PATENT REQUEST : STANDARD PATENT

I/We, being the person(s) identified below as the Applicant(s), request the grant of a Standard Patent to the person(s) identified below as the Nominated Person(s), for an invention described in the accompanying complete specification.

Applicant(s) and Nominated Person(s): ISOVER SAINT-GOBAIN

Address: "LES MIROIRS"
18 AVENUE D'ALSACE
92400 COURBEVOIE
FRANCE

Invention Title: PRODUCT FOR INSULATING PIPE ELBOWS AND ITS METHOD OF IMPLEMENTATION

Name(s) of Actual Inventor(s): BAUDOIN JAUSSEAUME DE LA BRETESCHE

Address for Service: GRIFFITH HACK & CO
509 ST KILDA ROAD
MELBOURNE VIC 3004

Attorney Code: HA

BASIC CONVENTION APPLICATION DETAILS
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ISOVER SAINT-GOBAIN
GRIFFITH HACK & CO

Patent Attorney for and on behalf of the Applicant

[Signature]
NOTICE OF ENTITLEMENT

I/We ISOVER SAINT-GOBAIN

of "LES MIROIRS"
18 AVENUE D'ALSACE
92400 COURBEVOIE
FRANCE

being the applicant(s) in respect of an application for a patent for an invention entitled PRODUCT FOR INSULATING PIPE ELBOWS AND ITS METHOD OF IMPLEMENTATION, state the following:

1. The nominated person(s) has/have, for the following reasons, gained entitlement from the actual inventor(s):

   THE NOMINATED PERSON WOULD BE ENTITLED TO HAVE ASSIGNED TO IT A PATENT GRANTED TO THE INVENTOR IN RESPECT OF THE SAID INVENTION.

2. The nominated person(s) has/have, for the following reasons, gained entitlement from the basic applicant(s) listed on the patent request:

   THE APPLICANT AND NOMINATED PERSON IS THE BASIC APPLICANT.

3. The basic application(s) listed on the request form is/are the first application(s) made in a Convention country in respect of the invention.

DATE: 19 October 1992

ISOVER SAINT-GOBAIN

GRIFFITH HACK & CO

Patent Attorney for and on behalf of the applicant(s)
1. Product comprising cylindrical insulating lagging components intended to form an insulating sleeve about an elbow having an angle \( \alpha \) of a pipe, characterised in that the lagging components are prismatic and of a number \( n \), and are identical if there are several of them; in that their two substantially flat surfaces having an elliptical outline, form angles respectively of \( + \beta \) and \( - \beta \) with the straight cross-sections of the laggings such that:

\[
\beta = \frac{\alpha}{2n + 2};
\]

and their longest generatrix has a length \( b \) such that:

\[
b = 2 (R + \frac{d}{2} + e) \frac{\tan \beta}{\sin \alpha};
\]

in which \( R \) is the radius of curvature of the pipe, \( d \) is its diameter and \( e \) is the thickness of the lagging walls and in that the straight parts of the cylindrical insulating laggings intended to be adjacent the elbows end in surfaces of which the angles form an angle \( \beta \) together with the straight cross-sections of the laggings.
Method of producing the insulation of a pipe elbow having an angle $\alpha$, a radius of curvature $R$ and diameter $d$ by means of cylindrical insulating lagging having an inner diameter $d$ and thickness $e$, characterised in that the cylindrical insulating lagging is cut according to substantially flat cross-sections, all of which are perpendicular to a single plane passing through its axis, the cutting planes forming angles alternately of $+\beta$ and $-\beta$ relative to the straight cross-sections of the lagging, such that:

$$\beta = \alpha / (2n + 2),$$

the number of cuts being $n + 1$; in that the lagging components obtained have their longest generatrix equal to $b$ such that:

$$b = 2 \left( R + \frac{d}{2} + e \right) \tan \beta$$

and the residual straight parts and the intermediate prismatic lagging components are assembled such as to obtain the maximum angle possible.
The following statement is a full description of this invention, including the best method of performing it known to me/us:
PRODUCT FOR INSULATING PIPE ELBOWS AND ITS METHOD OF IMPLEMENTATION

The invention relates to products for insulation of pipes, in the form of cylindrical sleeves produced from insulating foams or from mineral wools, glass wools or rock wools. More specifically it relates to acoustic and in particular thermal insulation of the elbowed parts of pipes in the field of heating and in the thermal and refrigeration industries.

When a fitter needs to insulate pipes, for example heating pipes, in cases when they are already installed inside or outside a building, he has cylindrical insulating sleeves known as "laggings" for this purpose. These sleeves, which are split along their length, are fitted around the pipes, and the operation is very simple to perform on the straight parts. There are two known techniques for pipe bends: either elbows are used which are preformed or are cut from a block of material which may or may not be identical to that which constitutes the shells, or the elbows are cut from straight parts of this material by means of templates and, when they are assembled, they enable the elbowed part of the pipe to be covered. The first technique requires storage of a large number of expensive pre-formed parts, and the second technique requires cutting on the site which is all the more delicate the greater the diameter, requiring a more highly qualified workforce and thus giving rise to a higher cost.

The object of the invention is to provide a product to be used for insulating pipe elbows, which
simultaneously processes the elbows and the straight parts adjacent thereto, which has good thermal characteristics and a low cost, and is also easy to store.

Techniques are known which enable insulating sleeves to be produced by means of organic foams. As far as mineral wools are concerned, several techniques for producing insulating sleeves known as shells are known. Thus for example US 4 830 806 provides a method for producing shells made from fibrous inorganic materials, by winding a felt comprising fibre and a bonding agent about a heated mandrel.

All these techniques thus enable cylinders to be produced, the inner radius of which corresponds to the outer radius of the pipe to be protected, and having an insulating thickness either of foam or of fibrous product which corresponds to the thermal resistance to be obtained. These laggings are in the form of straight components usually approximately one metre long, optionally protected by a plastics or metal film. These laggings are cut longitudinally along a half-diameter at least, such that they can be opened and introduced into the pipe to be protected. Although in given systems the products can be elbowed slightly such that they can follow a curved trajectory of the pipe, when the radius of curvature is too small the product cannot be deformed sufficiently to match perfectly the elbowed part. For this reason several methods have been developed which enable to produce separately the elbows to be fitted on pipe bends.

The first of these methods consists of cutting elbows from blocks of foam, or of forming elbows from blocks of mineral wool, and in particular rock wool, which
are connected on either side to the straight parts. These elbows are cut into two along their plane of symmetry, thus leaving a transverse slit which gives rise to heat losses. This technique, enabling high-precision elbows which match the form of the pipe and are connected satisfactorily to the straight parts to be obtained, is very costly. Additionally, the elbows need special packaging so that they can be transported to the site, and this likewise increases the cost price.

Another, more commonly used technique, consists of carrying out cutting on the site itself, which optionally, by means of a special mitre block such as that according to US 4 945 648, permits a recess having a triangular cross-section to be obtained at the required point in the cylindrical lagging on small diameters, thus enabling the lagging to be closed and the required angle to be obtained. This very simple technique has the advantage that any angle can be obtained on the site, provided that the cutting angle is adapted to the required results. It is also very cheap, but the insulation obtained at the pipe elbows is not of a very high quality. In fact the radius of curvature of a pipe bend is never zero. However, the elbowed part of the shell obtained by means of the preceding method forms an acute angle at the point of connection. As a result, the insulating material does not follow accurately the surface of the pipe. At given points the insulating material is compressed, but at other points a gap is left between the surface of the pipe and the insulating material. Furthermore on the site the angle is never set perfectly, and the segments are thus never contiguous. However, particularly in the case of sound insulation, it is essential for the insulating material to constitute a perfectly impermeable unit. The technique
according to the invention has been developed in order to overcome these various disadvantages.

The first of the variant embodiments of the invention comprises a product consisting of cylindrical lagging insulating components designed to form an insulating sleeve about an angle $\alpha$ of a pipe elbow, of which there are a number $n$ of prismatic lagging components, which are identical if there are several of them and the two substantially flat surfaces of which form angles of $+\beta$ and $-\beta$ with the straight sections of the lagging, such that:

$$\beta = \alpha/(2n + 2)$$

whereas their longest generatrix has a length $b$ such that:

$$b = 2 \left( R + d/2 + e \right) \tan\beta$$

where $R$ is the radius of curvature of the pipe, $d$ is its diameter and $e$ is the thickness of the lagging walls, the straight parts of the cylindrical insulating shells adjacent the elbows ending in surfaces of which the angles form an angle $\beta$ with the straight sections of the lagging.

In the other variant embodiment of the product, the angles $\beta$ conform to the ratio $\beta = \alpha / 2n$. In this case the cylindrical lagging adjacent the elbow end in straight sections.

The invention also relates to the method permitting insulation of pipe elbows having an angle $\alpha$, a radius of curvature $R$ and a diameter $d$, by means of cylindrical insulating laggings having an inner diameter $d$ and thickness $e$. According to the first variant of the method, a cylindrical insulating lagging is cut up into substantially flat cross-sections, all of which are
perpendicular to the same plane passing through its axis, the cutting planes forming angles alternatively of + β and - β relative to the straight cross-sections of the laggings, such that:

$$\beta = \alpha / (2n + 2)$$

the number of cuts being n + 1 and the lagging components obtained having their largest generatrix equal to b such that:

$$b = 2 \left( R + d/2 + e \right) \text{tg} \beta$$

and the residual straight parts and intermediary prismatic lagging components are assembled such as to obtain the maximum angle possible.

The second variant is a method in which a cylindrical insulating lagging is cut up according to substantially flat cross-sections, all perpendicular to a single plane passing through its axis, these planes forming angles alternately of + β and - β relative to the straight cross-sections of the lagging, such that:

$$\beta = \alpha / 2n$$

the lagging components thus obtained having their longest generatrix of a length b such that:

$$b = 2 \left( R + d/2 + e \right) \text{tg} \beta$$

and the pipe elbow is provided with n lagging components thus obtained, the adjacent lagging components ending in straight cross-sections.

Advantageously, after the laggings have been cut, the lagging components are packaged in the position they occupied before being cut, and are preferably retained in this form until they are used on the site. They are preferably maintained in this form by means of a heat-shrink-film.
Optionally in both methods, immediately after the prismatic or straight lagging components have been put into position on the pipe, they can be wrapped with adhesive film or adhesive fabric.

The technique according to the invention has a given number of obvious advantages in comparison with the prior art. Firstly, it solves the problem of insulation at the pipe elbows. Irrespective of the radius of the elbow or the angle, there will always be a solution which will enable the insulating material to follow closely the surface of the pipe, by limiting compression and distancing from the surface, and without retaining gaps between the sections. The technique according to the invention thus provides the same advantages as elbows formed by shaping, moulding or by cutting from a block of mineral wool or foam, but at a much lower cost price. The invention permits simultaneous processing of the elbows and the adjacent straight parts, such that insulating the elbows is no longer a separate operation. Furthermore by reconstituting the original lagging, the elbows can be packaged in a straight form maintained for example by means of a shrink-film, thus enabling the same packaging to be used as for conventional laggings, which saves storage space, and money, since special packaging is no longer required.

The following Figures and description will enable the invention to be understood better.

Figure 1 is a lagging of insulating material made of foam or fibre;
Figure 2 shows the use of the invention in the case of a single prismatic section;

In Figure 3 the pipe forms a right-angle and the sleeve has two prismatic sections.

In Figure 4 the same elbow is moulded closer to the insulation, owing to the use of three prismatic sections;

Figure 5 shows an elbow having any angle;

Figure 6 shows a variant of the cutting method according to the invention; and

Figure 7 shows a simple means of putting the sections in the correct position.

Figure 1 shows a lagging made of insulating material having the form used in most cases. It is cylindrical, and consists of an insulating material comprising either a foam, which in general is organic, but which may also be foamed glass or a fibrous, usually mineral material, based on rock wool or glass wool joined by a bonding agent. The two surfaces, i.e. the outer surface 1 and the inner surface 4 are cylindrical. When the lagging is in position, the pipe occupies the inner space 3 of the lagging. In order to enable the sleeve to cover the pipe, a longitudinal slit 5 has been provided which cuts through one thickness of the lagging and may also extend to a given depth on the opposite side.

Figure 2a shows a lagging as it is just after being cut in order to create a single prismatic section,
such that it can then be fitted onto a right-angled elbow. 9 and 10 are the straight parts of the cylindrical sleeve and 11 is the prismatic section. The flat surfaces 6 and 7 of the prism form an angle 8 together with the straight cross-section of the cylinder. In the Figure shown the angle is 22.5°, i.e. exactly a quarter of the right angle formed by the pipe. In order to define fully the prismatic section 11, additionally all that needs to be known is either the length a of its shortest generatrix in the upper part of Figure 2a, or the length b of its longest generatrix in the lower part of the Figure. These dimensions depend on the characteristics of the insulating sleeve and characteristics of the pipe, in particular on the radius of curvature R of the elbow. The general formulae enabling these to be calculated are given hereinafter.

Figure 2b shows the lagging and its elbow in position on the pipe. 12 is the pipe and 13 is its neutral axis which enables the radius of curvature of the elbow to be defined. As previously, 9 is the first straight part of the lagging and 10 is its second straight part, but this time the sleeve has been inverted, i.e. it has been rotated by 180 degrees about its axis. In the cross-section in Figure 2b, 15 is the outer periphery of the pipe, which is at a slight distance from the insulating material. On the other hand the inner periphery 14 of the pipe crushes the insulating material slightly in this area.

In Figure 3 exactly the same problem exists. The intention is to cover the same elbow using the same lagging, but to obtain improved insulation, the aim is to reduce the gap on the outer part of the bend and to reduce crushing of the insulating material on the inner part.
thereof. For this purpose two prismatic sections are cut from the lagging, instead of one. The angles formed by their surfaces with the straight cross-sections of the lagging are in this case $15^\circ$ on alternate sides, relative to these straight cross-sections. $16$ is the first of these sections, and $17$ is the second. As previously, the prismatic sections are positioned on the pipe elbow such that their widest part is on the outside of the bend, but unlike in the previous case the right-hand straight part of the lagging has been rotated such that it assists in forming the bend. Figure 3 shows clearly that the insulation is an improvement on the example shown in Figure 2.

The situation is further improved in Figure 4, which comprises three prismatic sections. It can be seen that here the surfaces of the pipe and the inner surfaces of the straight parts of the lagging and of the prismatic sections are in close contact along their entire length. On the left-hand part of Figure 4, it can be seen that $n + 1 = 4$ cuts have been made in order to create $n = 3$ sections. The cuts form an angle of $11.25^\circ$ with the straight cross-sections of the shell.

Figure 5 is a general view of the preferred system according to the invention. Here the angle $\alpha$ of the pipe elbow is $60^\circ$. The number $n$ of prismatic sections selected is two. Additionally, the radius of curvature of the pipe is known as $R$. The outer diameter of the pipe is $d$ and the thickness of the insulating material is $e$. The general formulae which enable the prismatic sections according to the invention to be defined are:

$$\beta = \alpha/(2n + 2)$$

$$a = 2 \ (R-d/2 - e) \ tg\beta$$
\[ b = 2\left(\frac{R+d}{2} + e\right)\tan \beta \]

where \( a \) is the length of the shortest generatrix of the prismatic section and \( b \) is that of its longest generatrix.

In each case these formulae enable the conditions of application of the method according to the invention to be defined. When the number \( n \) of sections has been selected, \( \beta \) is calculated by means of the first formula, and the cutting planes of the lagging are then alternated, orienting them according to \( +\beta \) or \( -\beta \) and separating them by "a" at the closest point and thus by "b" at the furthest point. All the examples in Figures 2 to 5 have been produced by conforming to the above-described cutting parameters.

The method described above can be applied within the context of manual production, in which, depending on the material available for the laggings and the specific features of the pipe and its elbow, and after having selected the number of sections \( n \), the parameters of each section and of the ends of the straight lagging contiguous to these sections, will be defined accurately. However, it can also be applied in cases in which the elbows are standardised elbows, since in industrial installations it is commonplace to have standard features in order to define universal elbows once and for all. In the latter case the main advantage of the method according to the invention, apart from its low cost, is that the insulation of the elbows and of the adjacent straight parts is processed simultaneously, and that these elbows can be stored in a straight form, i.e. similarly to standard straight laggings.
The system described above permits the maximum avoidance of wastage of lagging, since the straight parts upstream and downstream of an installed elbow simply consist of the straight parts which are on either side of the prismatic sections when the cutting is carried out. Each elbow installed thus ends in a perpendicular surface and can be joined to any other straight section.

A system produced according to that shown in Figure 6 would not be a departure from the context of the invention. This Figure shows three prismatic components of which the cutting surfaces form an angle $\beta$ with the straight cross-section of the lagging such that $\beta = \alpha/2\pi$. The large and small generatrices $b$ and $a$ of the prismatic sections are calculated by means of the same formulae as before. The essential difference from the preceding examples is that in this case the elbow itself is joined by means of a straight cross-section to the adjacent straight lagging. The main disadvantage is that the sectioned parts disposed to the left and to the right of the $n$ prismatic sections are unusable. In this case it would thus be advantageous to cut up all of the straight lagging which, on completion of the operation, would constitute a reserve of prismatic sections intended to be fitted on all elbows identical to one another.

An advantageous variant embodiment of the invention shown in Figure 7 enables the exact position of each section to be located easily when it is fitted onto the elbow.

When the initially straight shell is cut, instead of forming a cut according to a plane as previously described, this cut surface is provided with a rib which
projects on one side and is recessed on the other, and is symmetrical relative to the axis of the surface. At the time of assembly on the elbow, whether the section remains in its original position (such as the intermediate section in the case of three sections), or whether it is rotated by $180^\circ$ relative to the axis of the cut surface, its position can be located immediately by engaging the rib on the surface in the complementary rib on the opposite surface.

If the cutting is carried out by means of a wire saw as in the case of mineral wool shells, it is sufficient to move the wire away slightly from its flat path, when it is approaching the axis of the cut surface, and to return it symmetrically to the same plane, when this axis has been passed. This provides a right-angle rib constituting a symmetrical "wave" relative to the axis of the ellipse which forms the cross-section of the sections. This is shown in Figure 7. When the section 20 is separated from the adjacent straight part 25, instead of creating a simple flat cross-section such as cross-section 7 in Figure 2a, a surface in relief is produced which is symmetrical relative to the axis of the ellipse which this flat cross-section would constitute. In general, apart from this symmetry, the relief may be in any form. In the Figure the form of this rib 23 is very simple, being prismatic with an isosceles right-angled triangle cross-section and along the minor axis of the ellipse. The other surface 22 of the prismatic section 20 has an identical form, its camber being on the same side as the first surface. Thus it has a rib 24 in relief (whereas the rib 23 was recessed on the same prismatic section 20). In the case of the method according to Figures 2 to 5, the rib 23 and the rib 24 do not need to be identical. In fact the surface 21 disposed between the straight section 24 and the prismatic component
20 is between these same two components when the insulating material is fitted on the elbow (Figure 7 b). It is only in the method according to Figure 6, in which the straight sections have an origin other than that of the prismatic components, that their surfaces must have accurate, well-defined and complementary forms.

The advantages of the technique according to the invention in comparison with the prior art, are numerous. Firstly, it solves the problem of elbows and adjacent straight parts, at the same time providing good thermal and even acoustic performance levels, since it systematically eliminates the gaps between sections, and secondly it is cheaper, since it requires less manpower on the site than the manual method consisting of cutting the shell cross-sections on the spot. It will be appreciated that it is also less expensive than the prior industrial art which consisted of forming all types of bends by shaping from fibrous mat or from a rigid foam mass, with direct moulding as a variant in the latter case. From the point of view of storage it has been seen that the fact the elbows can be stored in their original cut form has the advantage that only one type of packaging need be used for the straight laggings and for the cut lagging designed to equip the elbows.

The flexibility of the method according to the invention should also be noted. Irrespective of the quality requirements of the insulation, by selecting the number n of sections, the required quality can be achieved.
THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. Product comprising cylindrical insulating lagging components intended to form an insulating sleeve about an elbow having an angle $\alpha$ of a pipe, characterised in that the lagging components are prismatic and of a number $n$, and are identical if there are several of them; in that their two substantially flat surfaces having an elliptical outline, form angles respectively of $+\beta$ and $-\beta$ with the straight cross-sections of the laggings such that:

$$\beta = \alpha/(2n + 2);$$

and their longest generatrix has a length $b$ such that:

$$b = 2 (R + d/2 + e) \tan \beta$$

in which $R$ is the radius of curvature of the pipe, $d$ is its diameter and $e$ is the thickness of the lagging walls and in that the straight parts of the cylindrical insulating laggings intended to be adjacent the elbows end in surfaces of which the angles form an angle $\beta$ together with the straight cross-sections of the laggings.

2. Product comprising insulating cylindrical lagging components intended to form an insulating sleeve about an elbow having an angle $\alpha$ of a pipe, characterised in that the lagging components are prismatic and of a number $n$, and are identical if there are several of them; in that their two substantially flat surfaces having an elliptical outline form angles respectively of $+\beta$ and $-\beta$ with the straight cross-sections of the laggings such that:

$$\beta = \alpha/2n;$$

and their longest generatrix has a length $b$ such that:

$$b = 2 (R + d/2 + e) \tan \beta$$

in which $R$ is the radius of curvature of the pipe, $d$ is its
diameter and \( e \) is the thickness of the lagging walls.

3. Product according to Claim 2, characterised in that the cylindrical laggings intended to be adjacent the elbow end in straight cross-sections.

4. Product according to any one of the preceding Claims, characterised in that the prismatic lagging components and optionally the adjacent straight parts are packaged such as to re-form all or part of the original cylindrical insulating lagging.

5. Product according to Claim 4, characterised in that a heat-shrink film maintains the prismatic components and optionally the straight parts in position.

6. Product according to any one of the preceding Claims, characterised in that the surfaces of the prismatic lagging components comprise components in relief, of which the form is symmetrical relative to the axes of the said surfaces, and the associated surfaces of the adjacent straight parts comprise a complementary form.

7. Product according to Claim 5, characterised in that the components in relief are straight ribs along the small axis of the elliptical outline of the surfaces.

8. Method of producing the insulation of a pipe elbow having an angle \( \alpha \), a radius of curvature \( R \) and diameter \( d \) by means of cylindrical insulating laggings having an inner diameter \( d \) and thickness \( e \), characterised in that the cylindrical insulating lagging is cut according to substantially flat cross-sections, all of which are perpendicular to a single plane passing through its axis,
the cutting planes forming angles alternately of + \( \beta \) and - \( \beta \) relative to the straight cross-sections of the lagging, such that:

\[
\beta = \alpha/(2n + 2),
\]

the number of cuts being \( n + 1 \); in that the lagging components obtained have their longest generatrix equal to \( b \) such that:

\[
b = 2 (R + d/2 + e) \tan \beta
\]

and the residual straight parts and the intermediate prismatic lagging components are assembled such as to obtain the maximum angle possible.

9. **Method of producing the insulation of a pipe elbow having an angle \( \alpha \), a radius of curvature \( R \) and diameter \( d \) by means of cylindrical insulating lagging having an inner diameter \( d \) and thickness \( e \), characterised in that a cylindrical insulating lagging is cut according to substantially flat cross-sections, all of which are perpendicular to a single plane passing through its axis, these planes forming angles of + \( \beta \) and - \( \beta \) alternately with the straight cross-sections of the lagging such that:

\[
\beta = \alpha/2n,
\]

the components thus obtained having their largest generatrix of a length \( b \) such that:

\[
b = 2 (R + d/2 + e) \tan \beta;
\]

and in that the pipe elbow is provided with \( n \) lagging components thus obtained, the adjacent straight lagging components ending in straight cross-sections.

10. **Method according to either of Claims 8 or 9**, characterised in that immediately after the prismatic or straight lagging components have been put into position, they are wrapped with adhesive film or adhesive fabric.
11. Method according to any one of Claims 8 to 10, characterised in that for a given diameter \( d \), the number \( n \) of prismatic sections is all the greater, the smaller the radius \( R \), and conversely for a given radius \( R \), \( n \) is all the greater the smaller \( d \) is.

12. Method according to any one of Claims 8 to 10, characterised in that after the laggings have been cut, the cut components are packaged in the position they occupied before being cut, and are preferably maintained in this form until they are used on the site.

13. Method according to Claim 12, characterised in that the cut components are maintained in place by means of a shrink-film.

DATED THIS 19TH DAY OF OCTOBER 1992
ISOVER SAINT GOBAIN
By its Patent Attorneys:
GRiffith Hack & Co.
Fellows Institute of Patent Attorneys of Australia
ABSTRACT

The invention proposes a technique for insulating pipe elbows by cutting cylindrical laggings of an insulating material into defined sections.

The number of sections selected enables optimum insulation to be obtained. Packaging the cut components in their pre-cutting position provides economical and practical packaging.

Figure 5
Fig. 3

Fig. 4