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(54) Combined bookbinding machine with automatic composition of overlapped signatures

(57) A solution is proposed for controlling a combined bookbinding machine (100). A corresponding method (600) comprises the steps of reading (648) configuration information associated at least in part with a basic signature being ready in each one of a plurality of feeding stations (110f,110p) of the combined bookbinding machine, the configuration information comprising a progressive number of basic signature indicative of a position of the basic signature within a corresponding overlapped signature comprising a plurality of basic signatures being overlapped one to another, selecting (642,645,660) at least one of the basic signatures in at least a selected one of the feeding stations according to the configuration information, depositing (654) said at least one selected basic signature from said at least one selected feeding station astride a transport saddle (140) of the combined bookbinding machine to contribute to the formation of a corresponding overlapped signature on the transport saddle, and transporting (667) each overlapped signature towards a binding station of the combined bookbinding machine to contribute to the formation of a corresponding book block, comprising a plurality of overlapped signatures being bound one to another, in response to the reading of an indicator of end of overlapped signature in the configuration information.

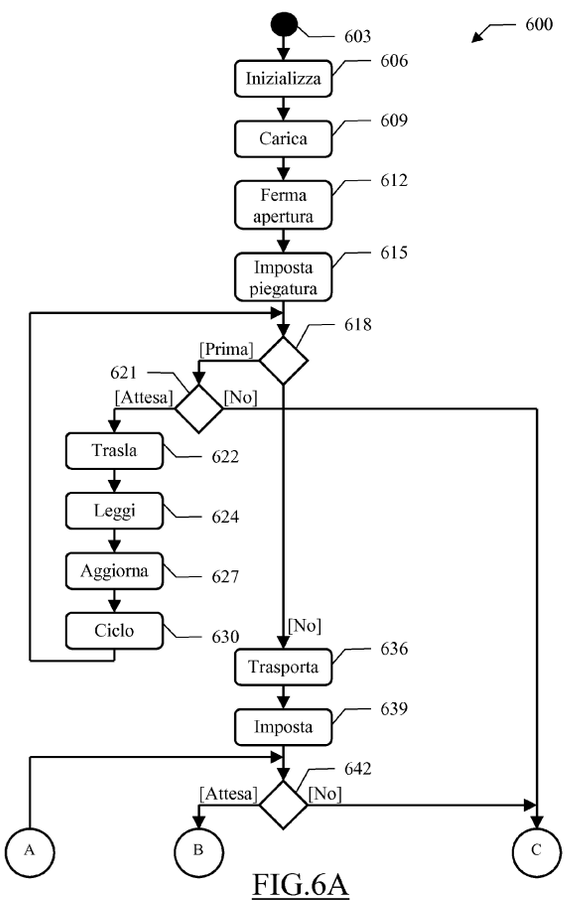

FIG.6A

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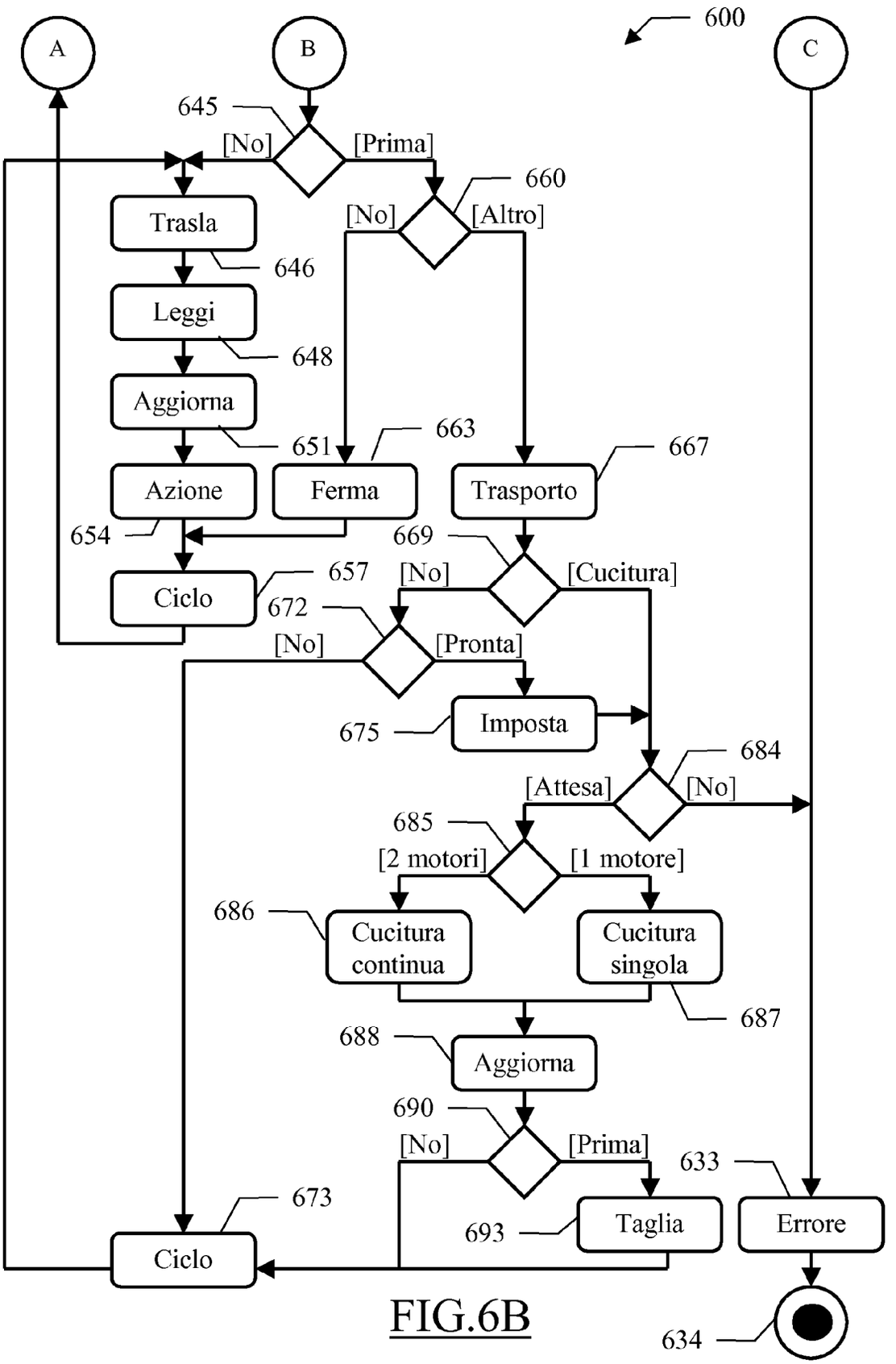
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FIG.6B

Description

[0001] The solution according to one or more embodiments of the present invention relates to the bookbinding field. More specifically, this solution relates to bookbinding binding machines.

[0002] Bookbinding binding machines are commonly used to make books formed by blocks of signatures bound together (for example, sewn together in sewn books); each signature is formed by a printed sheet, which is folded one or more times to define corresponding pages of the books. The sewn books may be made using either classic sewing machines (which process signatures already prepared) or more recent flat sheet machines (which also form the signatures).

[0003] Typically, a sewing machine comprises a feeding station, which extracts the signatures in succession from a hopper, opens them and deposits them onto a fixed saddle; the fixed saddle transports the signatures to a sewing station, wherein they are sewn to a book block in the making by means of continuous threads. The sewing machines are very fast, and they allow using signatures printed on very large sheets (reduced to the desired size of the signatures by means of multiple folds) that may be obtained with rotary or offset printers at high yield.

[0004] A flat sheet machine instead comprises a gathering device that extracts flat sheets in succession from a hopper, and stacks them to form groups of sheets corresponding to the signatures; as soon as each group of sheets has been completed, it is transferred to a folding device, which folds it in order to obtain a corresponding signature that is deposited astride the same fixed saddle directly (to be transported to the same sewing station). An example of flat sheet machine is described in EP-A-0846573 (the entire disclosure of which is herein incorporated by reference), while an example of commercially available flat sheet machine is KRISTEC® by Meccanotecnica S.p.A. (KRISTEC is a registered trademark of Meccanotecnica S.p.A. in some countries). The flat sheet machines are very flexible, and they allow producing books on request quickly and at low cost, even of very limited edition (especially in the case in which the corresponding flat sheets are printed with digital printers).

[0005] Some specific applications also require the use of overlapped (or composite) signatures, each of which is formed by two or more (basic) signatures superimposed one on another; for example, the overlapped signatures are used to add inserts into the books (such as special paper or custom inserts).

[0006] However, in the case of use of the sewing machines the formation of the overlapped signatures is more complex (since it requires additional operations after their folding). In addition, the opening of each overlapped signature in the sewing machine is problematic, because of its high number of layers to be separated; indeed, the suction cups commonly used for this purpose may be insufficient to reach a centre of the overlapped signature. In this case, it is necessary to form the overlapped signature with a projecting lap, and to provide the sewing machine with a blade that catches the lap for opening the overlapped signature. However, this requires non-standard folding operations, and complicates the structure of the sewing machine.

[0007] The above-mentioned problems do not occur in the case of use of the flat sheet machines. However, the flat sheet machine are considerably slower, since for each signature it is necessary to gather all the sheets composing it individually before its folding. This strongly reduces the yield of the flat sheet machines (especially in the case of signatures formed by a large number of sheets).

[0008] WO-A-2012/028725 instead describes a combined machine, which is able to process both the signatures provided already prepared both the signatures formed from the flat sheets. This allows exploiting the advantages of both the traditional sewing machines and the flat sheet sewing machines (limiting the drawbacks thereof); for example, it is possible always to use the signatures provided already prepared (faster), and the signatures formed from the flat sheets only when it is necessary (for example, to add inserts) - in particular for the formation of overlapped signatures.

[0009] In any case, the correct operation of both the sewing machines and the flat sheet machines requires that they should be suitably programmed. Indeed, for each job to be executed (consisting of the production of a batch of books of the same type) it is necessary to specify the number of signatures of each book block (to allow their correct sewing); moreover, in the case of flat sheet machines it is also necessary to specify the number of flat sheets of each signature (to allow their correct gathering). Furthermore, the sewing machines and the flat sheet machines are generally also equipped with control systems, more or less sophisticated, of the processing sequence of the signatures (for detecting corresponding errors automatically).

[0010] For example, EP-A-2213468 (the entire disclosure of which is herein incorporated by reference) describes a flat sheet machine that exploits configuration information inserted in a bar code printed on each flat sheet; such configuration information comprises a progressive number of the sheet in the corresponding signature, a total number of sheets of such signature, a progressive number of the signature in the corresponding book block, and a total number of signatures of the book block. The configuration information is used to cause the folding of a group of sheets when it has been completed (in response to the reading of the progressive number of sheet equal to the total number of sheets), and to cause the cutting of the threads of a group of signatures sewn together when it has been completed (in response to the reading of the progressive number of signature equal to the total number of signatures). The same configuration information is also used to detect sequence errors of the sheets (when the progressive number of sheet does not

match the one of the expected sheet in the signature or the progressive number of signature does not match the one of the expected signature in the book block).

[0011] In general terms, the solution according to an embodiment of the present invention is based on the idea of automatically controlling the formation of overlapped signatures comprising signatures of different types.

[0012] Particularly, one or more aspects of the solution according to specific embodiments of the invention are set out in the independent claims and advantageous features of the same solution are set out in the dependent claims, with the wording of all the claims that is herein incorporated *verbatim* by reference (with any advantageous feature provided with reference to a specific aspect of the solution according to an embodiment of the invention that applies *mutatis mutandis* to every other aspect thereof).

[0013] More specifically, an aspect of the solution according to an embodiment of the invention provides a method for controlling a combined bookbinding machine (for example, a combined sewing machine capable of processing both opening signatures being opened therein and folding signatures being formed directly therein by folding flat sheets). Configuration information associated at least in part with a basic signature being ready in each one of a plurality of feeding stations of the combined bookbinding machine is read (for example, from a bar code printed on each opening signature and on each flat sheet of a corresponding folding signature); the configuration information comprises a progressive number of basic signature indicative of a position of the basic signature within a corresponding overlapped signature, which comprises a plurality of basic signatures being overlapped one to another. At least one of the basic signatures is selected, in at least a selected one of the feeding stations, according to the configuration information (for example, when it indicates that a corresponding overlapped signature is in the making in front of the feeding station). Said at least one selected basic signature is deposited from said at least one selected feeding station astride a transport saddle of the combined bookbinding machine, to contribute to the formation of a corresponding overlapped signature on the transport saddle. Each overlapped signature is transported towards a binding station of the combined bookbinding machine (for example, a sewing station) to contribute to the formation of a corresponding book block, which comprises a plurality of overlapped signatures being bound (for example, sewn) one to another; this happens in response to the reading of an indicator of end of overlapped signature in the configuration information (for example, when it indicates that all the corresponding folding signatures and all the corresponding opening signatures have been gathered into the corresponding overlapped signatures in front of all the feeding stations).

[0014] Another aspect of the solution according to an embodiment of the invention provides a software program for performing such method (for example, in a control system of the combined bookbinding machine).

[0015] A different aspect of the solution according to an embodiment of the invention provides a corresponding bookbinding combined machine.

[0016] The solution according to one or more embodiments of the invention, as well as further features and the advantages thereof, will be best understood with reference to the following detailed description, given purely by way of a non-restrictive indication, to be read in conjunction with the accompanying drawings (wherein, for the sake of simplicity, corresponding elements are denoted with equal or similar references and their explanation is not repeated, and the name of each entity is generally used to denote both its type and its attributes - such as value, content and representation). In this respect, it is expressly intended that the figures are not necessary drawn to scale (with some details that may be exaggerated and/or simplified) and that, unless otherwise indicated, they are merely used to conceptually illustrate the structures and procedures described herein. Particularly:

FIG.1 shows a pictorial representation of a combined sewing machine in which the solution according to an embodiment of the invention may be applied,

FIG.2 shows an exemplary flat sheet (for a corresponding folding signature) that may be used to apply the solution according to an embodiment of the invention,

FIG.3 shows an exemplary opening signature that may be used to apply the solution according to an embodiment of the invention,

FIF.4A-FIG.4F show the various phases of a process of formation of exemplary overlapped signatures in this combined sewing machine according to an embodiment of the invention,

FIG.5A-FIG.4C show the various phases of a process of formation of exemplary overlapped signatures in this combined sewing machine according to another embodiment of the invention, and

FIG.6A-FIG.6B show a diagram describing the flow of activities relating to an implementation of the solution according to an embodiment of the invention.

[0017] With reference in particular to the FIG.1, there is shown a pictorial representation of a combined sewing machine 100 in which the solution according to an embodiment of the invention may be applied.

[0018] The combined sewing machine 100 is used to sew signatures together for the production of corresponding sewn books (not shown in the figure). Each signature is formed by a printed sheet, which is folded one or more times to define different pages of the books. The combined sewing machine 100 is capable of processing both signatures that are provided already prepared to the combined sewing machine 100 and opened therein (hereinafter, referred to as opening signatures Sp) and signatures that are formed in the sewing machine by folding a corresponding flat sheet (hereinafter, re-

ferred to as folding signatures Sf); for example, the opening signatures Sp are obtained by printing flat sheets in large quantities with rotary or offset printers and folding them in suitable folding machines, while the flat sheets for the folding signatures Sf are printed in small quantities with digital printers. For this purpose, the combined sewing machine 100 comprises an opening feeding station 110p for providing the opening signatures Sp in succession, and a folding feeding station 110f for providing the folding signatures Sf in succession.

[0019] Considering in particular the opening feeding station 110p, a hopper 115p is used to load a stack of opening signatures Sp (grouped in blocks of one or more opening signatures Sp, each one for a corresponding book); each opening signature Sp may comprise any number of pages being multiple of four according to its number of folds. A bar codes reader 117p (for example, based on a camera) is used to read bar codes printed on a front side of each opening signature Sp at the bottom of the hopper 115p. An extraction device 120p (for example, a gripper with suction cups) extracts the opening signatures Sp in succession from the bottom of the hopper 115p, and provides them to an opening device 125p; in turn, the opening device 125p (for example, based on a series of lower and higher suction cups) opens each opening signature Sp in the middle.

[0020] Moving instead to the folding feeding station 110f, a hopper 115f is used to load a stack of flat sheets FP (grouped in blocks of one or more flat sheets FP, each one for a corresponding book). A bar code reader 117f (for example, based on a camera) is used to read bar codes printed on a front side of each flat sheet Fp at the top of the hopper 115f. An extraction device 120f (for example, a suction wheel) extracts the flat sheets FP in succession from the top of the hopper 115f, and provides them to a folding device 125f; in turn, the folding device 125f folds each flat sheet FP in half to obtain the corresponding folding signature Sf (with four pages, in jargon a four-page signature); for example, the folding device 125f comprises a pair of belts, which transports the flat sheet FP from a pair of creasing rollers to a battery of one or more pairs of folding rollers.

[0021] The opening signatures Sp and the folding signatures Sf (hereinafter referred to in general as basic signatures) are provided by the opening feeding station 110p and by the folding feeding station 110f, respectively, to a transport station 130 for forming corresponding overlapped signatures Sa (as described below); each overlapped signature Sa comprises one or more folding signatures Sf and one or more opening signatures Sp being overlapped one to another. Particularly, the transport station 130 comprises a fixed saddle 140, which is formed by a saddle plate (being wedge-shaped, like an overturned V) for resting the (opened) overlapped signatures Sa; a chain with push pins (not shown in the figure) is housed inside the saddle plate, so that the pegs protrude through a longitudinal slot of the saddle plate (close to a vertex thereof) to push the overlapped signatures Sa along a transport direction thereof (from the right to the left in the figure). The folding feeding station 110f butts against the fixed saddle 140 at an input thereof along the transport direction (on the right in the figure); the opening feeding station 110p is instead at the side of the fixed saddle 140 slightly downstream the folding feeding station 110f along the transport direction (on its left in the figure). The overlapped signatures Sa are transported on the fixed saddle 140 individually towards a sewing station 155 (butting against the fixed saddle 140 at an output thereof).

[0022] The sewing station 155 comprises a movable saddle 160, which receives each overlapped signature Sa from the fixed saddle 140 (when it is opened so as to be aligned therewith). The movable saddle 160 is then closed to bring the overlapped signature Sa below a sewing head 165; the sewing head 165 sews the overlapped signature Sa loaded on the movable saddle 160 by means of continuous threads to a book block in the making (by binding it to a previous overlapped signature Sa of the book block if different from the first one). Once the book block has been completed, the threads are cut to separate it from the next overlapped signatures Sa. The book blocks thus obtained (denoted with the reference 170) are deposited in succession onto an output conveyor 175, from which they are provided to further machines (not shown in the figure) that complete the corresponding books.

[0023] The combined sewing machine 100 is provided with four separate motors 180p, 180f, 180t, and 180c (with their respective position transducers) for driving the opening feeding station 110p, the folding opening station 110f, the transport station 130 and the sewing station 155, respectively, in an independent way. This allows operating the various stations 110p, 110f, 130 and 155 in a differentiated way (during each operating cycle of the combined sewing machine 100) to obtain the desired overlapped signatures Sa. For this purpose, the folding feeding station 110f deposits one or more folding signatures Sf astride the fixed saddle 140, while the transport station 130 is maintained stationary, for contributing to the formation of a corresponding overlapped signature Sa; in this way, a first folding signature Sf is placed onto the fixed saddle 140, and any possible next folding signature Sf is placed onto a preceding folding signature Sf. The overlapped signature Sa in the making is then transported to the side of the opening feeding station 110p. At this point, the opening feeding station 110p deposits one or more opening signatures Sp astride the fixed saddle 140, while the transport station 130 is maintained stationary, for contributing as well to the formation of the overlapped signature Sa; in this way, a first opening signature Sp is placed onto a last folding signature Sf, and any possible next opening signature Sp is placed onto a previous opening signature Sp. Once the overlapped signature Sa has been completed, the transport station 130 transports it to the sewing station 155 for its sewing to the corresponding book block in the making.

[0024] The operation of the entire combined sewing machine 100 is managed by a programmable logic controller (PLC) 185. In general, the PLC 185 is provided with a control unit, a volatile working memory (for example, a RAM), and a non-volatile mass memory (for example, an E^2PROM); the control unit is connected in a conventional manner to a control panel (for example, of the touch-screen type).

[0025] An exemplary flat sheet FP (for a corresponding folding signature) that may be used to apply the solution according to an embodiment of the invention is shown in the FIG.2.

[0026] The flat sheet FP comprises four pages being printed in pairs on each side thereof, of which only a page 205a and a page 205b on the front side of the flat sheet FP (intended to be turned upwards in the hopper of the folding feeding station) are visible in the figure. The front side of the flat sheet FP also comprises a bar code BCf (for example, printed in an external trimming area - intended to be cut after the sewing to allow the opening of the pages of the book - at the beginning of the flat sheet FP along an extraction direction thereof from the hopper of the folding feeding station); the bar code BCf comprises a series of parallel lines having variable thickness and spacing, which represent a corresponding value according to a predefined encoding.

[0027] The value of the bar code BCf comprises configuration information, which is used to control the processing of the folding signature corresponding to the flat sheet FP (obtained by folding it in the folding feeding station). For example, the value of the bar code BCf comprises a progressive number of folding signature PRGf that indicates a position of the folding signature in the corresponding group of folding signatures of the corresponding overlapped signature, together with a total number of folding signatures TOTf of this overlapped signature; moreover, the bar code BCf may also comprise a progressive number of overlapped signature PRGa that indicates a position of the corresponding overlapped signature in the corresponding book block, together with a total number of overlapped signatures TOTa of this book block.

[0028] An exemplary opening signature Sp that may be used to apply the solution according to an embodiment of the invention is instead shown in the FIG.3. Particularly, in this example the opening signature Sp comprises eight pages (in jargon, a eight-page signature), of which only one page 305th on the front side of the opening signature Sp (intended to be turned downwards in the hopper of the opening feeding station) and a portion of a page 305b inside the opening signature Sp are visible in the figure. The front side of the opening signature Sp also comprises a bar code BCp (in this case as well printed in an external trimming area, at the beginning of the opening signature Sp along an extraction direction thereof from the hopper of the opening feeding station). The value of the bar code BCp comprises similar configuration information, which is used to control the processing of the folding signature Sp - *i.e.,* a progressive number of opening signature PRGp that indicates a position of the opening signature Sp in the corresponding group of opening signatures of the corresponding overlapped signature, together with a total number of opening signatures TOTp of this overlapped signature, and possibly the corresponding progressive number of overlapped signature PRGA together with the corresponding total number of overlapped signatures TOTa as well.

[0029] As described in detail below, the configuration information (of either the folding signatures or the opening signatures) is used to control the formation of the corresponding overlapped signatures automatically. This avoids, or at least substantially reduces, any manual programming operation of the combined sewing machine. In this way, the use of the combined sewing machine is remarkably simplified. Furthermore, the removal of the human intervention (for the programming of the combined sewing machine) substantially reduces the risk of errors. These advantages are particularly evident in the typical applications of the overlapped signatures (wherein very short jobs comprising the production of few books with different inserts are often executed), with a remarkable increase of its yield. This also allows producing different books using basic signatures of the same size without interruption; in this way, it is possible to group multiple jobs into a continuous execution stream (without the need to provide any additional information to indicate the number of books of each job).

[0030] The same information also allows controlling the processing sequence of the basic signatures in an automatic way. This prevents (or at least greatly reduces) the risk of obtaining defective book blocks, with a positive effect on the production quality of the books. This result is obtained without requiring any learning phase, since the basic signatures already comprise the information that defines their processing order.

[0031] The various phases of a process of formation of exemplary overlapped signatures in this combined sewing machine 100 according to an embodiment of the invention are shown in the FIG.4A-FIG.4F.

[0032] In the following, for the sake of description simplicity, the opening feeding station 110p, the folding feeding station 110f and the transport station 130 will be considered all working at the same operating frequency - so that during each operating cycle of the combined sewing machine 100 an operating cycle of the opening feeding station 110p, an operating cycle of the folding feeding station 110f and an operating cycle of the transport station 130 are performed (while the sewing station 155 may operate either at the same operating frequency of the transport station 130 or at a reduced operating frequency). Nevertheless, the opening feeding station 110p, the folding feeding station 110f and the transport station 130 may also operate at operating frequencies being independent one to another (for example, with the feeding stations 110p, 110f faster than the transport station 130, and particularly the folding feeding station 110f faster

than the opening feeding station 110p).

[0033] The basic signatures (*i.e.*, the opening signatures and the folding signatures with the corresponding flat sheets) are identified in the following by their reference symbol (*i.e.,* Sp, Sf and FP, respectively) followed by the corresponding configuration information. For example, let suppose that the books of a generic job to be executed on the combined sewing machine are each one formed by ten overlapped signatures, each one comprising three basic signatures; more specifically, the overlapped signature comprises two folding signatures (provided by the folding feeding station 110f) and an opening signature (provided by the opening feeding station 110p). Therefore, the first flat sheet and the corresponding first folding signature of the first overlapped signature are identified by FP(1/2,1/10) and Sf(1/2,1/10), respectively (to indicate the flat sheet and the folding signature 1 of 2 in the overlapped signature 1 of 10), its second flat sheet and the corresponding second folding signature are identified by FP(2/2,1/10) and Sf(2/2,1/10), respectively, and the first opening signature (third basic signature) is identified by Sp(1/1,1/10); the first flat sheet and the corresponding first folding signature of the second overlapped signature are identified by FP(1/2,2/10) and Sf(1/2,2/10), respectively, and so on until the first opening signature (third basic signature) of the last overlapped signature that is identified by Sp(1/1,10/10). Likewise, the overlapped signatures are identified in the following by their reference symbol (*i.e.*, Sa) followed by the relevant portion of the configuration information being equal in all the corresponding basic signatures (*i.e.*, the progressive number of overlapped signature PRGa and the total number of overlapped signatures TOTa). Therefore, in the example at issue the first overlapped signature - formed by the basic signatures Sf(1/2,1/10), Sf(2/2,1/10) and Sp(1/1,1/10) - is identified by Sa(1/10), and so on until the last overlapped signature that is identified by Sa (10/10).

[0034] Starting from the FIG.4A, let consider an initial situation of the combined sewing machine 100 wherein, in the sewing station 155, a book block in the making - comprising the overlapped signatures from Sa(1/10) to Sa(7/10) already sewn together - is present under the sewing head 165, while the movable saddle 160 is free. In the transport station 130 there are present (astride the fixed saddle 140, backwards along the transport direction from the sewing station 155 to the folding feeding station 110f) the next overlapped signatures Sa(8/10) (in front of the sewing station 55, ready to be provided thereto), Sa(9/10) and Sa(10/10) (at the side of the opening feeding station 110p), and the folding signature Sf(1/2,1/10) of the first overlapped signature in the making of a next book block (in front of the folding feeding station 110f). In the opening feeding station 110p there are present (backwards along a processing direction from the fixed saddle 140 to the hopper 115p) the opening signature Sp(1/1,1/10) (open in front of the fixed saddle 140, ready to be provided thereto), the opening signatures Sp (1/1,2/10), Sp(1/1,3/10) and Sp(1/1,4/10) (in course of opening in the opening device 125p) and the opening signature Sp(1/1,5/10) (at the bottom of the hopper 115p). In the folding feeding station 110f there are present (backwards along a processing direction from the fixed saddle 140 to the hopper 115f) the folding signature Sf(2/2,1/10) (open in front of the fixed saddle 140, ready to be provided thereto), the flat sheets FP(1/2,2/10) and FP(2/2,2/10) (in course of folding in the folding device 125F) and the flat sheet FP(1/2,3/10) (at the top of the hopper 115f).

[0035] Considering now the FIG.4B together with the FIG.4A, during a next operating cycle (of the combined sewing machine 100) only the folding feeding station 110f is activated, while the opening feeding station 110p, the transport station 130 and the sewing station 155 are maintained stopped. Therefore, in the folding feeding station 110f the folding signature Sf(2/2,1/10) is deposited astride the fixed saddle 140 onto the folding signature Sf (1/2,1/10) (stationary in front of the folding feeding station 110f), so as to add to the corresponding overlapped signature in the making; moreover, the flat sheet FP (1/2,2/10) completes its folding (so as to obtain the corresponding folding signature Sf(1/2,2/10) that moves in front of the fixed saddle 140, ready to be supplied thereto), the flat sheet FP(2/2,2/10) advances in the folding device 125f, and the flat sheet FP(1/2,3/10) is extracted from the hopper 115f and provided to the folding device 125f, so that a further flat sheet FP(2/2,3/10) moves to the top of the hopper 115f.

[0036] Considering the FIG.4C together with the FIG. 4B, during a next operating cycle the transport station 130 and the sewing station 155 are activated, while the opening feeding station 110p and the folding feeding station 110f are maintained stopped. Therefore, in the transport station 130 the overlapped signatures Sa(8/10), Sa (9/10), Sa(10/10) and the overlapped signature in the making (comprising all the folding signatures Sf(1/2,2/10) and Sf(2/2,2/10)) advance along the fixed saddle 140 by a position defined by its push pegs). In this way, the overlapped signature Sa(8/10) (ready on the fixed saddle 140 in front of the movable saddle 160) is conveyed onto the movable saddle 160 (lowered in front of the fixed saddle 140), the overlapped signature Sa(9/10) moves in front of the sewing station 155 (ready to be supplied thereto), the overlapped signature in the making moves in front of the opening feeding station 110p, and the position in front of the folding feeding station 110f is released. At this point, in the sewing station 155 the movable saddle 160 is closed to bring the overlapped signature Sa(8/10) under the sewing head 165 so that it is sewn to the book block in the making therein, and it is then opened to slip off the overlapped signature Sa(8/10) so that the movable saddle 160 is free when it returns aligned with the fixed saddle 140.

[0037] Considering the FIG.4D together with the FIG. 4C, during a next operating cycle both the opening feeding station 110p and the folding feeding station 110f are

activated, while the transport station 130 and the sewing station 155 are maintained stopped. Therefore, in the opening feeding station 110p the opening signature Sp (1/1,1/10) is deposited astride the fixed saddle 140 onto the folding signatures Sf(1/2,1/10) and Sf(2/2,1/10) (stationary in front of the opening feeding station 110p), so as to complete the corresponding overlapped signature Sa(1/10); moreover, the opening signature Sp(1/1,2/10) completes its opening (moving in front of the fixed saddle 140, ready to be supplied thereto), the opening signatures Sp(1/1,3/10) and Sp(1/1,4/10) advance in the opening device 125p, and the opening signature Sp(1/1,5/10) is extracted from the hopper 115p and provided to the opening device 125p, so that a further opening signature Sp(1/1,6/10) moves to the bottom of the hopper 115p. At the same time, in the folding feeding station 110f the folding signature Sf(1/2,2/10) is deposited astride the fixed saddle 140, so as to start the formation of the corresponding overlapped signature; moreover, the flat sheet FP(2/2,2/10) completes its folding (so as to obtain the corresponding folding signature Sf(2/2,2/10) that moves in front of the fixed saddle 140, ready to be provided thereto), the flat sheet FP(1/2,3/10) advances in the folding device 125f, and the flat sheet FP(2/2,3/10) is extracted from the hopper 115f and provided to the folding device 125f, so that a further flat sheet FP (1/2,4/10) moves to the top of the hopper 115f.

[0038] In this way, the gathering on the fixed saddle 140 of the opening signatures (from the opening feeding station 110p) and of the folding signatures (from the folding feeding station 110f) takes place as far as possible concurrently; this allows recovering (at least in part) the time required to process the folding signatures, with a beneficial effect on the yield of the entire combined sewing machine.

[0039] Similar operations are performed, as shown in the FIG.4E, until the last overlapped signature Sa(10/10) is ready on the fixed saddle 140 in front of the movable saddle 160 (with the overlapped signature Sa (2/10) completed on the fixed saddle 140 in front of the opening feeding station 110p and the next overlapped signature in the making, comprising all the folding signatures Sf (1/2,3/10) and Sf(2/2,3/1 0), on the fixed saddle 140 in front of the folding feeding station 110f).

[0040] Considering the FIG.4F together with the FIG. 4E, as above during a next operating cycle the transport station 130 and the sewing station 155 are activated (while the opening feeding station 110p and the folding feeding station 110f are maintained stopped). Therefore, in the transport station 130 the overlapped signatures Sa (10/10), Sa(1/10), Sa(2/10) and the overlapped signature in the making (comprising the folding signatures Sf (1/2,3/10) and Sf(2/2,3/10)) advance along the fixed saddle 140 by a position, with the overlapped signature Sa (10/10) that is conveyed onto the movable saddle 160 (lowered in front of the fixed saddle 140). At this point, in the sewing station 155 the movable saddle 160 is closed to bring the overlapped signature Sa(10/10) under the sewing head 165 so that it is sewn to the book block in the making therein; moreover, in this case the threads are cut so as to complete the corresponding book block 170, which will be deposited onto the output conveyor 175.

[0041] The same operations described above are then repeated cyclically.

[0042] In the technique described above the transport station 130 and the sewing station 155 are always activated simultaneously, so that the may also be provided with a single motor with a fixed mechanical connection. In this respect, it should be noted that the maintaining of the sewing station 155 stopped does not involve any significant problems in general, since a stop period of the movable saddle 160 (which is the part thereof with the greater inertia) is provided for in any case for receiving the signature to be sewn from the fixed saddle 140.

[0043] Alternatively (when the combined sewing machine is provided with separate motors for the transport station 130 and the sewing station 155), it is instead possible to drive the sewing station 155 continuously at an operating frequency lower than the one of the combined sewing machine 100 (*i.e.,* of the other stations 110p, 110f and 130), with a reduction ratio equal to the number of operating cycles of the feeding stations 110p and 110f required to form each overlapped signature. In this case, the transport station 130 only is stopped during the formation of each overlapped signature by the feeding stations 110p and 110f. This avoids any problems during the stopping and re-starting phases of the sewing station 155, which might be caused by its high inertia (while in general they do not occur for the transport station 130 due to its negligible inertia).

[0044] The various phases of a process of formation of exemplary overlapped signatures in this combined sewing machine 100 according with another embodiment of the invention are shown in FIG.5A-FIG.5C. Considering the same case of above (overlapped signature formed by three basic signatures obtained in two operating cycles of the combined sewing machine 100), the sewing station 155 has an operating frequency equal to 1/2 of the operating frequency of the combined sewing machine 100; therefore, during each operating cycle of the combined sewing machine 100 (defined by its phase from 0° to 360°, equal to a complete rotation of a shaft of the motor of each one of the stations 110p, 110f and 130 that are activated), the sewing station 155 performs a fraction - *i.e.,* 1/2 - of its operating cycle (defined by its phase Φ_s from 0° to 180° and from 180° to 360°, respectively, of a complete rotation of a shaft of the corresponding motor).

[0045] Starting from the FIG.5A, let consider a situation of the combined sewing machine 100 (corresponding to the FIG.4B-FIG.4C described above) in which the sewing station 155 is at the phase Φ_s=180° of an operating cycle thereof, with the movable saddle 160 closed and the overlapped signature Sa(7/10) that is in course of sewing to the book block in the making in the sewing

head 165.

[0046] Considering the FIG.5B together with the FIG. 5A, during a next operating cycle of the combined sewing machine 100 the sewing station 155 performs a final portion of the same operating cycle (phase Φ_s=180°-360°), while the transport station 130 performs a complete operating cycle thereof (with the opening feeding station 110p and the folding feeding station 110f being stopped). Therefore, in the sewing station 155 the sewing of the overlapped signature Sa(7/10) to the book block in the making in the sewing head 165 is completed, and the movable saddle 160 is opened to slip off the overlapped signature Sa(7/10) so that the movable saddle 160 is free when it returns aligned with the fixed saddle 140. At this point, in the transport station 130 the overlapped signatures Sa(8/10), Sa(9/10), Sa(10/10) and the overlapped signature in the making (comprising all the folding signatures Sf(1/2,2/10) and Sf(2/2,2/10)) advance along the fixed saddle 140 by a position, with the overlapped signature Sa(8/10) that is conveyed onto the movable saddle 160 (lowered in front of the fixed saddle 140).

[0047] Considering the FIG.5C together with the FIG. 5B, during a next operating cycle of the combined sewing machine 100 the sewing station 155 performs a first fraction of a next operating cycle (phase Φ_s=0°-180°), while the folding feeding station 110f and the folding feeding station 110f perform a complete operating cycle thereof (with the transport station 130 stopped). Therefore, in the sewing station 155 the movable saddle 160 is closed to bring the overlapped signature Sa(8/10) under the sewing head 165 and to begin sewing the book block in the making therein (while in the opening feeding station 110p the opening signature Sp(1/1,1/10) is deposited astride the fixed saddle 140 onto the folding signatures Sf (1/2,1/10) and Sf(2/2,1/10) so as to complete the corresponding overlapped signature Sa(1/10), and in the folding feeding station 110f the folding signature Sf(1/2,2/10) is deposited astride the fixed saddle 140, so as to start the formation of the corresponding overlapped signature).

[0048] The same operations described above are then repeated cyclically.

[0049] A diagram describing the flow of activities relating to an implementation of the solution according to an embodiment of the invention is shown in the FIG.6A-FIG.6B. For example, this solution may be implemented using a software program that is executed under the control of the PLC of the combined sewing machine. The corresponding information (programs and data) is typically stored in the mass memory of the PLC and loaded (at least partially) into its working memory when the programs are running. The programs are initially installed onto the mass memory, for example, from an external computer. In this respect, each block in the diagram may represent a module, segment or portion of code, which comprises one or more executable instructions for implementing the specified logical function (or more).

[0050] Particularly, the activity diagram represents an exemplary process that may be implemented in the above-described combined sewing machine (to produce books comprising overlapped signatures, formed in part by folding signatures and in part by opening signatures) with a method 600. The method 600 starts at the black start circle 603, and then passes to block 606 when a new job is launched on the combined sewing machine (after loading the corresponding stack of opening signatures and the corresponding stack of flat sheets into the hopper of the opening feeding station and into the hopper of the folding feeding station, respectively).

[0051] In this phase, a series of initialisation operations of the combined sewing machine for the new job are performed. Particularly, an opening vector VETp, a folding vector VETf and an overlapped vector VETa are initialised. The opening vector VETp comprises a shift register with a number of cells equal to the positions that may be taken by opening signatures along the processing direction of the opening feeding station, from the bottom of the corresponding hopper up to in front of the fixed saddle (five in the example at issue); each cell stores the configuration information of the opening signature in the corresponding position (*i.e.*, progressive number of opening signature PRGp, total number of opening signatures TOTp, progressive number of overlapped signature PRGA and total number of overlapped signatures TOTA). Likewise, the folding vector VETf comprises a shift register with a number of cells equal to the positions that may be taken by flat sheets or folding signatures along the processing direction of the folding feeding station, from the top of the corresponding hopper up to in front of the fixed saddle (four in the example at issue); each cell stores the configuration information of the folding signature in the corresponding position (*i.e.*, progressive number of folding signature PRGf, total number of folding signatures TOTf, progressive number of overlapped signature PRGa and total number of overlapped signatures TOTa). Finally, the overlapped vector VETa comprises a shift register with a number of cells equal to the positions that may be taken by overlapped signatures (both in the making and completed) along the transport direction of the transport station, from in front of the folding feeding station, passing in front of the opening feeding station up to in the front of the sewing station (four in the example at issue); each cell stores the relevant configuration information of the basic signature at the top of the overlapped signature in the corresponding position (*i.e.*, progressive number of overlapped signature PRGa and total number of overlapped signatures TOTa). Moreover, there are allocated an opening signature index INDp (indicative of an expected position of the opening signature being ready, in the opening feeding station in front of the fixed saddle, in the corresponding group of opening signatures of the corresponding overlapped signature), an opening overlapped signature index INDap (indicative of an expected position of the corresponding overlapped signature, in the making on the fixed saddle in front of the opening feeding station, in the corresponding book

block), a folding signature index INDf (indicative of an expected position of the folding signature being ready, in the folding feeding station in front of the fixed saddle, in the corresponding group of folding signatures of the corresponding overlapped signature), a folding overlapped signature index INDaf (indicative of an expected position of the corresponding overlapped signature, in the making on the fixed saddle in front of the folding feeding station, in the corresponding book block), and an overlapped signature index INDa (indicative of an expected position of the overlapped signature being ready, in the transport station in front of the movable saddle, in the corresponding book block); there are also allocated an opening signature register REGp (indicative of the total number of opening signatures in the overlapped signature in the making in front of the opening feeding station), a folding signature register REGf (indicative of the total number of folding signatures in the overlapped signature in the making in front of the folding feeding station), and an overlapped signature register REGp (indicative of the total number of overlapped signatures in the book block in the making in the sewing station). At the same time, a start sewing flag INIc is deasserted (to the logic value false).

[0052] Continuing to block 609, while the transport station and the sewing station are maintained stopped, the opening feeding station and the folding feeding station are activated (possibly out of phase to each other) for a number of operating cycles (of the combined sewing machine) necessary to load both the opening feeding station and the folding feeding station completely (*i.e.*, five operational cycles, with a delay operating cycle for the folding opening station, in the example at issue). Before each operating cycle, the bar code of the opening signature at the bottom of the corresponding hopper and the bar code of the folding signature at the top of the corresponding hopper are read and decoded; the values PRGp, TOTp, PRGa, TOTa and PRGf, TOTf, PRGa, TOTa, respectively, derived from the value of the bar code are stored into the corresponding cell of the opening vector VETp and of the folding vector VETf, respectively. In this respect, it should be noted that this information is used only when the basic signature becomes ready after passing through the feeding station (for its opening or folding, respectively); therefore, the whole time necessary for the processing of the basic signature may be used to decode the bar code, without any particular constraints to the operating speed of the combined sewing machine (or otherwise without any particular requirements to the processing speed of the PLC).

[0053] A series of operations are then performed to overlap the folding signatures of the first overlapped signature onto the fixed saddle. Particularly, the method 600 passes to block 612, wherein the opening feeding station is stopped (so that only the folding feeding station remains activated).

[0054] Continuing to block 615, the folding signature index INDf and the folding overlapped signature index INDaf are both set to 1, and the folding signature register REGf is set equal to the total number of folding signatures TOTf indicated in the configuration information of the ready folding signature (in the last cell of the folding vector VETf). Before each operating cycle, a test is performed at block 618 to verify whether the ready folding signature belongs to the first overlapped signature; for this purpose, the corresponding progressive number of overlapped signature PRGa (extracted from the configuration information of the ready folding signature in the last cell of the folding vector VETf) is verified. In the positive case (*i.e.,* PRGA=1), a further test is performed at block 621 to verify whether the ready folding signature is the expected one in the first overlapped signature; for this purpose, the progressive number of folding signature PRGf (extracted from the configuration information of the ready folding signature in the last cell of the folding vector VETf) is compared with the folding signature index INDf. In the positive case (*i.e.*, PRGf=INDf), at block 622 the relevant configuration information (*i.e*., the values PRGa, TOTa) of the ready folding signature (extracted from the last cell of the folding vector VETf) is moved into the cell of the overlapped vector VETa corresponding to the position along the fixed saddle in front of the folding feeding station (*i.e.,* the first one) to identify the corresponding overlapped signature. Continuing to block 624, the bar code of the flat sheet at the top of the corresponding hopper (for a corresponding next folding signature) is read and decoded. The configuration information in the folding vector VETf is shifted forward, so as to move the one of the folding signature that will become ready into the last cell and to release the first cell; the values PRGf, TOTf, PRGa and TOTa derived from the value of the bar code are then stored into the first cell of the folding vector VETf (in this case as well, with the decoding of the bar code that may complete later, as long as in time for when the new folding signature becomes ready at the end of the folding feeding station). Turning to block 627, the folding signature index INDf is updated by incrementing it by 1 (*i.e.,* INDf=INDf+1). The method 600 at the block 630 then enters a waiting condition for the completion of the operating cycle, wherein the ready folding signature is deposited from the folding feeding station onto the fixed saddle to contribute to the formation of the first overlapped signature (and a new folding signature becomes ready). The method then returns to the block 618 to repeat the same operations as above.

[0055] With reference again to the block 621, if the ready folding signature is not the expected one in the first overlapped signature (*i.e*., PRGf<>INDf or the last cell of the folding vector VETf is empty because no bar code has been found within a predetermined time-out), the method 600 descends into block 633. In this case, the combined machine enters an error condition, since the ready folding signature is not correct or it cannot be recognized (for example, because its bar code is corrupted or it has not been found); the combined sewing machine is then stopped, and a corresponding alarm signal is out-

put. The method 600 then ends at the final black and white concentric circles 634.

[0056] Returning to the block 618, if the ready folding signature does not belong to the first overlapped signature (*i.e.*, PRGa<>1), this means that all the folding signatures of the first overlapped signature have been gathered on the fixed saddle. Therefore, the method 600 passes to block 636, wherein the opening feeding station as well is stopped. The transport station is then activated for an operating cycle, and its completion is waited so that the first overlapped signature in the making advances along the fixed saddle to go in front of the opening feeding station, thereby releasing the position along the fixed saddle in front of the opening feeding station; at the same time, the configuration information in the overlapped vector VETa is shifted forward, so as to bring the configuration information of the first overlapped signature from the first cell (for the position in front of the folding feeding station) to the second cell (for the position in front of the opening feeding station). Continuing to block 639, the opening signature index INDp and the opening overlapped signature index INDap are both set equal to 1, and the opening signature register REGp is set equal to the total number of opening signatures TOTp indicated in the configuration information of the ready folding signature (in the last cell of the opening vector VETp).

[0057] At this point, the combined sewing machine may process both the opening signatures and the folding signatures regularly. For this purpose, the following operations are performed before each operating cycle for each one of the opening and folding feeding stations. Particularly, a test is performed at block 642 to verify whether the ready opening or folding signature (or ready basic signature) is the expected one - according to its configuration information extracted from the last cell of the opening or folding vector VETp/VETf (or basic vector VETp/VETf); for this purpose, the progressive number of opening or folding signature PRGp/PRGF (or progressive number of basic signature PRGp/PRGF) of the ready basic signature is compared with the opening or folding signature index INDp,INDf (or basic signature index INDp,INDf), and the progressive number of overlapped signature PRGa of the ready basic signature is compared with the opening or folding overlapped signature index INDap,INDaf (or basic overlapped signature index INDap,INDaf), respectively.

[0058] In the positive case (*i.e.*, PRGp=INDp and PRGa=REGap or PRGf=INDf and PRGa=REGaf), another test is performed at block 645 to verify whether the ready basic signature is the first one of the corresponding group of basic signatures in the corresponding overlapped signature, as indicated by its progressive number of basic signature PRGp/PRGF. If not (*i.e.,* PRGp<>1 or PRGf<>1), the ready basic signature may be extracted from the feeding station. Therefore, at block 646 the relevant configuration information (*i.e.*, the values PRGa, TOTa) of the ready basic signature (extracted from the last cell of the basic vector VETp,VETf) is moved into the cell of the overlapped vector VETa corresponding to the position along the fixed saddle in front of the feeding station (*i.e.,* the first one for the folding feeding station and the second one for the opening feeding station) to identify the corresponding overlapped signature. Passing to block 648, the bar code of the opening signature at the bottom of the corresponding hopper, or the flat sheet at the top of the corresponding hopper (for the corresponding next folding signature) is read and decoded. The configuration information in the basic vector VETp,VETf is shifted forward, so as to bring the one of the basic signature that will become ready into the last cell and to releases the first cell; the values PRGp/PRGf, TOTp/TOTf, PRGa and TOTa derived from the value of the bar code are then stored into the first cell of the basic vector VEPp,VETf (in this case as well, with the decoding of the bar code that may complete later on, as long as in time for when the new basic signature becomes ready at the end of the feeding station). Passing to block 651, the basic signature index INDp,INDf is updated by incrementing it by 1 in modulus equal to the opening or folding signature register REGp,REGf (or basic signature register REGp,REGf) - *i.e.*, INDp=(INDp +1) MOD REGp or INDf=(INDf +1) MOD REGf; in this way, the basic signature index INDp,INDf is increased continually during the formation of the corresponding overlapped signature (to point to the next basic signature), and it is set to 1 after the completion thereof (to point to the first basic signature of the next overlapped signature). The feeding station is then activated for an operating cycle at block 654. The method 600 at the block 657 then enters a waiting condition for the completion of the operating cycle (wherein the ready basic signature is deposited from the feeding station onto the fixed saddle to contribute to the formation of the corresponding overlapped signature, and a new basic signature becomes ready). The method then returns to the block 642 to repeat the same operations as above.

[0059] Returning to the block 645, if the ready basic signature is the first one of its type in the corresponding overlapped signature (*i.e.*, PRGp=1 or PRGf=1), another test is performed at block 660 to verify whether the other ready basic signature as well is the first one of its type in the corresponding overlapped signature. If not, the ready basic signature cannot be extracted from the feeding station (since the overlapped signature of the other feeding station is still in the making); this may happen in the opening feeding station (when the total number of opening signatures TOTp is lower than the total number of folding signatures TOTf) or in the folding feeding station (otherwise), while it never happens when the total number of opening signatures TOTp is equal to the total number of folding signatures TOTf. In this case, the feeding station is stopped (if necessary) at block 663. The method 600 at the same block 657 then enters a waiting condition for the completion of the operating cycle (wherein the ready basic signature remains in the feeding station) and later on returns to the block 642 to repeat

the same operations as above.

[0060] With reference again to the block 660, if the other ready basic signature is the first one of its type in the corresponding overlapped signature, this means that all the folding signatures of the overlapped signature in the making in front of the folding feeding station have been gathered and that all the opening signatures of the overlapped signature in the making in front of the opening feeding station have been gathered (by completing it); therefore these overlapped signatures (in the making and completed, respectively) may be advanced along the fixed saddle. For this purpose, at block 667 the transport station is activated for an operating cycle. At the same time, the basic signatures register REGp,REGf is set equal to the total number of opening or folding signatures TOTp/TOTf (or total number of basic signatures TOTp/TOTf) - extracted from the configuration information in the last cell of the basic vector VETp/VETf - to indicate the total number of basic signatures of the new overlapped signature.

[0061] The value of the sewing flag INIc is then verified at block 669. If the sewing flag INIc is deasserted (to indicate that the sewing of the overlapped signatures has not been started yet), another test is performed at block 672 to verify whether an overlapped signature is ready in the transport station in front of the movable saddle, as indicated by the last cell of the overlapped vector VETa. If not (*i.e.,* if the last cell of the overlapped vector VETa is empty), the sewing station cannot be activated yet since no overlapped signature has reached its movable saddle. Therefore, the method 600 at block 673 enters a waiting condition for the completion of the operating cycle (wherein the overlapped signatures on the fixed saddle advance by a position along it, with the completed overlapped signature in front of the opening feeding station that releases this position and the overlapped signature in the making in front of the folding feeding station that takes it thereby releasing the position in front of the opening feeding station); at the same time, the configuration information in the overlapped vector VETa is shifted forward by a position. The method 600 then returns to the block 646, so as to perform the operations described above for extracting the ready basic signature from the feeding station.

[0062] Returning to the block 672, if instead an overlapped signature is ready in the transport station in front of the movable saddle (*i.e.,* the last cell of the overlapped vector VETa stores the configuration information of its last basic signature), the sewing flag INIc is asserted (to the logic value true) at the block 675; at the same time, the overlapped signature index INIa is set to 0 and the overlapped signature register REGa is set to 1. The method 600 then continues to block 684; the same point is reached directly from the block 669 if the sewing flag INIc is asserted.

[0063] At this point, the overlapped signatures may be processed regularly. Particularly, a test is performed to verify whether the ready overlapped signature is the expected one; for this purpose, the progressive number of overlapped signature PRGa (extracted from the configuration information in the last cell of the overlapped vector VETa) is compared with the overlapped signature index INDa. In the positive case (*i.e.*, PRGa=INDa), the flow of activity branches at block 685 according to the configuration of the combined sewing machine. If the combined sewing machine is provided with two separate motors for the transport station and the sewing station that work independently, at block 686 the sewing station is activated continuously at a reduced operating frequency; the corresponding reduction ratio is set equal to the greater between the opening signature register REGp and the folding signature register REGf. Conversely, if the combined sewing machine is provided with a single motor for the transport station and the sewing station that work simultaneously, at block 687 the sewing station is activated for a single operating cycle. In both cases, the flow of activity merges at block 688, wherein the overlapped signature index INDa is updated by incrementing it by 1 in modulus equal to the overlapped signature register REGa (*i.e.*, INDa=(INDa +1) MOD REGa); in this way, the overlapped signature index INDa is increased continually during the formation of the corresponding book block (to point to the next overlapped signature), and it is set to 1 after the completion thereof (to point to the first overlapped signature of the next book block).

[0064] A test is then performed at block 690 to verify whether the ready overlapped signature is the first one of the corresponding book block, as indicated by its progressive number of overlapped signature PRGa. In the positive case (*i.e.,* PRGa=1), the preceding book block is completed. Therefore, at block 693 the continuous threads in the sewing head are cut to separate this book block and deposit it onto the output conveyor; at the same time, the overlapped signature register REGa is set equal to the total number of overlapped signatures TOTa indicated in the configuration information of the ready overlapped signature (in the last cell of the overlapped vector VETa) - to indicate the total number of overlapped signatures of the new book block. The method 600 then passes to the same block 673; the same point is also reached directly from the block 690 if the ready overlapped signature is not the first one of the corresponding book block (*i.e.,* PRGa<>1). In both cases, the method 600 enters the same waiting condition for the completion of the operating cycle (wherein the overlapped signatures on the fixed saddle advance by a position along it as above, but wherein the ready overlapped signature is also sewn to the book block in the making in the sewing station, by starting it if the first one thereof), and then returns to the block 646 (to extract the ready basic signature from the feeding station).

[0065] Returning to the block 684, if the ready overlapped signature is not the expected one (*i.e.*, PRGa<>INDa), the method 600 descends into the same block 633 (wherein the combined machine enters an error condition since the ready overlapped signature is not

correct, and is then stopped by outputting a corresponding alarm signal), and the method 600 ends at the final black and white concentric circles 634.

[0066] Likewise, returning to the block 642, if the basic signature is not the expected one (*i.e.,* PRGp <> INDp or PRGA <> REGap and/or PRGF <> INDf or PRGA <> REGaf), the method 600 descends in the same block 633 (wherein the combined machine is brought to an error condition since the basic signature is not correct or it cannot be recognized, and it is then stopped with the output of a corresponding alarm signal), and the method 600 ends at final black and white concentric circles 634.

[0067] The same operations described above are repeated continuously, until the combined sewing machine is stopped (to execute a new job).

[0068] Naturally, in order to satisfy local and specific requirements, a person skilled in the art may apply to the solution described above many logical and/or physical modifications and alterations. More specifically, although this solution has been described with a certain degree of particularity with reference to one or more embodiments thereof, it should be understood that various omissions, substitutions and changes in the form and details as well as other embodiments are possible (for example, with reference to numerical values and compositions). Particularly, different embodiments of the invention may even be practiced without the specific details set forth in the preceding description to provide a more thorough understanding thereof; conversely, well-known features may have been omitted or simplified in order not to obscure the description with unnecessary particulars. Moreover, it is expressly intended that specific elements and/or method steps described in connection with any embodiment of the disclosed solution may be incorporated in any other embodiment as a matter of general design choice. In any case, ordinal or other qualifiers are merely used as labels to distinguish elements with the same name but do not by themselves connote any priority, precedence or order. Moreover, the terms include, comprise, have, contain and involve (and any forms thereof) should be intended with an open, non-exhaustive meaning (*i.e.*, not limited to the recited items), the terms based on, dependent on, according to, function of (and any forms thereof) should be intended as a non-exclusive relationship (*i.e.*, with possible further variable involved), and the term a/an should be intended as one or more items (unless expressly indicated otherwise).

[0069] For example, similar considerations apply if the same solution is implemented with an equivalent method (by using similar steps with the same functions of more steps or portions thereof, removing some steps being non-essential, or adding further optional steps); moreover, the steps may be performed in a different order, concurrently or in an interleaved way (at least in part).

[0070] In any case, the configuration information may be provided in any other way (for example, with three-dimensional bar codes or with optical readable characters); moreover, nothing prevents reporting the configuration information only on part of the basic signatures (at most, with the configuration of each book block that is fully described only on a first basic signature of the whole job). The overlapped signatures may be transported to the sewing station with any other structure comprising a saddle (either a fixed or a movable one) on which its basic signatures are gathered. Equivalent techniques may be used to sew the overlapped signatures together, or more generally to bind them (for example, by means of glue or staples).

[0071] The solution described above lends itself to be used in a bookbinding combined machine with any other feeding stations (even of different types); moreover, the various feeding stations may also be temporarily disabled to obtain book blocks entirely formed by opening signatures only or by folding signatures only, even not overlapped one to another.

[0072] Particularly, the folding feeding station may have another structure, for example, the flat sheets may be folded more times, or it is possible to gather groups of flat sheets and then folding them together (to obtain a folding signature of the overlapped type as well).

[0073] Likewise, the opening feeding station may have another structure (for example, with a different opening device), and it may be used to provide opening signatures of any other type (for example, with any other number of folds).

[0074] In both cases, the configuration information may be read in other positions (for example, directly in the ready basic signature when it is stationary in front of the fixed saddle).

[0075] The feeding stations may be operated in another way, even using the same motor with mechanical decoupling systems (for example, based on corresponding gear change). Alternatively, it is also possible to activate the feeding stations continuously as usual; in this case, the same effect resulting from stopping the feeding stations may be obtained by simply disabling the extraction of the opening signatures and the flat sheets from the respective hoppers.

[0076] The feeding stations may be in any number and arranged in any way along the fixed saddle (for example, with multiple opening feeding stations and multiple folding feeding stations being alternate one to another). In any case, nothing prevents from gathering the basic signatures of a single overlapped signature at a time (in front of the corresponding feeding station), while all the other feeding stations are maintained stopped - for example, when a common position is provided on the fixed saddle both in front of the folding feeding station and in front of the opening feeding station.

[0077] The transport of the overlapped signature in the making from a feeding station to the next one along the fixed saddle may be controlled by other information (for example, a simple indicator of end of gathering of the corresponding basic signatures comprised in the configuration information). In a different embodiment of the invention, it is also possible to indicate the overall position

of each basic signature within the corresponding overlapped signature and the total number of all the basic signatures thereof on each basic signature (for example, 1/3, 2/3 and 3/3 in the example at issue), in this case, the total number of folding signatures is determined once their gathering has been completed, and the total number of folding signatures is determined by difference.

[0078] The completion of each book block may involve performing different and/or additional operations (for example, a blind stitch); in any case, it may be not managed through the configuration information of the basic signatures in a simplified implementation.

[0079] Likewise, the binding of the book blocks may be controlled by other information as well (for example, a simple indicator of end of book block provided on the last basic signature of the overlapped signature of each book block).

[0080] Different operations may be performed in response to the detection of a sequence error (without immediately stopping the combined sewing machine) - for example, suggesting a possible correction thereof; in any case, this control may be simplified or even omitted at all in a basic implementation.

[0081] The proposed solution may be implemented as a stand-alone module, as a plug-in for a control program of the PLC, or even directly in the control program itself. Alternatively, the same solution may be applied in a combined sewing machine comprising a distinct computer (or any equivalent data processing system). The software program (which may be used to implement each embodiment of the invention) may take any form suitable to be used by any data processing system or in connection therewith (for example, within a virtual machine), thereby configuring the system to perform the desired operations; particularly, the program may be in the form of external or resident software, firmware, or micro-code (either in object code or in source code - for example, to be compiled or interpreted). Moreover, it is possible to provide the program as an article of manufacture on a non-transitory computer-usable medium; the medium may be any element suitable to contain, store, communicate, propagate, or transfer the program. For example, the medium may be of the electronic, magnetic, optical, electromagnetic, infrared, or semiconductor type; examples of such medium are fixed disks (where the program may be pre-loaded), removable disks, tapes, cards, wires, fibres, wireless connections, networks, broadcast waves, and the like. In any case, the solution according to an embodiment of the present invention lends itself to be implemented even with a hardware structure (for example, integrated in a chip of semiconductor material), or with a combination of software and hardware suitably programmed or otherwise configured.

[0082] Similar considerations apply if the combined sewing (or more generally, binding) machine has a different structure or comprises equivalent components, or it has other operative characteristics. In any case, every component thereof may be separated into more elements, or two or more components may be combined together into a single element; moreover, each component may be replicated to support the execution of the corresponding operations in parallel. Moreover, it should be noted that (unless specified otherwise) any interaction between different components generally does not need to be continuous, and it may be either direct or indirect through one or more intermediaries.

Claims

1. A method (600) for controlling a combined bookbinding machine (100), the method comprising the steps of:

   reading (648) configuration information associated at least in part with a basic signature being ready in each one of a plurality of feeding stations (110f, 110p) of the combined bookbinding machine, the configuration information comprising a progressive number of basic signature indicative of a position of the basic signature within a corresponding overlapped signature comprising a plurality of basic signatures being overlapped one to another,
   selecting (642,645,660) at least one of the basic signatures in at least a selected one of the feeding stations according to the configuration information,
   depositing (654) said at least one selected basic signature from said at least one selected feeding station astride a transport saddle (140) of the combined bookbinding machine to contribute to the formation of a corresponding overlapped signature on the transport saddle, and
   transporting (667) each overlapped signature towards a binding station of the combined bookbinding machine to contribute to the formation of a corresponding book block, comprising a plurality of overlapped signatures being bound one to another, in response to the reading of an indicator of end of overlapped signature in the configuration information.

2. The method (600) according to claim 1, wherein the feeding stations (110f, 110p) comprise at least one folding feeding station (110f), the step of depositing (654) said at least one selected basic signature from said at least one selected feeding station astride a transport saddle (140) comprising, in each selected feeding station belonging to said at least one folding feeding station:

   obtaining (654) a next ready basic signature in the selected feeding station, each basic signature being obtained in the selected feeding station by extracting a printed sheet from a printed

sheet hopper (115f) and folding the printed sheet to obtain the basic signature being open.

3. The method (600) according to claim 2, wherein the step of reading (648) configuration information associated at least in part with a basic signature being ready in each one of a plurality of feeding stations (110f, 110p) comprises, in each of said at least one folding feeding station (110f, 110p):

reading (648) the configuration information from the corresponding printed sheet in the printed sheet hopper (115f).

4. The method (600) according to any one of claims from 1 to 3, wherein the feeding stations (110p, 110f) comprise at least one opening feeding station (110p), the step of depositing (654) said at least one selected basic signature from said at least one selected feeding station astride a transport saddle (140) comprising, in each selected feeding station belonging to said at least one opening feeding station:

obtaining (654) a next ready basic signature in the selected feeding station, each basic signature being obtained in the selected feeding station by extracting the basic signature from a basic signature hopper (115p) and opening the basic signature.

5. The method (600) according to claim 4, wherein the step of reading (648) configuration information associated at least in part with a basic signature being ready in each one of a plurality of feeding stations (110f, 110p) comprises, in each of said at least one opening feeding station (110p):

reading (648) the configuration information from the basic signature in the basic signature hopper (115p).

6. The method (600) according to any one of claims from 1 to 5, wherein the step of depositing (654) said at least one selected basic signature from said at least one selected feeding station astride a transport saddle (140) comprises :

activating (654) said at least one selected feeding station and maintaining stopped the other feeding stations being not selected.

7. The method (600) according to any one of claims from 1 to 6, wherein the feeding stations (110f, 110p) are arranged in an ordered sequence along a transport direction of the transport saddle (140), the step of transporting (667) each overlapped signature towards a binding station comprising:

advancing (667) the overlapped signature beyond a position in correspondence to a last feeding station (110p) in the sequence, and advancing each next overlapped signature in the making on the transport saddle from a position in correspondence to each feeding station (110f) different from the last feeding station (110p) in the sequence to a position in correspondence to a next feeding station (110p) in the sequence.

8. The method (600) according to claim 7, wherein the step of selecting (642,645,660) at least one of the basic signatures in at least a selected one of the feeding stations comprises:

selecting (642,645) each feeding station (110f, 110p) whose basic signature is different from a corresponding first basic signature provided by the feeding station for the corresponding overlapped signature, or
selecting (660) each feeding station whose basic signature is equal to the corresponding first basic signature only if the basic signatures of all the other feeding stations as well are equal to the corresponding first basic signatures.

9. The method (600) according to any one of claims from 1 to 8, wherein the progressive number of basic signature is indicative of a position of the basic signature within a group of basic signatures provided by a corresponding feeding station for the corresponding overlapped signature, and wherein the configuration information of each basic signature further comprises a total number of basic signatures of the corresponding group of basic signatures, the indicator of end of overlapped signature consisting in the progressive number of basic signature equal to the total number of basic signatures.

10. The method (600) according to any one of claims from 1 to 9, further comprising the step of:

completing (693) the binding of the book block in the binding station in response to the reading of an indicator of end of block in the configuration information of at least one corresponding basic signature.

11. The method (600) according to claim 10, wherein the configuration information of each basic signature comprises an overlapped signature progressive number indicative of a position of the corresponding overlapped signature in the corresponding book block and a total number of overlapped signatures of the corresponding book block, the indicator of end of block consisting in the overlapped signature progressive number equal to the total number of overlapped signatures.

12. The method (600) according to any one of claims from 1 to 11, further comprising the step of:

verifying (621,642,684) a correctness of the overlapped signature and/or of the book block according to the configuration information of the corresponding basic signatures.

13. A software program (600) comprising code means for causing a control system (185) of a combined bookbinding machine (100) to perform the steps of the method (600) according to any one of claims from 1 to 12 when the software program is executed on the control system.

14. A combined bookbinding machine (100) comprising means (185) for performing the steps of the method (600) according to any one of claims from 1 to 12.

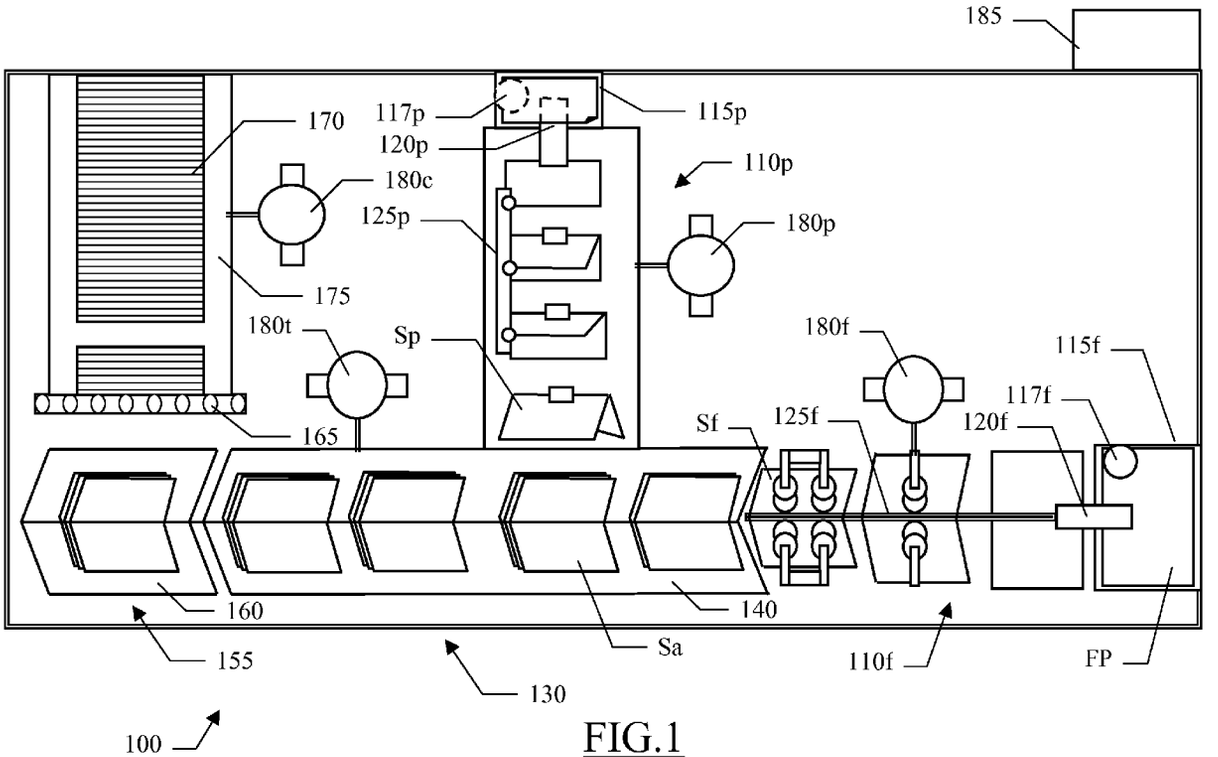

185
170
117p
120p
115p
110p
180c
125p
180p
175
180t
Sp
180f
115f
117f
120f
Sf
125f
165
160
140
155
Sa
110f
FP
130
100

FIG.1

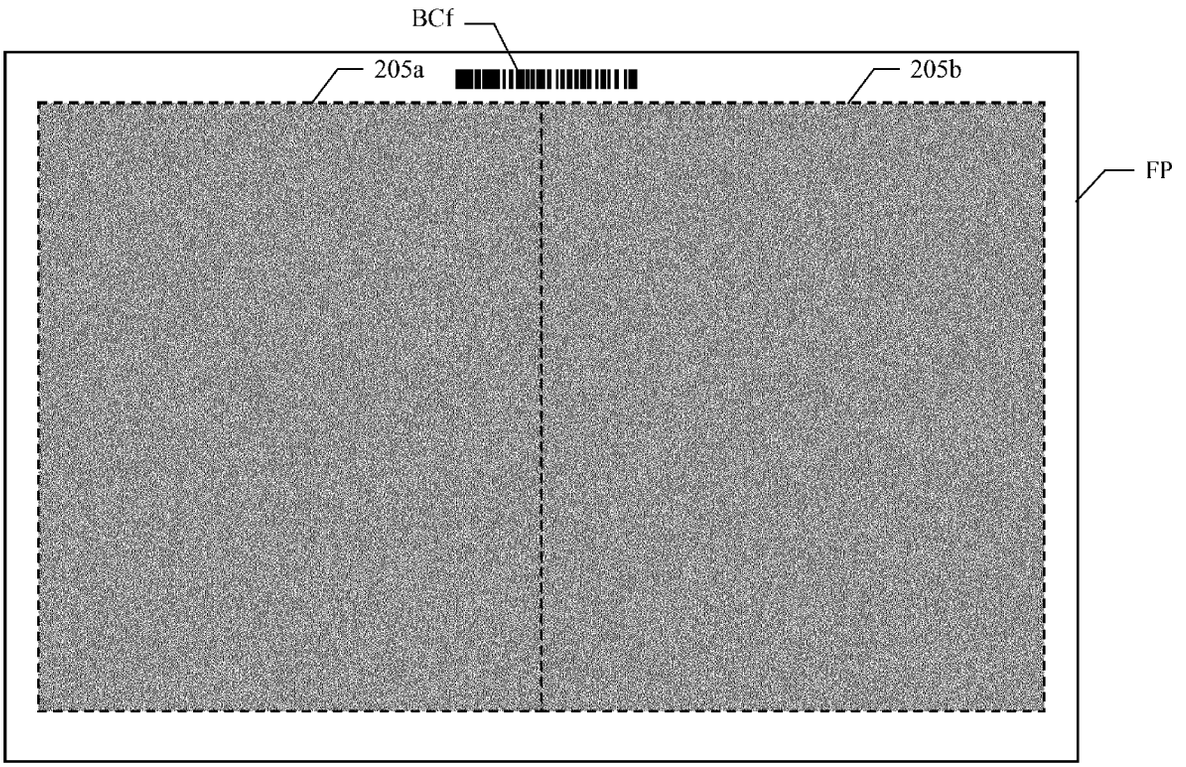


FIG.2

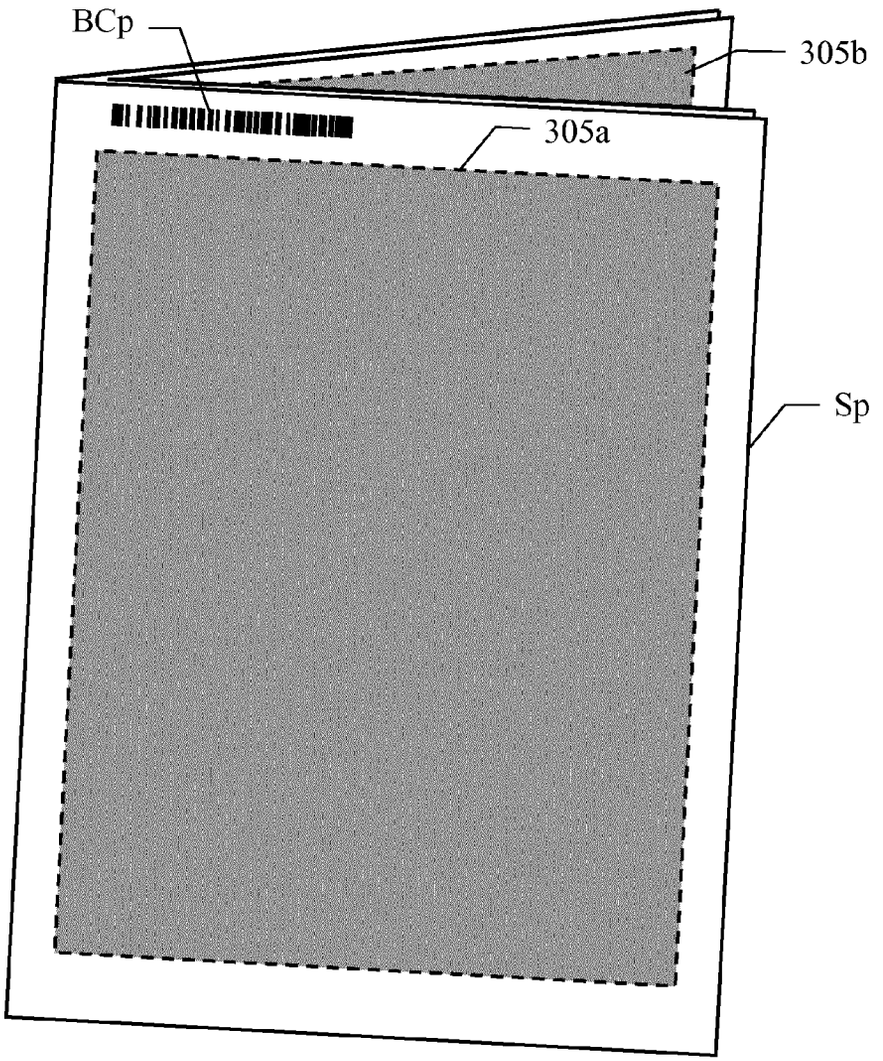
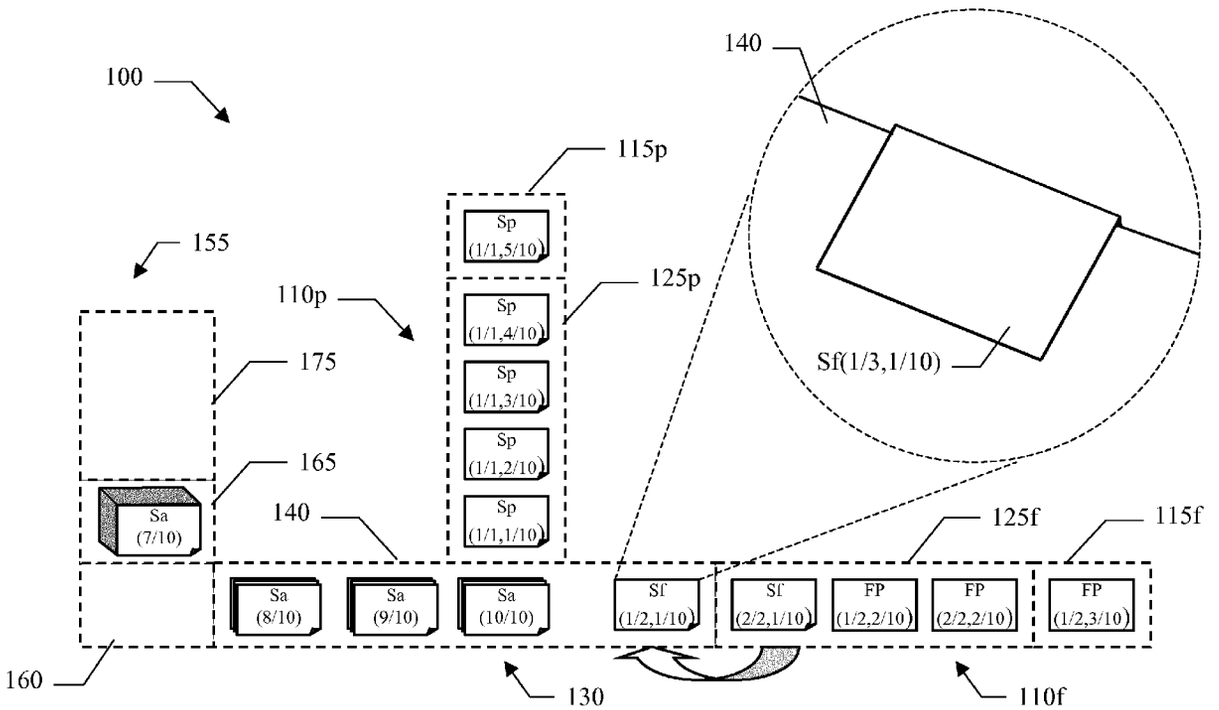


FIG.3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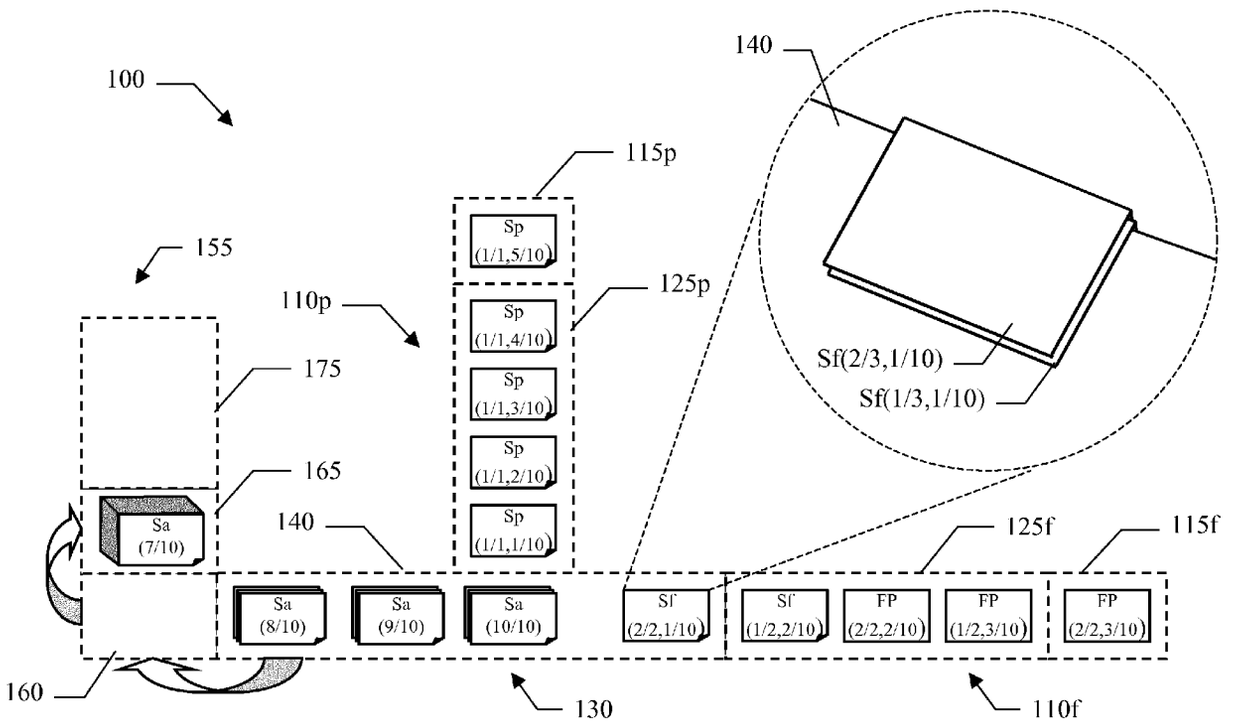
155
110p
175
165
140
160
115p
125p
Sp (1/1,5/10)
Sp (1/1,4/10)
Sp (1/1,3/10)
Sp (1/1,2/10)
Sp (1/1,1/10)
Sa (7/10)
Sa (8/10)
Sa (9/10)
Sa (10/10)
130
140
Sf(1/3,1/10)
125f
115f
Sf (1/2,1/10)
Sf (2/2,1/10)
FP (1/2,2/10)
FP (2/2,2/10)
FP (1/2,3/10)
110f

FIG.4A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115p
155
Sp (1/1,5/10)
110p
125p
Sp (1/1,4/10)
175
Sp (1/1,3/10)
165
Sp (1/1,2/10)
Sa (7/10)
140
Sp (1/1,1/10)
125f
115f
Sa (8/10)
Sa (9/10)
Sa (10/10)
Sf (2/2,1/10)
Sf (1/2,2/10)
FP (2/2,2/10)
FP (1/2,3/10)
FP (2/2,3/10)
160
130
110f
140
Sf(2/3,1/10)
Sf(1/3,1/10)

FIG.4B

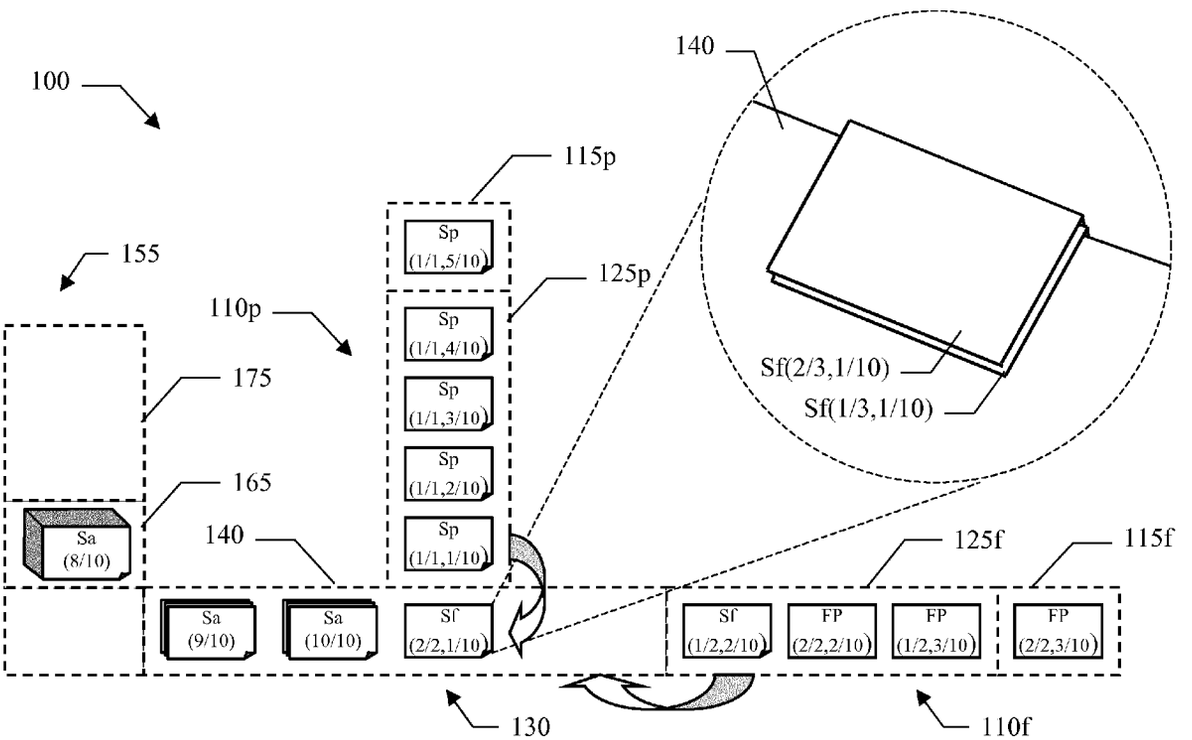
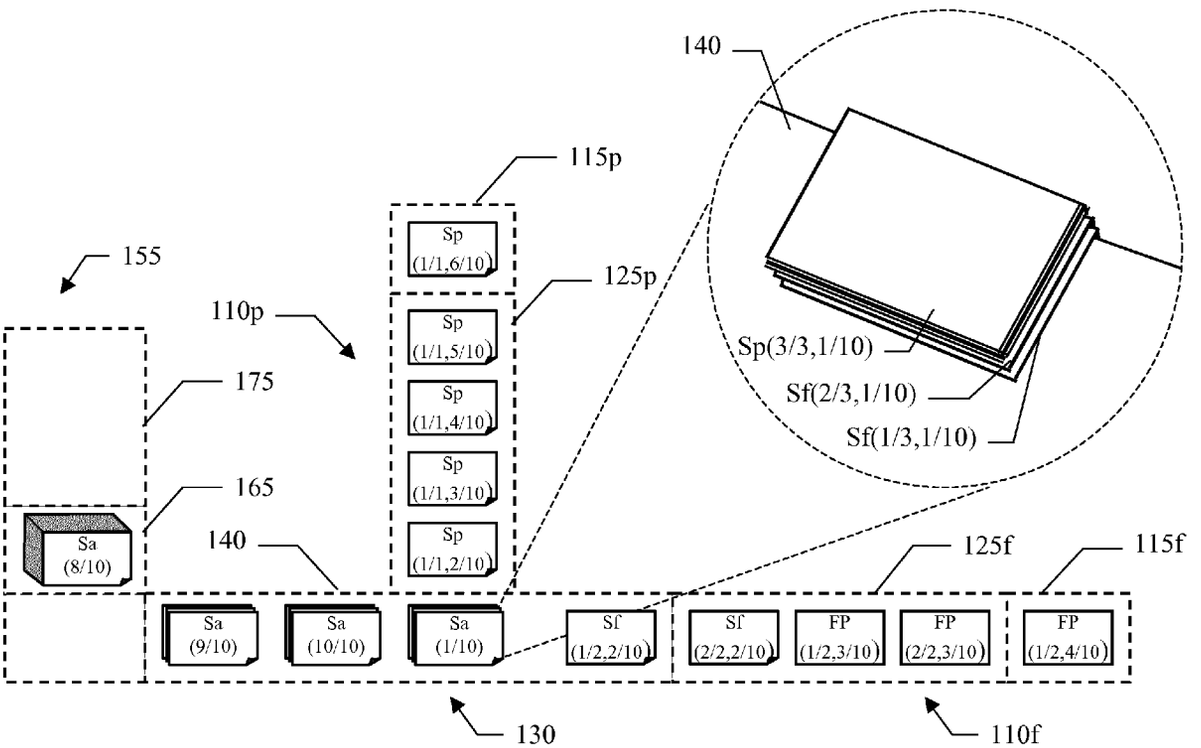

100
155
110p
175
165
140
115p
125p
Sp (1/1,5/10)
Sp (1/1,4/10)
Sp (1/1,3/10)
Sp (1/1,2/10)
Sp (1/1,1/10)
Sa (8/10)
Sa (9/10)
Sa (10/10)
Sf (2/2,1/10)
140
Sf(2/3,1/10)
Sf(1/3,1/10)
125f
115f
Sf (1/2,2/10)
FP (2/2,2/10)
FP (1/2,3/10)
FP (2/2,3/10)
130
110f

FIG.4C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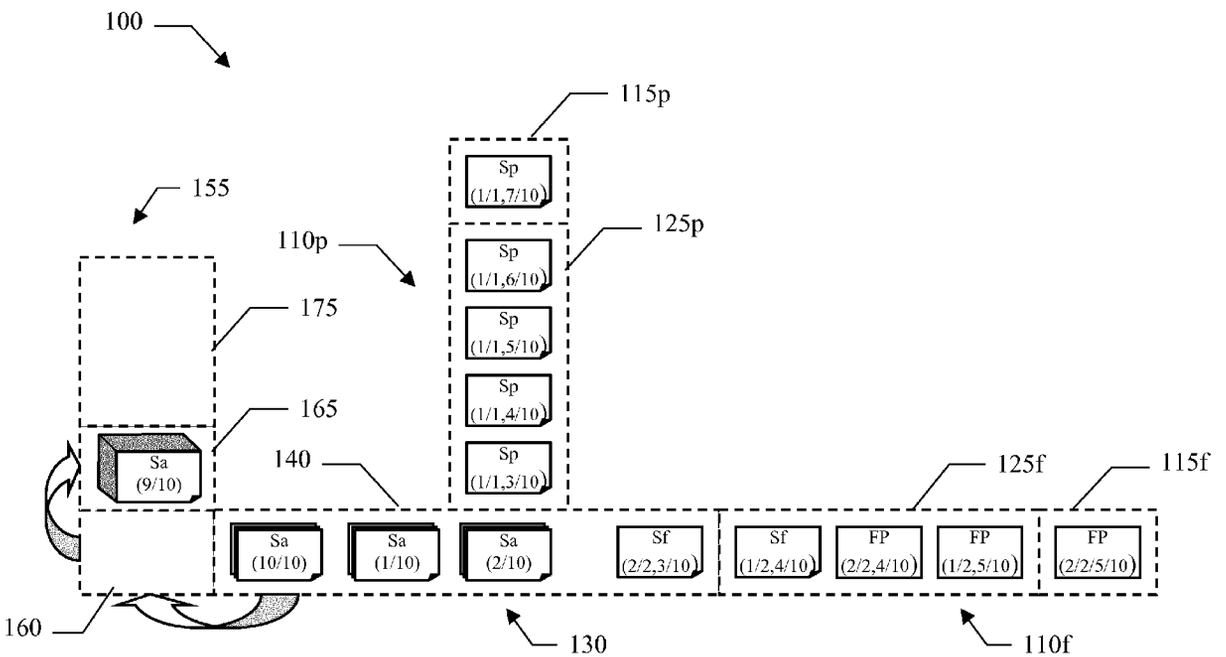
115p
155
Sp (1/1,6/10)
125p
110p
Sp (1/1,5/10)
Sp (1/1,4/10)
175
Sp (1/1,3/10)
165
Sp (1/1,2/10)
Sp(3/3,1/10)
Sf(2/3,1/10)
Sf(1/3,1/10)
Sa (8/10)
140
125f
115f
Sa (9/10)
Sa (10/10)
Sa (1/10)
Sf (1/2,2/10)
Sf (2/2,2/10)
FP (1/2,3/10)
FP (2/2,3/10)
FP (1/2,4/10)
130
110f

FIG.4D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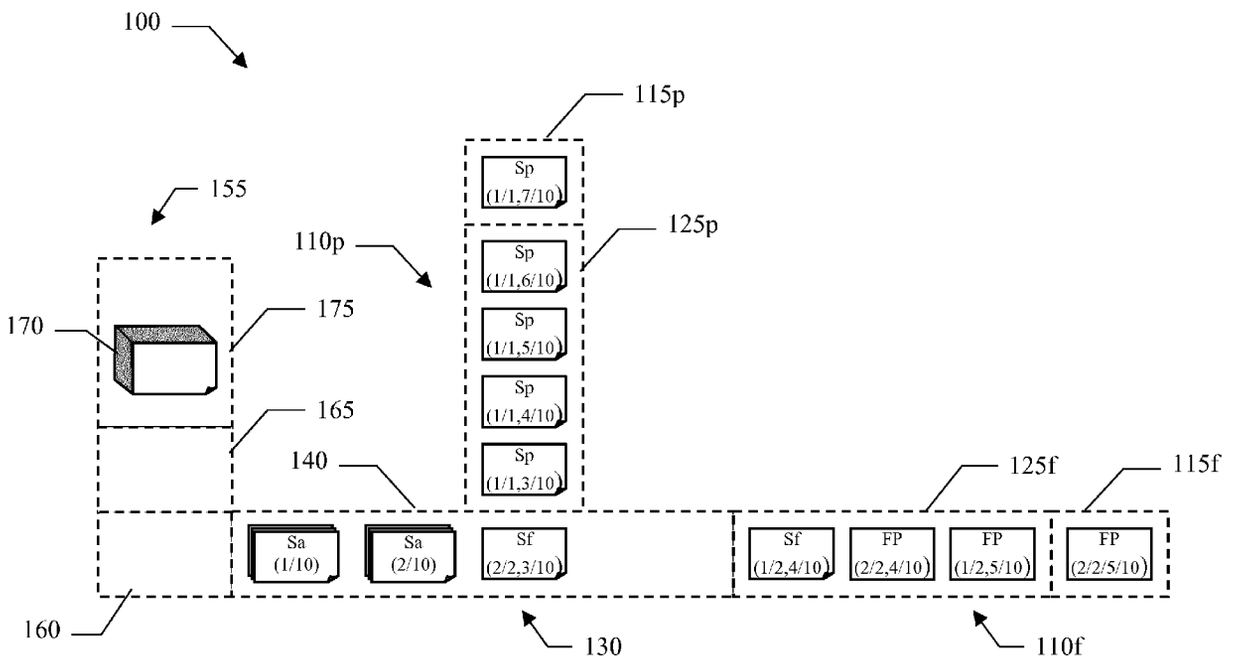
155
Sp (1/1,7/10)
110p
125p
Sp (1/1,6/10)
175
Sp (1/1,5/10)
Sp (1/1,4/10)
165
Sa (9/10)
Sp (1/1,3/10)
140
125f
115f
Sa (10/10)
Sa (1/10)
Sa (2/10)
Sf (2/2,3/10)
Sf (1/2,4/10)
FP (2/2,4/10)
FP (1/2,5/10)
FP (2/2/5/10)
160
130
110f

FIG.4E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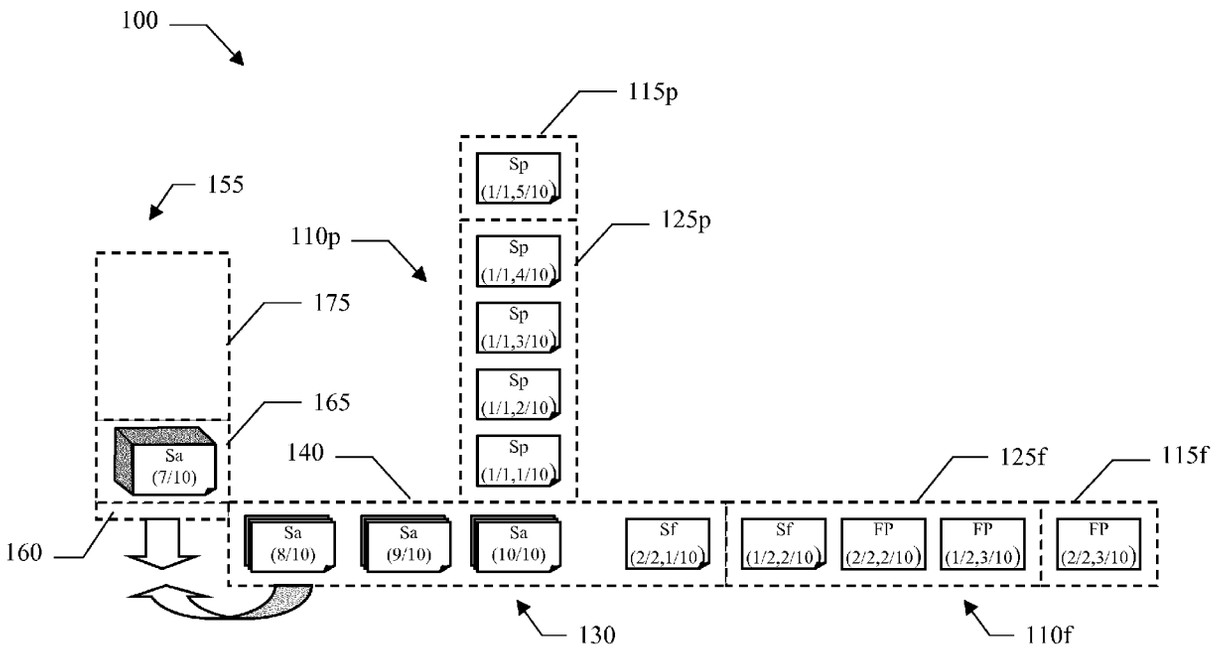
115p
155
Sp (1/1,7/10)
110p
125p
Sp (1/1,6/10)
Sp (1/1,5/10)
Sp (1/1,4/10)
Sp (1/1,3/10)
170
175
165
140
125f
115f
Sa (1/10)
Sa (2/10)
Sf (2/2,3/10)
Sf (1/2,4/10)
FP (2/2,4/10)
FP (1/2,5/10)
FP (2/2/5/10)
160
130
110f

FIG.4F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Sp (1/1,5/10)
110p
125p
Sp (1/1,4/10)
175
Sp (1/1,3/10)
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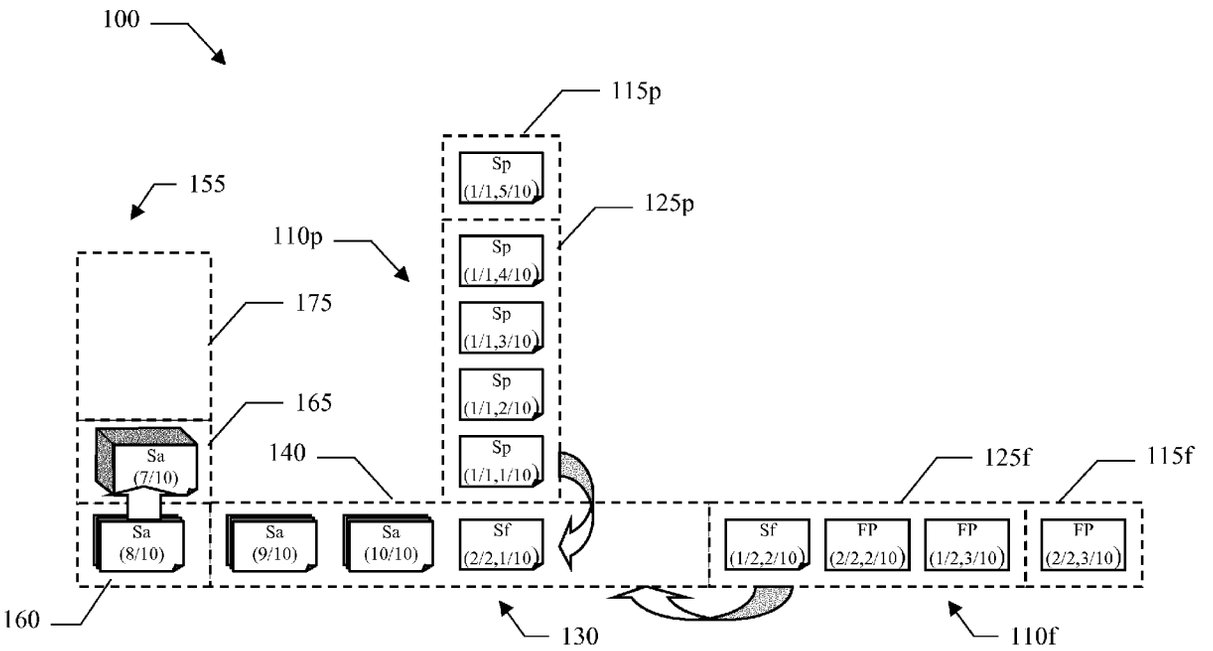
165
Sa (7/10)
140
Sp (1/1,1/10)
125f
115f
160
Sa (8/10)
Sa (9/10)
Sa (10/10)
Sf (2/2,1/10)
Sf (1/2,2/10)
FP (2/2,2/10)
FP (1/2,3/10)
FP (2/2,3/10)
130
110f

FIG.5A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125p
110p
Sp (1/1,4/10)
Sp (1/1,3/10)
Sp (1/1,2/10)
Sp (1/1,1/10)
175
165
140
125f
115f
Sa (7/10)
Sa (8/10)
Sa (9/10)
Sa (10/10)
Sf (2/2,1/10)
Sf (1/2,2/10)
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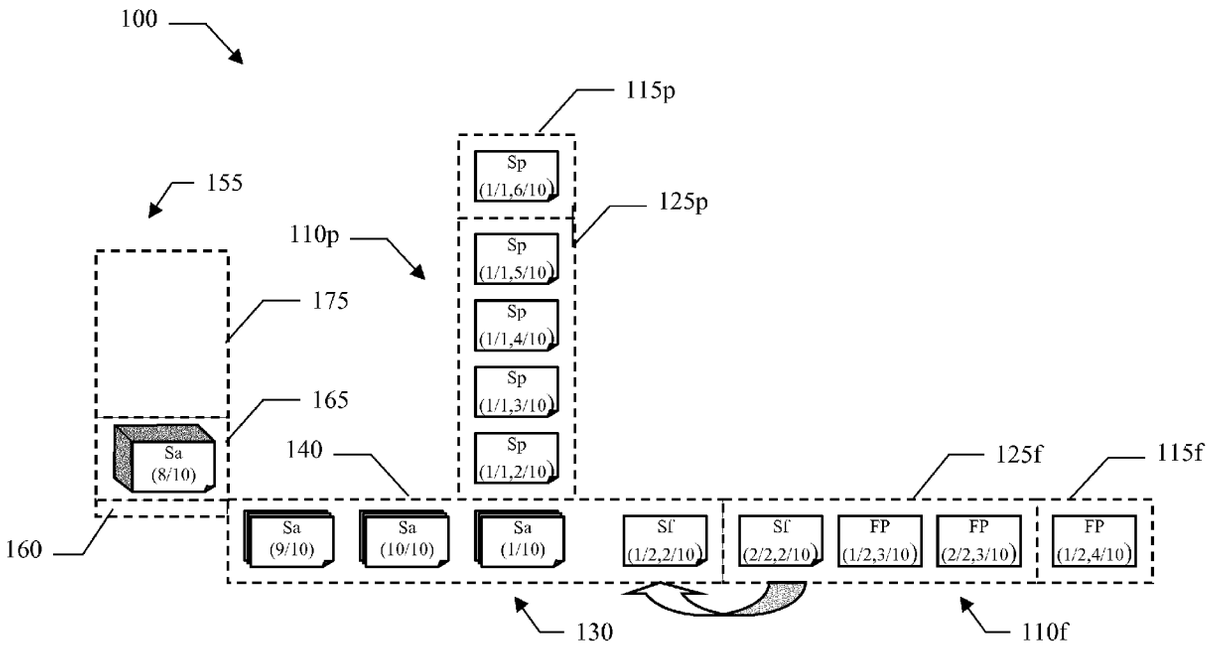
FP (1/2,3/10)
FP (2/2,3/10)
160
130
110f

FIG.5B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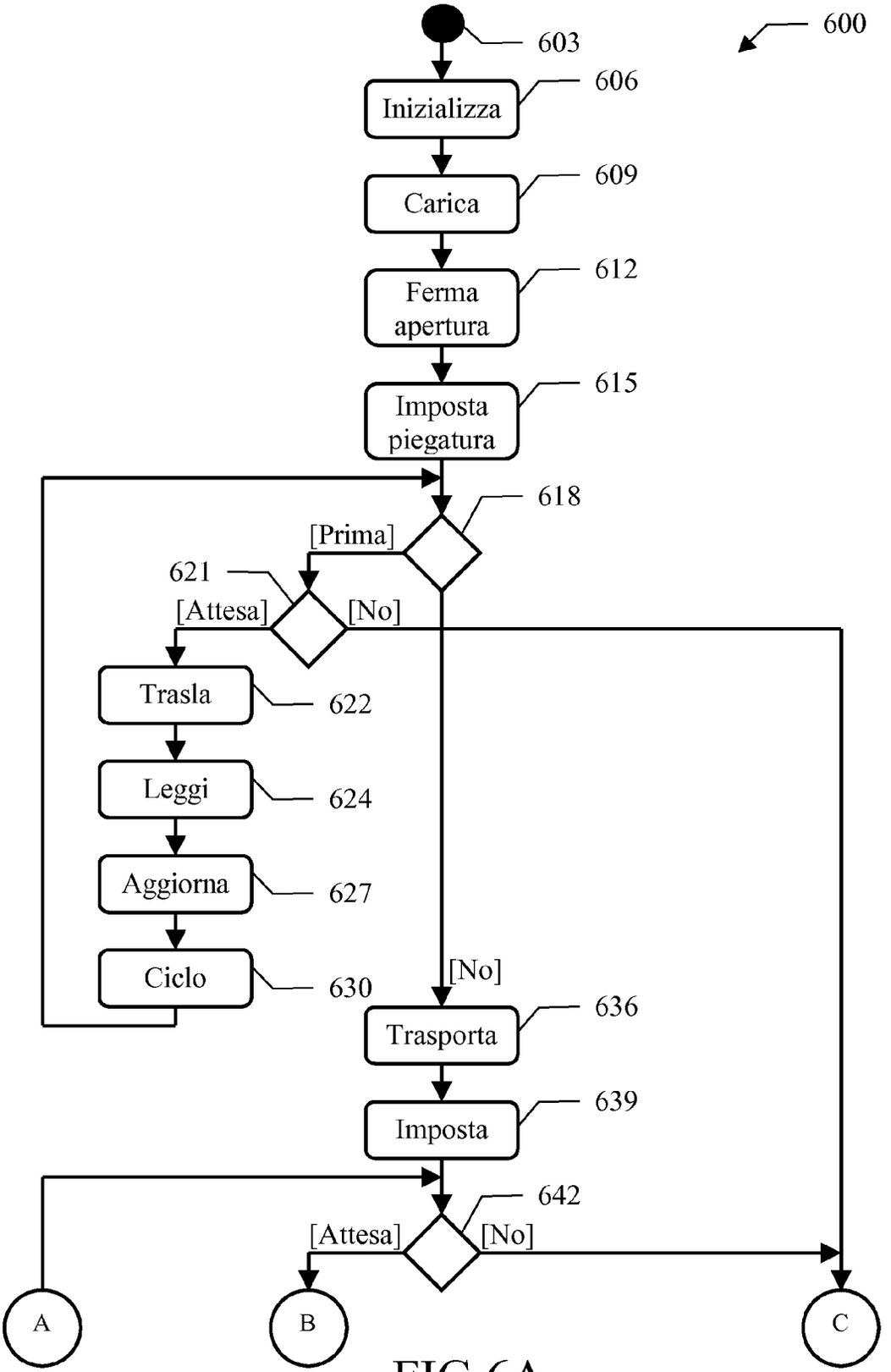
Sp (1/1,4/10)
Sp (1/1,3/10)
165
Sa (8/10)
140
Sp (1/1,2/10)
125f
115f
160
Sa (9/10)
Sa (10/10)
Sa (1/10)
Sf (1/2,2/10)
Sf (2/2,2/10)
FP (1/2,3/10)
FP (2/2,3/10)
FP (1/2,4/10)
130
110f

FIG.5C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618
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Aggiorna
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Ciclo
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Trasporta
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Imposta
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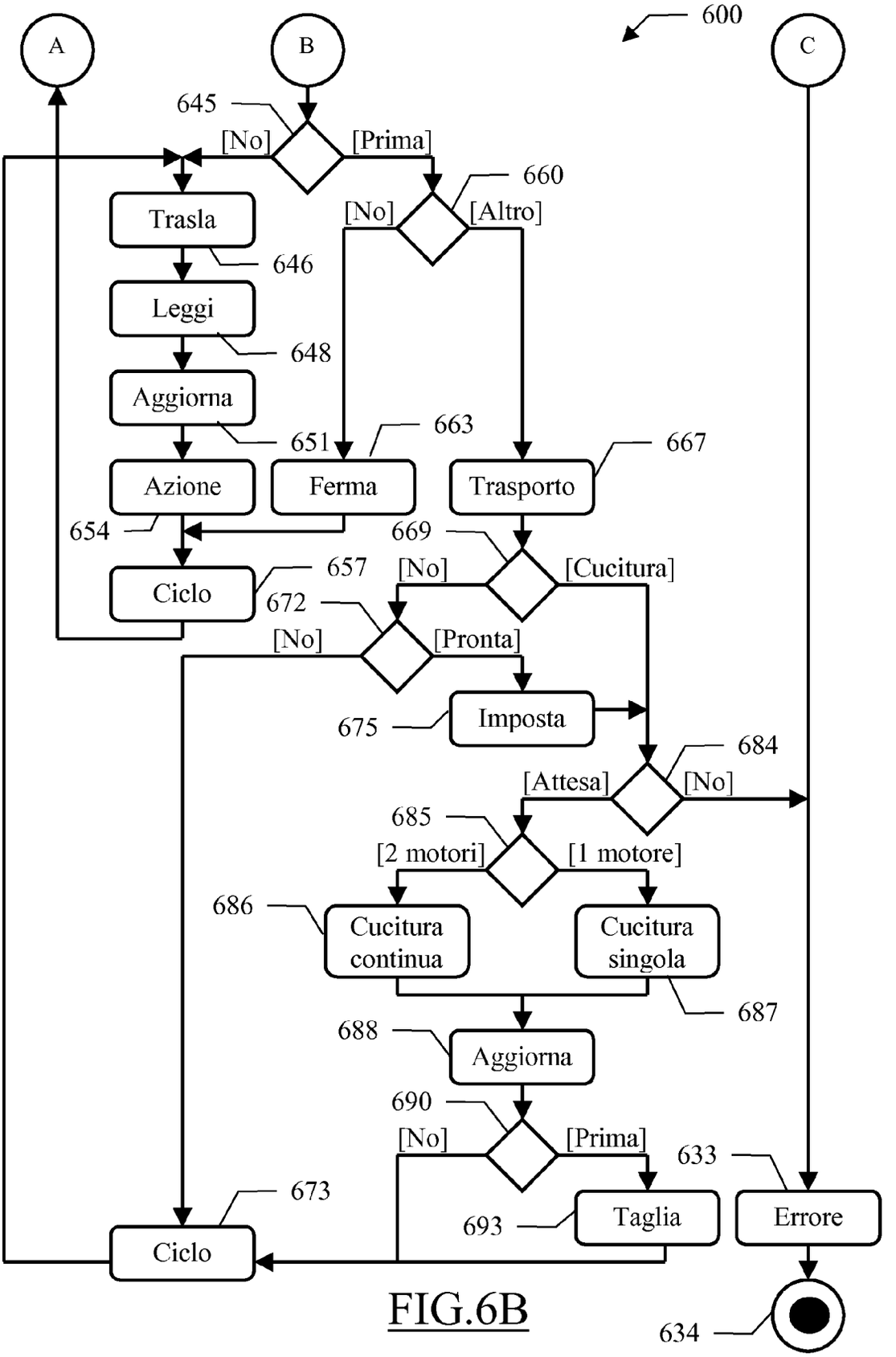
642
[Attesa]
[No]
A
B
C

FIG.6A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Ciclo
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Imposta
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[Attesa]
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[1 motore]
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Cucitura continua
Cucitura singola
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688
Aggiorna
690
[No]
[Prima]
633
673
693
Taglia
Errore
Ciclo
634

FIG.6B

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- EP 0846573 A **[0004]**
- WO 2012028725 A **[0008]**
- EP 2213468 A **[0010]**