(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 241 385 B9

(12) **CORRECTED EUROPEAN PATENT SPECIFICATION**

(15) Correction information:
Corrected version no 1 (W1 B1)
Corrections, see
Description Paragraph(s) 26
Claims EN 1

(48) Corrigendum issued on:
12.04.2017 Bulletin 2017/15

(45) Date of publication and mention of the grant of the patent:
19.10.2016 Bulletin 2016/42

(21) Application number: **08704328.7**

(22) Date of filing: **01.02.2008**

(51) Int Cl.:
B21C 1/24 *(2006.01)* ***B21C 25/04*** *(2006.01)*

(86) International application number:
PCT/JP2008/051619

(87) International publication number:
WO 2009/096034 (06.08.2009 Gazette 2009/32)

(54) **PROCESS FOR MANUFACTURING ULTRATHIN WALL METALLIC PIPE BY COLD DRAWING METHOD**

VERFAHREN ZUR HERSTELLUNG EINES METALLROHRS MIT ULTRADÜNNEN WÄNDEN DURCH EINE KALTZIEHPROZEDUR

PROCÉDÉ DE FABRICATION DE TUYAU MÉTALLIQUE À PAROI ULTRAMINCE PAR ÉTIRAGE À FROID

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MT NL NO PL PT RO SE SI SK TR

(43) Date of publication of application:
20.10.2010 Bulletin 2010/42

(73) Proprietor: **Nippon Steel & Sumitomo Metal Corporation**
Tokyo 100-8071 (JP)

(72) Inventor: **HAYASHI, Chihiro**
Osaka-shi
Osaka 541-0041 (JP)

(74) Representative: **dompatent von Kreisler Selting Werner -**
Partnerschaft von Patent- und Rechtsanwälten mbB
Deichmannhaus am Dom
Bahnhofsvorplatz 1
50667 Köln (DE)

(56) References cited:
WO-A1-2006/126565
WO-A1-2006/126565
JP-A- 7 195 115
JP-A- S5 744 429
JP-A- 57 044 429
JP-A- 2006 341 299
US-A- 5 533 376

Note: Within nine months of the publication of the mention of the grant of the European patent in the European Patent Bulletin, any person may give notice to the European Patent Office of opposition to that patent, in accordance with the Implementing Regulations. Notice of opposition shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

EP 2 241 385 B9

Description

[0001] The present invention relates to a method of cold-drawing a metallic tube, particularly to a method of producing an ultra thin wall metallic tube by a cold drawing process while a producible range is dramatically enlarged on the thin wall side of the metallic tube.

[0002] The metallic tube in a hot finished condition is subjected to a cold working process, when the metallic tube does not satisfy requirements in quality, strength, or dimensional accuracy. Generally, examples of the cold working process include a cold drawing process in which a plug or a mandrel and a die are used and a cold rolling process in which a cold pilger mill is used.

[0003] In the cold drawing process, a tube end of a mother tube is swaged by a swaging machine; acid pickling is performed to remove a surface scale and the like; and lubricating treatment is performed to draw the mother tube through a die. Examples of the cold drawing process include plug drawing, drawing by using a floating plug, drawing by using a mandrel bar, and sinking drawing without a plug. All the cold drawing processes are performed by diameter reduction working with the die (for example, see "Iron and Steel Handbook third edition" vol. 3, (2) Steel Bar, Steel Tube, and Rolling Common Facilities, pp. 1158 to 1183).

[0004] Fig. 1 is an explanatory view showing a diameter reducing drawing process, Fig. 1(a) shows the plug drawing, and Fig. 1(b) shows the drawing by using the mandrel bar.

[0005] The plug drawing shown in Fig. 1(a) is a most common drawing process. In the plug drawing, a plug 3 is inserted into a mother tube 1, the tube end of the mother tube 1 is gripped with a chuck 6, and the mother tube 1 is drawn through a die 2 in the direction shown by an arrow X in Fig. 1. The plug drawing has advantages in plug exchange and operation efficiency, and also allows a large reduction rate.

[0006] The drawing by using the mandrel bar shown in Fig. 1(b) is a process, in which a mandrel bar 5 is inserted into a mother tube 1 and the mother tube 1 with mandrel bar is drawn through a die 2 like plug drawing shown in Fig. 1(a) . In the drawing by using the mandrel bar, since the working of tube inner surface is performed by the mandrel bar, a product tube 7 having a glossy inner surface can be produced with high dimensional accuracy even in small diameter tubes. Therefore, the drawing by using the mandrel bar is used in producing a high grade tube for use in nuclear power plants and the like.

[0007] Most drawing machines used in the cold drawing are driven by a motor with a chain, but some drawing machines are driven hydraulically using medium of either oil or water.

[0008] In the metallic-tube cold drawing process, friction resistance is generated between the outer surface of tube material and the die surface and between the inner surface of tube material and the surface of the plug or mandrel bar, and the drawing is performed against the friction forces. Therefore, tension is generated in a longitudinal direction of tube material. Given tension stress is defined as: tension divided by post-drawing sectional area, when the tension stress becomes high, there occurs a phenomenon that the drawn tube diameter gets unexpectedly smaller, and the tube may rupture in the event that the tension stress reaches a deformation resistance of the tube material. Obviously, the thinner the wall thickness of the tube becomes, the more the tension stress is increased in a longitudinal direction, whereby the tube is ruptured easily. Therefore, there is inevitably a limit to a reduction rate of the wall thickness. Accordingly, in the drawing with the large reduction rate of the wall thickness, it is necessary that the number of drawing be increased to repeat the drawing, and the lubricating work is required in each case, which results in cost increases. In the case where work hardening is significantly generated in the tube material, annealing is also required.

[0009] JP-57044429, on which the preamble of claim 1 is based, discloses a method which requires a special drawing machine. Moreover, the prior art does not disclose a method of producing an ultra thin wall metallic tube by a cold drawing process in which the wall thickness of the mother tube is reduced to perform elongating while the outside diameter is not changed and only the inside diameter is expanded.

[0010] US 5,533,379 discloses a method for preparing a tubular blank having a thick wall for a following cascade drawing operation in which a tubular blank formed by casting or extrusion or the like and having a relatively thick wall is prepared for a following drawing operation, such as a tandem or cascade drawing, by widening one end of the tubular blank with a shackled mandrel.

[0011] In view of the above problems, an object of the present invention is to propose a method of producing an ultra thin wall metallic tube by a cold drawing process in which a producible range can be dramatically enlarged on the thin wall side of the metallic tube. Although the present invention is mainly directed to a thin wall seamless metallic tube, a welded metallic tube is also included in the target of the present invention, since the welded metallic tube is required to correct the uneven wall thickness generated in a welded part or a heat affected zone of the thin wall welded metallic tube.

[0012] The inventor conducted the research and development to solve the above problem based on the issues of the prior art, and the inventor obtained the following findings to complete the present invention.

[0013] Generally, in plastic working of tube materials, the wall thickness reduction is achieved by elongating the tube material in a longitudinal direction of tube. That is, in the cold drawing of tube materials, when the wall thickness is reduced between the die and the plug or mandrel bar, the drawing is performed while the diameter of the tube is reduced, and the tube is elongated in the longitudinal direction. Thus, as long as the elongation is performed only in a longitudinal direction, the reduction amount of wall thickness is considerably restricted to thereby make it difficult to enlarge available range on the thinner wall side.

[0014] The inventor has interpreted the above fact as meaning that since, when the wall thickness of the tube material is reduced by the plastic working, the elongation is performed only in a longitudinal direction, the reduction amount of wall thickness is restricted to thereby make it difficult to enlarge available range on the thinner wall side. Then, the inventor hits upon an idea that the above problem could be avoided when the tube material is elongated in a circumferential direction while elongated in a longitudinal direction in reducing the wall thickness of the tube material by the cold drawing process. When the rolling performed to a ring-shaped product by a ring rolling mill is studied as an extreme case, a ring-shaped blank material is elongated not in a longitudinal direction (axial direction) but only in a circumferential direction of the ring, so that the wall thickness can be infinitely reduced.

[0015] In order to elongate the tube material in a longitudinal direction while elongating it in a circumferential direction in the drawing process, it is necessary that the drawing be performed to reduce the wall thickness while the diameter of the tube material is expanded by using a solid die and a plug or a tapered mandrel bar, the die gradually increasing in diameter from its engaging inlet side toward its work-ending outlet side, either the plug or the tapered mandrel also gradually increasing in diameter over a corresponding distance from the engaging inlet side of toward the work-ending outlet side of the solid die.

[0016] The present invention is made based on the above findings, and the gist thereof pertains to a method of producing an ultra thin wall metallic tube by a cold drawing process according to claim 1.

[0017] The diameter expansion deformation of the tube material does not always require the plastic deformation in which the inside and outside diameters are simultaneously expanded. From the view of mechanics of plasticity, the plastic deformation that entails the expansion of a tube-wall centerline diameter (the mean diameter of inside and outside diameters) is collectively referred to as diameter expansion deformation.

[0018] Accordingly, since the tube-wall centerline diameter is surely expanded even if only the inside diameter is expanded while the outside diameter is not changed, it is also included in the category of the diameter expansion deformation.

[0019] When, even if the outside diameter is reduced, an expansion amount of the inside diameter is larger than a reducing amount of the outside diameter, the tube-wall centerline diameter is expanded, and it is also included in the category of the diameter expansion deformation.

[0020] As used herein, a diameter expansion ratio of inside or outside diameter shall mean a ratio in which the inside or outside diameter of the after-cold-drawing metallic tube is divided by the inside or outside diameter of the before-cold-drawing metallic tube. A diameter reducing ratio of the outside diameter shall mean that the diameter expansion ratio of the outside diameter becomes smaller than 1.

[0021]

Fig. 1 is an explanatory view of a conventional diameter reducing drawing, Fig. 1(a) shows plug drawing, and Fig. 1(b) shows mandrel drawing which uses a mandrel bar.

Fig. 2 is an explanatory view of a diameter expansion drawing process not subject of the present invention in which a wall thickness is reduced to perform elongating while inside and outside diameters are simultaneously expanded, Fig. 2(a) shows the plug drawing, and Fig. 2(b) shows the mandrel drawing.

Fig. 3 is an explanatory view of a diameter expansion drawing process according to the present invention in which the wall thickness is reduced to perform elongating while the inside diameter is expanded and the outside diameter is not changed, Fig. 3(a) shows the plug drawing, and Fig. 3(b) shows the mandrel drawing.

Fig. 4 is an explanatory view of a diameter expansion drawing process according to the present invention in which the wall thickness is reduced to perform elongating while the outside diameter is reduced and the inside diameter is expanded, Fig. 4(a) shows the plug drawing, and Fig. 4(b) shows the mandrel drawing.

[0022] As described above, the present invention is a method of producing an ultra thin wall metallic tube by a cold drawing process in which a drawing machine is used. A first aspect not subject of the present invention is a method of producing an ultra thin wall metallic tube by a cold drawing process in which a drawing machine is used, the method includes the steps of: feeding a mother tube having an expanded portion at an end into a solid die, the solid die gradually increasing in diameter from engaging inlet side toward work-ending outlet side; inserting a plug or a tapered mandrel bar, either of them gradually increasing in diameter over a corresponding distance from engaging inlet side of the solid die toward work-ending outlet side of the solid die, into the mother tube; and drawing the mother tube in the direction from the engaging inlet side toward the work-ending outlet side by gripping the expanded tube-end portion with a chuck, whereby a wall thickness of the mother tube is reduced to perform elongating while inside and outside diameters are simultaneously expanded between the solid die and the plug or tapered mandrel bar.

[0023] In order to put the diameter expansion drawing process of the tube material into practical use, it is preferable that the operation method of the cold drawing is changed as follows in comparison with the conventional drawing process.

[0024] First, a tube-end portion of mother tube is expanded in diameter in a tapered manner by a tube-end expander. For example, a press-expanding technique may be used for the tube-end expander. Second, after the acid pickling and the lubricating treatment are performed to the mother tube having an expanded tube-end, the mother tube is introduced into the solid die from the work-ending outlet side of the solid die and is drawn while being expanded in diameter between the solid die and the plug or tapered mandrel bar, either of them having inner-surface working/restricting diameter larger than the outside diameter of the mother tube. Third, the plug or tapered mandrel bar is also supported from the work-ending outlet side of the die. Although peripheral devices are concentrated on the work-ending outlet side of the die, this provides such a large advantage that the thin wall metallic tube can be drawn.

[0025] Fig. 2 shows an embodiment not subject of the present invention. Fig. 2(a) shows plug drawing and Fig. 2(b) shows mandrel drawing which uses a mandrel bar. As shown in Figs. 2 (a) and 2(b), a solid die 12 increases in diameter from its engaging inlet side (left side of the solid die 12 in Fig. 2) toward its work-ending outlet side (right side of the solid die 12 in Fig. 2), and the mother tube 1 having an expanded tube-end is fed into the solid die 12 from the work-ending outlet side of the solid die 12. A plug 13 or a tapered mandrel bar 15 is inserted into the mother tube 1, the plug 13 or tapered mandrel bar 15 increasing in diameter over a corresponding distance from inlet side of the solid die 12 toward work-ending outlet side of the solid die 12 and the maximum working diameter of the plug 13 or tapered mandrel bar 15 being larger than the outside diameter of the mother tube 1. Then, the mother tube 1 having an expanded tube-end is drawn in the direction shown by an arrow X in Fig. 2 while the expanded tube-end portion of the mother tube 1 is gripped with a chuck 6. Through the operation, the mother tube 1 is drawn while the diameter of the mother tube 1 is expanded between the solid die 12 and the plug 13 or tapered mandrel bar 15.

[0026] Through the above process, the mother tube 1 having an outside diameter .d_0 and a wall thickness t_0 is drawn into a drawn tube product 17 having an outside diameter d and a wall thickness t while the diameter of the mother tube 1 is expanded.

[0027] A second aspect of the present invention is a method of producing an ultra thin wall metallic tube by the cold drawing process, in which its wall thickness is reduced to perform elongating while its outside diameter is not changed and only its inside diameter is expanded. A third aspect of the present invention is a method of producing an ultra thin wall metallic tube by the cold drawing process, in which its wall thickness is reduced to perform elongating while its outside diameter is reduced and its inside diameter is expanded, an expansion amount of the inside diameter being ensured larger than a reducing amount of the outside diameter. Figs. 3 and 4 show embodiments of the present invention. Figs. 3(a) and 4(a) show the plug drawing, and Figs. 3(b) and 4(b) show the mandrel drawing. Through the same process as that of Fig. 2, the drawing is performed while the diameter is expanded between the solid die 12 and the plug 13 or tapered mandrel bar 15.

(Examples)

[0028] In order to confirm the effects of the method of producing an ultra thin wall metallic tube by the cold drawing process according to the present invention, the following tests of three examples were performed to evaluate the results. Since action and effects of the mandrel drawing are substantially identical to those of the plug drawing, only the plug drawing will be described in the examples.

(Example 1)

[0029] A 18%Cr-8%Ni stainless steel tube having an outside diameter of 34.0 mm and a wall thickness of 3.5 mm produced by the Mannesman-mandrel mill process was used as a mother tube for testing, the mother tube was drawn while its diameter was expanded by the cold drawing process, and the obtained tube had an outside diameter of 50.8 mm and a wall thickness of 1.6 mm.

[0030] The test conditions and results are summarized as follows.

Diameter of tapered solid die: D=34.0 to 50.8 mm
Plug diameter: dp=47.5 mm
Mother tube outside diameter: d_0=34.0 mm
Mother tube wall thickness: t_0=3.5 mm
Outside diameter of tube after drawing: d=50.8 mm
Wall thickness of tube after drawing: t=1.6 mm
Expansion ratio of outside diameter: d/d_0=1.49
Elongating ratio: $t_0(d_0-t_0)/\{t(d-t)\}$=1.36
(Wall thickness/outside diameter) ratio: t/d=3.15%
Expansion ratio of centerline diameter of tube wall: $(d-t)/(d_0-t_0)$=1.61

(Example 2)

[0031] A 18%Cr-8%Ni stainless steel tube having an outside diameter of 50.8 mm and a wall thickness of 4.5 mm produced by the Mannesman-mandrel mill process was used as a mother tube for testing, the mother tube was drawn while its diameter was expanded by the cold drawing process, and the obtained tube had an outside diameter of 50.8 mm and a wall thickness of 1.8 mm.

[0032] The test conditions and results are summarized as follows.

Diameter of tapered solid die: D=50.8 to 50.8 mm
Plug diameter: dp=47.8 mm
Mother tube outside diameter: d_0=50.8 mm
Mother tube wall thickness: t_0=4.5 mm
Outside diameter of tube after drawing: d=50.8 mm
Wall thickness of tube after drawing: t=1.8 mm
Expansion ratio of outside diameter: d/d_0=1.00
Elongating ratio: $t_0(d_0-t_0)/\{t(d-t)\}$=2.36

(Wall thickness/outside diameter) ratio: t/d=3.54%
Expansion ratio of centerline diameter of tube wall: $(d-t)/(d_0-t_0)=1.06$

(Example 3)

[0033] A 18%Cr-8%Ni stainless steel tube having an outside diameter of 53.4 mm and a wall thickness of 5.5 mm produced by the Mannesman-mandrel mill process was used as a mother tube for testing, the mother tube was drawn while its diameter was expanded by the cold drawing process, and the obtained tube had an outside diameter of 50.8 mm and a wall thickness of 2.0 mm.

[0034] The test conditions and results are summarized as follows.

Diameter of tapered solid die: D=53.4 to 50.8 mm
Plug diameter: dp=47.4 mm
Mother tube outside diameter: d_0=53.4 mm
Mother tube wall thickness: t_0=5.5 mm
Outside diameter of tube after drawing: d=50.8 mm
Wall thickness of tube after drawing: t=2.0 mm
Expansion ratio of outside diameter: $d/d_0=0.95$
Elongating ratio: $t_0(d_0-t_0)/\{t(d-t)\}=2.70$
(Wall thickness/outside diameter) ratio: t/d=3.94%
Expansion ratio of centerline diameter of tube wall thickness: $(d-t)/(d_0-t_0)=1.02$

[0035] The steel tubes obtained by the above tests of three examples had glossy inner and outer skin surface, and there was no particular issue in quality. In the 18%Cr-8%Ni stainless steel tube having an outside diameter of 50.8 mm, since an available minimum wall thickness by the conventional diameter reducing drawing process is 2.4 mm or so, it is clear that the diameter expansion drawing process of the present invention has the significant advantage.

[0036] The use of the method of producing an ultra thin wall metallic tube by the cold drawing process according to the present invention can dramatically enlarge the producible range on the thin wall side of the metallic tube by the cold drawing process. As a seamless metallic tube having a wall thickness not more than about two-thirds of the conventional cold-finishing seamless metallic tube is economically stably produced by the method of the present invention, thin wall welded metallic tubes such as TIG welded tubes and laser welded tubes can be replaced with the high-reliability ultra thin wall seamless metallic tubes produced by the method of the present invention. When the ultra thin wall seamless metallic tube having a wall thickness in the range from 0.6 to 0.8 mm is stably produced, the ultra thin wall seamless metallic tube can be applied to high-technology fields such as a heating sleeve of a color laser printer, a pressurizing roll of the same, a cell case of a fuel cell, or the like.

Claims

1. A method of producing an ultra thin wall metallic tube (17) by a cold drawing process in which a drawing machine is used, comprising the steps of:

feeding a mother tube (1) into a solid die (12), the mother tube (1) having an expanded tube-end portion,
inserting a plug (13) or a tapered mandrel bar (15) into the mother tube (1), either the plug (13) or the tapered mandrel bar (15) gradually increasing in diameter over a corresponding distance from the engaging inlet side of the solid die (12) toward the work-ending outlet side of the solid die (12); and
drawing the mother tube (1) from the engaging inlet side toward the work-ending outlet side by gripping the expanded tube-end portion with a chuck (6), whereby a wall thickness t_0 of the mother tube (1) is reduced to perform elongating while a tube-wall centerline diameter is expanded between the solid die (12) and the plug (13) or tapered mandrel bar (15), the tube-wall centerline diameter being the mean diameter of the outside and inside diameters of the mother tube (1), **characterized in that** feeding the mother tube (1) into the solid die (12) which is gradually decreasing in diameter from its engaging inlet side toward its work-ending outlet side and reducing the wall thickness t_0 to perform elongating while the outside diameter d_0 is reduced and the inside diameter is expanded, and an expansion amount of the inside diameter being ensured larger than a reducing amount of the outside diameter (d), or

feeding the mother tube (1) into the solid die (12) which is constant in diameter (D) from its engaging inlet side towards its work-ending outlet side and reducing the wall thickness t_0 to perform elongating while the outside diameter (d) is not changed and only the inside diameter is expanded.

Patentansprüche

1. Verfahren zum Herstellen eines ultradünnwandigen Metallrohrs (17) durch einen Kaltziehvorgang, bei dem eine Ziehmaschine verwendet wird, mit den Schritten:

Zuführen eines Ausgangsrohrs (1) in eine feste Druckform (12), wobei das Ausgangsrohr (1) einen erweiterten Rohrendabschnitt aufweist,
Einsetzen eines Stopfens (13) oder einer sich verjüngenden Dornstange (15) in das Ausgangsrohr (1), wobei der Stopfen (13) oder die

sich verjüngende Dornstange (15) über einen entsprechenden Abstand von der aufnehmenden Einlassseite der festen Druckform (12) zu der arbeitsseitigen Auslassseite der festen Druckform (12) allmählich im Durchmesser zunehmen, und

Ziehen des Ausgangsrohrs (1) von der aufnehmenden Einlassseite zu der arbeitsseitigen Auslassseite durch Greifen des erweiterten Rohrendabschnitts mittels einer Spannvorrichtung (6), wobei eine Wanddicke (t_0) des Ausgangsrohrs (1) reduziert wird, um das Strecken durchzuführen, während ein Rohrwandmittelinien-Durchmesser zwischen der festen Druckform (12) und dem Stopfen (13) oder der sich verjüngenden Dornstange (15) erweitert wird, wobei der Rohrwandmittelinien-Durchmesser der mittlere Durchmesser von Außen- und Innendurchmesser des Ausgangsrohrs (1) ist,

dadurch gekennzeichnet, dass ein Zuführen des Ausgangsrohrs (1) in die feste Druckform (12), die sich von ihrer aufnehmenden Einlassseite zu ihrer arbeitsseitigen Auslassseite im Durchmesser allmählich abnimmt, und ein Reduzieren der Wanddicke (t_0) zum Durchführen des Streckens erfolgt, während der Außendurchmesser (d_0) reduziert wird und der Innendurchmesser erweitert wird, und gewährleistet ist, dass ein Aufweitungsbetrag des Innendurchmessers größer ist als ein Reduzierungsbetrag des Außendurchmessers (d), oder ein Zuführen des Ausgangsrohrs (1) in die feste Druckform (12), die von ihrer aufnehmenden Einlassseite zu ihrer arbeitsseitigen Auslassseite im Durchmesser (D) konstant ist, und ein Reduzieren der Wanddicke (t_0) zum Durchführen des Streckens erfolgt, während der Außendurchmesser (d) nicht verändert wird und nur der Innendurchmesser erweitert wird.

Revendications

1. Procédé de production d'un tube métallique à paroi ultra mince (17) par un processus d'étirage à froid dans lequel une machine d'étirage est utilisée, comprenant les étapes :

d'introduction d'un tube mère (1) dans une filière monobloc (12), le tube mère (1) ayant une portion d'extrémité de tube élargie,

d'insertion d'un bouchon (13) ou d'une barre porte-mandrin effilée (15) dans le tube mère (1), le diamètre du bouchon (13) ou de la barre porte-mandrin effilée (15) augmentant progressivement sur une distance correspondante du côté entrée de mise en prise de la filière monobloc (12) vers le côté sortie de fin de travail de la filière monobloc (12) ; et

d'étirage du tube mère (1) du côté entrée de mise en prise vers le côté sortie de fin de travail en saisissant la portion d'extrémité de tube élargie avec un mandrin (6), moyennant quoi une épaisseur de paroi (t_0) du tube mère (1) est réduite pour réaliser un allongement, tandis qu'un diamètre de ligne centrale de paroi de tube est agrandi entre la filière monobloc (12) et le bouchon (13) ou la barre porte-mandrin effilée (15), le diamètre de ligne centrale de paroi de tube étant le diamètre médian des diamètres extérieur et intérieur du tube mère (1), **caractérisé par** l'introduction du tube mère (1) dans la filière monobloc (12) dont le diamètre diminue progressivement de son côté entrée de mise en prise vers son côté sortie de fin de travail et par la réduction de l'épaisseur de paroi (t_0) pour réaliser l'allongement tandis que le diamètre extérieur (d_0) est réduit et que le diamètre intérieur est agrandi, et une quantité d'agrandissement du diamètre intérieur étant garantie plus grande qu'une quantité de réduction de diamètre extérieure (d) ou

l'introduction du tube mère (1) dans la filière monobloc (12) dont le diamètre (D) est constant de son côté entrée de mise en prise vers son côté sortie de fin de travail et la réduction de l'épaisseur de paroi (t_0) pour réaliser l'allongement tandis que le diamètre extérieur (d) n'est pas changé et qu'uniquement le diamètre intérieur est agrandi.

FIG. 1

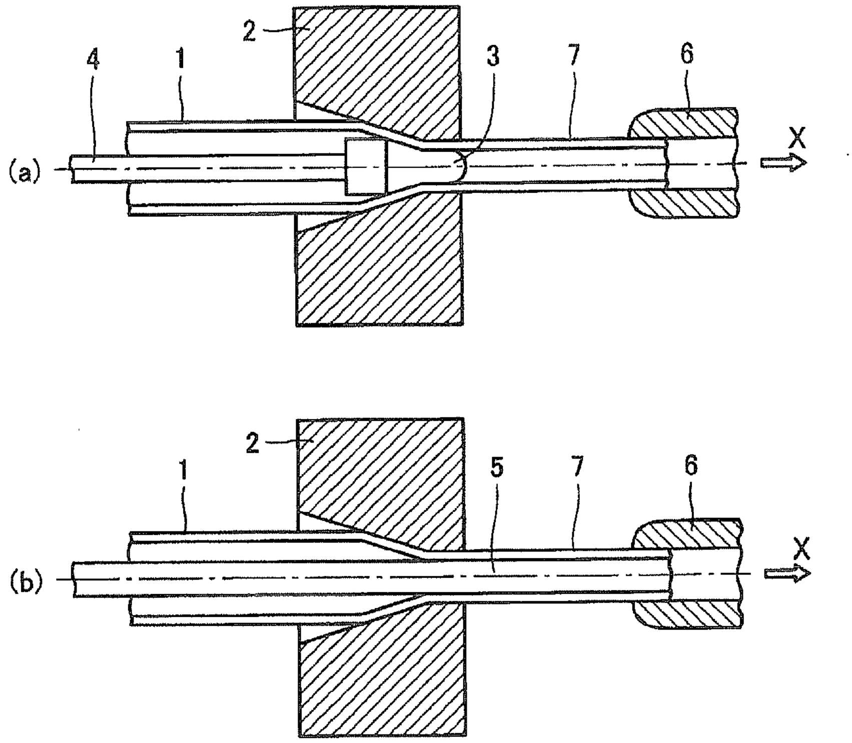

2
4
1
3
7
6
(a)
X
2
1
5
7
6
(b)
X

FIG. 2

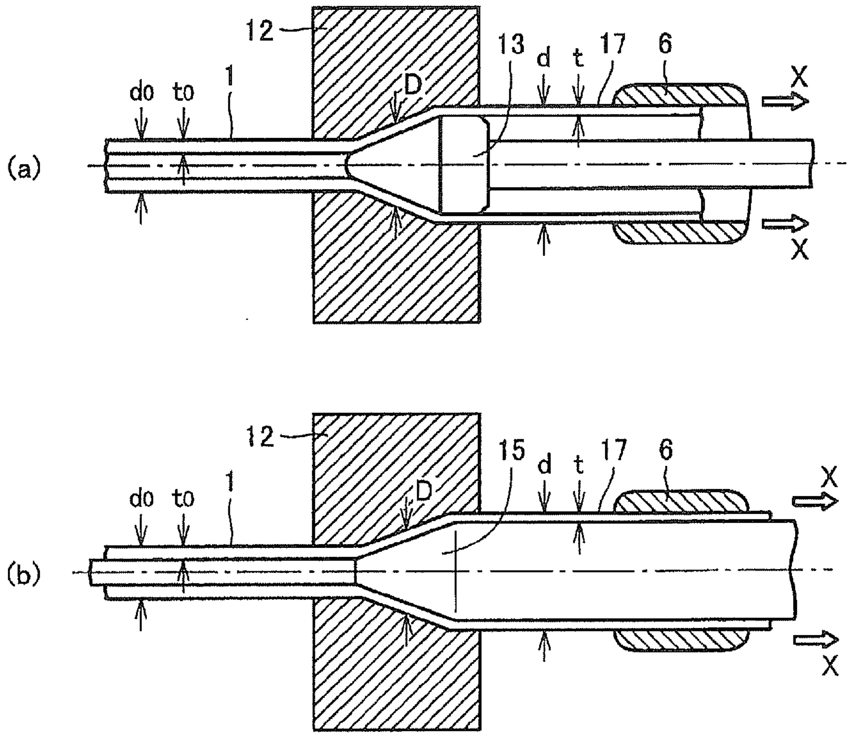

12
13
d
t
17
6
d0
t0
1
D
(a)
X
X
12
15
d
t
17
6
d0
t0
1
D
(b)
X
X

FIG. 3

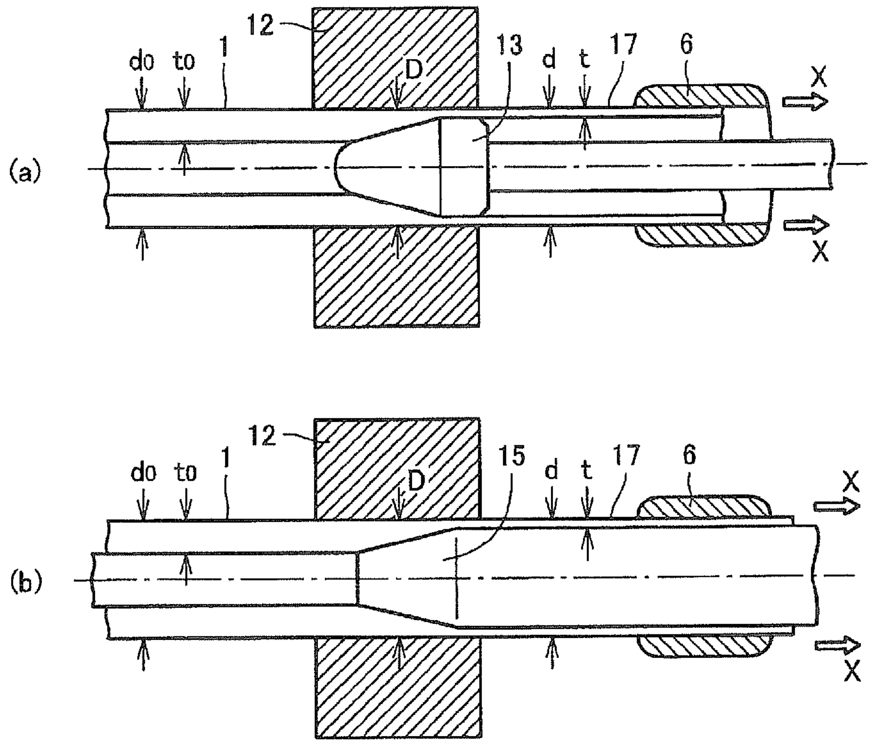
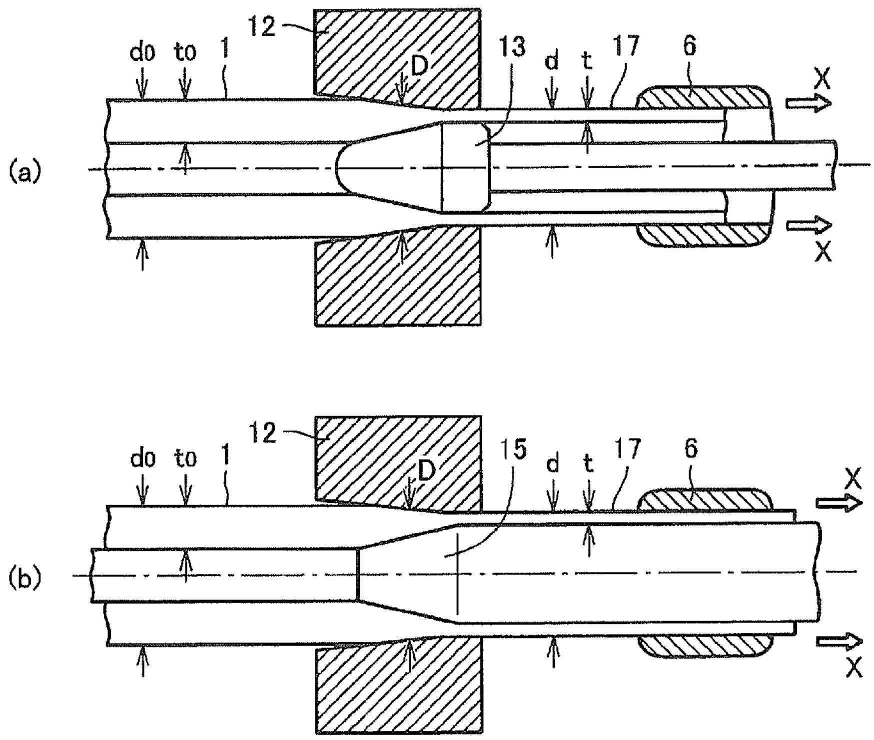


FIG. 4



REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 57044429 B **[0009]**
- US 5533379 A **[0010]**

Non-patent literature cited in the description

- Steel Bar, Steel Tube, and Rolling Common Facilities. Iron and Steel Handbook. vol. 3, 1158-1183 **[0003]**