 5

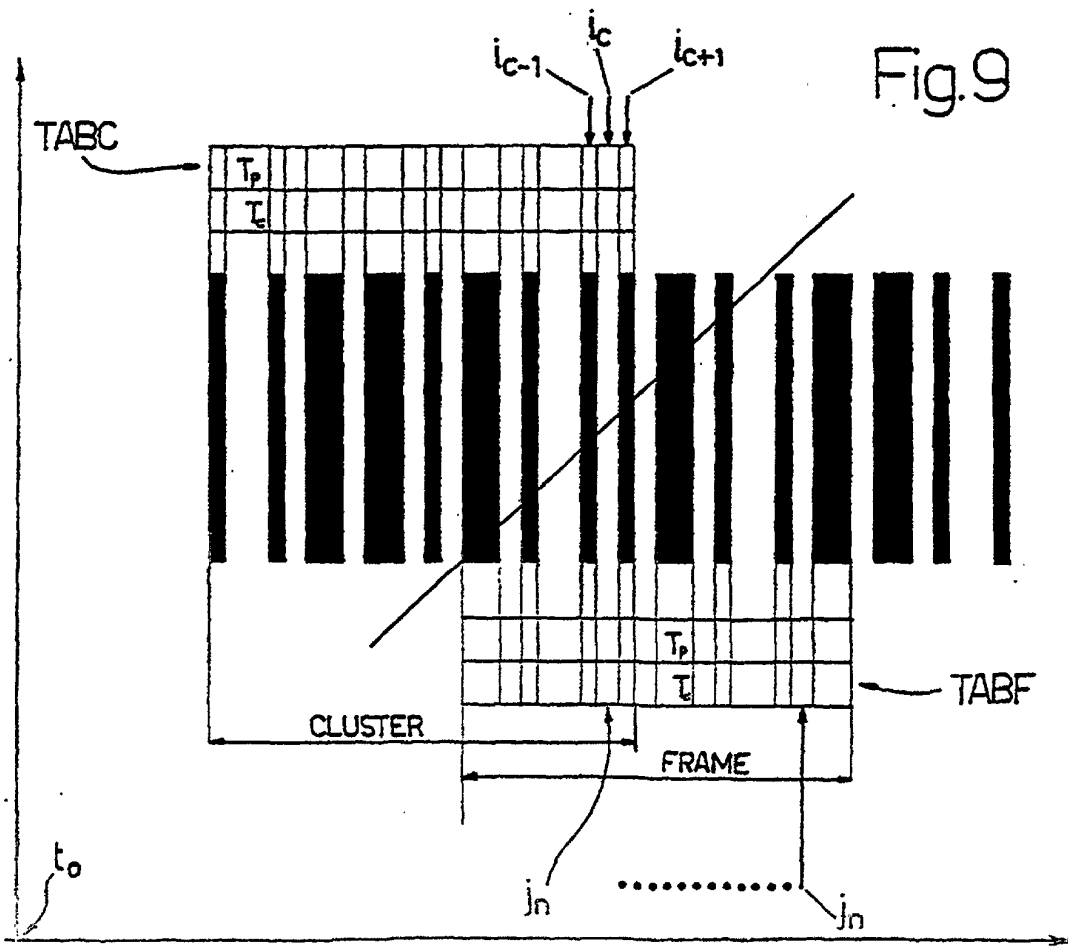


Fig. 9