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(71) Applicant *(for all designated States except AU CA NZ US)*: INA ACQUISITION CORP. [US/US]; Suite 300, 1770 Kirby Parkway, Memphis, TN 38138 (US).

(71) Applicant *(for US only)*: BULL, Miranda, Jane (legal representative of the deceased inventor) [GB/GB]; 7 Mourne View, Peel, Isle of Man IM5 1UJ (GB).

(71) Applicant *(for AU NZ only)*: INSITUFORM LICENSEES BV/SA [NL/NL]; West Blaak 6, 3rd floor, 3012KK, Rotterdam (NL).

(71) Applicant *(for CA only)*: INSITUFORM (NETHERLANDS) BV [NL/NL]; West Blaak 6, 3rd floor, 3012KK, Rotterdam (NL).

(72) Inventor: WOOD, Eric (deceased).

(74) Agent: BAILEY WALSH & CO.; 5 York Place, Leeds LS1 2SD (GB).

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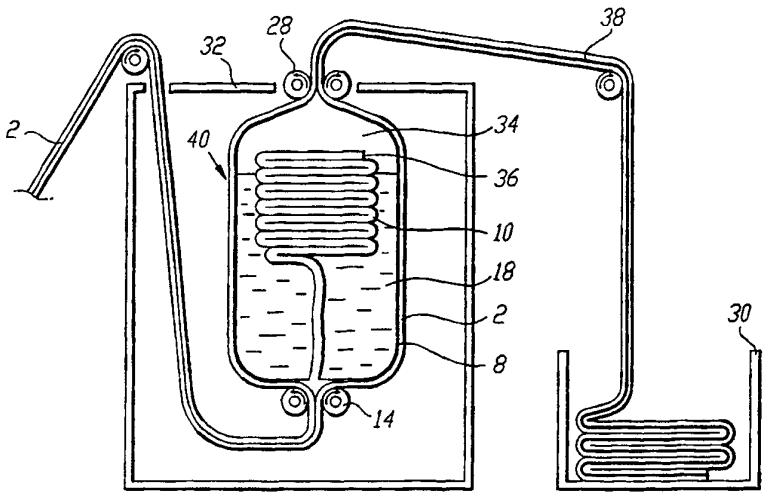

(57) Abstract

A resin impregnated lining tube (2) for the lining of pipelines or passageway is provided with a prelining tube (38) prior to insertion into the pipeline by the insertion of a stack (10) of prelining tube material into one end of the lining tube (2), a corresponding end of the prelining tube (38) being everted to lie outside the lining tube (2) end and a quantity of liquid is provided within the everted portion of prelining tube (38). Further eversion of the prelining tube (38) onto the inside surface of the lining tube (2) is caused by upward movement of the lining tube (2) and previously everted prelining tube (38) between a pair of upper (28) and lower rollers (14), during which time the stack (10) of prelining tube (38) freely unravels. A float (42) may be provided above the stack (10) of prelining tube (38) to maintain its position within the eversion liquid (18), and further the apparatus may be held within a nitrogen spray tank (32) to cool the lining during production.

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PRODUCTION OF LINING TUBES

This invention relates to the production of lining tubes, and particularly to the production of lining tubes for installation into a pipeline or passageway for the rehabilitation thereof.

The lining tubes to which this invention relates in one known form comprise an outer impervious lining and an inner layer or layers of resin absorbent material e.g. needled felt saturated with synthetic resin, and this lining tube has generally been applied by a method disclosed in United Kingdom Patent Specification No 1,449,455. In this method, the tube is everted under fluid pressure so that the needled felt layer(s) lies against the surface of the passageway and the impervious layer lies to the inside of the newly resurfaced passageway. This lining is then "cured in place" by the application of heated fluid to the inside of the tube so that the synthetic resin sets and creates a new lining on the wall of the passageway.

In the production of lining tubes webs of the felt material are coiled into tubular form to provide layers and the longitudinal edges which come together are connected by sewing, adhesive or flame bonding, or any other means. The outer layer or the layer if there is only one, has an impervious outer coating. At this stage the tube is "dry" and has no resin therein, but subsequently the dry tube is impregnated with a quantity of synthetic resin so that the felt of the layer or layer becomes saturated therewith. It is this tube which is then everted into the passageway, and what can happen with this technique is that at the everting face of the lining tube, where the layers are turned inside out if the resin containing layer comes into contact with air, air can be drawn into the felt which may cause problems

in the finished article.

One attempt to deal with this possible problem is disclosed in International Patent Application No WO 90/11468, wherein a prelining tube is sealingly connected to the leading end of the resin impregnated lining tube, and air is excluded from the prelining tube. The prelining tube is pulled into the passageway, and the resin impregnated lining tube is everted gradually into this preliner without the ingress of air into the felt layer. However, this installation procedure is clearly more protracted than the conventional soft lining technique and in many applications the speed of installation is crucial, since the installation procedure can cause disruption if for example the passageway is a sewer running under city streets.

Another solution is now proposed wherein a resin impregnated lining tube is provided with an internal impervious layer or prelining tube during the production of said tube, so that an improvement of quality can be obtained by the reduction of air pockets in the installed tubing, without protracting the installation procedure.

According to the present invention, a resin impregnated lining tube is provided with prelining tube by the introduction of a stack or roll or otherwise compacted length of prelining tube material into one end of the resin impregnated lining tube followed by the gradual eversion of the prelining tube material onto the inner surface of the resin impregnated lining accompanied by the relative displacement of the stack or roll or otherwise compacted length of prelining tube material and the said lining tube in the direction of the length of the resin impregnated lining tube.

The said compacted length of preliner is preferably held in place by confining meanswhereas the said lining tube is moved over the said length of preliner and past the said confining meansduring application of the preliner.

The compacted length of preliner is preferably introduced within a vertically disposed length of the resin impregnated lining tube and as the the lining tube is moved upwards, the prelining tube is caused to evert onto the inner surface of the lining tube gravitationally, preferably by providing a quantity of liquid to the outside of the prelining tube where it is compacted and inside the everting portion of the prelining tube.

The lining tube can be caused to move by being pulled through an upper pair of rollers and a lower pair of rollers, between which the lining tube is caused to inflate by virtue of said liquid. This section between the pairs of rollers might be aptly described as an eversion balloon. Thus it can be seen that the eversion liquid will contain and perhaps buoyantly support the compacted length of prelining tube so that the compacted length freely unravels as eversion takes place and also the compacted length is maintained separate from the upper pair of rollers by gravitational forces. The eversion liquid preferably has some lubricating properties.

The upper pair of rollers may be driven rotationally to pull the assembled lining tube with the prelining tube through the mechanism as it grips the lining tube above the eversion balloon.

A float with significant weight may be provided above the stack or roll or otherwise compacted length of preliner to ensure that, although it may be buoyantly supported in the liquid, the compacted length remains substantially submerged

therein.

The eversion balloon may be located in a nitrogen spray tank used to cool the lining, the upper and lower roller arrangement being disposed within the tank. The cooled environment in the tank chills the lining tube so that undesired onset of curing of the resin within the tube is delayed. Without chilling the tube to a cold temperature before it is transported to the installation site, there may in some circumstances be a chance that the resin will set to some extent during transport, rendering the tube useless.

Within the section of the lining tube which is ballooned whilst the application of the preliner is taking place, there may be a rolling pig which circulates as eversion of the preliner inside the lining tube takes place.

Application of the preliner takes place over a limited length section of the lining tube so that, progressively, the lining tube with the applied preliner can be folded or rolled up ready for transportation, and so that it is not necessary to lay out the lining tube to its entire length for the application of the preliner. This means that the preliner can readily be applied in factory conditions. It can be unfolded or unwound as the application of the preliner is taking place, and immediately folded or rewound after the application of the preliner along the said section of the lining tube.

Clearly, the length of the preliner will be equal to the length of the lining tube at least and the lining tube and preliner may have lead in portions to facilitate the commencement of the operation.

The application of the preliner may take place at the same

time as the lining tube is being impregnated with synthetic resin.

The resulting composite lining comprising the lining tube and preliner will be impregnated with synthetic resin and will have a preliner applied thereto so that when eventually the composite lining is applied to a pipeline or passageway by eversion, the preliner will lie to the outside of the impregnated layer and will prevent the raw resin from contacting the pipeline or passageway surface and will prevent escape of resin into the lateral connections.

The preliner over said limited length may be inflated alternatively by air trapped in said limited length whilst the progressive everting of the preliner takes place and the preliner is applied to the inner surface of said lining tube.

The present invention will now be described with reference to the accompanying diagrams, wherein:-

Fig. 1 shows a lining tube useable in the invention

Fig. 1A shows an enlarged section of the ringed portion of the tube of Fig. 1.

Fig. 1B is a sectional elevation of the lining tube in inflated condition;

Fig. 2 shows how a lining tube may be impregnated with a resin;

Fig. 2A shows in enlarged section, the ringed portion of Fig. 2;

Fig. 3 illustrates a prelining tube folded cantilever fashion

into a stack for use in the present invention;

Fig. 3A shows a sectional view of the prelining tube shown in Fig. 3;

Fig. 4 shows in sectional view a stack of prelining tube and the open end of a lining tube immediately prior to the insertion of the prelining tube stack into the lining tube according to the present invention;

Fig. 4A shows in enlarged detail a portion of the prelining tube section ringed in Fig. 4;

Fig. 5 shows in sectional view the prelining tube being applied to the inside surface of the lining tube; and

Fig. 6 shows how a float may be provided above the stack of preliner.

Fig. 7 is a sectional view showing how a lining tube may be provided with a preliner in accordance with a further embodiment of the invention;

Fig. 7A is a sectional elevation taken on the line IV-IV of Fig. 7.

Figs. 8 to 13 respectively show in a series of steps, how the preliner may be used to establish the positioning of the preliner on the inner surface of the lining tube.

Referring to the drawings, and firstly to Fig. 1, a lining tube (2) is shown as being folded concertina fashion, although it could be rolled on a drum or reel, and it is in the condition in which it is flexible but dry insofar as it has not been impregnated with the synthetic resin.

The enlarged detail shown in Figs. 1A and 1B illustrates the construction of the lining tube and it comprises an outer membrane or coating (5), and an inner layer (7) of resin absorbent material such as a fibrous sheet structure made up of one or more layers of fibrous felts such as a polyester felt.

In order to impregnate the felt with the curable synthetic resin, the resin is pumped into the end of the tube indicated by reference (3), and the tube is then fed as shown in Fig. 2 by means of a pair of nip and drive rollers (9), or any other suitable means, so that the tube feeds in the direction of arrow (11). As shown in enlarged ring detail in Fig. 2A, inside the tube at the bulged portion is a quantity (13) of the synthetic resin, and the resin thoroughly impregnates the absorbent layer (7) so as thoroughly to impregnate same with the resin.

Air can be expelled from the felt layer (7) by maintaining the tubing under vacuum pressure during the resinating process, and the resulting lining tube will be devoid of air, and preferably the ends will be sealed to prevent further ingress of air.

As the tube (2) progressively is fed past the rollers (9) it may, as indicated in dotted lines at reference (15) be folded concertina fashion into a sack. Alternatively, it may be rolled up for storage and/or transportation.

In a preferred embodiment of the present invention the prelining tube (8) is compacted in the manner shown in Figs. 3 and 3A. The prelining tube is first folded longitudinally into the H shaped cross section shown in Fig. 3A, and is then folded laterally concertina fashion to the stacked

configuration of Fig. 3. The width of the stack is in this configuration less than the internal diameter of the prelining tube (8), and therefore one end of the prelining tube can be inverted and pulled up into a cup shaped form to surround the stack (10), as shown in Fig. 4, in which condition the prelining tube (8) is in a prepared state for insertion into the open end (12) of the mesh impregnated lining tube (2).

Prior to this insertion however the lining tube must be also prepared for the insertion of the prelining stack (10), and the end (12) of the resin impregnated lining tube (2) is fed through lower rollers (14), which grip the lining tube with a force that is both sufficient to resist the ingress of air into the centre of the lining tube, but this force is not sufficient to squeeze the resin from the needled felt layer (7). The end (12) is then opened out after a short length of the lining tube (2) has been drawn through the rollers (14), and the prelining stack (10) is inserted into this open end (12) so that the cup shape of everted preliner (8) lies against the inner surface of the lining layer (2).

Fig. 4A shows the prelining tube (8) comprising a tube of thin strong and flexible material such as the material sold under the name "Valeron" (trade mark).

The cup shaped everted prelining section is then filled with a quantity of liquid (18) which urges the preliner (8) against the inner surface of the lining tube (2), and this gradual input of liquid into the cup section (16) effectively expels the majority of the air caught between the lining tube and the adjacent prelining tube.

The prelining stack (10) also rises away from the bottom of the prelining cup as it begins to be buoyantly supported by

the everting water (18). When a sufficient quantity of everting water (18) is present inside the cup (16) and the air between the preliner (8) and lining tube (2) has been effectively expelled the free edges (20) and (22) of the prelining tube (8) and lining tube (2) respectively are preferably taped together or otherwise sealed to prevent further ingress of air into the lining tube (2).

It will be appreciated with reference to Fig. 5 that in this condition by pulling the open end of the tubes upwards, application of preliner to the lining tube (2) will be effected at the meeting place of the everting face (24) of the prelining tube (8) and the opening point (26) of the lining tube (2). The prelining tube (8) will be gradually unravelled from the compacted stack (10) to lie against the inner surface of the felt layer (4).

With reference to Fig. 5, a vertical pulling action is effected in this preferred embodiment by the use of an opposed pair of driven upper rollers (28) through which the lining tube with preliner (38) is driven and urged into a flattened condition by the action of the rollers (28). At this stage the application of a preliner to the lining tube (2) can be progressively effected merely by rotation of the upper rollers (28), and the lining tube with preliner (38) may subsequently be stacked concertina fashion onto a pallet (30) for transportation to the site of installation.

Rather than allowing the preliner stack (10) to float freely in the eversion liquid (18), a more reliable arrangement as shown in Fig. 6 includes a heavy float (42) which is placed on top of the stack (10). The float (10) ensures that the preliner stack (10) cannot be caught between the upper driven rollers (28) during operation, and this is achieved by maintaining the stack (10) below the surface of the liquid

(18). The eversion liquid (18) has lubricating properties, so that the travelling preliner tube (16) slides smoothly past the confined stack (10) during operation.

The inflated section of tubings (2) and (8) between the lower pair of rollers (14) and the upper pair of rollers (28) might be referred to as an eversion balloon (40), and this eversion bubble might be contained within a nitrogen spray cabinet (32). This nitrogen spray cabinet (32) serves to provide a cold environment whereby the lining tube can be chilled prior to transportation so that the potential lifetime of the resin impregnated soft tube is extended. Without this chilling, the resin might set under the influence of the ambient temperature, and if the tube does set during transportation and prior to insertion into the pipeline or passageway to be lined, the lining tube may become inutile, as it cannot be effectively everted into the pipeline or passageway to be lined.

It is considered that the cooling cabinet (32) is suitably positioned around the eversion balloon, however it is to be noted that the rate of cooling of the lining tube is to be coordinated with the rate of transit of the lining tube (2) through the spray cabinet, thereby ensuring that the eversion liquid (18) is not frozen under the influence of the cooling cabinet temperature.

It will be appreciated that during the process of the invention the compacted stack (10) of prelining tube (8) is progressively displaced along the length of the lining tube (2) as the coating process is effected.

The lining tube (2) and prelining tube (8) are preferably approximately equal in length, and when the insertion process is complete the sealed end of the lining tube 2 will meet

with the preliner's trailing end (36) which should preferably be sealed to prevent ingress of the air (34) or the everting liquid (18) between the prelining tube (8) and lining tube (2) during the eversion of the coating (8). However when this eversion is complete the seals will be broken to allow the everting liquid (18) and the remaining air (34) inside the eversion balloon to escape. The trailing edges of the lining tube with preliner (38) will then preferably be taped or otherwise sealed to further prevent the ingress of air into the resin layer (7).

If reference is made to Fig. 7, which shows a further embodiment of the invention, it will be seen that in the inflated portion (126) there is provided the preliner (132) which is stacked concertina fashion (it may alternatively be rolled) as indicated at (134) inside the section (126). The stacked preliner (132) is held in a polypropylene case (133) which is open at the left hand end.

The left hand end of the preliner (132) is shown as being everted at (136) against the inner surface of the tube (2) as the section (126) progresses relatively to the length of the lining tube and the preliner (132) therefore progressively everts onto the inner surface of the tube (2), and the tube (132) in fact embraces the interior of section (126) and eventually emerges with the tube (2) through the roller pair (128) so that as shown by reference (138) the emerging composite lining comprises the outer impregnated lining tube with the applied preliner.

The interior of section (126) is provided with a rolling pig (140) which is an inflatable bag turned upon itself as shown, and the pig serves to maintain the internal pressure, and provide a means over which the everting preliner and the travelling outer tube can pass in travelling to the nip

between rollers (128).

The section (126) is shown as being supported on conveyor (142) so that the section (126) does not sag.

The flexible tube (134) may be folded longitudinally as well as being folded concertina fashion in order conveniently to be located inside the section (126).

The application of the preliner may take place after the impregnation as indicated by Fig. 2, or simultaneously with the impregnation of Fig. 2, in which case there would be a further machine or station defined by the section (126) downstream of the station adjacent rollers (9) where the application of the resin takes place.

Again, when the application of the preliner has been completed, the lining tube may be restacked.

Reference is now made to Figs. 8 to 13 which show a further method of enabling the application of the preliner to take place. Although there are differences between the arrangement shown in Figs. 8 to 13 and Figs. 1 to 7, these are differences of detail and not of principle. The method described in relation to and as illustrated in Figs. 8 to 13 can be applied to the arrangements shown in Figs. 1 to 7.

Figs. 8 to 13 respectively show a sequence of steps for arranging for the preliner to be pre-assembled and inserted in the impregnated lining tube.

In Fig. 8 the preliner (100) is shown and it is folded concertina fashion in its centre portion (102) and it has a leading end (104) and a trailing end (106).

As shown in Fig. 9 the trailing end (106) initially is everted over the concertina portion (102) and its extremity is taped so as to form a throat or collar (103) through which the tube (102) can be pulled as eversion takes place.

Where the trailing end (106) is everted over the concertina portion (102) there is applied a length of adhesive tape (110) which holds that everted portion in position during the eversion process.

As shown in Fig. 10, the leading end (104) is now everted over the entire assembly so that its extremity (112) as shown in Fig. 11 can be connected to an air pipe (114). Air is injected into the enclosure defined by the everted leading end (104) to inflate same. The air pipe is removed from the extremity (112) and the extremity (112) is sealed to trap the air in the end (104). The end (104) can now be fed by the rollers (120) as shown in Fig. 12 and the leading end (116) fed into the everting preliner as shown in Figs. 11 and 12, to move the same.

Nip and feed rollers (120) as shown in Fig. 12 are used to feed the preliner between the rollers (120), and to feed out the concertined section of the preliner through the collar (103) which applies a drag force, formed by the taping of the extremity of the trailing end (106). This causes the lining tube (118) to be fed as shown by arrow (120) over the inflated leading end (104) of the preliner tube until the position in Fig. 13 is reached when the impregnated lining tube (118) is also being fed through the rollers with the preliner.

Although not shown in Figs. 8 to 13, the rolling pig as shown in Fig. 7 may also be provided inside the inflated enclosure defined by the leading end (104) of the preliner.

The resulting liner tube with applied preliner can be used directly for eversion into a pipeline or passageway for the lining of same, for purposes here and before described, but the lining has the advantage that it can be stored until ready for use.

Furthermore, during the eversion of the lining (38) onto the passageway surface, the felt layer (7) will not absorb air at the everting face during its various compressions and deformation under the everting forces because of the adjacent impermeable layer (8), which is effectively incorporated into the lining tube during production by the process of the present invention.

CLAIMS

1. A method of providing a resin impregnated lining tube with a prelining tube wherein a stack or roll or otherwise compacted length of prelining tube material is introduced into one end of the said lining tube followed by the gradual eversion of the said tube material onto the inner surface of the said lining tube accompanied by the relative displacement of the said compacted length of prelining tube material and the lining tube in the direction of the length of the said lining tube.

2. A method according to claim 1 wherein the said compacted length of preliner is held in place by confining means whereas the said lining tube is moved over the said length of preliner and past the said confining means during application of the preliner.

3. A method according to claim 2 wherein the confining meanscomprises a quantity of liquid provided to the outside of the prelining tube where it is compacted and inside the everting portion of the prelining tube.

4. A method according to any of claims 1 to 3 wherein the said compacted length of preliner is introduced within a vertically disposed length of the said lining tube, the prelining tube being caused to evert onto the inner surface of the lining tube gravitationally as the lining tube is moved upwards.

5. A method according to any of claims 2 to 4 wherein the lining tube is caused to move by being pulled in turn through a first pair of rollers and then a second pair of rollers, between which the lining tube is caused to balloon.

6. A method according to any of claims 3, 4 or 5 wherein the eversion liquid has lubricating properties.

7. A method according to claim 5 or 6 wherein the second pair of rollers is driven rotationally to pull the lining tube and the prelining tube through the mechanism.

8. A method according to any of claims 2 to 7 wherein a float with significant weight is provided above the said compacted length of preliner to ensure that, although it may be buoyantly supported in the eversion liquid, the compacted length remains substantially submerged therein.

9. A method according to any of claims 1 to 8 wherein the prelining tube is introduced into the resin impregnated lining tube within a nitrogen spray tank used to cool the lining.

10. A method according to claim 1 or 2 wherein the lining tube is inflated over a limited length section by air trapped within the preliner whilst progressive eversion of the preliner takes place.

11. A method according to any of claims 2 to 10 wherein the said confining means comprises a rolling pig which circulates as eversion of the preliner inside the lining tube takes place.

12. A method according to any of claims 2 to 11 further comprising the impregnation of the lining tube with synthetic resin at the same time as the application of the preliner.

13. Apparatus whereby a resin impregnated lining tube may be provided with a prelining tube by the introduction of a stack or roll or otherwise compacted length of prelining tube

material into one end of the resin impregnated lining tube followed by the gradual eversion of the prelining tube material onto the inner surface of the resin impregnated lining accompanied by the displacement of the stack or roll or otherwise compacted length of prelining tube material along the length of the resin impregnated lining tube, comprising a first pair of rollers and a second pair of rollers between which the lining tube is caused to inflate by providing a quantity of liquid inside the everting portion of the prelining tube.

14. Apparatus according to claim 10, further comprising a float with significant weight which is placed above the said compacted length of preliner to ensure that the said length remains substantially submerged within the eversion liquid.

15. Apparatus according to claims 10 or 11 further comprising a nitrogen spray tank wherein the roller arrangement is disposed, whereby the lining is cooled as the lining tube moves through the roller arrangement.

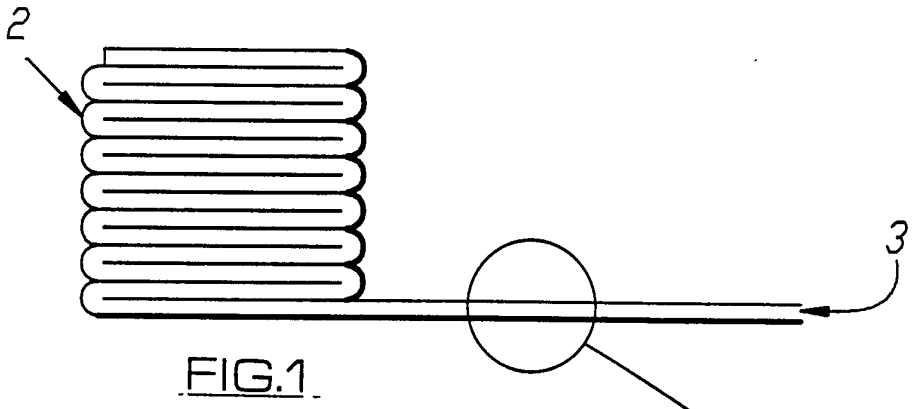

FIG.1

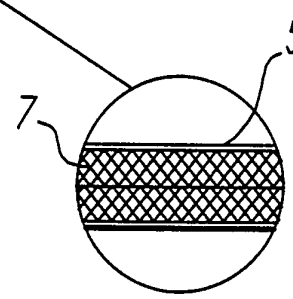

FIG.1A

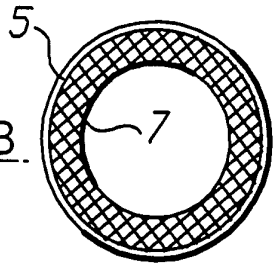

FIG.1B

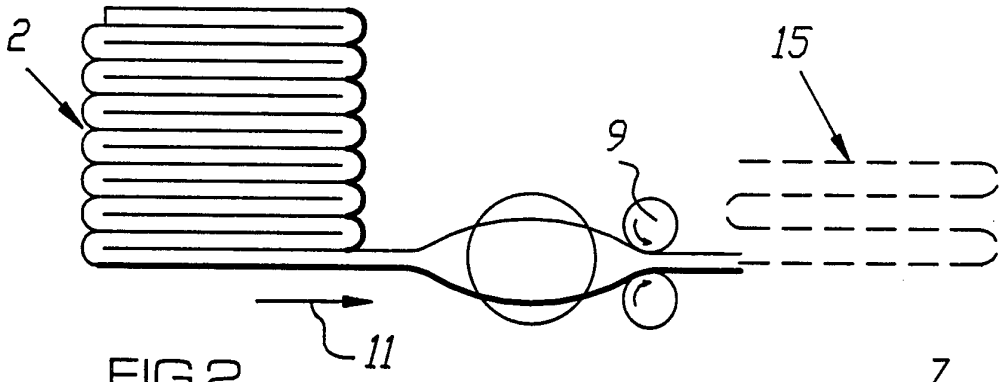

FIG.2

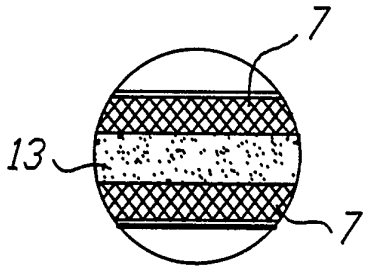

FIG.2A

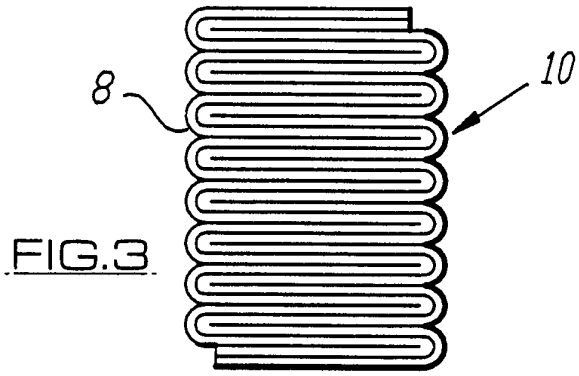

FIG.3

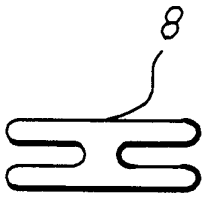

FIG.3A

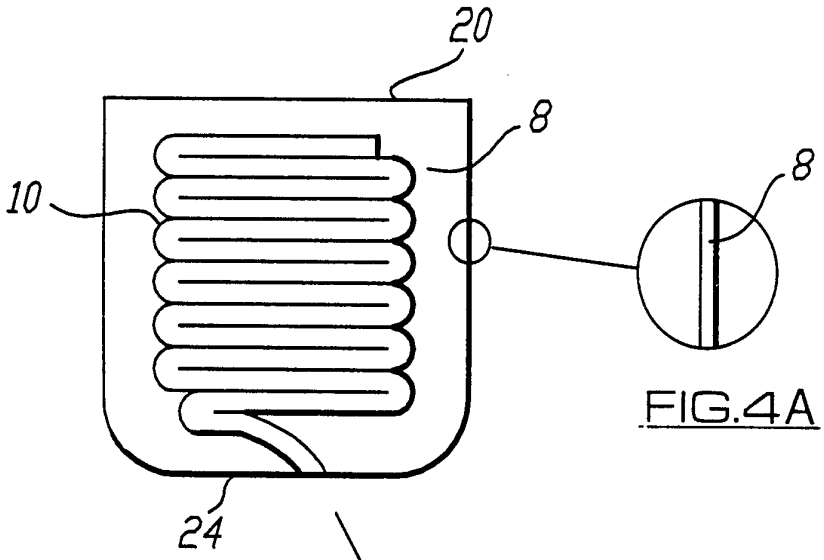

FIG.4A

FIG.4

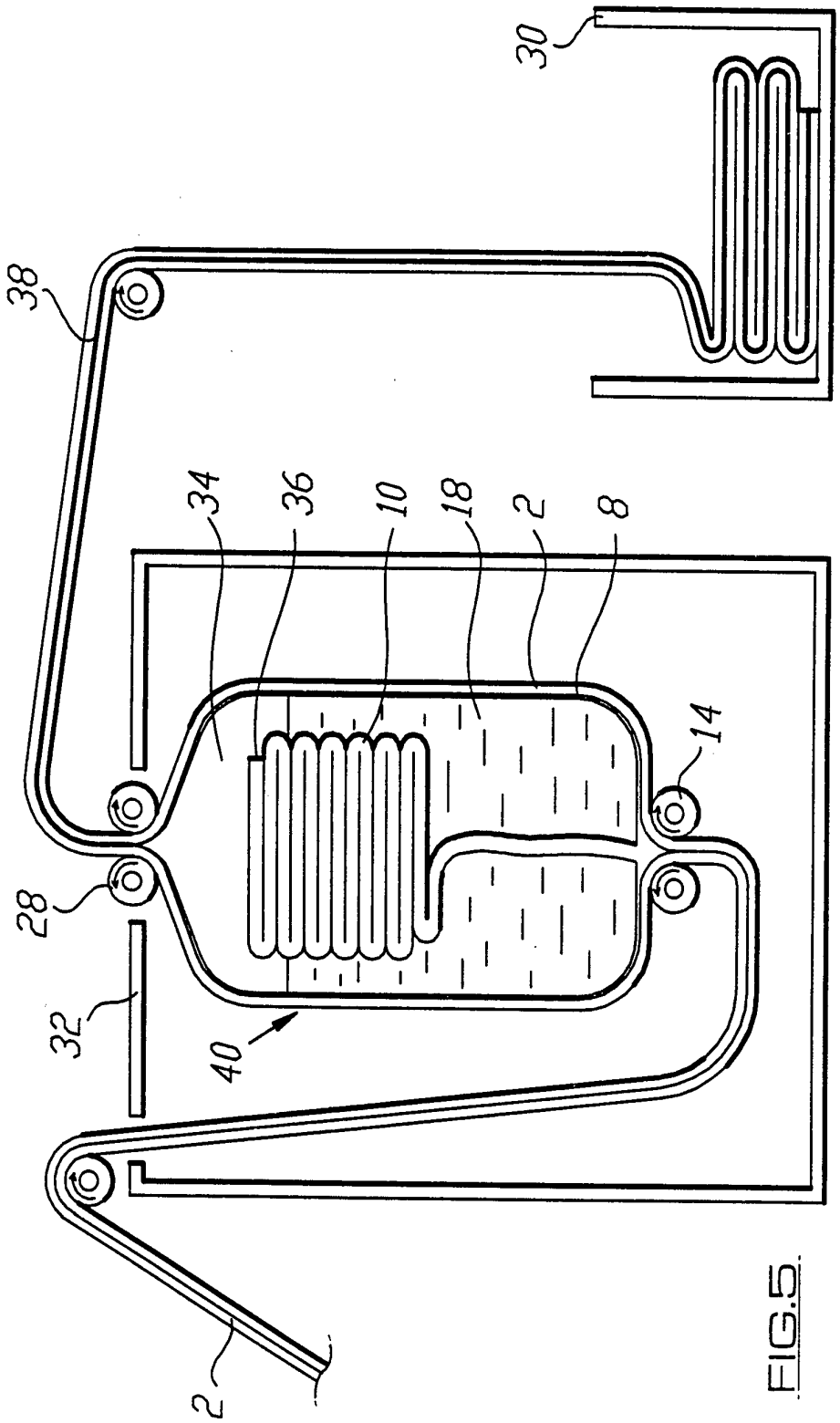

FIG.5

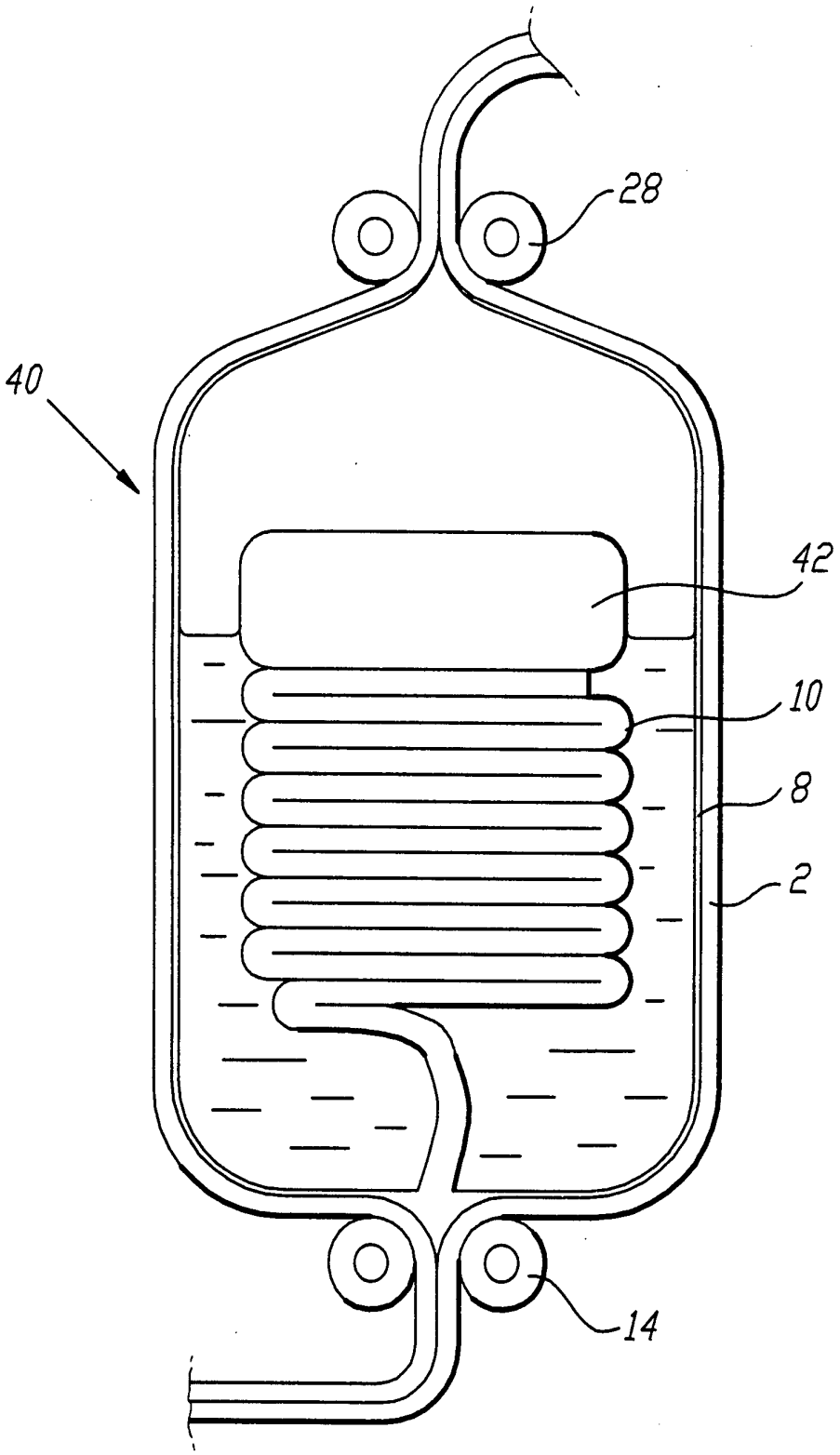

FIG.6

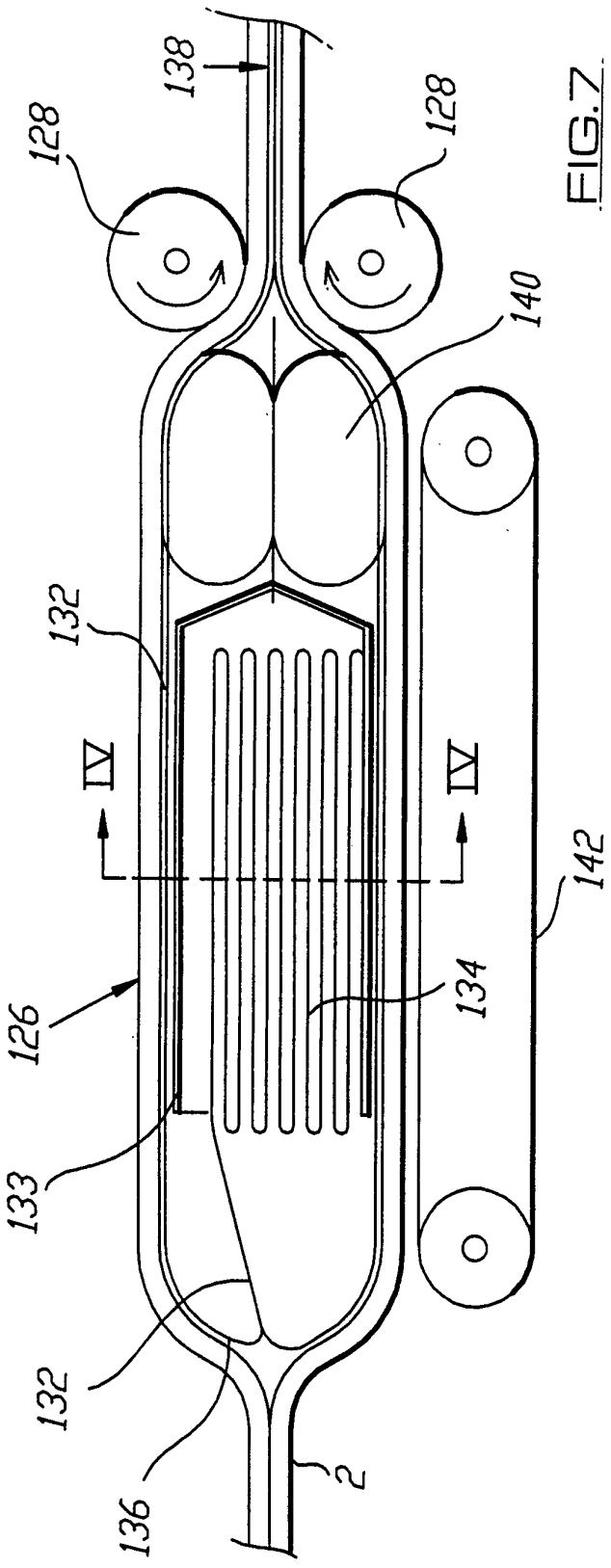

FIG.7

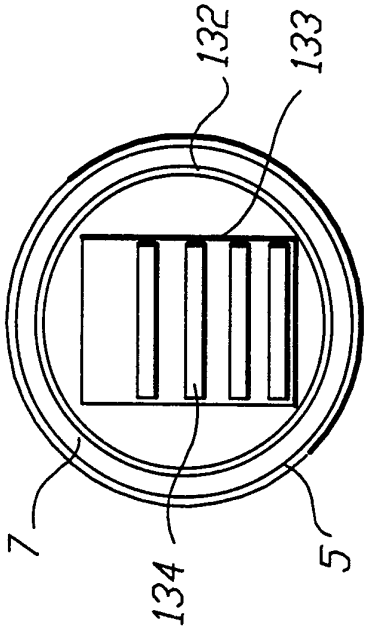

FIG.7A

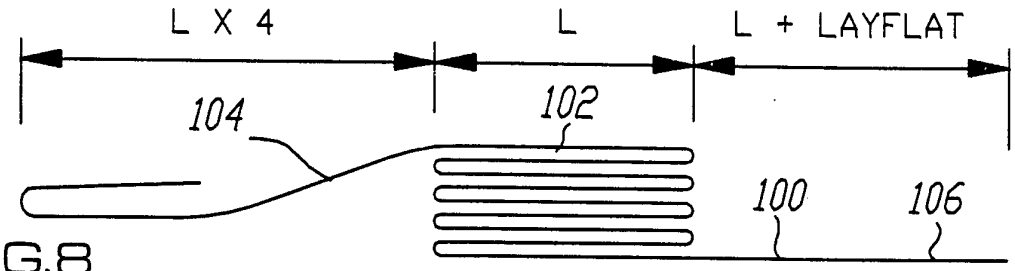

FIG.8

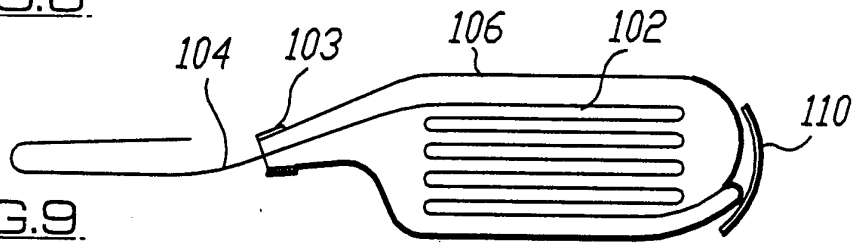

FIG.9

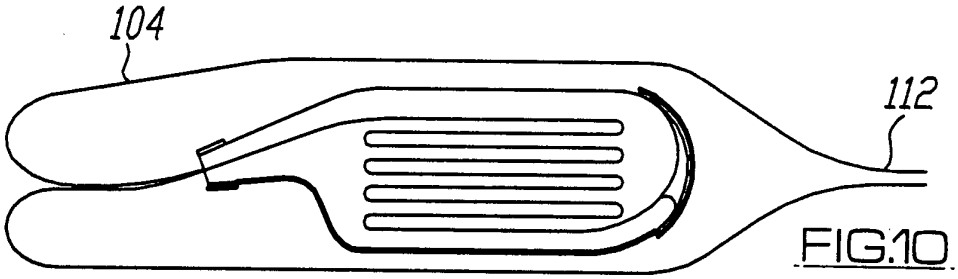

FIG.10

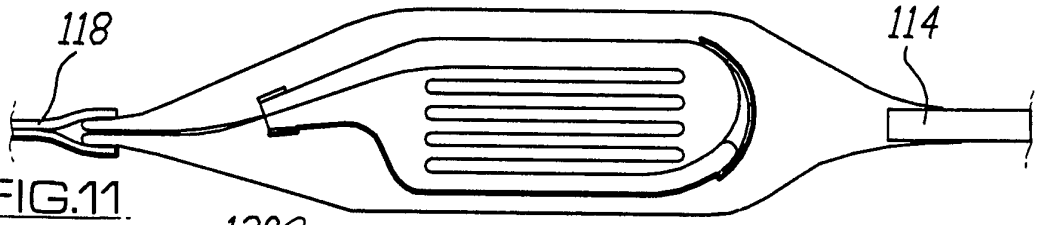

FIG.11

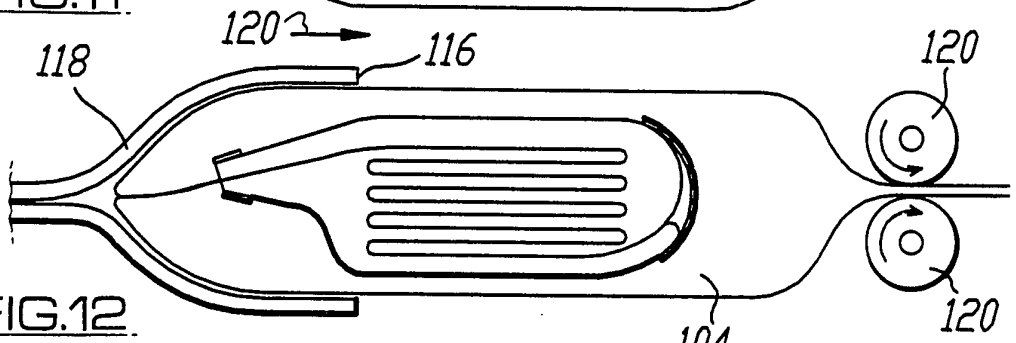

FIG.12

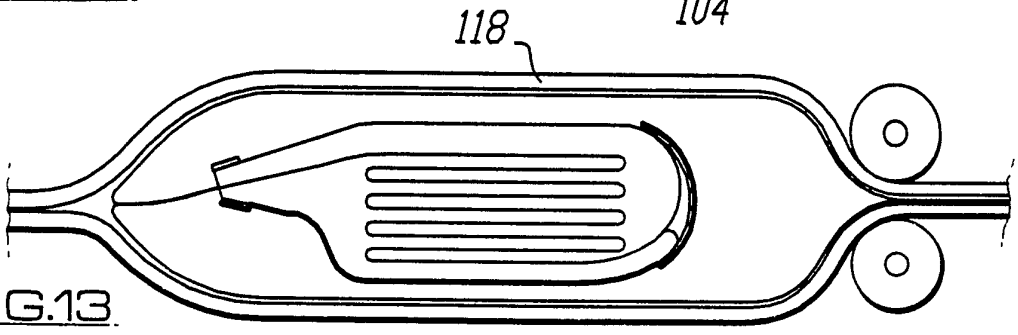

FIG.13

INTERNATIONAL SEARCH REPORT

Interr al Application No
PCT/GB 94/00762

A. CLASSIFICATION OF SUBJECT MATTER
IPC 5 B29C63/36 F16L55/165

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 5 F16L B29C D06G

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

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP,A,0 393 304 (MÜLLER, HANS) 24 October 1990 see figures 1,2	1,13
A	WO,A,90 11175 (INSITUFORM GROUP LIMITED) 4 October 1990 see figures	1,13

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

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"O" document referring to an oral disclosure, use, exhibition or other means

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
16 June 1994	25. 07. 94

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax (+31-70) 340-3016	Budtz-Olsen, A

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INTERNATIONAL SEARCH REPORT

Information on patent family members

Inter nal Application No
PCT/GB 94/00762

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		AU-B-	612858	18-07-91
		AU-A-	3719789	25-01-90
		DE-D-	58906539	10-02-94
		EP-A-	0351570	24-01-90
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		EP-A-	0464121	08-01-92
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