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(54) **Method of controllably adjusting amount of knitting yarns.**

(57) A method of controllably adjusting amount of knitting yarns available for a knitting operation with a flat knitting machine comprising the following sequential steps.

A step of storing a predetermined amount X or a data on the amount Ms of integrated yarn length of length Si of available knitting yarns at the moment at which said yarn length Si exceeds said predetermined amount X in conjunction with a data on said yarn length Si related to each course 'i' of a sample knit fabric composed by operating a flat knitting machine. A step of storing a data on the amount Mc of integrated yarn length of said predetermined amount X of length Ci of available knitting yarns in conjunction with said yearn length Ci related to each course 'i' of an actually knitted fabric having composition identical to that of said sample knit fabric. A step of executing a comparative arithmetic operation to make comparison between said amount Ms of integrated yarn length of said sample knit fabric and said mount Mc of integrated yarn length of said actually knitted fabric. A step of correcting stitch cam in the event that the compared value E is less than or more than a predetermined range. A step of subtracting a predetermined amount 'm' from said amount Ms of integrated yarn length of said sample knit fabric and said amount Mc of integrated yarn length of said actually knitted fabric. A step of adding said length Si of knitting yarn related to each course 'i' of said sample knit fabric to the amount (Ms - m) of integrated yarn length of said sample knit fabric and other amount (Mc - m) of integrated yarn length of said actually knitted fabric remaining from said subtraction of said predetermined amount 'm'. A step of storing either said predetermined amount X or the amount Msn of integrated yarn length in the event that said amount Msn exceeds said predetermined amount X. A step of storing the amount Mcn of integrated yarn length of said predetermined amount X. A step of executing a comparative arithmetic operation to make comparison between said amount Msn of integrated yarn length of said sample knit fabric and said amount Mcn of integrated yarn length of said actually knitted fabric. A step for correcting stitch cam in the event that the compared value E is less than or more than a predetermined range. The method sequentially and repeatedly executes the comparative arithmetic operations set above so that a predetermined amount of knitting yarns can securely be maintained in a specific range.

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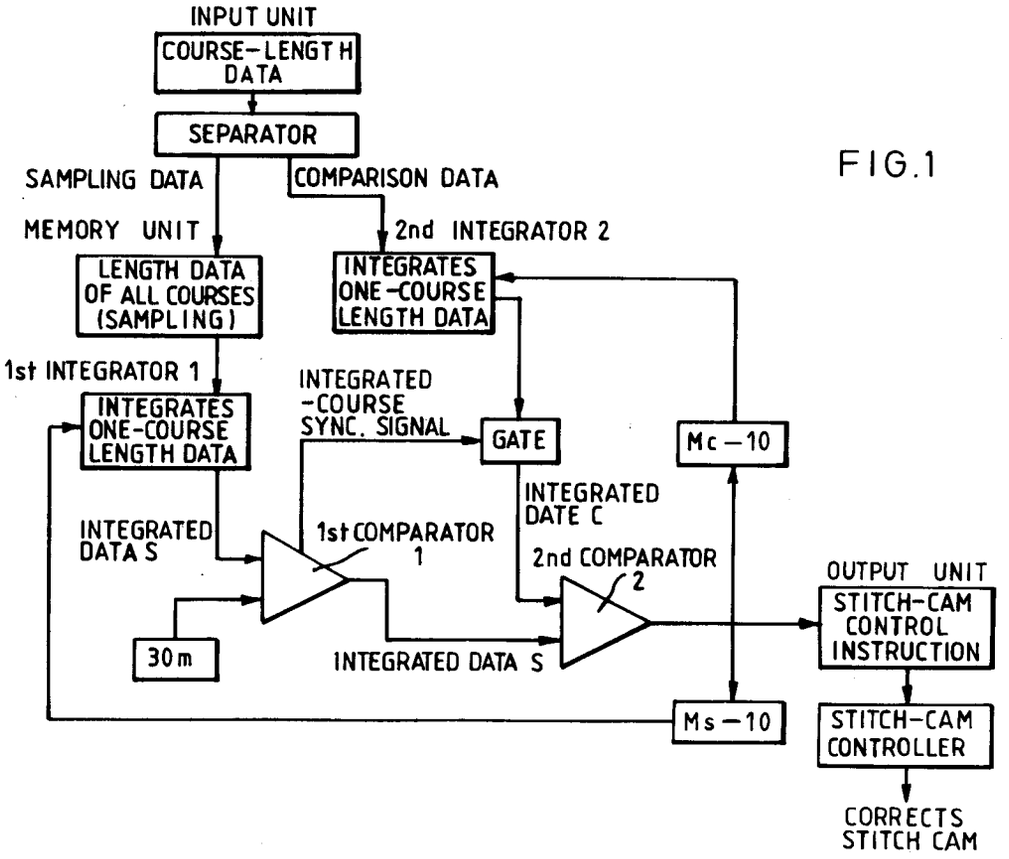

INPUT UNIT
COURSE-LENGTH DATA
SEPARATOR
SAMPLING DATA
COMPARISON DATA
MEMORY UNIT
2nd INTEGRATOR 2
LENGTH DATA OF ALL COURSES (SAMPLING)
INTEGRATES ONE-COURSE LENGTH DATA
1st INTEGRATOR 1
INTEGRATES ONE-COURSE LENGTH DATA
INTEGRATED -COURSE SYNC. SIGNAL
GATE
Mc-10
INTEGRATED DATE C
INTEGRATED DATA S
1st COMPARATOR 1
2nd COMPARATOR 2
OUTPUT UNIT
STITCH-CAM CONTROL INSTRUCTION
30m
INTEGRATED DATA S
Ms-10
STITCH-CAM CONTROLLER
CORRECTS STITCH CAM

FIG.1

BACKGROUND OF THE INVENTION

The present invention relates to a method of controllably adjusting the amount of knitting yarns in process of composing a variety of knits with a flat knitting machine by properly controlling stitches of respective courses constant in an identical knit so that the amount of available knitting yarns can properly be adjusted into a predetermined length.

Conventionally, when manufacturing a large amount of identical knits having a variety of shapes and patterns with a flat knitting machine, in order to coordinate the amount of knitting yarns available for each knit and the hand of each knit to be constant, as shown in Figures 4 through 6 for example, data on the length of available knitting yarns in respective courses "i" of a sampled knit fabric are sequentially stored in a memory unit as data "Si" of the sampled knit. Next, the data "Si" of respective courses "i" of the sampled knit fabric are subject to a comparison with a course data "Ci" on the length of knitting yarns available for respective courses "i" of the actually knit fabric via a comparator before permitting the CPU to identify whether stitch cam should be corrected or not by detection of the presence or absence of a comparative numerical value E in a predetermined range.

Nevertheless, as a matter of course, there is a difference in the length of knitting yarns in each course relative to the shape and pattern of the knitted fabric. As a matter of fact, correct data can hardly be generated insofar as varied lengths of knitting yarns available for respective knitting courses are applied to comparative data between each course. Since the conventional method determines the need for correcting stitch cam merely by making a comparison between the sampled knit fabric and the actually knitted fabric, it is quite difficult for any conventional method to achieve stability of stitch cam.

On the other hand, there is such an idea of making comparison between the sampled knit fabric and the actually knitted fabric every several courses corresponding to each other. Nevertheless, the method based on this idea executes less rounds of comparison against the total knits than being done by the conventional practice which covers every course. In other words, depending on the composition of processed knits, the method based on this idea may need to sharply correct stitch cam.

The invention has been achieved to fully solve those technical problems cited above. The object of the invention is to provide a novel method of controllably adjusting the amount of knitting yarns while operating a flat knitting machine. The method proposed by the invention permits the control unit to effectively execute comparison of highly reliable data without decreasing the rounds of execution of comparison of data from that of the conventional practice so that the hand of each knit and the consumable amount of knitting yarns can properly be held constant.

SUMMARY OF THE INVENTION

Therefore, to fully achieve the above object, the method embodied by the invention sequentially and repatedly executes those functional processes including the following: Initially, the control unit stores data on a predetermined amount X or an amount Ms of integrated yarn length of the length Si of available knitting yarns when the amount Ms ever exceeds the predetermined amount X in conjunction with the length Si of those available knitting yarns in each course "i" of a sampled knit fabric knitted by a flat knitting machine. Next, the control unit also stores data on an amount Mc of integrated yarn length Ci corresponding to the predetermined amount X in conjunction with the length Ci of those available knitting yarns of each course "i" of the actually knitted fabric having the composition identical to that of the sampled knit fabric. Next, the control unit comparatively executes an arithmetic operation to make a comparison between the amount Ms of integrated yarn length of knitting yarns available for the sampled knit fabric and the other amount Mc of integrated yarn length of the actually knit fabric, and then, if the compared value E were less than or more than a predetermined range, then the control unit corrects stitch cam. Next, the control unit subtracts a predetermined amount "m" from both the amount Ms of integrated yarn length of the sampled knit fabric and the other amount Mc of integrated yarn length of the actually knitted fabric. Then, the control unit adds the length Si of knitting yarns of each course "i" of the sampled knit fabric to the amount Ms of integrated yarn length remaining from the subtraction of the predetermined amount "m" (i.e., Ms - m) and also to the amount Mc of integrated yarn length of the actually knitted fabric (i.e., Mc - m), and then, the control unit stores an amount Msn of integrated yarn length at the moment when the amount Msn exceeds the predetermined amount X. On the other hand, the control unit also adds up the length Ci of knitting yarns of each course "i" of the actually knitted fabric having the composition identical to that of the sampled knit fabric to the amount (Mc - m) of integrated yarn length remaining from the subtraction of the predetermined amount "m", and then, the control unit stores the amount msn of integrated yarn length of the predetermined length X. Next, the control unit comparatively executes an arithmetic operation to make

a comparison between the amount msn of integrated yarn length of the sampled knit fabric and the amount mcn of integrated yarn length of the actually knitted fabric. In this case, if the compared value E were less than or more than a predetermined range, then the control unit properly corrects stitch cam. By virtue of the execution of those sequential and repeated processes described above, the novel knitting system embodied by the invention can securely maintain the predetermined amount of knitting yarns on the way of operating a flat knitting machine.

While composing those knits having a variety of shapes and patterns as well as long and short courses, initially, the control unit executes a comparative arithmetic operation between the amount Ms and the amount Mc of integrated yarn length of a predetermined amount X in a single course or in a plurality of corresponding courses of the sampled knit fabric and the actually knitted fabric before eventually determining whether stitch cam should be corrected, or not.

Next, the control unit integrates the amounts (Ms - m and Mc - m) of integrated yarn length calculated by subtracting the predetermined amount "m" from the amounts (Ms and Mc) of integrated yarn length of the sampled knit fabric and the actually knit fabric in relation to the amounts (Msn and Mcn) of integrated yarn length of the sampled knit fabric and the actually knitted fabric until the predetermined amount is eventually reached. Next, the control unit executes an arithmetic operation to make comparison between the amount Msn and the amount Mcn of integrated yarn length of the sampled and the actually knitted fabric. If the compared value E were less than or more than a predetermined range, then the control unit properly corrects stitch cam. The knitting system embodied by the invention sequentially and repeatedly executes those comparative arithmetic operations in order to determine whether stitch cam should be corrected, or not.

As is clear from the above description, unlike the conventional practice which determines whether stitch cam should be corrected or not after merely making comparisons of corresponding courses of the sampled knit fabric and the actually knitted fabric, the knitting system embodied by the invention initially executes a comparative arithmetic operation to make comparisons of the predetermined amount of integrated yarn length in corresponding locations of the sampled knit fabric and the actually knitted fabric before eventually determining whether stitch cam should be corrected or not. Thenceforth, the control unit again integrates the amount of integrated yarn length resulted from the subtraction of a predetermined amount of the knit-yarn length from those amounts of integrated yarn length previously applied to the comparative arithmetic operation against the predetermined length of consumable yarns. The control unit again executes a comparative arithmetic operation to make comparison between those predetermined amounts of integrated yarn length of the sampled knit fabric and the actually knitted fabric before eventually determining whether stitch cam should be corrected, or not. In this way, the knitting system embodied by the invention sequentially and repeatedly follows up serial processes and judgements needed for correcting stitch cam. As a result, even though the length of courses of knitted fabrics may be inconsistent, since the control unit makes up comparative data by means of the length of a predetermined amount of yarns without making comparison between each course, the resultant comparative data are extremely reliable to permit the control unit to more precisely determine whether stitch cam should be corrected, or not. In consequence, the knitting system embodied by the invention securely produces a large amount of identical knits containing more stable hand. Furthermore, even when each knit fabric incurs a variety of adverse effects like fluctuated climate, or varied knitting speed, or erroneous components in mechanical structure for example, all the knitting yarns available for composing each knit can maintain constant length to some extent.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 schematically designates an overall block diagram of the knitting-yarn length control system according to an embodiment of the invention;

Fig. 2 presents an operation flowchart available for storing sampling data according to an embodiment of the invention;

Fig. 3 presents an operation flowchart available for determining execution of correction of stitch cam according to an embodiment of the invention;

Fig. 4 presents an operation flowchart available for correcting stitch cam according to a conventional practice;

Fig. 5 presents an operation flowchart available for storing sampling data according to a conventional practice; and

Fig. 6 presents an operation flowchart available for determining execution of correction of stitch cam according to a conventional practice.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the accompanying drawings, full detail of the method of controllably adjusting

knitting yarns according to an embodiment of the invention is described below. Fig. 1 schematically designates an overall block diagram of the knitting yarn control system according to an embodiment of the invention. Fig. 2 presents an operation flowchart available for storing data on the length of knitting yarns per course based on a sampled knit fabric. Fig. 3 presents an operation flowchart drawn out of the block diagram shown in Fig. 1. Functional operation of the control unit shown in Fig. 1 is described below.

First, the control unit receives data on the lengths of respective knitting courses. More particularly, the control unit receives data on the amount Si of knitting yarns available for composing a sampled knit fabric and the other data on the lengths of respective courses of an actually knitted fabric, in other words, it receives the amount Ci of those knitting yarns available for composing the actually knitted fabric. Next, a memory unit of the control unit stores the data Si on the lengths of respective knitting courses of the sampled knit fabric via a separator. Next, the first integrator 1 integrates the length data Si of each course "i" of the sampled knit fabric. Next, the first comparator 1 makes a comparison between an integrated data S (which is substantially the amount Ms of integrated yarn length) and a numerical value 30m designated for the predetermined amount X. If the integrated data S(the amount Ms) exceeds 30m, then, the first comparator 1 transmits a signal to the second comparator 2 so that the integrated data S can be compared to a data Mc on the actually knitted fabric.

On the other hand, the memory unit transmits a comparative data consisting of the above-identified data Ci on the lengths of respective courses of the actually knitted fabric to the second integrator 2 via the separator. Then, the seccond integrator 2 sequentially integrates the data Ci on the length of each course. Next, the first integrator 1 transmits the integrated data S (the amount Ms) of the sampled knit fabric to the second comparator 2 via the first comparator 1. Simultaneously, the first comparator 1 transmits an integrated course synchronizing signal to a gate on the part of the actually knit fabric. The gate then transmits the data C integrated by the second integrator 2 to the second comparator 2. On receipt of the integrated data C, the second comparator 2 executes a comparative arithmetic operation to make comparison between the integrated data S (the amount Ms) of the sampled knit fabric and the other integrated data C (the amount Mc) of the actually knitted fabric. If the comparative ratio were out of a predetermined range, then, the second comparator 2 delivers a stitch-cam control instruction to the output unit to permit the stitch-cam controller to properly control the stitch cam.

On the other hand, after executing a comparative arithmetic operation, the second comparator 2 subtracts 10m of the predetermined amount from the integrated data S (the amount Ms) of the sampled knit fabric and the other integrated data C (the amount Mc) of the actually knitted fabric. In this case, actually, the second comparator 2 subtracts "m1" of integrated yarn length exceeding the predetermined amount "m" up to the course P of the sampled knit fabric and also subtracts "m2" of integrated yarn length of those courses corresponding to those being present up to the course P of the sampled knit fabric. More particularly, if there were 9.8m of the integrated yarn length "m1" on the part of the sampled knit fabric, then, the yarn length covering 8 courses is subject to a subtraction process. If there were 9 courses each having 10.5m of yarn length on the part of the sampled knit fabric, then, the yarn length covering 9 courses is subject to a subtraction process. The following description merely designates the effect of the above subtraction by way of (Ms - 10) and (Mc - 10).

After subtracting 10m of the integrated yarn length from the integrated data S (the amount Ms) of the sampled knit fabric and the other integrated data C (the amount Mc) of the actually knitted fabric, the integrated data (Ms - 10) related to the sampled knit fabric, in other words, the integrated data Msn, is fed back to the first integrator 1, whereas the other integrated data (Mc - 10) related to the actually knitted fabric, in other words, the integrated data Mcn, is fed back to the second integrator 2. Next, these first and second integrators 1 and 2 respectively execute integration of those length data Si and Ci of each course against those integrated data (Ms - 10) and (Mc - 10). When the integrated yarn length exceeds 30m subsequent to the integration of the length data Si per course against the other integrated data (Ms - 10) on the part of the sampled knit fabric, the length data Ci per course is integrated against the other integrated data (Mc - 10) on the part of the actually knitted fabric. Next, the second comparator 2 makes a comparison between these integrated data before eventually determining whether stitch cam should be corrected, or not. If the second comparator 2 determines to effect correction of stitch cam, then it generates a stitch-cam control instruction. Next, the second comparator 2 again subtracts 10m from those integrated data related to the sampled knit fabric and the actually knitted fabric compared to each other in the preceding process, and then, the second comparator 2 transmits the 10m-subtracted integrated data to the first and second integrators 1 and 2. In this way, the control system sequentially and repeatedly executes those pro-

cesses and judgements mentioned above until fully completing those processes for all the courses, and finally determines whether stitch cam should be corrected, or not.

As is clear from the above description, the knitting yarn length control system embodied by the invention causes the control unit to initially subtract the predetermined yarn length amount "m" from those integrated data Ms and Mc related to the sampled knit fabric and the actually knitted fabric, and then, the control unit integrates those yarn-length data Si and Ci of respective knitting courses against those integrated data (Ms - m) and (Mc - m) remaining from subtraction of the predetermined amount "m" until a specific amount is eventually reached, and then, the control unit compares both the integrated data (Ms - m) and (Mc - m) before eventually determining whether stitch cam should be corrected, or not.

By virtue of the execution of those sequential processes described above, unlike the conventional practice which merely makes comparison of the yarn-length data per course, those integrated data complete with the comparative processes embodied by the invention further promotes reliability, and yet, the knitting yarn length control system embodied by the invention executes as many rounds of comparison as that is performed for each knitting course by the conventional practice, thus permitting the control unit to more precisely determine whether stitch cam should be corrected, or not.

Figures 2 and 3 respectively present operation flowcharts which are more concretely explanatory of the functional processes executed by the control unit shown in Fig. 1. As is explained by the flowchart shown in Fig. 2, sampling data comprising the length Si of knitting yarns available for each course "i" of the sampled knit fabric are sequentially and repeatedly stored in the address "i" of the memory unit until the yarn length Si covering all the courses are fully stored therein. These sequential processes are designated in terms of (Ms = Ms + Si) in the flowchart shown in Fig. 3. On the other hand, the memory unit of the control unit reads data Ci related to each course "i" of the actually knitted fabric to permit the first and second integrators to respectively integrate the read-out data into the integrated yarn length Mc (Mc = Mc + Ci) of the actually knitted fabric.

Next, the first and second comparators comparatively determine whether the integrated yarn length Ms of the sampled knit fabric is Ms $\geqq$ 30m, or not. If the answer were NO, then, these integrators continuously integrate the yarn length data Si available for the following course "i". Conversely, if the answer were YES, then these comparators respectively execute a comparative arithmetic operation E = Mc/Ms X 100% to make comparison between the amount Mc of integrated yarn length of the actually knitted fabric and the other amount Ms of integrated yarn length of the sampled knit fabric before determining whether the compared value E is in a specific range 99 $\leqq$ E $\leqq$ 101, or not. If the answer were YES, then, the control unit determines that no correction is needed for the stitch cam. Conversely, if the answer were NO, then, the control unit determines that the stitch cam should be corrected.

Furthermore, the control unit again adds those "i" course data Si and Ci to those amounts Ms and Mc of integrated yarn length remaining from subtraction of 10m from those amounts Ms and Mc of integrated yarn length of the sampled knit fabric and the actually knitted fabric, and then sequentially and repeatedly executes those comparative arithmetic operations described above until fully completing those processes relevant to all the courses.

The above embodiment provisionally provides 30m of yarn length for the predetermined amount X and 10m of yarn length to make up the predetermined amount "m", respectively. Nevertheless, these values may optionally be varied into any numerical value as required. Although the above embodiment solely expresses the yarn length by means of the predetermined amounts X and m, instead of these amounts, unit of yarn length may also be expressed by means of "course" as required. More particularly, design is also changeable to permit the control unit to sequentially execute comparative arithmetic operations by setting up the predetermined amount X to optional numbers of "course" (n-course) and the other predetermined amount "m" to optional numbers of "course" (y-course), respectively.

Claims

1. A method of controllably adjusting amount of knitting yarns available for a knitting operation with a flat knitting machine comprising the sequential steps of;

a step for storing a predetermined amount X or a data on the amount Ms of integrated yarn length of length Si of available knitting yarns at the moment at which said yarn length Si exceeds said predetermined amount X in conjunction with a data on said yarn length Si related to each course "i" of a sample knit fabric composed by operating a flat knitting machine;

a step for storing a data on the amount Mc of integrated yarn length of said predetermined amount X of length Ci of available knitting yarns in conjunction with said yarn length Ci

related to each course "i" of an actually knitted fabric having composition identical to that of said sample knit fabric;

a step for executing a comparative arithmetic operation to make comparison between said amount Ms of integrated yarn length of said sample knit fabric and said mount Mc of integrated yarn length of said actually knitted fabric;

a step for correcting stitch cam in the event that the compared value E is less than or more than a predetermined range;

a step for subtracting a predetermined amount "m" from said amount Ms of integrated yarn length of said sample knit fabric and said amount Mc of integrated yarn length of said actually knitted fabric;

a step for adding said length Si of knitting yarn related to each course "i" of said sample knit fabric to the amount (Ms - m) of integrated yarn length of said sample knit fabric and other amount (Mc - m) of integrated yarn length of said actually knitted fabric remaining from said subtraction of said predetermined amount "m";

a step for storing either said predetermined amount X or the amount Msn of integrated yarn length in the event that said amount Msn exceeds said predetermined amount X;

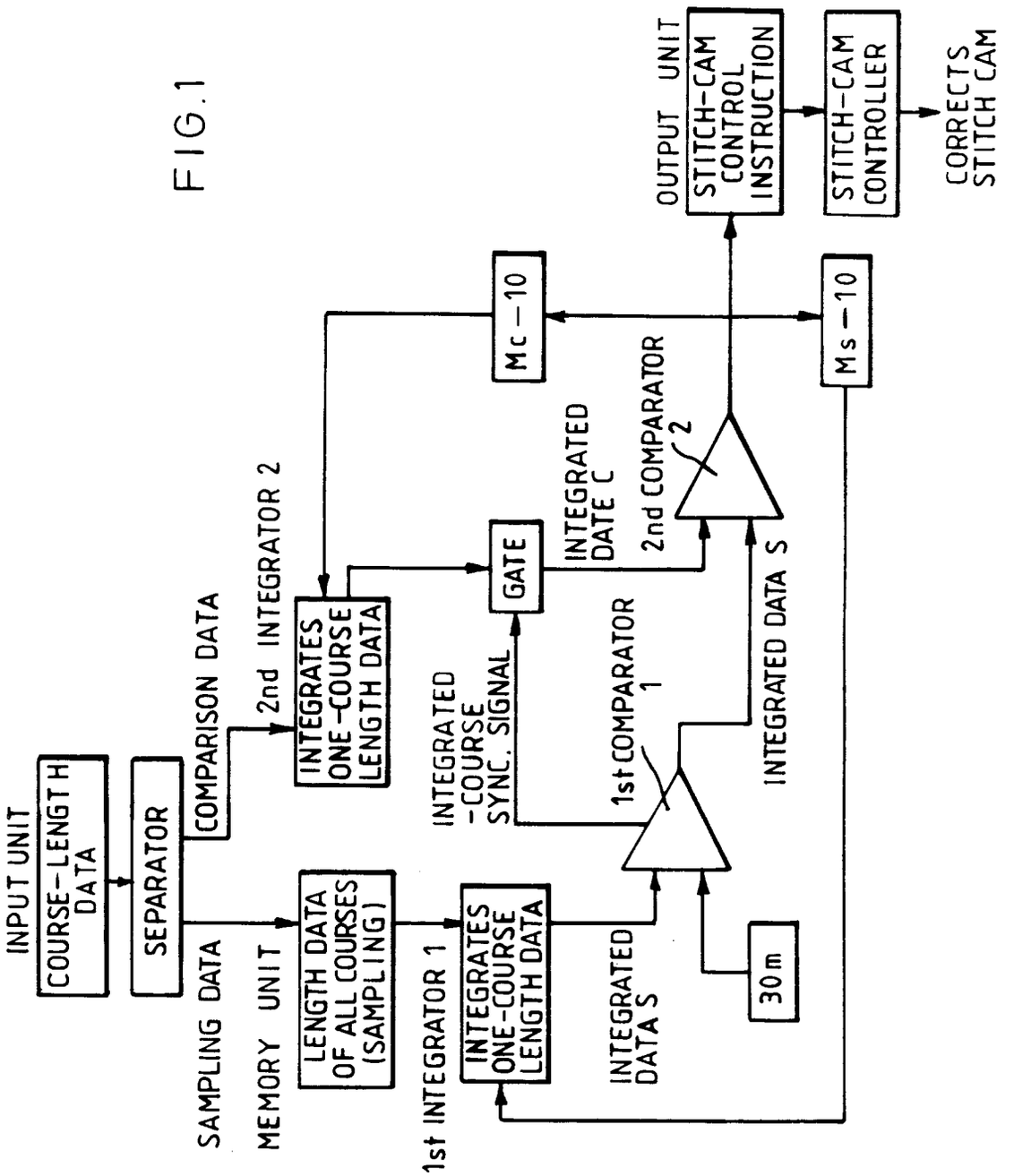
a step for storing the amount Mcn of integrated yarn length of said predetermined amount X;

a step for executing a comparative arithmetic operation to make comparison between said amount Msn of integrated yarn length of said sample knit fabric and said amount Mcn of integrated yarn length of said actually knitted fabric; and

a step for correcting stitch cam in the event that the compared value E is less than or more than a predetermined range;

wherein said method sequentially and repeatedly executes those comparative arithmetic operations defined above so that a predetermined amount of knitting yarns can securely be maintained in a specific range.

FIG.1


INPUT UNIT
COURSE-LENGTH DATA
SEPARATOR
SAMPLING DATA
COMPARISON DATA
MEMORY UNIT
LENGTH DATA OF ALL COURSES (SAMPLING)
1st INTEGRATOR 1
INTEGRATES ONE-COURSE LENGTH DATA
2nd INTEGRATOR 2
INTEGRATES ONE-COURSE LENGTH DATA
INTEGRATED -COURSE SYNC. SIGNAL
GATE
INTEGRATED DATE C
Mc-10
Ms-10
1st COMPARATOR 1
2nd COMPARATOR 2
INTEGRATED DATA S
INTEGRATED DATA S
30m
OUTPUT UNIT
STITCH-CAM CONTROL INSTRUCTION
STITCH-CAM CONTROLLER
CORRECTS STITCH CAM

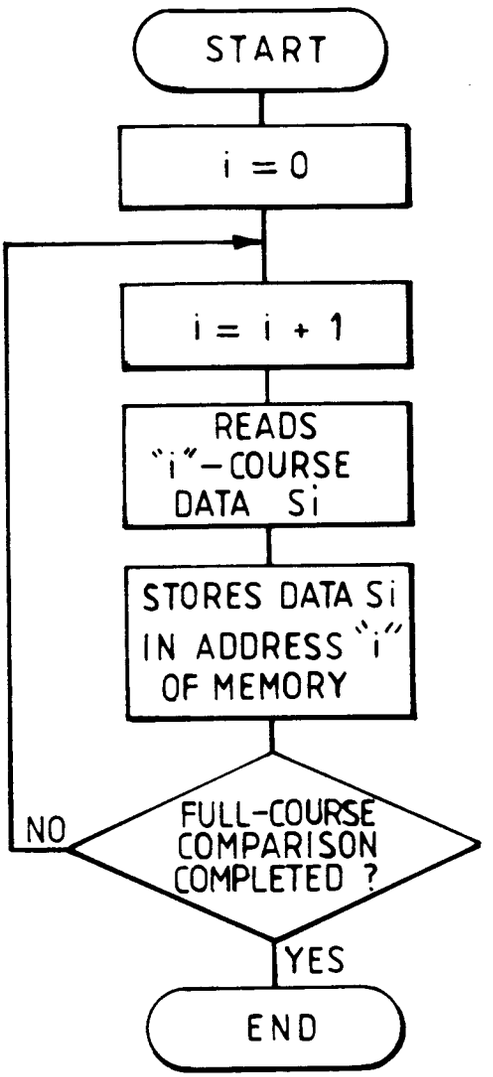

START
i = 0
i = i + 1
READS "i"-COURSE DATA Si
STORES DATA Si IN ADDRESS "i" OF MEMORY
FULL-COURSE COMPARISON COMPLETED ?
NO
YES
END

FIG. 2

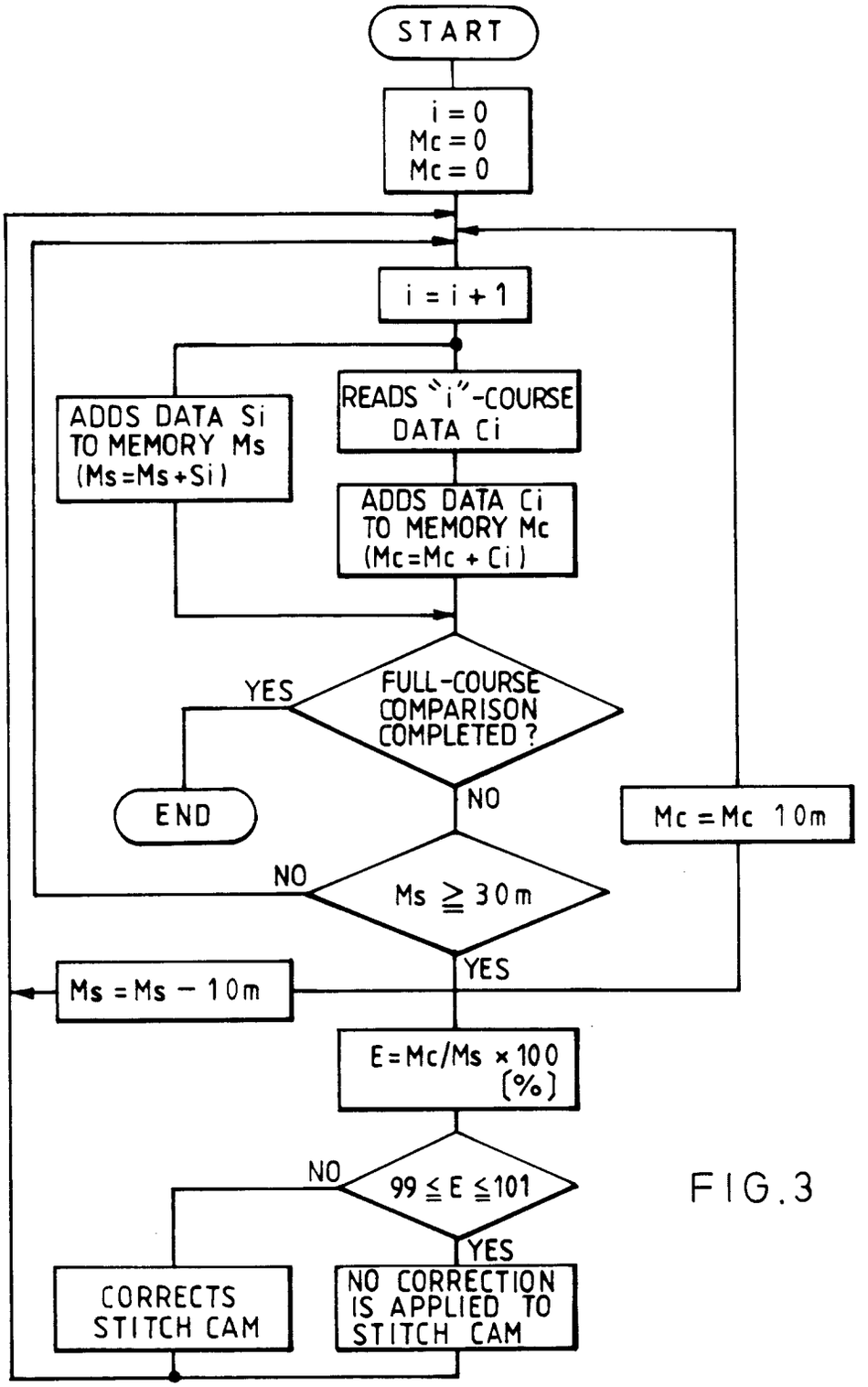

START
i = 0
Mc = 0
Mc = 0
i = i + 1
ADDS DATA Si TO MEMORY Ms (Ms=Ms+Si)
READS "i"-COURSE DATA Ci
ADDS DATA Ci TO MEMORY Mc (Mc=Mc + Ci)
YES
FULL-COURSE COMPARISON COMPLETED ?
NO
END
Mc = Mc 10m
NO
Ms ≧ 30m
YES
Ms = Ms − 10m
E=Mc/Ms × 100 (%)
NO
99 ≦ E ≦101
YES
CORRECTS STITCH CAM
NO CORRECTION IS APPLIED TO STITCH CAM

FIG.3

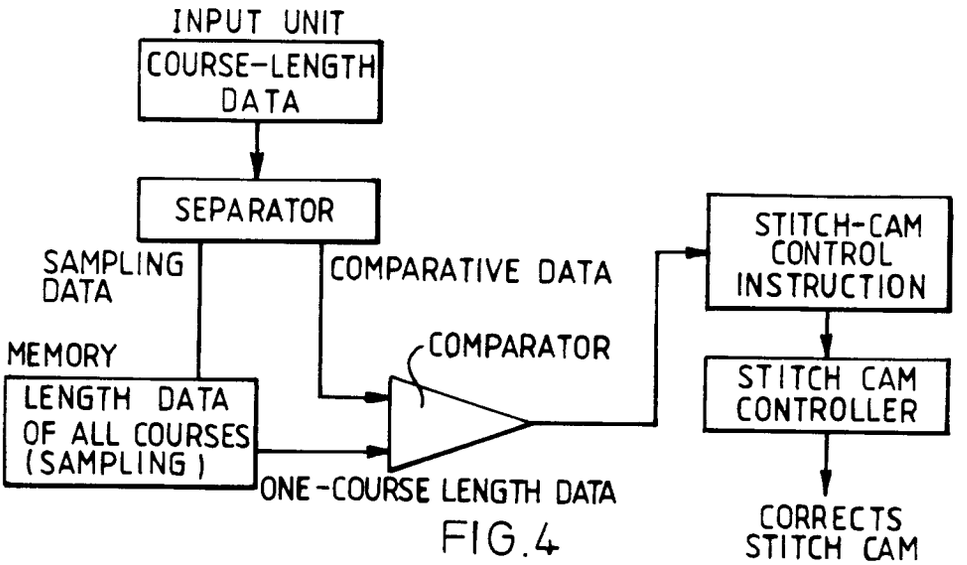

INPUT UNIT
COURSE-LENGTH DATA
SEPARATOR
SAMPLING DATA
COMPARATIVE DATA
MEMORY
COMPARATOR
LENGTH DATA OF ALL COURSES (SAMPLING)
ONE-COURSE LENGTH DATA
STITCH-CAM CONTROL INSTRUCTION
STITCH CAM CONTROLLER
CORRECTS STITCH CAM

FIG.4

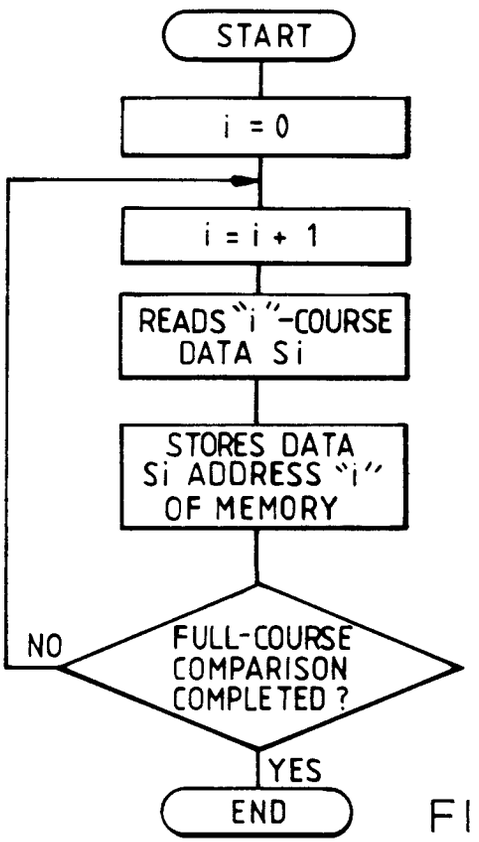

START
i = 0
i = i + 1
READS "i"-COURSE DATA Si
STORES DATA Si ADDRESS "i" OF MEMORY
NO
FULL-COURSE COMPARISON COMPLETED ?
YES
END

FIG.5

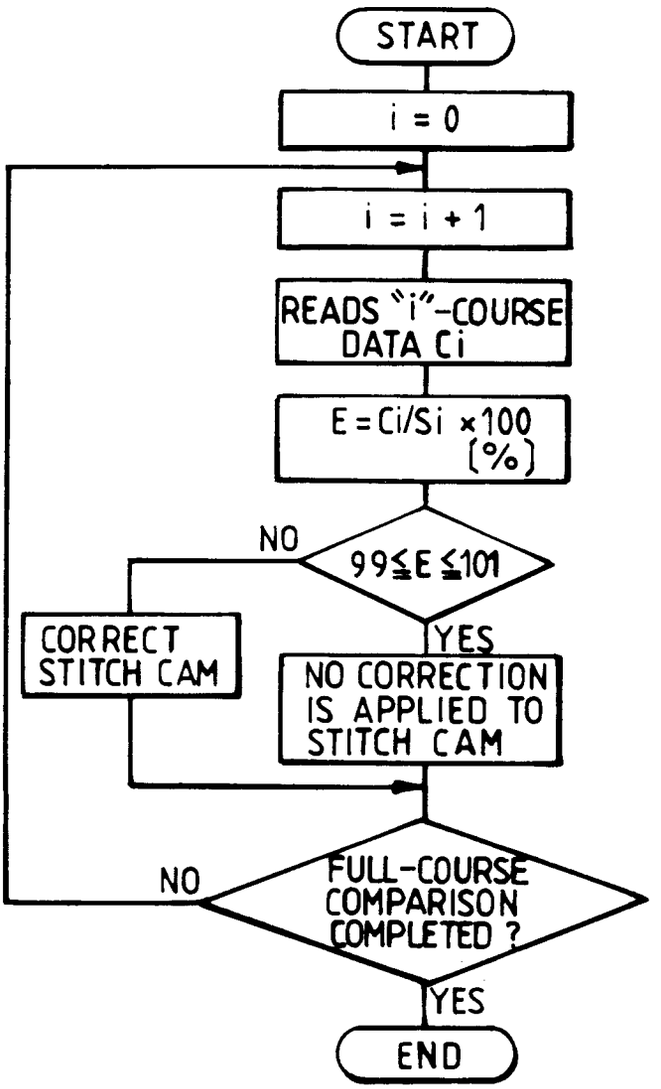

START
i = 0
i = i + 1
READS "i"-COURSE DATA Ci
E = Ci/Si ×100 (%)
NO
99≦E≦101
YES
CORRECT STITCH CAM
NO CORRECTION IS APPLIED TO STITCH CAM
NO
FULL-COURSE COMPARISON COMPLETED ?
YES
END

FIG.6

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 92 30 2483

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	EP-A-0 485 005 (SAVIO S.P.A.)		D04B15/32
A	DE-A-2 631 858 (ELITEX)		
A	US-A-3 490 691 (TATSUYA UYETANI)		

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

D04B
G05B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	03 JULY 1992	VAN GELDER P.A.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P0401)