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DescriptionBackground of the invention

- 5 The invention relates to a method for expanding the end of a pipe, particularly of a multi-layer composite pipe or of a thin-walled metal pipe.

Prior art

- 10 Particularly in the field of home installations, pressings have evolved over the past years as standard connection methods for pipes. Furthermore, an increasing use of multi-layer composite pipes is observed. These pipes consist of metallic and non-metallic layers bonded to one another by means of adhesives as well as bonding agents. The advantage of multi-layer composite
- 15 pipes consists in the reduction of the necessary cost intensive metal quantities and good processing properties (e.g. easy bending) without losing the advantages of metal pipes. In case of a widely used type of multi-layer composite pipes, an intermediate layer consisting of aluminium is coated with a plastic layer on the inside and on the outside. Multi-layer composite pipes with a
- 20 thin copper layer on the inside as well as an outer plastic coating have been developed as replacement for massive copper pipes which are still regarded among experts as optimal with respect to the food chemistry properties. Especially in case of the latter type of composite pipes certain problems are encountered when using press couplings.
- 25 Basically one differentiates between pipe press-fits of external sealing type, which do without a push-in sleeve inserted into the end of the pipe, and press-fits of internal sealing, in case of which a supporting sleeve is necessary. For press-fits of multi-layer composite pipes – at least in case of small pipe cross-sections as they are used in installation technology – only internal sealing pipe
- 30 press-fits using a supporting sleeve can be used from experience due to the unfavourable compression properties. The supporting sleeves shall be manufactured from a material which is electrochemically comparable to copper – normally brass – because they come into contact with the medium transported

- inside the pipes. Due to the relatively high forces acting radially in case of a press-fit, the wall thickness of these interior supporting sleeves has to be dimensioned relatively large, thereby leading on the one hand to high material costs and on the other hand – this being very detrimental in the practical application – to a reduction of the free pipe diameter in case of ordinary supporting sleeves in the area of small pipe diameters (e.g. $\frac{3}{4}$ inch) by around 30% to 60%, resulting in substantial and not acceptable pressure and streaming losses in case of multiple press-fits connected in series.
- 10 It is known from the field of pipe press-fits for plastic pipes how to widen them by means of a widening tool and how to push them onto a supporting sleeve in the widened state which is maintained by the plastic pipes for a certain time due to the memory effect, with the result that the cross-section narrowing can be more or less compensated by the wall thickness of the supporting sleeves.
- 15 Widening tools used for this purpose have a hollow cylindrical widening tool made of a plurality of widening tool parts arranged in a way as to contact one another, in the conically formed hollow interior of which a mandrel is pressed forward for the widening, such that the widening tools parts expand and therefore expand the pipe end into which the widening body has been inserted.
- 20 Usage of suitable widening tools for multi-layer composite pipes has however proved to be problematic because the individual parts of the widening body of the widening tool don't distribute the widening forces uniformly around the circumference, such that inhomogeneities are created particularly on the interior side of the pipe. In case of plastic pipes this is no problem due to their elasticity. In case of multi-layer composite pipes it has however been found that the non-uniform force distribution leads to cracks in the metal layer of the composite pipe already in case of small widening dimensions, and therefore to the uselessness of the pipe end. This problem can also arise in case of thin-walled
- 30 metal pipes.

A smoothing sleeve for solving this disadvantage is proposed in EP-A-1 674 241, which is arranged between the widening body of the widening tool and the

interior of the pipe. In this way it is possible to avoid a non-uniform deformation by the individual widening segments, however cracking of the metal layer is still possible. A widening tool of this kind is known from EP-A-2 153 917, having a limiting sleeve. In this way it is possible to better avoid damage of multi-layer composite pipes. However, the multi-part widening body of this widening tool may also lead to an inhomogeneous widening and potentially to layer cracks in the widened end of the pipe. US 3 677 684 A shows a widening tool without calibration sleeve with two widening areas provided for pipes with different inner diameters.

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Description of the invention

It is the objective of the invention to provide an improved method for widening, which is particularly better suitable for multi-layer composite pipes and for thin-walled metal pipes. Particularly, a more uniform widening shall be possible with it.

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This objective is reached by the features of claim 1 for the method mentioned at the beginning.

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Due to providing two widening areas in the tool, with different distances between the widening body and the calibration sleeve, the widening can be performed within the same widening tool in two steps. A larger widening is created during the first widening process in the first step and a smaller widening in the second step during the second widening process. Together they result in the desired total widening. The sleeve acts as calibration sleeve which sets the outside dimension for the end of the pipe, which is impinged by the widening body. It has been noticed that in this way the widening can be done in a much more homogenous way, thereby avoiding damage of the pipe during widening.

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It is particularly preferred that the distances between the widening body and the calibration sleeve are chosen in such a way for both widening areas separated by the step that a widening of 90% results in the first widening process and the

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rest of the widening takes place to 100% of the desired widening or of the widening preset by the widening tool.

In a preferred embodiment the step runs obliquely, thereby simplifying in the second widening area the push of the pipe which was widened already in the first widening area. In a further preferred embodiment the calibration sleeve is arranged on the tool casing in a replaceable manner, thereby allowing use of calibration sleeves with different diameters for different pipe diameters or pipe diameter ranges, respectively. The replacement can be carried out in a particularly simple way if the calibration sleeve is made in two parts and comprises a first outer sleeve attached to the tool casing and a second sleeve which is insertable into the first sleeve. Removal of the widened pipe is simplified if the calibration sleeve has a conical inner surface opening against the insertion opening of the calibration sleeve in a preferred embodiment. A conicity of some degrees suffices.

It is particularly preferred that in case of opened widening tool the surface of the widening tool, which is facing the expanding mandrel, is located by the expanding mandrel along its entire length. It has been noticed that in this way a tilt effect of the individual parts of the widening tool can be avoided during widening, thus reducing the risk of cracks in layers of the pipe, as well as making possible a cylindrical widening along a longer area. The front end of the expanding mandrel in idle position of the widening tool (corresponding to the opened position of the tool, in which the end of the pipe is inserted into the tool) is aligned with the end of the widening body or it protrudes above it.

Furthermore it is preferred that the conical expanding mandrel is attached inside the widening tool in such a way that the expanding mandrel is replaceable. Therefore, it is possible to choose in a simple way from a set of expanding mandrels the expanding mandrel with its conicity (being e.g. in the range from 5 degrees to 10 degrees) fitting to the desired widening and to use it in the widening tool. The expanding mandrel may have a screw thread, allowing screwing on or screwing in the operating device, e.g. at its rear end by means of which it is attached to the operating device.

In case of a special embodiment it is possible to engrave a bead into the widened end of the pipe together with the widening in the second widening area. For this, the widening body has an annular shape (which may also be interrupted if the bead shall have interruptions) in its second widening area, which shape is engraved into the pipe material during the second widening step. If the calibration sleeve has a recess corresponding in terms of position with the annular shape, it is possible to engrave a deeper bead.

10 Short description of the drawings

In the following embodiments of the invention will be described in more detail by means of the drawings. It is shown in

15 Fig. 1 a front view onto a widening tool for describing the method according to the invention with the widening body in the idle position and with an inserted end of a pipe which has not yet been widened;

Fig. 2 a vertical section view through the widening tool in the position of Fig. 1
20 and with the pipe inserted into the first widening area;

Fig. 3 the view of Fig. 2 after widening the pipe in the first widening area;

Fig. 4 a view in case of which the widening tool is again in idle position and the
25 widened end of the pipe has been inserted into the second widening area;

Fig. 5 the widening of the pipe in the second widening area by the widening body;

30 Fig. 6 a tool according to an aspect which is not according to the invention in idle position of the tool and in a vertical section view in an embodiment in case of which the expanding body has a shaping and the calibration sleeve has a recess corresponding to its position for shaping;

Fig. 7 the view of Fig. 6 but in working position of the tool in which the bead has been pressed into the pipe;

- 5 Fig. 8 a further embodiment not according to the invention like Fig. 6 but without recess in the calibration sleeve; and

Fig. 9 the embodiment of Fig. 8 in the working position.

10 Embodiments of the invention

The method is described by the drawings 1-5 with respect to a first embodiment of the widening tool. Fig. 1 shows a front view on the tool from the front or a view in direction of the arrow A of Fig. 2, respectively. Fig. 2 shows a vertical
 15 section view through a part of the tool, wherein only the parts above the longitudinal middle axis R are shown, because the tool is assembled in a substantially rotational symmetric way about the axis R with respect to the elements of tool which are relevant for the invention. The widening body 22 is visible in Fig. 1, being assembled of multiple widening body parts 4, as known.
 20 In this example there are six widening body parts. This widening body 22 is arranged inside a tool casing 2 which is only indicated in the figures and which is formed in the way known by the skilled person for these tools, except if something different is described in the following. The widening tool may be a manually actuated tool or, as the case may be, a pneumatically or electrically
 25 actuated widening tool. Only one element of the actuating means with the lever section 3 is indicated in the figures, as well as in Fig. 2 to Fig. 5 the expanding mandrel 30 as the main element of the actuating means for expanding the widening body, which will be explained later. In the idle position of the widening tool or the insertion position for the end of the pipe 12 to be widened,
 30 respectively, shown in Fig. 1 and 2, the parts 4 of the widening body lie substantially side by side and the widening body has its smallest diameter in the idle position. In the section views of Fig. 2 to 5 it can be seen that the widening body has a step 5 extending in an annular way around the widening body 22. It

is shown here as bevelled step, which is preferred. The step 5 of the widening body separates a first area 6 of the widening tool from a second widening area 7 of the widening tool. In the shown idle position (or in case of a non-expanded widening body, respectively) there is a distance between the outer surface 4' of a calibration sleeve 10 of the widening tool 22 and the inner surface 10' of a calibration sleeve 10 of the widening tool. In the first widening area 6 which extends from the insertion opening 13 for the end of the pipe until the step 5, this distance is larger than in the second widening area 7 which extends from the step 5 to a rear abutment 19 of the widening body.

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Fig. 2 shows the distance at the first widening area 6 as d_1 and at the second widening area as d_2 . The distances are chosen in such a way that a widening of about 90% of the maximum widening results in the first widening area 6, when the widening body is expanded and such that the rest of the widening up to the maximum widening results in the second widening area 7. This will be described in the following. Fig. 2 shows that the end of a multiple layer composite pipe 12 is pressed onto the widening body 22, wherein this has been done up to the step 5. The end of the pipe 12 to be widened is therefore located in the first widening area 6 and the second widening area 7 is not used for the first step of the widening.

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The widening body 22 normally has a substantially cylindrical outer shape. The individual parts 4 of the widening body 22 are kept together e.g. by an elastic element 14 which may e.g. be an O-ring made of rubber. The widening body 22 formed in this way is kept inside the casing 2 of the widening tool 1, wherein this is done by means of an annular nut 13 which is formed by a bridge 17 and an abutment 18 in the shown example. An annular flange 28 of the widening body 22 is received in this nut, being formed at the individual parts 4. The widening body 22 furthermore has an inner opening 20, the walls 21 of which run in a conical way towards the front face 23 of the widening body 22. This makes possible the widening movement by inserting a conical expanding mandrel 30 into the hollow space 20, which presses the individual parts of the widening body radially towards the exterior when the expanding mandrel is shifted in

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direction of the arrow B, which will be explained in more detail in the following. The shifting or the actuation of the expanding mandrel 30, respectively, in direction of arrow B is not described here in more detail because it is known by the person skilled in these widening tools. The expanding mandrel 30 may be
5 actuated by manual levers in direction B and may also be pulled back in the opposite direction again or the mandrel 30 may be actuated pneumatically, hydraulically or in other ways.

Preferably, the expanding mandrel 30 is attached in a replaceable way at the actuating means of the widening tool, this being indicated in Fig. 2 by the recess
10 30' with inner thread. This makes possible the replacement of an expanding mandrel, wherein the expanding mandrels may differ from one another particularly in the slope of their conicity, which may e.g. lie between 5 degrees and 10 degrees.

It is furthermore preferred that the widening body 22 lies entirely on the
15 expanding mandrel 30 with its walls 21, already in the idle position shown in Fig. 2. In other words the expanding mandrel 30 has such a length that it reaches the front end 23 of the widening body 22 or even protrudes beyond it already in the idle position – without shifting in direction B by the actuation device -, as shown. It has been noticed that in this way a more uniform widening movement
20 can be reached, thereby also avoiding damage of the pipe.

In Fig. 3 it is shown that the expanding mandrel 30 has been forced forward in direction B, thereby forcing apart the widening body 22 or its parts 4, respectively. In this way the end of the pipe is widened. This widening is limited
25 by the calibration sleeve 10, wherein the outer side 12' of the widened end of the pipe 12 comes to lie at the inner side 10' of the calibration sleeve 10. The calibration sleeve 10 is preferably arranged in a replaceable way at the tool casing 2, e.g. by means of the shown screw connection 16. The shown two-part embodiment of the calibration sleeve 10, in case of which it has an outer sleeve
30 section 8 and an insertion sleeve 9 which is insertable into the outer sleeve part 8, is particularly preferred. In this way the replacement of the calibration sleeve and thereby the adjustment of the distances d1 and d2 is simplified by choosing different calibration sleeves.

The widening by means of the first widening area 6 or the first widening process shall result in around 90% of the total desired widening of the end of the pipe. This can be determined by choosing the appropriate calibration sleeve.

- 5 Fig. 4 shows that the widening tool is again in idle position. This is reached by again pulling back the expanding mandrel 30 by means of the actuating device (counter to arrow direction B). The widening body 22 also follows this movement and adopts again the idle position due to the elastic element 14. Now, the end of the pipe widened before in the first widening area can be
10 pressed into the second widening area 7. The pipe 12 can additionally be rotated a little about its longitudinal axis.

Fig. 5 shows the following second widening step. Again, the expanding mandrel is pressed forward in the direction B in order to force apart the widening body.

- 15 The end of the pipe is widened in this way in the second widening area 7 against the calibration sleeve and the latter limits the widening. The entire desired widening is accomplished by this second widening step.

- A shaping at the widening body 22 could be provided in the second widening
20 area 7, as shown in the following by Fig. 6 or Fig. 8 in case of another tool. Furthermore, a recess could be provided in the calibrating sleeve, corresponding with its position with the shaping at the widening body 22, as shown in Fig. 6, such that a bead is pressed into the material during the second widening step.

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- Consequently, a widening body 22 is provided with a calibration sleeve 10 surrounding it in case of a widening tool 1 for pipe ends. The widening is done against the calibration sleeve, which results in a defined widening in the tool. The widening body has a step 5. This results in two different widening areas 6,
30 7 which are used in two consecutive steps. In a first step a widening of about 80% to 90% of the total desired widening is carried out and in the second step the rest of the widening is carried out. In this way the tool is well suited for

multiple layer composite pipes which tend to crack in their layers when the pipe is widened.

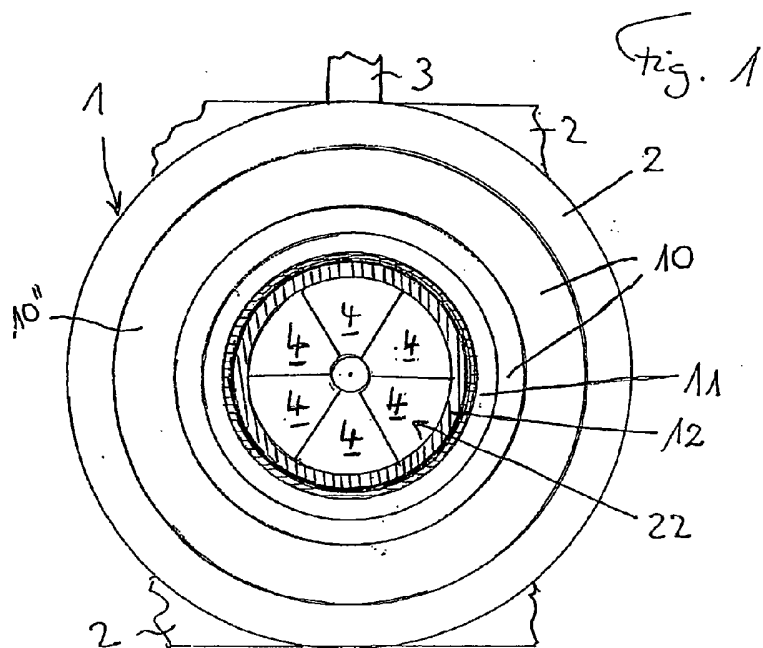
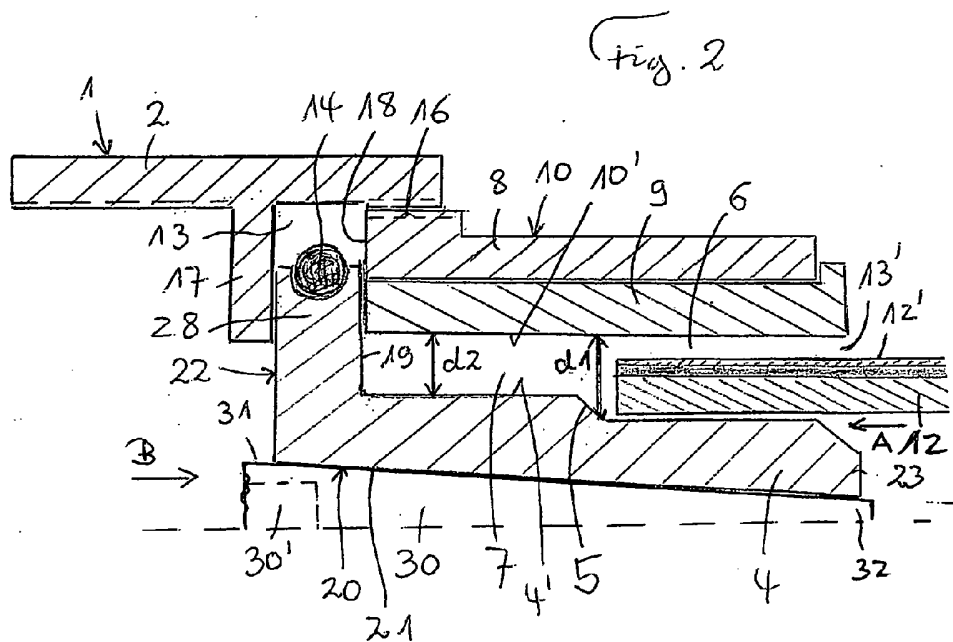
Fig. 6 to 9 show a tool not according to the invention, which is constructed in a very similar way to the described widening tool. However, the tool according to Fig. 6 to 9 doesn't widen the end of the pipe but presses a bead into it. Same or similar parts like in case of the widening tool of Fig. 1 to 5 have same references. The preceding description is referenced, which is incorporated here by reference to the preceding pages. Consequently, a tool casing 2 and a calibration sleeve 10 which is particularly formed in two parts with an outer sleeve 8 and an inner sleeve 9, are particularly provided. In the embodiments of Fig. 6 and 7 the insertion sleeve is separated. An expanding mandrel 22' which is formed by multiple expanding mandrel parts 4, like the widening body 22, is expanded by an expanding mandrel 30 when the latter is forced in the direction B. For this, a not shown actuation device is present. It is referred to the preceding description of the widening tool regarding its form. It is visible in Fig. 6 and 7 that the expanding body and the calibration sleeve are formed and arranged here in such a way that no widening of the end of the pipe 12 results. A deformation of the pipe material results however when the expanding body is widened by the expanding mandrel, due to a shaping 25 at the expanding body 22' and a recess 26 in the calibration sleeve 10, which corresponds with the shaping 25 with respect to its position. In this way a bead or in other words an annular nut is pressed into the end of the pipe. It may e.g. serve for receiving an O-ring. Fig. 8 and 9 show a variant in case of which only the shaping 25 is provided, however not the recess 26 in the calibration sleeve. Therefore a bead or a nut, respectively, with a smaller depth is introduced into the pipe. The outer walls of the pipe remains substantially even in this variant and has no protrusions, as this is the case for the variant of Fig. 6 and 7.

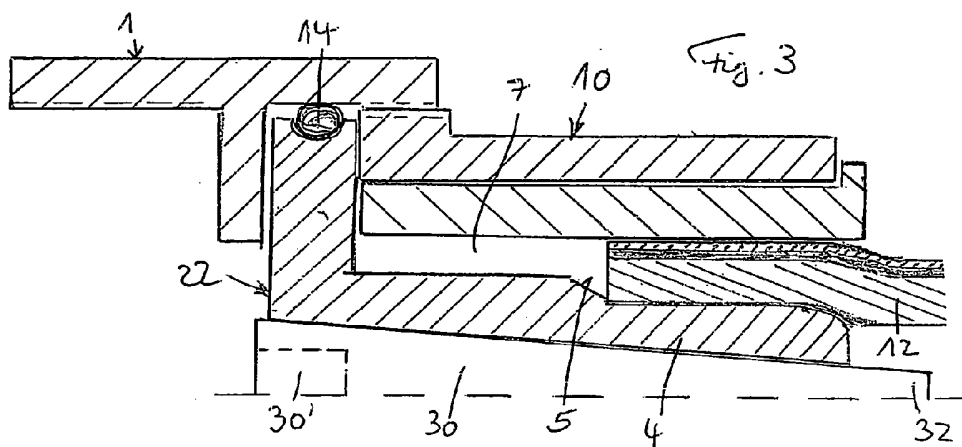
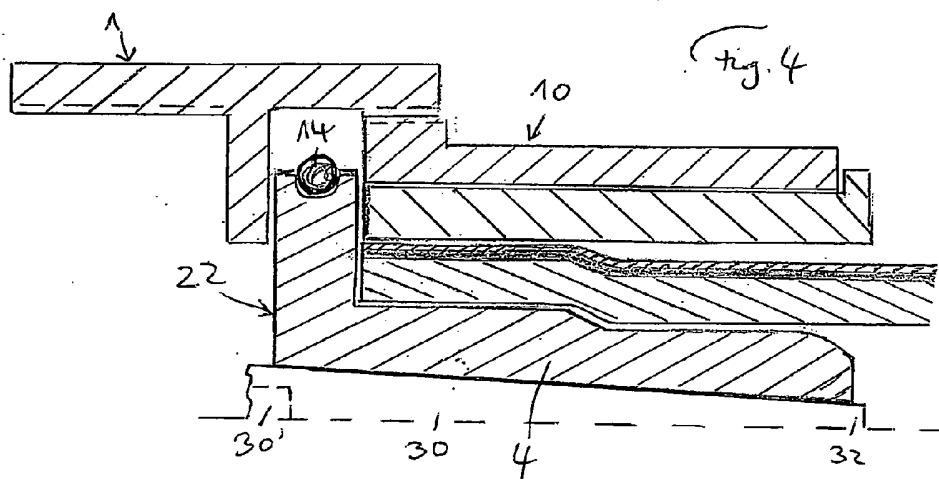
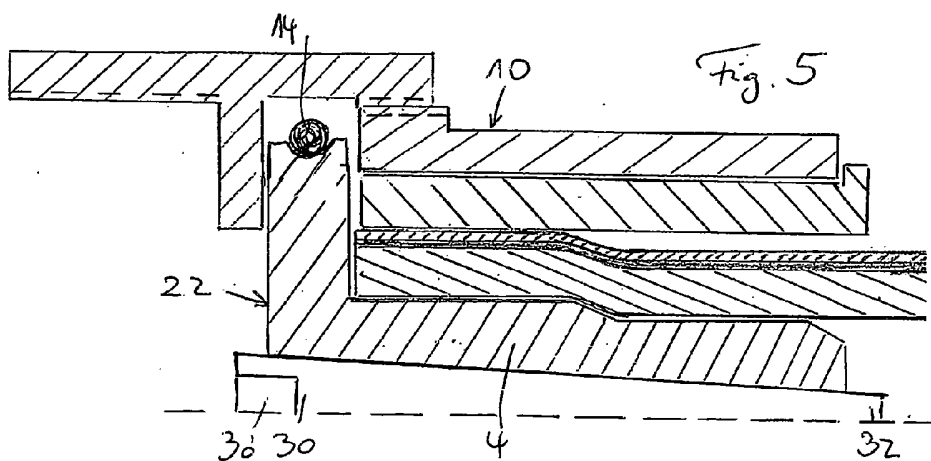
Patentkrav

1. Fremgangsmåde til udvidelse af enden af et rør, især et flerlaget kompositrør eller et installationsrør af metal, **kendetegnet ved, at**
5 udvidelsesproceduren foretages i to trin under anvendelse af et udvidelsesværktøj (1), som er indrettet til at udvide en ende af et rør (12), og et værktøjshus (2), en aktiveringsindretning med en sprededorn (3, 30), et ved hjælp af sprededornen (30) udvideligt og af flere dele bestående udvidelseslegeme (22; 22') samt en ved værktøjshuset (2) fastgjort,
10 udvidelseslegemet omgivende hylse, og hvor udvidelseslegemet (22) har et trin, idet udvidelsesværktøjet har to forskellige, til en udvidelse beregnede udvidelsesområder med forskellig afstand mellem udvidelseslegemet (22) og den som kalibreringshylse virkende hylse (10), og at der i en første udvidelsesprocedure – ved hjælp af udvidelseslegemet – i et område af trinnet
15 foretages en udvidelse af rørenden med mere end 80%, men mindre end 100% af den ønskede udvidelse af rørenden, og at der derefter i en anden udvidelsesprocedure foretages en anden udvidelse op til 100% af den ønskede udvidelse, idet udvidelseslegemet befinder sig i et område bag nævnte trin.
- 20 2. Fremgangsmåde ifølge krav 1, **kendetegnet ved, at** nævnte afstand i forbindelse med det første udvidelsesområde er således valgt, at den kan klare en udvidelse på omkring 90%, og at nævnte afstand i forbindelse med det andet udvidelsesområde er således valgt, at den kan klare den resterende udvidelse op til 100%.
- 25 3. Fremgangsmåde ifølge krav 1 eller 2, **kendetegnet ved, at** det nævnte trin er skråt udformet.
4. Fremgangsmåde ifølge et af kravene 1 til 3, **kendetegnet ved, at** den
30 anvendte kalibreringshylse (10) er således indrettet, at den kan udskiftes på værktøjshuset.

5. Fremgangsmåde ifølge krav 4, **kendetegnet ved, at** den anvendte kalibreringshylse (10) er todelt udformet og omfatter en ved værktøjshuset fastgjort ydre første hylse og en i den første hylse indstikkelig anden hylse.
- 5 6. Fremgangsmåde ifølge et af kravene 1 til 5, **kendetegnet ved, at** den anvendte kalibreringshylse har en konisk forløbende, hen mod en indføringsåbning i kalibreringshylsen sig åbnende inderflade.
7. Fremgangsmåde ifølge et af kravene 1 til 6, **kendetegnet ved, at** det,
10 når det anvendte udvidelsesværktøj er åbent, gælder, at over for sprededornen (30) beliggende flade på udvidelseslegemet, i hele sin længde kan bringes til at ligge an mod sprededornen.
8. Fremgangsmåde ifølge et af kravene 1 til 7, **kendetegnet ved, at** den
15 anvendte sprededorn er således fastgjort i udvidelsesværktøjet, at den kan udskiftes.
9. Fremgangsmåde ifølge et af kravene 1 til 8, **kendetegnet ved, at** det anvendte udvidelseslegeme i udvidelsesområdet har en lille afstand mellem sig
20 selv og kalibreringshylsen, og har en ringagtig form.
10. Fremgangsmåde ifølge krav 9, **kendetegnet ved, at** den anvendte kalibreringshylse har en med sin ringagtige form positions-korresponderende udtagning.

1





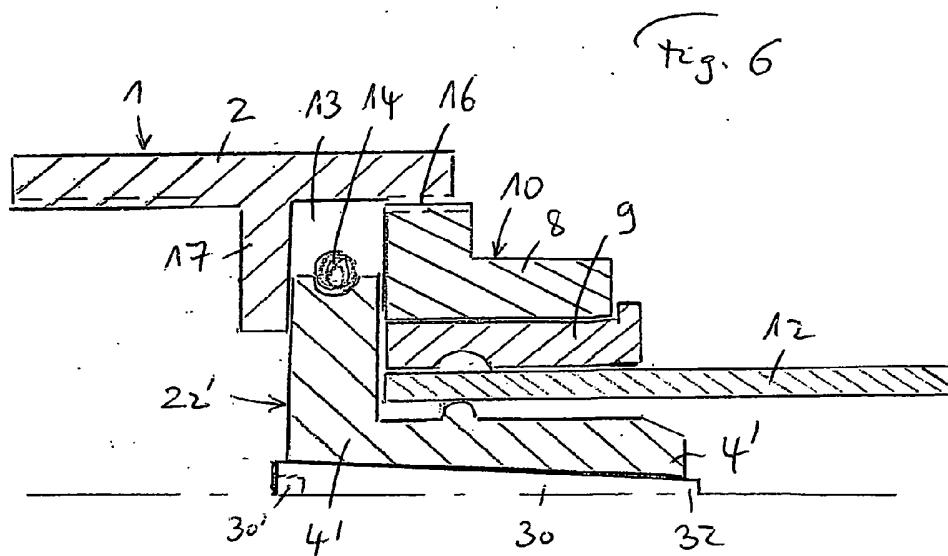
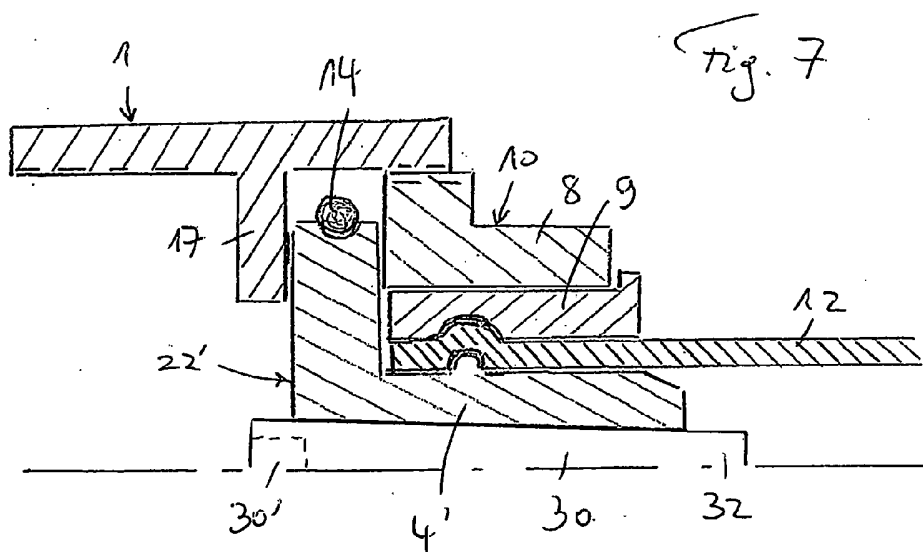


Fig. 8

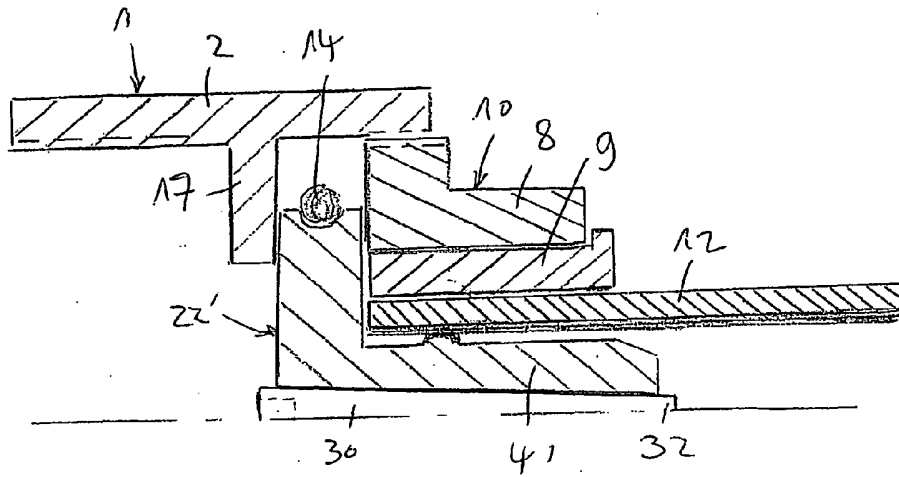


Fig. 9

