

METHOD FOR MANUFACTURING A DRILLING NON-MAGNETIC
STABILIZER OR A BLANK THEREFOR

This invention relates to a method for manufacturing stepped round rod-like blanks which are suitable for the non-magnetic stabilizer for oil drilling as one typical example of application, and more particularly to a method for imparting a high strength to such rod-like blanks uniformly by cold working.

Taking the stabilizer for oil drilling as an example, in the case of a directional drilling method in which a number of bored holes extend in different directions from a single rig, it is necessary to employ a drilling tool of a non-magnetic material over the length of about 500 m from the tip end of the tool in order to eliminate the influences of terrestrial magnetism in monitoring the position of the drilling tip end by means of a magnetic sensor, and therefore the stabilizer must be of high strength and toughness and non-magnetic as shown in Figures 1 and 2.

Figure 1 shows a schematic vertical section of an oil well drill, and,

Figure 2 is a schematic side view of the stabilizer end blank.

The target values in the properties of the stabilizer are greater than about 70 kg/mm^2 in 0.2% proof stress, and less than 1.01 in specific magnetic permeability. In Figure 2, the double-dot-and-dash

line indicates the shape of a blank 2 for forming the stabilizer 1 with stem portions 3, an intermediate bulged portion 4 and shoulder portions 5.

5 It has hitherto been difficult to produce stepped round rods of high strength and toughness and high resistance to stress corrosion cracking by precipitation hardening, unless hardening by cold working is resorted to. However, the cold working involves
10 various technical restrictions and difficulties due to the particular shape of the material and the severe values in target properties. The following problems or difficulties are involved in the various conventional cold working methods.

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(a) Tap Forging

Tap forging, which progressively stretches a rod axially by applying forces in the radial direction
20 on a forging machine like a press equipped with a tool having a curved surface complementary to the shape of the stabilizer to be produced, has the problem that the so-called dead metal which does not undergo work hardening because of the restriction
25 of plastic flow by the frictional force between the contacting surfaces of the working material and the tool exists on the circumferential surface of the rod-like workpiece. Besides, the workpiece undergoes considerable hardening by a large localised flow of
30 material in the shear strain zone at the boundary between an unloaded portion and a loaded portion including the dead metal. The conspicuous localised

flow of material which takes place in the shear strain zone gives rise to fine internal or surface cracking of the material which can be detrimental. Consequently, it is difficult to effect uniform
5 hardening in view of the irregular deformation regions in the material caused by the work hardening. Further, unless the applied force effectively reaches the internal portion of the material, there will be irregularities in the properties between the internal
10 and surface layer portions of the work as a result of surface-wise working of the material.

(b) Tensile Cold Working In Axial Direction

15 In cold tensile working of a stepped rod-like workpiece, it is possible to cause plastic deformation of the stem portions of smaller diameter but not to the bulged portion 4 of larger diameter. If the working operation is carried out on the basis
20 of the large diameter portion, it will cause a marked drop in the yield of the material. Although there barely occurs irregular distribution of strain in the cold axial tensile working of the rod, the resulting hardened material often does not possess
25 the required strength due to the Bauschinger effect depending upon the direction of the acting force. For example, application of a compressive load cannot impart a strength comparable to that attained by application of a tensile load. Since the stabiliser
30 is subjected to axial compression stress during operation, this working method is also unsuitable.

(c) Rotational Forging, Rolling & Extrusion

In most cases, the surface layer of material only is worked, so that it is difficult to strengthen the material over its entire sectional area. In addition, in the case of a workpiece of a shape like the stabilizer 2, it is necessary to provide special working equipment, and it is difficult to strengthen the boundary portions between the large and small diameter portions of the rod.

According to the present invention, there is provided a method for manufacturing a blank for a drilling stabilizer comprising:

15 hot working a piece of non-magnetic steel into a rod-like form with a bulged portion at a point between the opposite ends thereof;

subjecting the resulting rod-like workpiece to a solution heat treatment and a machining operation to obtain a semi-finished workpiece of predetermined shape relative to the shape of the ultimate product; and

20 subjecting said semi-finished workpiece to cold axial compressive working at a work hardening temperature range in a die cavity substantially of a complementary shape to the desired shape of said blank.

Furthermore, the invention also provides a method for manufacturing a drilling stabilizer, said method comprising:

30 hot working a piece of non-magnetic steel into a rod-like form with a bulged portion at a point between the opposite ends thereof;

subjecting the resulting rod-like workpiece to a solution heat treatment and a machining operation to obtain a semi-finished workpiece of predetermined shape relative to the shape of the desired ultimate product;

- 5
- subjecting said semi-finished workpiece to cold axial compressive working at a work hardening temperature range in a die cavity substantially of a predetermined shape; and
- 10
- subjecting said workpiece to stress relief annealing prior to a finish machining operation.

The above features and advantages of the present invention will become apparent from the following

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description taken in conjunction with the accompanying drawings which show illustrative embodiments of the invention.

In the accompanying drawings:

Figure 1 is a schematic vertically sectioned view of oil well drilling, showing the position of a stabilizer;

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Figure 2 is a schematic side view of an oil drilling stabilizer and a blank as obtained according to the method of the present invention;

10 Figure 3 is a flowsheet of a working process including the method of the present invention;

Figures 4(a) to 4 (c) are vertically sectioned side views showing the work in different stages of the cold compressive working operation according to the present invention, of which, Figure 4(a) shows the work setting stage, Figure 4(b) shows a first phase of the compressive working, and Figure 4(c) a second phase of the compressive working;

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Figure 5 is a diagram showing the compressive load during one compressive deformation;

Figure 6 is a diagram showing the strength in relation to the working rate;

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Figure 7 is a vertically sectioned side view of a tool useful in the cold compressive working according to the method of the invention;

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Figure 8 is a diagrammatic view showing the qualitative hardness distribution across a vertical section of a stabilizer obtained by the method of the present invention; and,

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Figures 9 to 12 are diagrammatic views showing the shape, sampling positions of specimens, hardness distribution and qualitative characteristics of strength respectively of the stabilizer blank produced by the method of the present invention.

As already indicated, the material of the stabilizer should be non-magnetic and have a high strength. Thus a non-magnetic steel is used as a material for the blank to be worked. In order to secure the properties which are required of the stabilizer, namely, the non-magnetic property, high strength and corrosion resistance, it is necessary to work-harden the non-magnetic steel, ie, low C. high Mn-Cr austenite steel.

As for the low C. high Mn-Cr steel with excellent cold working hardenability, it is preferred to select a steel with a basic composition of 0.05-0.3% C, 16-25% Cr, for example, 0.12 C - 18 Mn - 15 Cr steel.

Referring to Figures 3 to 12 of the accompanying drawings and first to Figure 3, there is shown the steps of a working process incorporating the present invention, in which a workpiece in the form of a steel ingot 6 from a casting stage (I) is formed by a hot working stage (II) at 800 - 1200°C into a first semi-finished workpiece 7 of a rod-like shape with a bulged large-diameter portion 7' at the centre thereof. In the hot working stage (II), hot working cracks would occur if the temperature was lower than 800°C, and on the contrary hot brittleness would occur if the temperature was higher than 1200°C. Therefore, the hot working (II) should be carried out at a temperature in the range of 800-1200°C. Further, the hot working may be effected

in one operation or progressively by a number of operations. The workpiece heated to 800-1200°C consists of austenite steel, so that the working rate in the final hot working stage should be greater than 30% to make the austenite grains finer.

In the next stage (stage III), the semi-finished workpiece 7 is subjected to an ordinary solution heat treatment (III) in which the workpiece is heated to and retained at, for example, a temperature of 1100°C and then watercooled to obtain a second semi-finished workpiece. The solution heat treatment is preferably carried out at a temperature in the range of 1000-1150°C because the heating temperature should be above 1000°C in order to form a solid solution of Cr carbides and below 1150°C in order to prevent coarsening of crystal grains.

Subsequent to the texture control by the solution heat treatment and water toughening, the second semi-finished work is machined (stage IV) into a rod 8 to form a third semi-finished product which generally conforms with the stabilizer 2 of the ultimate product in shape and strength. This machining operation is intended to accurately apportion the material (weight calculation) in accordance with the theory of cold working of the present invention.

Nextly, the third semi-finished workpiece 8 is subjected to cold compression working (stage V) axially in a die with a cavity of a substantially complementary shape to obtain a blank 2 for a stabilizer for oil drilling. The temperature of the workpiece in this cold

compression working stage should be in a range which induces hardening by cold working and at the same time does not give rise to harmful precipitates. In the case of a non-magnetic steel, it is preferred to conduct the cold compressive working at a temperature range below 350°C , preferably in the range of from room temperature to 350°C . The temperature range of the cold compressive working is in some cases determined by the capacity of the equipment which is to be actually used for the cold compression working, but it is desirably to be from 150°C to 350°C in view of the thermal stability of the strength of the blank resulting from the cold compression working and/or the stabilizer.

The blank 2 which is obtained by the method of the present invention in the above-described manner is then subjected to stress relief annealing (stage VI) for several hours at $200-350^{\circ}\text{C}$ to prevent softening of the stabilizer. It is assumed that the maximum temperature at which the stabilizer will be operated in service is 150°C . The annealed workpiece is then finished in a final machining stage (VII) to obtain a stabilizer 1.

Axial compressive working is effected in the stage of cold working (V) according to the present invention. The technical points and the reasons in support of such cold working are given below, along with illustrative Examples.

In the cold compressive working stage (V), the third semi-finished workpiece has a portion in which the ratio of its length (ℓ) to its diameter (d), ℓ/d , is

greater than 3.0. Generally, when compressing a column which has an l/d ratio greater than 3.0 it is difficult to apply an axial compression load without causing bend buckling. It is difficult even if l/d = 2.5 especially in a case where the opposite end faces of the column are not supported (or not restricted) and the load is not applied accurately along the axis of the column. Once bend buckling occurs, the bend is rapidly magnified by an increase in the rate of working.

To cope with this problem, the cold compressive working stage (V) employs a tool including an upper die 10 and a lower die 11 which are axially guided in an outer cylinder 9, and a punch 12 which is also guided by the outer cylinder 11, as illustrated in Figure 4. The third semi-finished workpiece 8 is mounted in the die as shown in Figure 4(a), and a compression load (P) is applied in the axial direction (X) of the workpiece as shown in Figure 4(b) by means of a forging press or the like. At this time, the compressive stress (σ) which occurs in a workpiece with a sectional area (A) is expressed by the equation

$$\sigma = P/A \dots\dots\dots (1)$$

The outer end portion of the tapered stem 3 of small diameter reaches the plastic deformation range first and begins to undergo plastic deformation and hardening by working. As the load is increased, the plastic working progresses toward the inner end of the stem 3, so that the entire portion of the stem 3 is uniformly subjected to plastic working.

The compression working ratio of the stem 3 is predetermined in consideration of the properties of the blank to be produced. Upon reaching a predetermined compression working ratio, the first phase (F) of the compression working of Figure 5 is finished, and the upper and lower dies 10 and 11 abut against the shoulders 5 of the workpiece as shown in Figure 4(b); there then follows an increase of the compression load to start the compression working of the bulged portion 4 of large diameter in the centre portion of the work so as to force the bulged portion 4 to the shape of the die cavity which is formed complementary to the shape of the desired ultimate product. As soon as the workpiece fills the die cavity as shown in Figure 4(c), the compression load increases abruptly due to the increase of the reaction force, and the last phase of the working of Figure 5 is then terminated. In an actual operation, the cold working is performed by a single action and in an extremely efficient manner. As is clear from the smooth compression curve of Figure 5 which plots the compression load on the ordinate against a time period of one compressive deformation on the abscissa, the compressive working of the first and second phases can be effected easily and continuously.

Figure 6 is a diagram showing the relation of strength with working ratio in a cold working of an exemplary material, the diagram plotting the desired strength on the ordinate and the distortion ratio of $E = \ln(l_0/l)$ (in which l_0 = the length before working and l = the length after working) on the abscissa at various temperatures which act as a parameter.

It is important in the cold compressive working by the method of the present invention to cause uniform plastic deformation in various parts of the workpiece. For this purpose, it is necessary to give consideration to the correlation between the shape of the ultimately obtained stabiliser blank 2 (corresponding to the shape of the die cavity) and the shape and dimensions of the workpiece prior to the cold working, namely, of the third semi-finished work 8. More particularly, although the shape of the die cavity is provided with a taper of 0.5 to 5° to facilitate the withdrawal of the workpiece after completion of the cold working operation, it is required to maintain the same compressive working ratio at different positions along the axial direction of the workpiece in spite of the existence of the taper. It is also necessary to take into consideration the fact that the application of the compressive strain in the axial direction causes additional tensile strains in the radial and circumferential directions of the workpiece. Further, the bend buckling which may affect the workpiece has to be restricted within the die while shaping and hardening the workpiece into the appropriate shape and dimensions. For this purpose, it is necessary to calculate beforehand to determine the correct volume and dimensions of the workpiece.

The calculations for the stem portions 3 at the opposite ends of the workpiece are made separately from the bulged centre portion 4. Taking one stem portion 3 as an example, it is positioned in the die with the outer and inner ends thereof in the smaller and larger diameter portions of the tapered die cavity, respectively. With regard to the length of the work,

since

$$E = \ln(l_0/l) \dots\dots\dots (2)$$

5 the length before working is expressed by

$$l_0 = eE \cdot l \dots\dots\dots (3)$$

Let the diameters of the outer end before and after
10 working be d_0 and d , and the diameters of the inner
end before and after working be D_0 and D , respectively,
we obtain

$$\text{from } E = \ln(d/d_0)^2 \dots\dots\dots (4)$$

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$$d_0 = (e^E)^{-\frac{1}{2}} d \dots\dots\dots (5)$$

and

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$$\text{from } E = \ln(D/D_0)^2 \dots\dots\dots (6)$$

$$D_0 = (e^E)^{-\frac{1}{2}} D \dots\dots\dots (7)$$

Therefore, from Equations (3), (5) and (7), the taper
25 angle θ of the work before cold working is expressed
by

$$\theta = \tan(D_0 - d_0/2 l_0) \dots\dots\dots (8)$$

30 The value of θ does not coincide with the taper angle of
the tool which is determined so as to prevent a
contacting restriction of the workpiece. The reason
why logarithmic strain is used in the foregoing
calculations is to provide the axial compressive
35 working rate and the radial and circumferential tensile
working rates on the same scale.

Referring to Figure 7, there is shown an example of an apparatus useful for carrying out the cold compressive working according to the present invention, including an upper die 10 and a lower die 11. The upper die 10 comprises an outer supporter 10a and an inner impression member 10b (a core die) with a shaping cavity on the inner side, which are connected by a recessed supporter 10c and a hexagon socket 10d. Similarly, the lower die is constituted by an outer supporter 11a and an inner impression member 11b which are connected by a recessed supporter 11c and a hexagon socket bolt 11d. The impression member 10b and 11b are replaceable according to the shape of the work to be handled. The upper die 10 is fixed to a pressing die 12 by bolts 13, while the lower die 11 is fixed to the outer cylinder 9 by bolts 14. There are supporters 15 and 16 for the upper and lower dies 10 and 11, respectively, and rams 17 for adjusting the position of the die.

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Thus, the work is preadjusted by predetermined procedures and in consideration of working conditions prior to the cold compressive working stage. As a result of actual measurement of hardness at 1264 different points over the entire surface of a vertical section of a stabilizer 2, it has been confirmed that the work is hardened substantially uniformly by the cold compressive working. Upon studying the strain distribution in greater detail, it is observed that the stem portions 3 are substantially uniform, and non-deformed soft portions only exist in a shallow surface layer of shoulders 5 and in the centre dead metal zone 18 which are softer by about 10%. The

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shear strain zone 19 including the fillet portion is harder by about 10-15% and contributes effectively to the structural strength. The soft portions 5 and 18 give rise to no problems in strength since they are cut out in the subsequent finish machining stage (VII).

Example

- 10 A non-magnetic steel having a basic composition of 0.12%C-18%Mn-15%Cr was hot-forged in a temperature range of 1000 - 850°C and then subjected to a solution heat treatment and a machining operation to obtain a semi-finished workpiece. The semi-finished workpiece
- 15 was formed into a stabilizer blank, as shown in Figure 9, by cold compressive working (cold die forging) applying a compressive load in the axial direction of the work.
- 20 Figure 10 shows the sampling positions of specimens which were used to determine the properties of the stabilizer blank obtained. Each specimen was bisected in the axial direction, using one half for measurement of hardness distribution and the other half for the
- 25 measurement of mechanical properties and specific magnetic permeability.

a) Hardness Distribution

- 30 Figure 11 shows the hardness distribution of each specimen along with hardness (Hv) of the measured points. Generally, this sort of product manufactured by a conventional method is hardened only in its surface

layer and exhibits irregularities in the hardness distribution in the radial and circumferential directions, and it is difficult to enhance the strength of the bulged centre portion to a level
5 higher than that of the stem portions. In contrast, as is clear from the hardness distribution and values of hardness (Hv) shown in Figure 11, the method of the present invention can increase the strength of the bulged centre portion more than the stem
10 portions with a uniform hardness distribution in the radial and circumferential directions. Also, the cold compressive working according to the method of the present invention can control the hardness of the bulged centre portion and the stem portions
15 independently if desired.

b) Mechanical Properties

From each one of sections A to H located at different
20 positions in the axial direction of the stabilizer blank shown in Figure 10, specimens were sampled at radial sampling positions 1 to 5. As shown in Figure 10, the longitudinal sides of specimens sampled from the blank sections A to C, E, G and H lay in the axial
25 direction at the respective sampling positions 1 to 5. On the other hand, the longitudinal sides of specimens sampled from the sections D and F lay in the radial direction at the sampling position 1 and in the circumferential direction at the sampling position 2.
30 Table 1 shows the results of compression and tensile tests of the specimens obtained from the above-mentioned sampling positions of the respective blank sections.

Table 1 Mechanical properties of the non-magnetic stabilizer strengthened by cold die forging

Location of specimens ¹⁾			Test results (tested at 20°C)					
Site		Direction	Compression 0.2% P.S. (kgf/mm ²)	Tension			Impact	
Axial Position	Radius			0.2% P.S. (kgf/mm ²)	T.S. ² (kgf/mm ²)	El. (%)		R.A. (%)
A	1 Inner	Axial	-	72.8	96.5	30.3	69.8	-
	2 1/2 R	do.	92.1	70.6	97.6	29.0	69.8	13.9
	3 Outer	do.	101.4	71.4	98.7	32.7	68.7	13.3
B	1 Inner	do.	-	71.5	98.6	30.4	68.0	-
	2 1/2 R	do.	85.7	71.5	98.6	30.4	68.0	14.7
	3 Outer	do.	94.1	70.8	98.8	29.0	68.0	13.6
C	1 Inner	do.	-	70.5	98.0	35.0	67.3	-
	2 1/2 R	do.	86.4	73.2	101.0	30.9	68.5	13.8
	3 Outer	do.	98.0	79.6	107.2	26.0	62.8	13.2
D	— 1	Radius	-	93.9	109.6	25.6	63.0	14.8
	— 2	Tangential	-	81.7	101.4	26.8	62.6	15.2
E	1 Inner	Axial	-	78.0	106.0	26.1	63.1	-
	2 1/4 R	do.	110.0	78.0	107.4	26.1	64.1	9.9
	3 1/2 R	do.	107.3	78.9	108.1	26.1	62.0	10.2
	4 3/4 R	do.	101.7	79.8	109.2	26.6	65.2	9.9
	5 Outer	do.	97.6	80.1	111.3	26.2	64.1	8.5

1) See Fig. 10

- to be continued -

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Location of specimens			Test results (tested at 20°C)						
Site		Direction	Compression		Tension			Impact	
Axial Position	Radius		0.2% P ₂ S. (kgf/mm ²)	0.2%P.S. (kgf/mm ²)	T.S. ² (kgf/mm ²)	El. (%)	R.A. (%)	VE20 (kg·m)	
F	—1	Radius Tangential	—	92.4	109.6	25.1	62.5	13.8	
	—2		—	83.1	102.0	26.1	61.0	15.0	
G	1 Inner	Axial do. do.	—	70.3	96.8	28.2	62.6	—	
	2 1/2 R		85.8	73.2	102.2	26.4	63.0	13.1	
	3 Outer		97.6	79.6	109.5	26.2	63.0	12.3	
H	1 Inner	do. do. do.	—	71.1	96.2	31.0	68.0	—	
	2 1/2 R		90.1	70.2	96.6	30.5	68.0	13.5	
	3 Outer		98.6	71.6	99.5	29.8	68.3	12.8	

As is clear from Table 1, the compressive 0.2% proof stress in the axial direction of the blank sections A to C, E, G and H varied depending upon the radial sampling position of the specimen but all specimens showed a high level of strength in the range of 85 - 110 kgf/mm². The tensile 0.2% proof stress in the radial and circumferential directions of the blank sections D and F was at a high level of 81 - 94 kgf/mm² which was higher than the tensile 0.2% proof stress in the axial direction of the blank sections A to C, E, G and H. It is a feature of the described cold compressive working method to provide a product with such strength characteristics. More specifically, the stabilizer blank produced by the method of the present invention has a tendency as shown qualitatively in Figure 12, of a high strength against compressive stress in the axial direction and tensile stress in the circumferential and radial directions. In the case of the known tap forging and tensile working methods mentioned hereinbefore, the product would possess the opposite strength characteristics.

c) Specific Magnetic Permeability

The measurement of specific magnetic permeability (μ) revealed that all specimens had a specific magnetic permeability of $\mu \approx 1.002 < 1.01$, retaining a suitable non-magnetic property even after the cold compressive working.

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As is clear from the foregoing description, the method of the present invention can manufacture a stepped rod-like blank of non-magnetic steel suitable for a

stabilizer for oil drilling in such a manner that the blank has high strength and uniform toughness, improving the service life of the stabilizer to a marked degree.

CLAIMS

1. A method for manufacturing a blank for a drilling stabilizer, comprising:

hot working a piece of non-magnetic steel into a rod-like form with a bulged portion at a point
5 between the opposite ends thereof;

subjecting the resulting rod-like workpiece to a solution heat treatment and a machining operation to obtain a semi-finished workpiece of predetermined shape relative to the shape of the ultimate product;
10 and

subjecting said semi-finished workpiece to cold axial compressive working at a work hardening temperature range in a die cavity substantially of a complementary shape to the desired shape of said
15 blank.

2. The method as claimed in claim 1, wherein said cold axial compressive working is effected in a temperature range below 350°C.

3. The method as claimed in claim 1 wherein said cold axial compressive working is effected in a temperature range of from room temperature to 350°C.

4. The method as claimed in claim 1, wherein said cold axial compressive working is effected in a temperature range of 150 to 350°C.

5. The method as claimed in any of claims 1 to 4, wherein said hot working is effected at a heating temperature of 800 to 1200°C.



6. The method as claimed in claim 5, wherein the rate of said hot working is greater than 30%.

7. The method as claimed in any of claims 1 to 6, wherein said solution heat treatment is effected in a temperature range of 1000 to 1150°C.

8. A method for manufacturing a drilling stabiliser, said method comprising:

10 hot working a piece of non-magnetic steel into a rod-like form with a bulged portion at a point between the opposite ends thereof;

15 subjecting the resulting rod-like workpiece to a solution heat treatment and a machining operation to obtain a semi-finished workpiece of predetermined shape relative to the shape of the desired ultimate product;

20 subjecting said semi-finished workpiece to cold axial compressive working at a work hardening temperature range in a die cavity substantially of a predetermined shape; and

subjecting said workpiece to stress relief annealing prior to a finish machining operation.

25 9. The method as claimed in claim 8, wherein said stress relief annealing is effected in a temperature range of 200 to 350°C.

30 10. The method as claimed in claim 8 or 9, wherein said cold axial compressive working is effected in a temperature range below 350°C.



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11. The method as claimed in claim 8 or 9, wherein said cold axial compressive working is effected in a temperature range of from room temperature to 350°C.

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12. The method as claimed in claim 8 or 9, wherein said cold axial compressive working is effected in a temperature range of 150 to 350°C.

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13. The method as claimed in any of claims 8 to 12 wherein said hot working is effected at a heating temperature of 800 to 1200°C.

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14. The method as claimed in claim 13, wherein the rate of said hot working is greater than 30%.

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15. The method as claimed in any of claims 8 to 14, wherein said solution heat treatment is effected in a temperature range of 1000 to 1150°C.

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16. The method as claimed in any of claims 1 to 7, wherein said blank for drilling stabilizer has a 0.2% proof stress greater than 70 kg/mm².

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17. The method as claimed in any of claims 1 to 7, wherein said blank for drilling stabilizer has a specific magnetic permeability smaller than 1.01.

18. The method as claimed in any of claims 8 to 15, wherein said drilling stabilizer has a 0.2% proof stress greater than 70 kg/mm².



19.. The method as claimed in any of claims 8 to 15, wherein said drilling stabilizer has a specific magnetic permeability smaller than 1.01.

5 20. The method as claimed in claim 1 or claim 8 substantially as hereinbefore described.

21. A blank for an drilling stabilizer manufactured according to any of claims 1 to 7.

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22. An drilling stabilizer manufactured according to any of claims 8 to 15.

15 23. A method for manufacturing a blank for an oil drilling stabilizer, comprising:

hot working a stock of non-magnetic steel into a rod-like form with a bulged large diameter portion at a median point between the opposite ends thereof;

20 subjecting the resulting rod-like work to a solution heat treatment and a machining operation to obtain a semi-finished work with a shape substantially conforming with the shape of the ultimate product; and

25 subjecting said semi-finished work to cold axial compressive working in a die cavity substantially of a complementary shape and in a work hardening temperature range.



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