(54) Title: A METHOD AND APPARATUS FOR STRETCHING AND COLLECTING A KNITTED FABRIC PRODUCED BY CIRCULAR KNITTING MACHINES

(57) Abstract

A method for stretching and collecting a knit fabric produced by circular knitting machines comprising the phase of progressively cutting a flattened tubular piece along a longitudinal generatrix, spreading the piece according to diverging lines inclined downwards until reaching inferiorly a position laterally offset relative to the vertical central axis of the knitting machine and of collecting the stretched piece. Also provided is an apparatus for stretching and collecting a knit fabric in tubular piece comprising piece-pressure rollers (10) for flattening the tubular piece coming from the circular machine, a rotating blade (18) positioned downstream from said piece-pressure rollers (10), at least two spreading rollers (13) positioned according to diverging lines inclined downwards, at least a roller (14) for transmitting the stretched piece positioned in a first edge area (2a) of the frame of the apparatus, and a set (22) for collecting the stretched piece positioned in a second edge area of the support frame.
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Description

A METHOD AND APPARATUS FOR STRETCHING AND COLLECTING A KNITTED FABRIC PRODUCED BY CIRCULAR KNITTING MACHINES

Technical Field

The present invention relates to a method and an apparatus for stretching and collecting a knitted fabric produced by circular knitting machines comprising the phases of substantially flattening a tubular piece coming from the circular machine, progressively cutting the flattened tubular piece along a longitudinal generatrix, spreading the piece and its lateral edges obtained from its cutting, stretching the spread piece in a single layer of fabric, and collecting the stretched piece into a roll.

The apparatus comprises a support frame positioned inferiorly to said circular knitting machine and able to rotate integrally with its cylinder, means for substantially flattening the tubular piece coming from the circular machine, cutting means positioned downstream of said flattening means and able to cut the tubular piece longitudinally along a generatrix, means for opening and stretching the cut piece in a single layer of fabric, and an assembly for collecting the piece stretched in a single layer.

Background Art

As is well known, the traditional method and apparatuses for stretching and collecting into rolls or superposed layers the knitted fabrics produced by circular knitting machines provide for the tubular pieces exiting therefrom to be subjected to downward traction and gradually flattened until they reach the final conformation with two superposed planar layers.
This traditional technique entails, in the case of elastic and/or delicate yarns and in the presence of weak knit structures, the formation of two permanent lateral creases, difficult or impossible to remove, which cause negative effects also in the fabric finishing operation.

To overcome the aforementioned drawbacks, in the case of circular machines of very large diameter, i.e. up to 60 inches, the technique is known of opening the tubular fabric by means of two diametrically opposite longitudinal cuts, so as to obtain two individual layers of fabrics of equal width, equalling the width of the flattened tubular piece (see European Patent no. 534917 in the name of the same applicant).

In the case of circular machines with large diameters, i.e. about 30 inches, if the prior art were employed, i.e. opening the tubular piece with two cuts, fabrics would be obtained with excessively small width, hence not acceptable.

It is therefore necessary to open the tubular piece with a single longitudinal cut in order to enable to stretch it in a single layer whose width corresponds to the entire circumference of the fabric.

The prior art for this process, taught for instance in European Patent no. 456576 and in US Patent no. 5,556,558, provides for the use of apparatuses each fitted with a support frame situated inferiorly to the circular knitting machine and able to rotate integrally with its cylinder.

On this support frame are positioned means able to effect an initial and substantial flattening of the tubular piece coming from the circular machine, cutting means
able to cut longitudinally along a generatrix the tubular piece and means for opening and stretching the cut piece in a single layer of fabric. In particular such opening and stretching means are constituted by rollers mounted idle on the support frame of the machine.

Also associated to the support frame are one or more sets of driving rollers for the controlled advance of the piece in the passage along the aforementioned flattening, cutting, opening and stretching means and a set for collecting the piece stretched in a single layer of fabric in a roll or in superposed layers.

Lastly, helically grooved rollers are also provided for stretching the edges of the piece before it is collected. The prior art summarily described above presents important drawbacks.

First of all, since the driving and collecting sets and the means for opening and stretching the fabric are substantially aligned underneath the vertical central axis of the cylinder of the circular machine, the overall height development of these known apparatuses is considerable and forces therefore to position the knitting machine at a height from the ground that makes inconvenient and difficult the operations for servicing the machine by the assigned personnel.

To overcome said drawback, the aforementioned US Patent provides for positioning a walkway platform around the circular machine, above the apparatus for stretching and collecting the fabric or, alternatively, for inserting the latter in a pit obtained in the ground of the factory. It is evident that in the first case access to the circular machine is not immediate, since it is necessary to climb on the walkway, whilst in the second
case additional operating costs are incurred both for removing the piece collected in a roll and for maintaining the apparatus and the pit.

5 It should also be noted that the final positioning of the piece wound in a roll, or accumulated in superposed layers, substantially takes place in correspondence with the central area of the knitting machine so that it is difficult and expensive to extract the piece by means of appropriate loading and transporting trucks, even if automated.

In particular it should be noted that in European Patent 456.576 the piece, in some phases of advance before entering the driving roller set, follows an excessively horizontal path which causes deficiencies in the regularity of the drive action during the phases whereby the knit is formed and the piece itself is spread and stretched.

Another considerable limitation of the prior art is given by the fact that the spreader rollers, being idle, are driven by the motion of the knit and cannot actively participate in the opening of the edges which, by their nature, tend to curl up.

Another technical and functional limitation consists in the fact that the helically grooved rollers take control of the kinematic mechanisms which set in motion other organs of the machine, so that they intervene with little effectiveness on the stretching of the edges. In practice these rollers rotate at a sharply lower speed than the one required for a satisfactory stretching of the edges of the piece.

The prior art according to the aforementioned patents
offers a rigid solution to the stretching and collection of tubular fabric since, if it were necessary, for instance, to wind the tubular piece in the traditional manner, i.e. in double layer without cutting and opening, it would require radical and costly modifications to the structure of the apparatus to adapt it to this change in function.

**Disclosure of Invention**

In this situation, the technical task constituting the basis for the present invention is to provide a method and an apparatus for stretching and collecting the knitted fabric produced by circular knitting machines able substantially to overcome the aforementioned drawbacks.

Within the scope of this technical contact, an important aim of the invention is to devise a method and an apparatus for stretching in a single layer and collecting a knitted fabric produced in a tubular piece which allow to maintain substantially unaltered, relative to the traditional technique for collecting the fabric in double layer, the positioning of the circular knitting machine in terms of height.

Another important aim of the invention is to provide a method and an apparatus which allow a better and more delicate stretching in a single layer of a knitted fabric produced in tubular piece.

A further aim is to devise a method and an apparatus which favour the employment of loading and transporting trucks, also automated, for the removal of the fabric collected in a roll or in superposed layers.

Yet another aim of the invention is to make available an
apparatus which is easily converted from the function of stretching width-wise, i.e. in a single layer, a tubular piece to the traditional function of applying traction without cutting and widening the tubular piece itself.

The technical task set out above and the specified aims are substantially reached by a method and by an apparatus for stretching and collecting a knitted fabric in tubular piece produced by circular knitting machines which are characterised in that they comprise one or more of the technical solutions claimed hereafter.

The description shall now be provided, by way of non limiting indicative example, of a preferred but not exclusive embodiment of an apparatus according to the invention, illustrated in the enclosed drawings.

**Description of the Drawings**
- Figure 1 shows a side elevation view of the apparatus;
- Figure 2 is a perspective view of the apparatus of Figure 1;
- Figure 3 presents a partial and schematic perspective view of the main components of the apparatus;
- Figure 4 shows a view similar to the one of Figure 3 highlighting the successive operative phases where to a circular fabric is subjected.

**Description of the Illustrated Embodiment**

With reference to the aforementioned drawings, the apparatus according to the invention is indicated in its entirety with the number 1.

It comprises a support frame 2 positioned inferiorly to a known circular knitting machine 3 provided for producing, in correspondence with a cylinder 4, of
knitted fabric in tubular piece 5.

The support frame is able to rotate integrally with the cylinder 4 about a vertical central axis 6 and is positioned internally to a fixed structure 7 which sustains both the frame 2 itself and the circular machine 3. In proximity to the upper part of the frame 2 are provided means for the substantial flattening 8 of the piece 5 coming from the cylinder 4. The means 8 comprise a piece-widening frame 9, known in itself, able progressively to modify the cylindrical shape of the piece by substantially flattening it along a diametrical direction thereof and a pair of parallel piece-pressing roller 10 suitably distanced from each other and externally delimiting the piece.

Immediately below the parallel rollers 10 are positioned cutting means 11, able progressively to cut the tubular piece 5 along a generatrix, and means 12 for opening and stretching the cut piece, able to widen it in a single layer 5a.

More specifically the opening and stretching means 12 comprise two rollers 13 for spreading the piece 5 and its lateral edges 5b obtained from the cutting and a roller 14 for transmitting the stretched piece.

Originally the spreading rollers 13 are arranged according to diverging lines inclined downwards and developing starting from upper extremities 13a mutually approached and positioned in an area of the piece opposite said cut generatrix. More in detail the upper extremities 13a are positioned in opposition to the cutting means 11 and substantially level therewith, until reaching inferiorly, with lower extremities 13b, a first edge area 2a of the support frame 2 laterally displaced
relative to the central vertical axis of the knitting machine.

In this edge area 2a is positioned the roller 14 for the transmission of the stretched piece 5a. The spreading rollers 13 are hinged, in correspondence with their approached upper extremities 13a, to a first terminal portion 15a of a support body 15 integral to the support frame 2 and have the lower extremities 13b able to be fastened at an adjustable mutual distance to an arched base element 16 also integral with the frame 2.

In this way it is possible to vary, according to requirements, the spreading of the piece 5 and of its lateral edges 5b.

The spreading rollers 13 can be mounted idle on the support roller 2, but preferably and advantageously are provided with independent motors 13c the further to favour the stretching of the piece in single layer.

The direction of rotation imposed by the motors to the rollers is preferably opposite the direction of advance of the piece to enhance the stretching effect on the piece.

The first terminal portion 15a of the support 15 extends externally with a rotating element 17 with curved profile able to guide the piece immediately below the parallel rollers 10 favouring its sliding in the critical area of increased tension opposite to the cut generatrix.

The rotating element 17 can be constituted by a wheel or a ball. Alternatively to the rotating element, an oscillating arm with curved extremity, tensioned by a spring, can be provided.
In correspondence with a second terminal portion 15b of the support body 15 are positioned the cutting means 11 which, advantageously, comprise a rotating blade 18, a blade guide 19 and a motor 20 for supporting and controlling the blade, available in a position adjustable on the support body 15 itself to enable varying, according to operative requirements, the distance of the rotating blade 18 from the central axis 6. Also the position of the rotating element 17 can be adjusted, since it is mounted on a bar 17a able to be fastened by means of screws to corresponding slots obtained in the support body 15.

In a central area of the support frame 2, substantially level with the transmission roller 14, is engaged a pair of driving rollers 21 for the controlled advance of the piece along the path downstream of the cylinder 4 through said flattening means 8, said cutting means 11 and said opening and stretching means 12. The set of driving rollers 21 comprises a central tensioning roller 21a and two lateral contrasting rollers 21b.

Preferably, the set of driving rollers 21 is controlled by a motor 21c independently of the means for actuating the other rollers or of the means that serve other functions of the apparatus.

Downstream from the driving rollers set 21, in correspondence with a second edge area 2b of the support frame 2 and laterally offset relative to the central axis 6, is positioned a set 22 for collecting the piece stretched in a single layer into a roll.

Alternatively, a known device can be provided, suitable for collecting the piece in superposed layers.

Between the transmission roller 14 and the driving roller
set 21 is provided a first roller for tensioning the piece in the transverse direction 23 having two grooved portions helically wound in opposite directions able to contrast the tendency of the bands of the piece itself that are proximate to the lateral edges 5b to curl themselves longitudinally.

Also provided is a piece-presser roller 23a positioned in the vicinity of the transverse tensioning roller 23 to increase the winding angle of the piece about the transverse tensioning roller with the consequent increase of the effectiveness of the action of the helically grooved portions on the edges of the piece.

Also between the driving roller set 21 and the collecting set 22 is interposed a second roller 24 for tensioning in the transverse direction 24, co-operating with a corresponding piece-presser roller 24a.

The piece-presser rollers 23a and 24a can be adjusted both horizontally towards and away from the respective transverse tensioning rollers 23, and vertically to determine a greater or lesser winding of the piece about the transverse tensioning roller 23.

The transverse tensioning rollers 23 and 24 are equipped with motors 23b and 24b independent from the other functions of the machine to have speeds greater than that of the prior art, with the consequent improvement in the stretching of the edges of the piece which tend to become curled up.

In the support frame 2 (Fig. 1), inferiorly to the upper and lower extremities 13a and 13b of the spreading rollers 13, are provided respectively holed seats 25 and 26 for the possible housing of the extremities of a motor
roller and of a transmission roller able to sustain and make advance a belt for driving and bearing the central part of the piece between the spreading rollers 13.

Lastly, advantageously, the support frame 2 has a pair of horizontal cross members 27 oriented orthogonally to said driving rollers set 21 and provided with supplementary seats 28 (Fig. 2) for the extremities of the piece presser rollers 10.

The seats 28 allow a simple and rapid re-positioning of the piece-presser rollers 10 themselves to 90° when, alternatively to the cutting and the width-wise opening of the tubular fabric, its stretching and traditional collection in two superposed layers are required.

Moreover, proximity sensors 29 or contact oscillators have been shown schematically, for arresting the apparatus if the operator should approach it excessively, or even come in contact with the rotating support frame 2. Advantageously the sensors 29 are positioned at least in correspondence with the edges of the rotating support frame.

The operation of an apparatus described above in a prevalently structural sense is as follows. The tubular piece 5 coming from the cylinder 4 is gradually flattened by the piece-spreader frame 9, by the parallel piece-presser rollers 10 and by the blade guide 19.

Subsequently the flattened tubular piece, tensioned longitudinally by the driving roller set 21, is cut by the cutting means 11 along one of its generatrices whilst, in correspondence with the opposite generatrix, it slides on the rotating element 17 which prevents
deflections and the formation of creases. The cut piece is progressively widened and stretched by the spreading rollers 13, until it passes, completely open, on the transmission roller 14.

Therefore, the single-layer fabric continues along a substantially horizontal path, moving from the first edge area 2a of the support frame 2, where the transmission roller 14 is located, to a second, opposite, edge area 2b where the set 22 for collecting in a roll or possibly in superposed layers.

During this substantially horizontal path, the transverse tensioning rollers 23 and 24 maintain the knitted fabric perfectly flat, preventing it from curling in correspondence with the edges.

The invention implements a new method which also forms an integral part of the present patent.

It consists of subjecting to an operative phase whereby the tubular piece coming from the circular machine is substantially flattened. Subsequently, a progressive cut is effected along a generatrix of the flattened piece whilst maintaining curved the area of the piece opposite the cut generatrix so as to prevent it from forming creases and deflections.

Downstream from the cut, the spreading and the stretching of the piece and of its lateral edges obtained from the cut is effected.

This spreading operation is performed gradually according to downwards-inclined lines developing substantially from the height of the cutting area until reaching inferiorly a first position laterally offset relative to the central
vertical axis of the knitting machine. In correspondence with this first position, the stretching of the piece spread in a single layer of fabric is completed.

Downstream from said first position the path of the piece continues substantially horizontally and reaches a second position laterally offset relative to the central axis, opposite to the first position itself. In this second position, the stretched piece is collected in a roll or in superposed layers.

In the substantially horizontal segment of the path of the piece lying between said first and second position, the piece is subjected to traction for its controlled advance through all the operative phases illustrated downstream of the cylinder of the knitting machine.

Moreover in this horizontal segment, advantageously, the stretched piece is subjected to two tensioning operations in the transverse direction able to contrast the tendency of the edge bands to curl themselves.

The invention achieves important advantages. First of all, the apparatus and the method obtain a path of the piece in the cutting and opening phases and subsequently of the stretched piece which exploits to the fullest extent the horizontal space underneath the cylinder of the knitting machine.

The vertical dimension of the apparatus is therefore limited and hence the height and accessibility of the overlying knitting machine are practically unchanged relative to the traditional technique without width-wise opening.

The ease of access to the cylinder working plane is
determined by the fact that the driving, collecting and transverse tensioning rollers are situated on a single plane positioned at the base of the machine. This alignment of the rollers below leaves room in the high end of the machine and allows to incline the spreader rollers, thereby facilitating the operator's task when he or she needs to approach the operative organs of the circular machine.

Also to facilitate the operator's intervention relative to traditional machines, the diameter of the ring 30 supporting the thread feeders 31 has also been increased, making it substantially equal to the dimensions of the base. In this way the feeders are moved away from the axis of the machine and closer to the operator.

The architecture of the machine, given the above description, allows to position laterally the set for collecting the stretched fabric in a roll or in superposed layers, thereby facilitating the positioning of a truck, which can also be automated, for the extraction and transport of the wound piece.

Moreover, the length of the widening segment of the knit obtained from the original disposition of the spreader rollers and the cut with rotating blade allow to obtain a gradual and delicate opening of the knitted piece itself and to maintain a regular tensioning both in the phase of forming the knit and in the subsequent path towards the set for collecting in a roll.

Lastly, it should be stressed that the apparatus according to the invention has high operative flexibility as it allows easily and rapidly to shift - as need be - to traditional tensioning and collecting in a roll without cutting and widening the piece.
Obviously, numerous modifications and variations can be made to the method and to the apparatus described above, without thereby departing from the scope of the inventive concept that characterises them.
Claims

1. A method for stretching and collecting a knit fabric produced by circular knitting machines comprising the following phases:
   substantially flattening a tubular piece coming from the circular machine,
   progressively cutting the flattened tubular piece along a longitudinal generatrix,
   spreading the piece and its lateral edges obtained from its cutting,
   stretching the spread piece in a single layer of fabric, and collection of the stretched piece, characterised in that said spreading of the piece and of its lateral edges is conducted gradually according to divergent lines inclined downwards and developing starting substantially from the height of the cutting area until reaching inferiorly a first portion offset laterally relative to the central and vertical axis of the knitting machine so that the completion of said stretching of the piece is carried out in said first laterally offset position and in that the collection of the stretched piece is performed in a second position offset laterally relative to said central axis on the opposite side and substantially level with that first position.

2. A method as claimed in claim 1, characterised in that said piece is subjected to traction for a controlled advance of the piece itself during the working phases.

3. A method as claimed in claim 2 characterised in that said traction for the controlled advance of the piece is performed in an area of the path of the piece lying between said first position wherein the stretching operation is completed and said second position wherein
the piece itself is collected.

4. A method as claimed in any of the previous claims, characterised in that it further provides for subjecting the piece stretched in a single layer, before it is collected, to at least a tensioning operation in a transverse direction to the direction of advance able to contrast the tendency of the edge bands of the piece to curl themselves.

5. A method as claimed in any of the previous claims, characterised in that during said progressive cutting of the flattened tubular piece along a generatrix the area of the piece opposite to said generatrix is maintained curved in order to prevent creases and deflections.

6. An apparatus for stretching and collecting a knitted fabric in tubular piece produced by circular knitting machines comprising: a support frame (2) positioned inferiorly to said circular knitting machine (3) and able to rotate integrally with its cylinder (4), means (8) for substantially flattening the tubular piece (5) coming from the circular machine, cutting means (11) positioned downstream from said flattening means (8) and able to cut the tubular piece longitudinally along a generatrix, means for opening and stretching (12) the cut piece in a single layer of fabric, and a set (22) for collecting the piece stretched in a single layer, characterised in that said means (12) for opening and stretching the cut piece comprise: at least two rollers (13) for spreading the piece (5) and its lateral edges (5b) obtained from the cut, said spreading rollers being positioned according to diverging lines inclined downwards and developing starting from an area of the piece opposite to said cut generatrix and
positioned substantially level with said cutting means (11) until reaching inferiorly a first edge area (2a) of the support frame (2) laterally offset relative to the central and vertical axis (6) of the knitting machine (3), and at least a roller (14) for the transmission of the stretched piece positioned in said first edge area (2a), and in that said set (22) for collecting the stretched piece in a roll or in superposed layers is positioned in a second edge area (2b) of the support frame (2) laterally offset relative to said central axis on the opposite side and substantially level with said transmission roller (14).

7. An apparatus as claimed in claim 6, characterised in that it comprises at least a set of driving rollers (21) for the controlled advance of the piece along its path through said flattening means (8), said cutting means (11) and said opening and stretching means (12).

8. An apparatus as claimed in claim 7, characterised in that said set of driving rollers (21) is positioned between roller (14) for the transmission of the stretched piece and said collecting set (22).

9. An apparatus as claimed in claim 6, characterised in that it comprises at least a roller (23, 24) for tensioning the stretched piece in the transverse direction positioned between said transmission roller (14) and said collecting roller (22) and formed by two grooved portions helically wound in opposite directions able to contrast the tendency of the bands of the piece itself proximate to the lateral edges (5b) to curl themselves longitudinally.

10. An apparatus as claimed in claim 9, characterised in
that it further comprises at least a piece-presser roller (23a) positioned in the vicinity of the transverse tensioning roller (23) to increase the angle of winding of the piece about the transverse tensioning roller.

11. An apparatus as claimed in claim 6, characterised in that it comprises at least a rotating element (17) for guiding the piece with curved profile positioned substantially in correspondence with mutually approached upper extremities (13a) of said spreading rollers (13) and able to allow the sliding of the piece (5) in said area opposite to the cut generatrix.

12. An apparatus as claimed in claim 11, characterised in that said rotating guide element (17) is constituted by a wheel.

13. An apparatus as claimed in claim 11, characterised in that said rotating guide element (17) is constituted by a ball.

14. An apparatus as claimed in claim 6, characterised in that it comprises at least an oscillating arm for guiding the piece with curved profile situated substantially in correspondence with mutually approached upper extremities (13) of said spreading rollers and able to favour the sliding of the piece (5) in said area opposite to the frame generatrix, said oscillating arm being tensioned by a spring.

15. An apparatus as claimed in claim 6, characterised in that said spreading rollers (13) have upper extremities (13a) approached and hinged to a support body (15) integral with said support frame (2) and lower extremities (13b) able to be fastened at adjustable mutual distance to a base element (16) integral with the
supporting element (2) to vary the spreading of the piece and of its lateral edges.

16. An apparatus as claimed in claim 6, characterised in that said spreading rollers 13 are provided with motors (13c) independent of the other operative organs of the machine.

17. An apparatus as claimed in claim 16, characterised in that said motors (13c) impose to the spreading rollers (13) rotations in the direction opposite to the direction of advance of the piece.

18. An apparatus as claimed in claim 6, characterised in that said cutting means (11) comprise a rotating blade (18) controlled by a motor (20) available in operative position at a variable distance from said central vertical axis (6).

19. An apparatus as claimed in claim 6, characterised in that said means (8) for substantially flattening the tubular piece (5) comprise a pair of piece-presser parallel rollers (10) and in that said support frame (2) comprises a pair of horizontal cross members (27) oriented orthogonally to said drive roller set (21) and presenting supplementary seats (28) for the extremities of the piece-presser rollers (10) able to allow, alternatively, the re-positioning of the piece-presser rollers (10) at 90° for the stretching and collecting of uncut tubular fabric in two superposed layers.
# INTERNATIONAL SEARCH REPORT

## A. CLASSIFICATION OF SUBJECT MATTER

**IPC 7** D04B15/08

According to International Patent Classification (IPC) or to both national classification and IPC.

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

**IPC 7** D04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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<td><strong>EP 0 696 658 A (PRECISION FUKUHARA WORKS, LTD)</strong> 14 February 1996 (1996-02-14) cited in the application</td>
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Further documents are listed in the continuation of box C.

**X** Patent family members are listed in annex.

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Date of the actual completion of the International search: 31 May 2000

Date of mailing of the international search report: 13/06/2000

Name and mailing address of the ISA:

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**Van Gelder, P**
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