

Expanding Tool for Cold Forming  
Technical Field

The present invention relates to an expanding tool  
5 consisting of a generally cylindrically shaped expanding  
mandrel which is provided with an at least partially  
conically shaped inner bore and which is subdivided in  
axial direction into a multiple number of expanding members  
substantially having the shape of a cylindrical sector,  
10 further consisting of respective holding members protruding  
from the outer circumference of the expanding members,  
biasing means acting upon the holding members for biasing  
the expanding members into mutual engagement in order to  
form the generally cylindrically shaped expanding mandrel,  
15 a housing within which the holding members are radially  
displaceably guided, conically shaped expanding means for  
engaging the at least partially conically shaped inner bore  
of the expanding mandrel, and actuating means for axially  
displacing the expanding means within the inner bore of the  
20 expanding mandrel and expanding the same against the force  
of the biasing means.

Background Art

25 Such expanding tool is known from German Published Patent  
Application No. 42 20 794 and serves for expanding tube  
ends of tubes, which are made of plastics and which are  
reversibly deformable in a manner such that the tube ends  
can be firmly and sealingly connected to other tubes or a  
30 tube connector.

A similar expanding tool is known, for example, from  
European Published Patent Application No. 0 619 152 and  
contains a clamping cap which is connected to the expanding



members by means of specifically constructed connecting and guiding means.

Furthermore, there is known from German Published Patent  
5 Application No. 38 17 442 as well as German Utility Model  
No. 94 04 513 a connector comprising at least one  
connecting member for connection to a reversibly expanded  
tube end. For firm and sealing connection to the tube end,  
the connecting member is provided with at least one holding  
10 element defining an outer surface which gradually slopes  
towards the free end of the holding member, and a steeply  
sloped surface on the opposite side. The gradually sloping  
outer surface facilitates pushing-on the expanded tube end  
while the steeply sloped surface conjointly with the  
15 gradually sloping outer surface defines a sealing edge  
which is of significance for forming the firm and sealing  
connection.

The initially mentioned expanding tool includes an  
20 expanding mandrel which forms a closed circumferential  
surface only in the non-actuated condition of the expanding  
means. In the actuated, i.e. expanded condition, the  
expanding members are forced outwardly and thus apart from  
each other under the action of the expanding means.  
25 Consequently, there exist gaps which are formed between the  
expanded expanding members in the circumferential direction  
of the expanding mandrel and which extend along the  
expanding mandrel. The expansion of the tube end, which is  
placed onto the expanding mandrel, will be incomplete in  
30 the region of these gaps so that the inner wall of the  
expanded tube end does not define a closed cylindrical  
surface but includes less expanded sections which are  
distributed in circumferential direction. As a consequence,  
the expanded tube end may not uniformly engage the  
35 connecting member around its circumference whereby the



strength and tightness of the thus formed connection may be adversely affected.

Disclosure of the Invention

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Accordingly, it is the object of the invention to provide an expanding tool of the initially mentioned type which ensures firm and sealing engagement of the expanded tube end to the particular connecting member.

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In accordance with the invention, this object is achieved in that each one of the expanding members comprises a recess which is located intermediate the free end and the holding member and which extends along the circumference of the expanding member.

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The inventive construction of the expanding members has the consequence that the expansion of the tube end will not be effected in a non-uniform manner in the region of the recesses but rather uniformly to good approximation. While the expansion of the tube end may be somewhat less in this region, this smaller expansion will only little or not at all impede placing the tube end onto the particular connecting member. When the expanded tube end is pushed onto the particular connecting member, this region rather uniformly engages the outer surface of the particular connecting member whereby the desired firm and sealing connection is ensured in the end.

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In an advantageous further development of the invention, a ring which is made of a self-reconvertible material, is received within the recess and substantially fully or partially fills the recess. The material of the ring may be selected from either (i) an elastic material, (ii) a material which is self-reconvertible at ambient

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temperature, or (iii) a material having a reconversion behavior comparable to that of the tube end to be expanded; the ring may also be made of a reinforced material.

5 In the presence of such ring there is likewise formed a uniformly deformed region at the inner wall of the expanded tube end, however, this region protrudes less into the interior as the region formed in the absence of the ring. In comparison, pushing-on the tube end onto the connecting  
10 member is facilitated thereby. The advantage of the uniformly deformed region is preserved and there is gained the additional advantage that the ring contributes to an improved mutual hold of the expanding members to each other and also provides a higher restoring force which acts upon  
15 the expanding members after withdrawal of the expanding cone.

It is particularly advantageous using an expanding tool in conjunction with connectors having connecting members  
20 which comprise the aforementioned holding elements including a sealing edge and wherein the recesses at the expanding members are aligned to the holding elements. Specifically, the recesses at the expanding members may be arranged in a manner such that the sealing edge at the  
25 holding element is disposed symmetrically relative to the recesses. If desired, there may be provided more than one recess at the expanding mandrel and more than one sealing edge at the connecting member.

30 In such construction of the expanding mandrel, the less but uniformly expanded region of the tube end extends in circumferentially closed manner around its inner wall and experiences temporary expansion and self-reconversion when pushed over the sealing edge of the particular connecting  
35 member. It is thereby ensured that at least this region of



the tube end firmly and sealingly engages the connecting member on both sides of the sealing edge whereby a firm and sealing connection is formed *in toto*.

5 Exemplary embodiments of the inventive expanding tool are illustrated in the drawings and will be explained and described in detail hereinbelow having regard to the reference characters. There are shown in

10 Brief Description of the Drawings

Figure 1 a longitudinal section through a first exemplary embodiment of the expanding tool according to the invention;

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Figure 2 a cross-section through the expanding tool as shown in Figure 1 along the line II-II;

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Figure 3 a view of a connector which may be used in connection with the expanding tool as shown in Figure 1 or Figure 4;

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Figure 4 a longitudinal section through a modified construction of the expanding tool as shown in Figure 1; and

Figure 5 a longitudinal section through a further exemplary embodiment of the inventive expanding tool.

30 Preferred Embodiments of the Invention

Figure 1 shows a longitudinal section through a first exemplary embodiment of an expanding tool including a housing 1 which contains at one end thereof actuating means  
35 2 for actuating the expanding tool. In the illustrated



exemplary embodiment the actuating means 2 comprise a pressure fluid operated piston 3 which is connected to expanding means in the form of an expanding cone 4 by means of, for example, a screw connection. Instead of the  
5 pressure fluid operated piston 3 there may also be provided different actuating means like, for example, mechanical actuating means. The pressure fluid may be axially or radially fed to the housing 1. The housing 1 may be provided with holding means permitting the housing to be  
10 held during operation; the housing is constructed such as to also permit overhead work.

At the opposite end of the housing 1 there is arranged a generally cylindrically shaped expanding mandrel 5. This  
15 expanding mandrel 5 contains an inner bore 6 comprising a conically shaped bore portion 7, which is engaged or can be brought into engagement with the expanding mandrel 4, and a cylindrical bore portion 8 in the free end thereof. At this free end, the expanding mandrel 5 is provided with a  
20 chamfer 9 which may extend at an angle in the range of  $5^{\circ}$  to  $20^{\circ}$  relative to the circumferential surface of the expanding mandrel 5. The edges which delimit the chamfer 9, are rounded. The chamfer 9 as well as its rounded edges prevent damages to the inner wall of the a tube end 19 into  
25 which the expanding mandrel 5 is inserted for expansion.

The expanding mandrel 5 is multiply subdivided in lengthwise direction and comprises a number of expanding members 10 which assume the shape of cylinder sectors; in  
30 the illustrated exemplary embodiment, see Figure 2, the expanding mandrel 5 is subdivided eightfold and thus comprises eight expanding members 10. In the inoperative or non-actuated condition of the expanding mandrel 1, the expanding members 10 engage each other in circumferential

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direction and thus define a generally cylindrical circumferential surface.

5 A thickened section 11 is formed at the inner end of the expanding mandrel 5 or at the inner ends of the expanding members 10, respectively. Holding members extend therefrom and thereby the expanding mandrel 5 is exchangeably held in the associated end of the housing 1. In detail, each one of the holding members comprises an arm 12 which radially  
10 projects from the circumference of the thickened section 11 and which is provided at its circumference with an accommodation 13 for receiving biasing means such as, for example, an annular spring 14. The annular spring 14 exerts a radially inwardly directed bias on the expanding members  
15 10 whereby the expanding members 10 are held in mutual engagement in the non-actuated condition of the expanding mandrel 5 and whereby the generally cylindrical circumferential surface of the expanding mandrel 5 is formed. The radially projecting arms 12 are radially  
20 displaceably placed in guide means at the associated end wall of the housing 1 and such guide means comprise a holding plate 15 and a bearing plate 16 provided with a slide element 17. The holding plate 15 is releasably mounted at the end wall of the housing 1 by means of screws  
25 so that the expanding members 10 or the expanding mandrel 5, respectively, are exchangeably arranged at the end wall of the housing 1 by means of the radial arms 12 and the holding plate 15.

30 Respective recesses 18 are located at the expanding members 10, a recess 18 is located intermediate the thickened section 11 and the chamfer 9 and constructed such as to form a circumferential groove in the closed or non-actuated state of the expanding mandrel 5. Preferably, the



edges of the recesses 18 are bevelled in order to avoid damages to the tube end upon insertion.

5 In this as well as the exemplary embodiments described hereinbelow, the members such as the expanding cone and the expanding members of the expanding mandrel which are subjected to high mechanical stress, are manufactured from high-order tool steel. There is thus prevented, on the one hand, the formation of frictions and seizures between the  
10 parts which act upon each other, and deformation of the expanding members under the action of high expanding forces, on the other hand.

15 In the upper half of Figure 1 the expanding tool is shown in the inoperative condition. In this condition, the expanding cone 5 merely is placed within the conically shaped bore portion 7 of the inner bore 6 of the expanding mandrel 5 and there is no axially directed force which acts upon the expanding cone 4. The expanding members 10 are,  
20 then, in mutual engagement and the expanding mandrel 5 forms a generally cylindrical body as shown in Figure 2.

Upon applying pressure to the piston 3, this piston and therewith the expanding cone 4 are displaced within the  
25 housing 1 towards the expanding mandrel 5. The expanding cone 4 is thereby forced into the conically shaped bore portion 7 whereby the expanding members 10 are urged apart in radial direction against the force of the annular spring 14. The lower half of Figure 1 shows the expanding cone 4  
30 in the terminal position of its displacement path in which position the maximum expansion of the expanding mandrel 5 is achieved. During such expansion, gaps are formed in longitudinal direction between the expanding members 10.



For expansion, the expanding mandrel 5 is inserted, in the inoperative condition of the expanding tool, into a tube end 19 of a material which preferably is self-reconvertible at ambient temperature such as, for example, medium density, high density or cross-linked polyolefin. During such insertion, the end wall of the tube end 19 engages the thickened section 11 and thereby the axial length of the to-be-expanded tube end 19 is delimited. Upon actuating the expanding cone 4, the expanding members 10 are outwardly urged against the force of the annular spring 14 whereby the tube end 19 is expanded by a corresponding amount. During this operation, the inner surface of the tube end 19 engages the outer surface of the expanding mandrel 5, however, not in the region of the aforementioned axial gaps between the forced-apart expanding members 10. Axially extending and inwardly projecting ribs are thereby formed at the inner wall of the expanded tube end 19. Additionally, during the expansion, the inner wall of the tube end 19 also does not engage the circumference of the expanding mandrel 5 in the region of the recesses 18. In correspondence therewith, there are formed at the inner wall of the expanded tube end 19 sections or lands which extend in circumferential direction and protrude inwardly and have a height which is determined by the depth of the respective recesses 18.

The significance of the recesses 18 and the lands formed thereby at the inner wall of the expanded tube end 19 will be recognized in view of the connector to which the expanded tube end 19 is connected by means of its self-reconversion. Such connector may be constructed, for example, like the tube connector according to German Utility Model No. G 94 04 513 and is illustrated in longitudinal section in Figure 4. The tube connector 20 defines a straight piece of tubing comprising connecting



members 21 at its opposite ends. Each one of the connecting members 21 includes a holding element 22 for connection to an expanded tube end like the tube end 19. Each one of the holding elements 22 includes an outer surface 23 which  
5 gradually slopes towards the free end of the tube connector 21 and a sealing edge 24 which steeply slopes on the other side.

The recesses 18 of the expanding members 10 are aligned  
10 to the axial position of the sealing edge 24 at the connecting member 21 onto which the reversibly expanded tube end 19 is placed. Preferably, the sealing edge 24 is symmetrically disposed relative to the recesses 18 such that the lands, which remain at the circumference of the  
15 inner wall at the tube end 19 after expansion, also extend symmetrically relative to the sealing edge 24 in axial direction. During placement of the expanded tube end 19, the lands are subject to a short-time and likewise reversible deformation and, thereafter, engage the  
20 connecting member 21 on both sides of the sealing edge 24 around its entire circumference whereby a firm and sealing connection between the tube end 19 and the connecting member 21 is obtained at least in this region.

25 The connecting member 21, if desired, may comprise more than one sealing edge 24; in such case, there are present more than one recess 18 at corresponding locations of the expanding mandrel 5.

30 Figure 4 is an illustration which corresponds to Figure 1 and shows a modified construction of the expanding tool. Identical parts therein are denoted by the same reference characters. There will be recognized therein the housing 1 containing actuating means 2 in the form of a pressure



fluid operated piston 3 which cooperates with an expanding cone 4.

5 An expanding mandrel 25 includes an inner bore 26 which has conical configuration throughout and extends along the entire axial length of the expanding mandrel 25. Otherwise, also here the expanding mandrel 25 is composed of eight expanding members which are held together under the bias of an annular spring 14. The annular spring 14 is held in an  
10 accommodation 13 of radial arms 12 which extend from a thickened section 11 at the inner end of the expanding mandrel 25 and which are radially displaceably arranged at the end wall of the housing 1 between a holding plate 15 and a bearing plate 16 having a slide element 17.

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The expanding mandrel 25 has a chamfer 9 with rounded edges and at least one recess 18 is located at the expanding members 10 intermediate the chamfer 9 and the thickened section 11. The function of the recesses 18 and  
20 the mode of operation of this expanding tool correspond to those which have been described hereinabove with reference to Figures 1 to 3.

The longitudinally sectional illustration of Figure 5  
25 shows only the expanding mandrel 27 of a further exemplary embodiment; the expanding members of this expanding mandrel comprise one or, if desired, more than one recess 18. The expanding mandrel 27 includes a ring 28 which is inlaid into the recesses 18. Otherwise, the expanding tool is  
30 constructed in correspondence with either Figures 1 and 2 or Figure 4.

The ring 28 completely or partially fills the recesses 18. It is made of an elastic material or a material which  
35 is self-reconvertible at ambient temperature and which



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material, if desired, may be the same as that of the tube end to be expanded. Consequently, a practically uniformly deformed region is formed upon expansion of the tube end in the area of the ring 28 and extends across the inner wall of the tube end; this region has the same effect as the corresponding region which is formed in the absence of the ring 28. However, this region protrudes inwardly to a lesser extent whereby pushing the expanded tube end onto the respective connecting member 20 will be facilitated without adversely affecting the effects which are achieved by the presence of the uniformly deformed region. Additionally, the ring 28 represents part of the biasing means since the presence of the ring 28 has the effect of holding together the expanding members of the expanding mandrel 27 and subjecting the same to an additional restoring force after withdrawal of the expanding cone 4.

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1. Expanding tool consisting of a generally cylindrically  
5 shaped expanding mandrel (5,25,27) which is provided  
with an at least partially conically shaped inner bore  
(6,26) and which is subdivided in axial direction into  
a multiple number of expanding members (10)  
10 substantially having the shape of a cylindrical sector,  
further consisting of respective holding members  
protruding from the outer circumference of the  
expanding members (10), biasing means acting upon the  
holding members for biasing the expanding members (10)  
15 into mutual engagement in order to form the generally  
cylindrically shaped expanding mandrel (5,25,27), a  
housing (1) within which the holding members are  
radially displaceably guided, conically shaped  
expanding means (4) for engaging the at least partially  
20 conically shaped inner bore (6,26) of the expanding  
mandrel (5, 25,26), and actuating means (2) for axially  
displacing the expanding means (4) within the inner  
bore (6,26) of the expanding mandrel (5,25,27) and  
expanding the same against the force of the biasing  
25 means,  
  
characterized in that each one of the expanding members  
(10) comprises a recess (18) which is located  
intermediate the free end and the holding member and  
which extends along the circumference of the expanding  
30 member (10).
2. Expanding tool according to claim 1, characterized in  
that the recess (18) is delimited by bevelled edges.

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3. Expanding tool according to claim 1 or 2, characterized in that a ring (28) is made of a self-reconvertible material and accommodated in the recess (18).
- 5 4. Expanding tool according to claim 3, characterized in that the ring (28) substantially fills the recess (18).
- 10 5. Expanding tool according to claim 3 or 4, characterized in that the material of the ring is selected from either (i) an elastic material, (ii) a material which is self-reconvertible at ambient temperature or (iii) a material having a reversion behavior which is comparable to the material of the tube end to be expanded.
- 15 6. Expanding tool according to claim 5, characterized in that the material of the ring constitutes a reinforced material.
- 20 7. Expanding tool according to any one of the preceding claims, characterized in that the holding member defines a radial arm (12) extending from the expanding member (10) in an end region remote from the free end of the expanding member.
- 25 8. Expanding tool according to claim 7, characterized in that the housing (1) comprises an end wall and guide means (15,16,17) thereat for radially displaceably guiding the holding members.
- 30 9. Expanding tool according to claim 8, characterized in that the expanding members (10) are exchangeably arranged at the end wall of the housing (1).





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10. Expanding tool according to claim 9, characterized in that a guide member (15) of the guide means is releasably mounted at the end wall of the housing (1) and that the expanding members (10) are exchangeably held at the end wall of the housing (1) by means of the holding members and the releasably mounted guide member (15).
11. Expanding tool according to any one of claims 1 to 10, characterized in that the expanding members comprise respective chamfers (9) at their free ends.
12. Expanding tool according to claim 11, characterized in that the chamfer (9) is delimited by rounded edges.
13. Expanding tool according to any one of claims 1 to 12, characterized in that the end region remote from the free end of the expanding member (10) comprises a thickened section (11) from which the holding member extends and which defines an engagement edge for a tube end (19) to be expanded and placeable onto the expanding mandrel (5,25,27).
14. Expanding tool according to claim 13, characterized in that the at least one recess (18) is formed intermediate the thickened section (11) and the chamfer (9).
15. Expanding tool according to claim 14 for use with a connector comprising a connecting member (21) having at least one sealing edge (24), characterized in that the at least one recess (18) at the respective expanding members (10) is aligned to the at least one sealing edge (24) of the connecting member (21).

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16. Expanding tool according to claim 15, characterized in that the at least one sealing edge (24) is symmetrically disposed relative to the at least one recess (18).

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17. Expanding tool according to any one of claims 1 to 16, characterized in that the inner bore (6) of the expanding mandrel (5) is composed of a conically shaped bore portion (7) and a cylindrical bore portion (8).

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18. Expanding tool according to any one of the preceding claims, characterized in that the inner bore (26) of the expanding mandrel (25) is of conical configuration along its entire axial length.

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