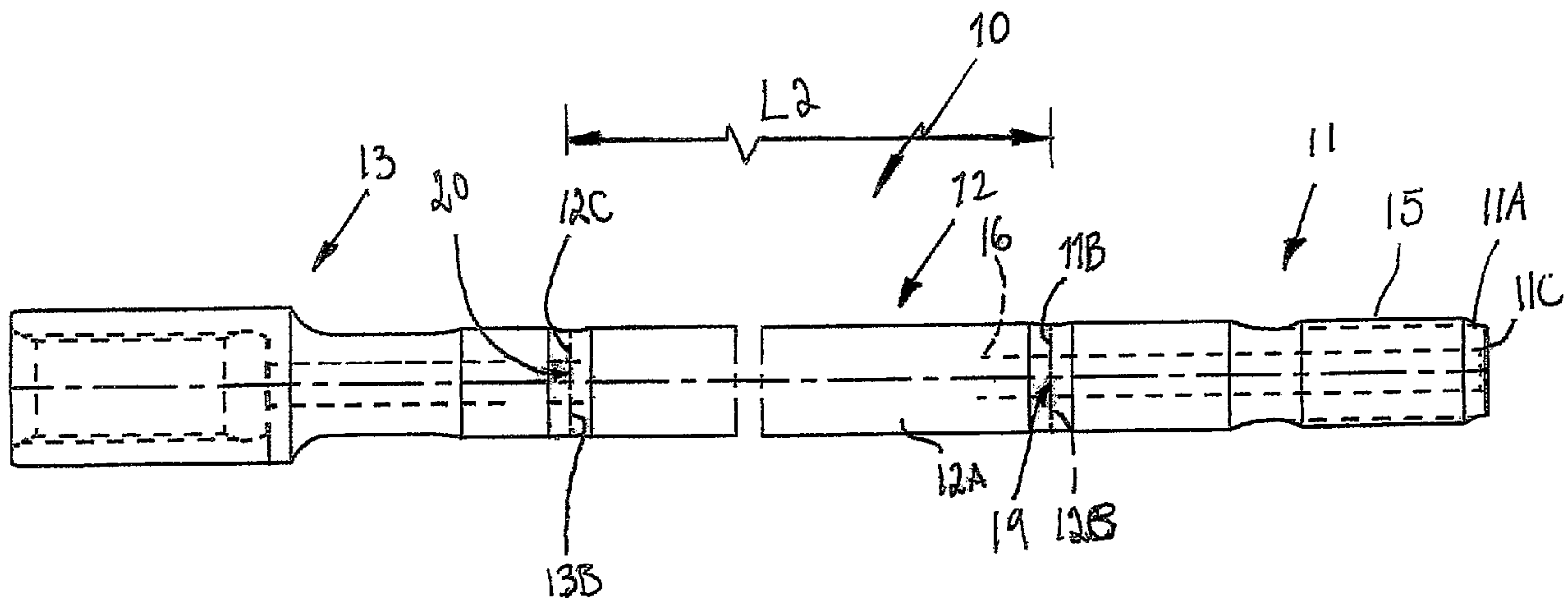




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(57) Abrégé/Abstract:

The present invention relates to a drill rod for percussive rock drilling and a method in order to manufacture the drill rod. The drill rod (10) has a first rod part (11) comprising a free end (11A), an opposite end (11B), an inner duct (14), and an externally threaded part (15) near the free end, the externally threaded part being entirely or partly hardened by heat treatment, and an additional rod part (13) comprising a free end (13A), an opposite end (13B), an inner duct (17), and an internally threaded part (18) near the free end (13A) of the second rod part, the internally threaded part (18) being entirely or partly hardened by heat treatment. The opposite ends (11B, 13B) of the rod parts have been welded together with each other or with an intermediate hollow rod part (12) in order to define a weld zone (19, 20) next to each opposite end. The weld zone is not heat-treated after welding.

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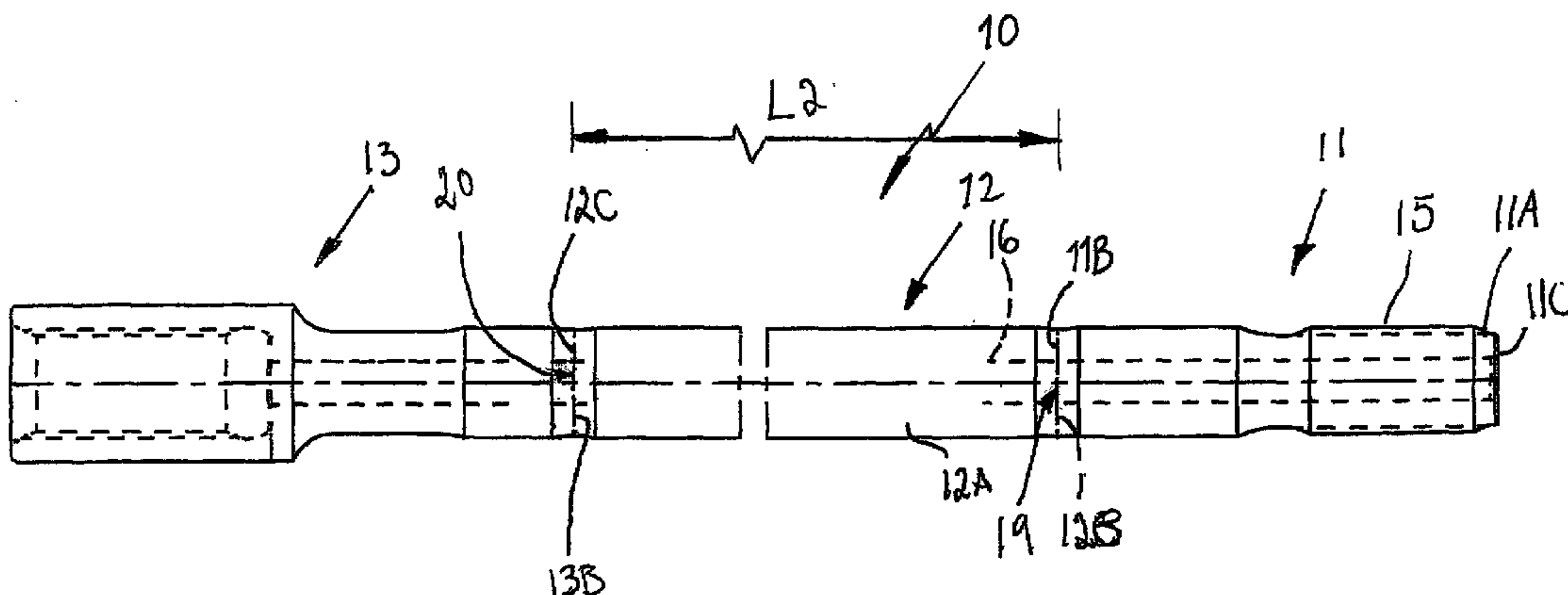
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(54) Title: DRILL ROD AND METHOD IN ORDER TO MANUFACTURE THE SAME



(57) **Abstract:** The present invention relates to a drill rod for percussive rock drilling and a method in order to manufacture the drill rod. The drill rod (10) has a first rod part (11) comprising a free end (11A), an opposite end (11B), an inner duct (14), and an externally threaded part (15) near the free end, the externally threaded part being entirely or partly hardened by heat treatment, and an additional rod part (13) comprising a free end (13A), an opposite end (13B), an inner duct (17), and an internally threaded part (18) near the free end (13A) of the second rod part, the internally threaded part (18) being entirely or partly hardened by heat treatment. The opposite ends (11B, 13B) of the rod parts have been welded together with each other or with an intermediate hollow rod part (12) in order to define a weld zone (19, 20) next to each opposite end. The weld zone is not heat-treated after welding.

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DRILL ROD AND METHOD IN ORDER TO MANUFACTURE THE SAME

Technical Background

The present invention relates to a drill rod and method of manufacture a drill rod.

Prior Art

- 5 In WO 01/42615 a friction welded drill rod of the above-mentioned type is disclosed. A disadvantage of the known rod is that the manufacture thereof is complicated and thereby expensive. The same can be said about the drill rods disclosed in US-A-5,919,578, US-A-5,988,301 and US-A-6,095,266.

Objects of the Invention

- 10 An object of the present invention is to provide a drill rod and method in order to manufacture a drill rod, the manufacture of which is uncomplicated and thereby cost efficient.

Brief Description of the Drawings

- Fig. 1 shows a drill rod according to the present invention in side view. Fig. 2 shows a part before welding. Fig. 3 shows another part, partly in cross-section, before welding. Fig. 4 shows a chart regarding core hardness distribution in the longitudinal direction of a drill rod according to the present invention around the melting line.

Detailed Description of an Embodiment of the Invention

- In Fig. 1, a drill rod 10 is shown comprising a first rod part 11, a second rod part 12 and a third rod part 13. Said parts are at least partly cylindrical. The drill rod 10 has a through-going duct for transportation of flushing medium such as water, air or a mixture of the same.

- The first rod part 11 according to Fig. 2 comprises a free end 11A, an opposite end 11B, an inner duct 14, and an externally threaded part 15 near the free end. The free end has a stop face 11C for transfer of shock waves. The externally threaded part 15 is entirely or partly hardened by heat treatment. The first rod part 11 has a largest length L1, which is 0.2-0.5 m. In a preferred embodiment, the length L1 is 0.27 m. The

externally threaded part 15 is hardened to a hardness in the interval of 440 HV1 to 750 HV1. The first rod part 11 is preferably tempered and high-frequency hardened before welding to another part.

The second rod part 12 consists of a round rod 12A having an inner duct 16, see Fig. 1. The rod part 12 has end surfaces 12B and 12C, each one of which has a diameter having substantially the same dimensions as the one of the opposite end 11B of the first rod part 11. The second rod part 12 has a largest length L2, which is 1-5 m. In a preferred embodiment, the length L2 is 3.8 m. The second rod part 12 does not need to be heat-treated before welding to another part. The steel, which the second rod part is manufactured from, has a core hardness that is in the interval of 350 HV1 to 440 HV1.

The third rod part 13 comprises a free end 13A, an opposite end 13B, an inner duct 17, and an internally threaded recess or part 18 associated to the inner duct of the second rod part near the free end 13A. The internally threaded part 18 is entirely or partly hardened by heat treatment. The third rod part 13 has a largest length L3, which is 0.2-0.5 m. In a preferred embodiment, the length L3 is equal to the length L1, for instance 0.27 m. The recess 18 has a bottom surface 18A intended to co-operate with a stop face 11C of an associated second drill rod, not shown, in order to transfer shock waves at percussive rock drilling. The internally threaded part is hardened to hardness in the interval of 440 HV1 to 750 HV1. The third rod part 13 is heat-treated preferably by acierage and direct hardening by means of air-cooling before welding to another part.

The opposite ends 11B and 13B of the rod parts 11 and 13, respectively, are friction welded together with each other or the second rod part 12 in a conventional way in order to define weld zones or melting lines 19 and 20 at the respective opposite ends 11B and 13B. The weld zones have not been heat-treated, for example annealed, after welding. Each weld zone 19, 20 has at least partly higher hardness value than the core hardness of the steel which the second rod part 12 is manufactured from. The readily usable rod comprises soft zones at each side of the weld zone 19, 20. The hardness of the soft zone is more than 300 HV1 but less than 360 HV1 at each side of the weld zone 19,20.

The drill rod comprises two welds, spaced-apart from each other in the axial direction of the rod with a distance of 1-5 m. The largest length L of the completed drill rod is in the interval of 3-10 m, preferably around 4,5 m.

- 5 Fig. 4 shows a chart regarding core hardness distribution in the longitudinal direction of a drill rod according to the present invention around the melting line. HV1 is Vicker's hardness with a load of 1 kg. We have surprisingly found that it is possible to use the drill rod 10 directly after friction welding without subsequent heat treatment.

10 At friction welding, soft zones arise around the melting line. The melting line may be defined as the bonding zone between two components and is shown by means of a vertical dashed line in Fig. 4. The melting line may be regarded as having a width of 0.3-3 mm. The weld zone includes the melting line and is preferably 7-11 mm in the axial direction. The core hardness profile is shown by means of an unbroken line and the hardness increases significantly from the starting material in the direction of the
15 melting line. In the chart, the structure that the respective part has after the friction welding is given. The rod 12 is only rolled and contains about 50% bainite B and about 50% martensite M. The threaded part or the rod part 11 or 13 is preferably tempered but the opposite end thereof consists of about 50% bainite and about 50% martensite.

- 20 On both sides (about 4 mm) of the melting line, the weld zone 19, 20 has substantially (more than 50%) non-annealed, martensitic structure and high hardness (just below 500 HV1). Axially next to the non-annealed, martensitic structure, there is a structure substantially consisting of bainite and pearlite P. The later structure has a relatively low hardness around 320 HV1. In spite of this large difference in hardness, the drill
25 rod 10 according to the present invention has at tests turned out to obtain production results equivalent to those of heat- treated conventional drill rods.

30 The method for manufacturing the drill rod comprises the following steps: provide a first rod part 11 with an inner duct 14, a free end 11A, an opposite end 11B and an externally threaded part 18 near the free end, the externally threaded part entirely or partly being hardened by heat treatment; provide an additional rod part 13 having an inner duct 17, a free end 13A, an opposite end 13B, and an internally threaded part 18

associated to the inner duct of the additional rod part, the internally threaded part entirely or partly being hardened by heat treatment; wherein the opposite ends of the rod parts are welded together in order to define a weld zone next to the opposite ends, the drill rod being intended to be used without the weld zone having been heat-treated after welding. Preferably, the rod parts 11 are friction welded to another hollow rod part 12. Preferably, each weld zone is then turned, so that the radially outer surface of the weld zone becomes smooth and somewhat concave. The drill rod is welded preferably at two points, spaced-apart from each other by at least one metre in the axial direction of the rod. The drill rod is made from steel having a certain core hardness. The weld zone is given the same hardness value as, or higher hardness value than, the core hardness of the steel in the hollow rod part. The externally threaded part and the internally threaded part are hardened to hardness in the interval of 440 HV1 to 750 HV1.

With the objects of uncomplicated and cost effective production the rod is preferably manufactured from at least three separate, readily machined parts, thus there are at least two weld zones after friction welding. By having an intermediate storage of those separate parts they can be combined in different ways to provide prerequisites for a quick and flexible production of different shapes of rods. Thus, the size of the stock of readily usable rods can be reduced and thereby reducing the costs for storage and the risk for obsolete products.

CLAIMS

1. A drill rod for percussive rock drilling comprising:

a first rod part comprising first and second ends, an inner duct, and an external thread disposed adjacent the first end, wherein the external thread is at least partly hardened
5 by heat treatment; and

a second rod part comprising first and second ends, an inner duct, and an internal thread disposed adjacent the first end thereof, wherein the internal thread is at least partly hardened by heat treatment,

wherein the second end of the first rod part and the second end of the second rod part
10 are welded together to define a weld zone having a substantially martensitic structure, and

wherein the hardening of the external and internal threads is performed to achieve a hardness in the range of 440 to 750 HV1.

2. The drill rod according to claim 1 wherein axially successive weld zones are spaced
15 apart by at least one meter.

3. The drill rod according to claim 1 wherein the weld zone includes a friction weld.

4. A method for the manufacture of a drill rod for percussive rock drilling, comprising the steps of:

A) providing a first rod part having first and second ends, an inner duct, and an
20 external thread disposed adjacent the first end, wherein the external thread is at least partly hardened by heat treatment;

B) providing a second rod part having first and second ends, an inner duct, and an internal thread disposed adjacent the first end thereof, wherein the internal thread is at least partly hardened by heat treatment; and

25 C) welding together the second ends of the first rod part and the second rod part to define a weld zone having a substantially martensitic structure and to provide a drill rod ready for use,

wherein the weld zone has a higher hardness value than a core hardness of the first and second rod parts, the internal and external threads being hardened to a value in the range of 440 to 750 HV1.

5 5. The method according to claim 4 further including a plurality of additional weld zones, wherein axially successive weld zones are spaced apart by at least one meter.

6. The method according to claim 4 wherein the weld zones are not heat treated after welding.

7. A drill rod for percussive rock drilling comprising:

10 a first rod part comprising first and second ends, an inner duct, and an external thread disposed adjacent the first end, wherein the external thread is at least partly hardened by heat treatment; and

a second rod part comprising first and second ends, an inner duct, and an internal thread disposed adjacent the first end thereof, wherein the internal thread is at least partly hardened by heat treatment; and

15 at least one intermediate hollow rod part;

wherein the second ends of the first and second rod parts are welded to respective ends of the intermediate hollow rod parts to define weld zones having a substantially martensitic structure, and

20 wherein the hardening of the external and internal threads is performed to achieve a hardness in the range of 440 to 750 HV1.

8. The drill rod according to claim 7 wherein axially successive weld zones are spaced apart by at least one meter.

9. The drill rod according to claim 7 wherein the weld zone includes a friction weld.

25 10. A method for the manufacture of a drill rod for percussive rock drilling, comprising the steps of:

A) providing a first rod part having first and second ends, an inner duct, and an external thread disposed adjacent the first end, wherein the external thread is at least

partly hardened by heat treatment;

B) providing a second rod part having first and second ends, an inner duct, and an internal thread disposed adjacent the first end thereof, wherein the internal thread is at least partly hardened by heat treatment;

5 C) providing at least one intermediate rod part; and

D) welding the second ends of the respective first and second rod parts to respective ends of intermediate rod parts to define weld zones having a substantially martensitic structure,

10 wherein each weld zone has a higher hardness value than a core hardness of the first and second rod parts; the internal and external threads being hardened to a value in the range of 440 to 750 HV1.

11. The method according to claim 10 wherein axially successive weld zones are spaced apart by at least one meter.

12. The method according to claim 10 wherein the joined first rod part, second rod
15 part and at least one intermediate part form a first drill rod, and the method further includes joining a plurality of additional first, second and intermediate rod parts welded together with additional weld zones to form additional drill rods and threadedly joining at least two drill rods to form a drill string, wherein axially successive weld zones are spaced apart by at least one meter.

20 13. The method according to claim 12 wherein a bottom surface of a recess associated with the internal thread on one second rod part is in contact with a stop face of the first end of one first rod part to transfer a shock wave during percussive rock drilling.

14. The method according to claim 10 wherein the weld zones are not heat treated after welding.

25 15. A drill rod for percussive rock drilling comprising:

a first rod part comprising first and second ends, an inner duct, and an external thread disposed adjacent the first end, wherein the external thread is at least partly hardened by heat treatment; and

a second rod part comprising first and second ends, an inner duct, and an internal thread disposed adjacent the first end thereof, wherein the internal thread is at least partly hardened by heat treatment,

5 wherein the second end of the first rod part and the second end of the second rod part are welded together to define a weld zone having a substantially non-annealed martensitic structure, wherein the weld zone has a higher hardness value than a core hardness of the first and second rod parts, and

wherein the hardening of the external and internal threads is performed to achieve a hardness in the range of 440 to 750 HV1.

10 16. The drill rod according to claim 15 wherein axially successive weld zones are spaced apart by at least one meter.

17. The drill rod according to claim 15 wherein the weld zone includes a friction weld.

18. A drill rod for percussive rock drilling comprising:

15 a first rod part comprising first and second ends, an inner duct, and an external thread disposed adjacent the first end, wherein the external thread is at least partly hardened by heat treatment; and

a second rod part comprising first and second ends, an inner duct, and an internal thread disposed adjacent the first end thereof, wherein the internal thread is at least
20 partly hardened by heat treatment; and

at least one intermediate hollow rod part;

wherein the second ends of the first and second rod parts are welded to respective ends of the intermediate hollow rod parts to define weld zones having a substantially non-annealed martensitic structure,

25 wherein the weld zone has a higher hardness value than a core hardness of the first and second rod parts, and

wherein the hardening of the external and internal threads is performed to achieve a

hardness in the range of 440 to 750 HV1.

19. The drill rod according to claim 18 wherein axially successive weld zones are spaced apart by at least one meter.

20. The drill rod according to claim 18 wherein the weld zone includes a friction
5 weld.

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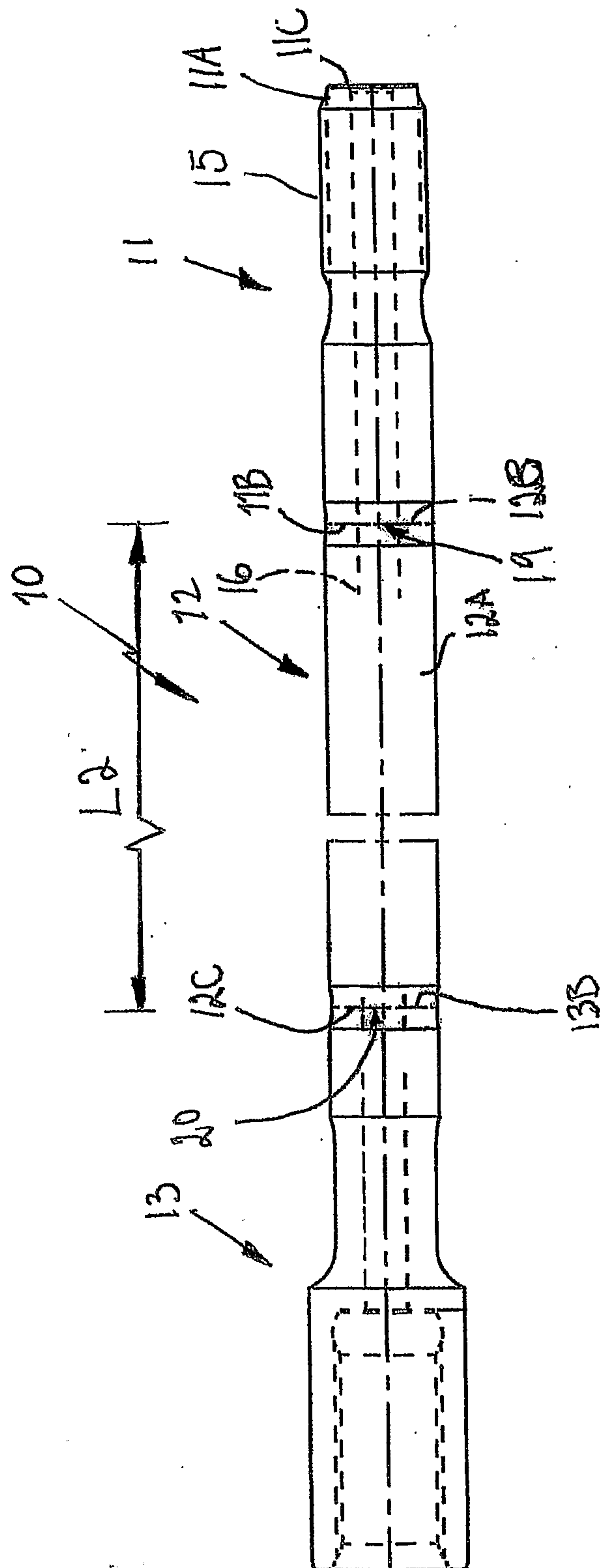


FIG. 1

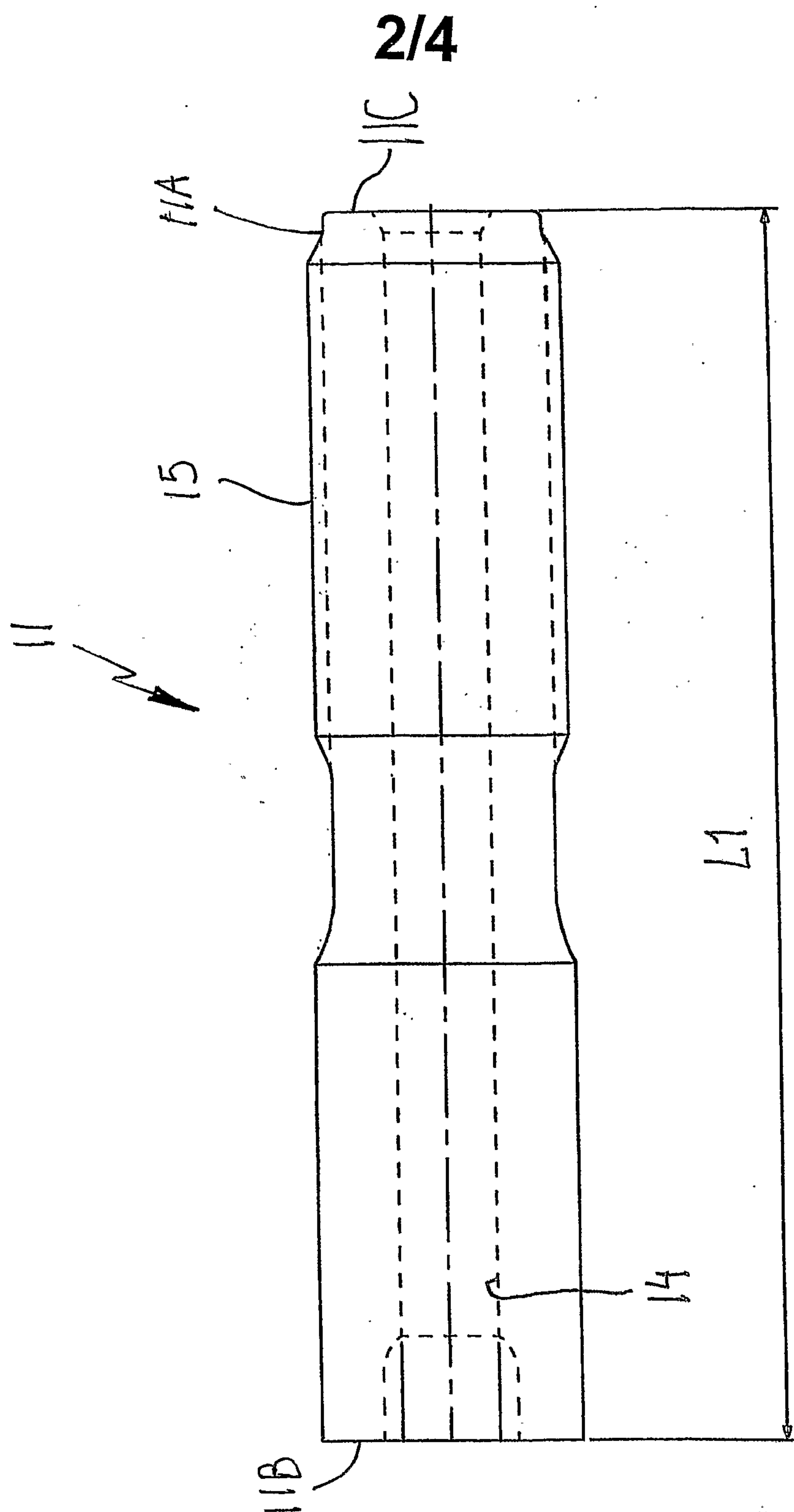
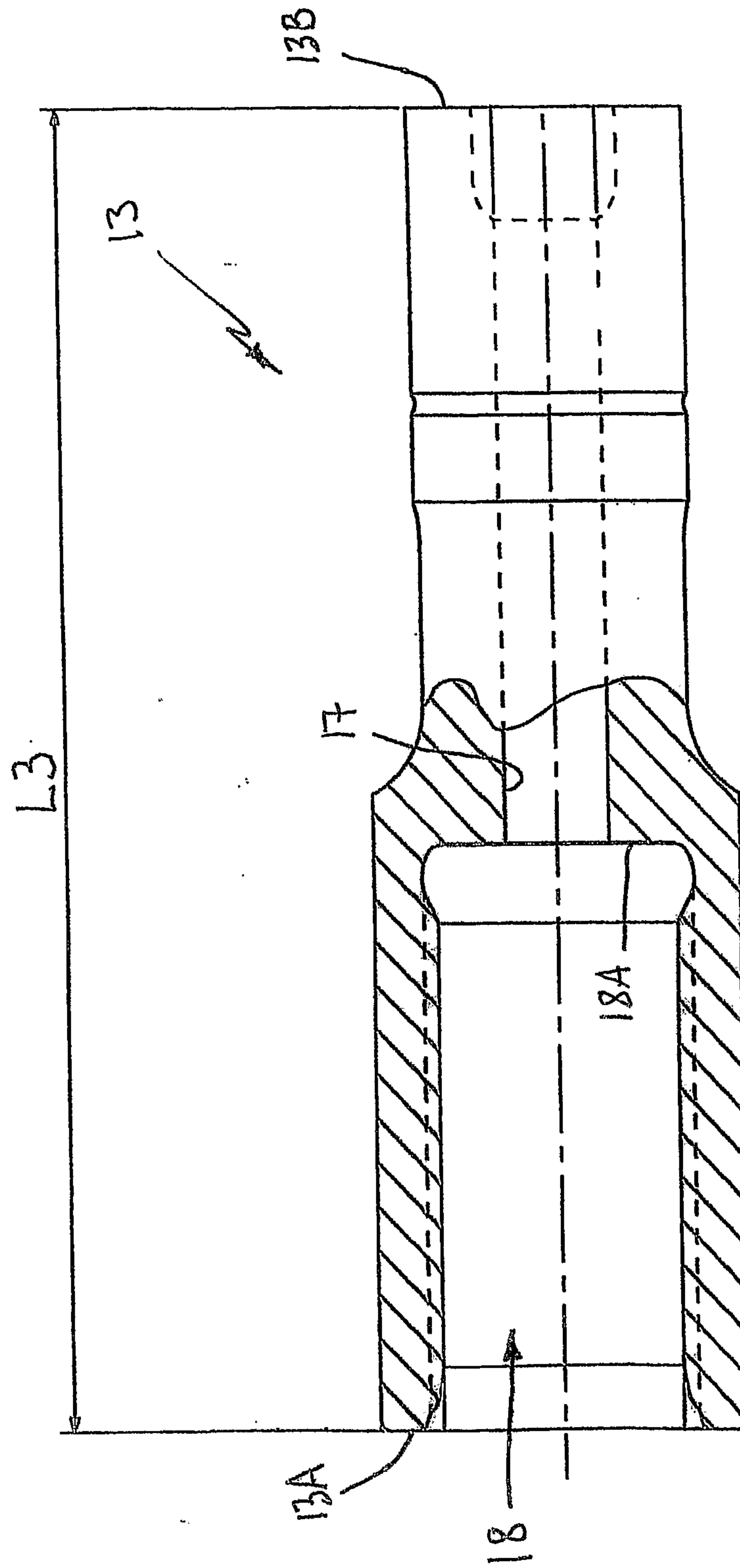


FIG. 2

3/4**FIG. 3**

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