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

(11) **EP 3 623 066 A1**

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
18.03.2020 Bulletin 2020/12

(21) Application number: **17909616.9**

(22) Date of filing: **10.05.2017**

(51) Int Cl.:
B21B 25/00 *(2006.01)*

(86) International application number:
PCT/RU2017/000296

(87) International publication number:
WO 2018/208184 (15.11.2018 Gazette 2018/46)

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

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(54) **CONTINUOUS TUBE ROLLING METHOD AND MANDREL ASSEMBLY FOR THE IMPLEMENTATION THEREOF**

(57) A method for rolling tubes on a continuous tube rolling mill involves deforming a tube billet using a mandrel assembly. The mandrel assembly comprises a cylindrical mandrel configured such that its ends can be alternately coupled to an attachment of the mandrel assembly. The mandrel is configured such that its ends have portions with a beveled lateral surface, wherein the angle of the generatrix of said surface to the longitudinal axis of the mandrel is between 10 and 70 degrees. The deformation of tube billets is carried out until the amount of wear on the working regions at both ends of the mandrel is not less than 25% of a critical value, then the mandrel is sharpened. The invention increases the service life of a mandrel, reduces the formation of flaws on the inside surface of the tubes, and prevents accidents from occurring during the rolling process.

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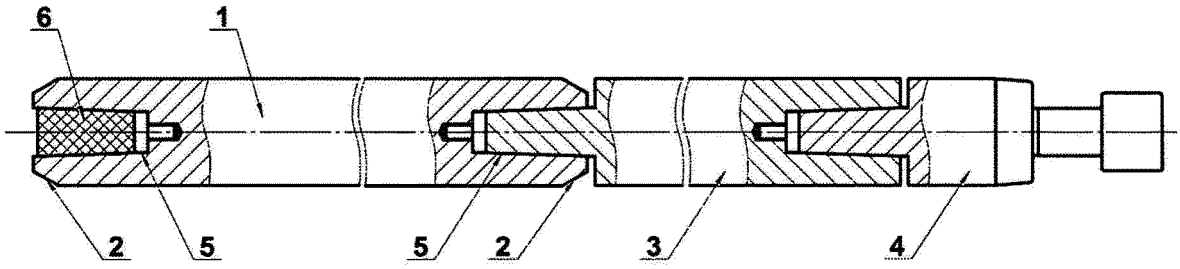

Fig.1

Description

FIELD OF THE INVENTION

[0001] The present invention relates to tube production, in particular to the production of tubes on a continuous tube rolling mill and the design of a mandrel assembly.

BACKGROUND OF THE INVENTION

[0002] Continuous tube rolling mills with a floating long cylindrical mandrel have been known since 1885 (patent of Canada No. 24956, published on the 13th of September, 1886). For rolling tubes on the continuous mills, a floating mandrel is used, it is inserted into a tubular billet (hollow shell), and when rolling the mandrel moves with rolled material beyond the continuous mill, then the mandrel is removed from the rolled material using a chain-type mandrel extractor. In this case, the mandrel is made monolithic, with a guide cone at the front end, a cylindrical part and a tail part in the form of an annular groove, for which a mandrel extractor grip is hooked.

[0003] Based on the necessity to expand the range of rolled tubes through increasing outer diameter and reducing mandrels weight, continuous tube-rolling mills with a retained mandrel were developed, they became widespread since the 60th of last century (patent of Great Britain No. 1092718, IPC B21B 17/04, B21B 21/00, published on the 11th of November, 1967).

[0004] A mandrel assembly with controlled movement during rolling is used for rolling tubular billets (hollow shell) on continuous tube rolling mills of two- and three-roll type (MPM, PQF, FQM). The retention rate of the mandrel assembly during rolling may be in the range from 500 to 2000 mm / s depending on rolled tube grades, equipment design features and selected parameters for rolling. Extracting the mandrel from the rolled material is carried out with a mill-extractor, which is located on the same line with the continuous mill. The mandrel assembly consists of a cylindrical mandrel with a guiding taper section at the front end, which opposite end is connected to an extension element through a nipple connection, and in the same way the extension element is connected to a shank end (the rear end part of a mandrel assembly) to retain the mandrel in a gripper during rolling (patent of the USA No. 3120139, B21B 25 / 04, published on the 4th of February, 1964).

[0005] When rolling with a mandrel assembly, hollow shells are deformed by a cylindrical mandrel, other elements of the mandrel assembly relate to a machine-tool attachment and may include one or more extension elements, a shank end, a plug fitting, various inserts, bushings and fixtures.

[0006] The working part of the mandrel assembly is operated under complex temperature conditions during the production process and is subjected to constant cyclic alternating loads, which intensify its wear from level of which the quality of finished tubes is depended. A significant problem in the tube production on units with a continuous rolling mill is a short service life and a high cost of mandrels, which are mostly imported.

[0007] The critical value of mandrel wear is regarded as the mismatch of geometric parameters and the state of a mandrel surface to specified requirements. The critical value of mandrel wear is specified in technological instructions of tube manufacturers. The mandrels are taken out of service when exceeding the wear critical value that includes various parameters, for example: occurrence of sections where the wear value at an outer diameter is above the specified one, occurrence of the variety of surface inconsistencies in the form of "comets" on the mandrel surface, mechanical damage, rough cracks formed as a result of temperature influence, as well as when mandrel surface roughness exceeds the specified critical values.

[0008] When the critical value of the mandrel wear is reached, the average specific mandrel consumption ranges from 0.1 to 4.0 kg / ton. The specific consumption is regarded as the difference between weight of a worn mandrel before regrinding and mandrel weight after regrinding, referred to the number of rolled tons of products.

[0009] The disadvantage of the method of producing tubes on a continuous mill with the use of a mandrel assembly of built-up construction is that during rolling the mandrel wear is occurred at 200 ÷ 7500 mm from the front end, whereas the opposite part of the mandrel practically does not wear out. However, when there is the critical value of mandrel wear, the mandrel is sent to regrinding, during which the metal is removed over the entire mandrel surface, which significantly reduces its operating life.

[0010] The most similar technical solution considered as the prototype for the method and the mandrel assembly is the production of tubes on a continuous tube-rolling mill using a mandrel assembly (patent of the Russian Federation No. 2486976, IPC B21B 25/00, published on the 7th of July, 2013), in which a cylindrical mandrel is used. At the ends of a mandrel cylindrical part there are blind openings for connecting the cylindrical part alternately to the extension element and the conical part of the mandrel.

[0011] However, when producing tubes, as a result of deformation, rolled metal flows into the gap between the conical and the cylindrical mandrel parts, and various types of defects are formed on the inner tube surface. In addition, it is possible that emergencies occur on a continuous mandrel mill and a extractor-mill, for example, stopping the rolling process because of equipment breakage, failure of protecting devices, full contact of all the mandrel with the rolled metal, the formation of unfinished product. Also the prototype does not regulate the value of the mandrel wear, which requires the necessary replacement of the end connection of the mandrel with mandrel assembly attachment, which can cause pre-

schedule mandrel shutdown.

BRIEF SUMMARY OF THE INVENTION

[0012] The technical problem solved in the Invention is to extend the service life of the mandrel through increasing the number of rolled tubes on the same mandrel, improving tubes surface quality and eliminating emergency situations during rolling.

[0013] The specified problem is solved due to that the continuous tube rolling method includes the deformation of the tubular hollow shell using a cylindrical mandrel with identical coaxial blind openings at the ends, control of mandrel dimensions and mandrel regrinding. The mandrel is connected with the mandrel assembly attachment alternately to deform tubular hollow shell by the working sections from different ends of the mandrel. According to the Invention, the deformation of the tubular hollow shell is carried out until the wear value is at least 25% of the critical value for one end of the mandrel working section. However, the mandrel regrinding is carried out after changing the end connection of the mandrel with the mandrel assembly attachment, after subsequent deformation of the tubular hollow shells and the wear of the working section on the other mandrel end is at least 25% of the critical value.

[0014] The specified problem is also solved due to that the mandrel assembly of a continuous tube rolling mill, comprising a cylindrical mandrel that is made with a beveled side surface at one end, has identical coaxial blind thread openings at the mandrel ends for the alternate connection through joining the mandrel to the mandrel assembly attachment according to the Invention, the opposite mandrel end is made with a beveled side surface, the angle of the beveled surfaces generatrix with the longitudinal mandrel axis at the both ends is the same and is in the range from 10 to 70 degrees, whereas the opening at the front mandrel end is plugged at the working position.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] The invention is illustrated by the drawing, which schematically shows a mandrel assembly for the implementation of the method of continuous tube rolling. The mandrel assembly includes a cylindrical mandrel 1 with a beveled side surface 2 at both ends and a machine-tool attachment in the form of an extension element 3 and a shank end 4. At both ends of the cylindrical mandrel 1 identical blind thread openings 5 are made for connecting the mandrel to the extension element 3 alternately by means of, for example, a nipple connection. At the working position, the opening at the mandrel front end is plugged with the plug fitting 6 to protect from external influence and prevent from clogging of scale and lubricant materials during rolling. The mandrel assembly can be connected with the shank end 4 also by means of a nipple connection.

DETAILED DESCRIPTION OF THE INVENTION

[0016] During producing tubes on a continuous tube rolling mill, the wear of a section of the mandrel cylindrical part occurs mainly closer to the front mandrel end, whereas the mandrel section near to the opposite mandrel end is not almost subjected to the wear. The deformation of the billets (hollow shells) is carried out until the wear value of the working mandrel section on the one end is at least 25% of its critical value. When the wear value does not exceed 25% of the critical value, satisfactory condition of the mandrel surface and operational life is maintained, but when such mandrels are removed from a mandrels circulation system of the continuous rolling mill and when they are reground to a smaller diameter, a significant amount of metal is grinded and the mandrels average specific consumption increases from 2 to 40 times. In addition, the pre-schedule removal of mandrels from operation significantly increases tool cost and adversely affects the performance of tube-rolling equipment as a whole.

[0017] After the working mandrel section is worn away at one end, other mandrel end is connected to the machine-tool attachment, the plug fitting is inserted into an opening at the front mandrel end and hollow shells are deformed. Furthermore, during the next operation cycle rolling is carried out on the unworn working mandrel section until the wear value reaches at least 25% of the critical value at the section on the other mandrel end. After wearing of the cylindrical mandrel is at least 25% of critical value almost along its entire length, the mandrel can be reground to other outer diameter along its entire length, which favor to increase the service mandrel life, taking into account the regulation of its wear value and improve the quality of finished tubes.

[0018] The mandrels wear value is regulated in the technological documentation of the enterprise and depends, in particular, on deformation modes on a continuous rolling mill, on power parameters of the process, on the range and steel grade of rolled tubes, on the temperature of rolled metal and rolling tools, on lubricants properties and antioxidants for different tubes grades.

[0019] The mandrel is designed in such a way that the angle of the beveled surfaces 2 generatrix with the longitudinal mandrel axis at the both ends is the same and is in the range from 10 to 70 degrees, which ensures to insert the mandrel easily into a hollow shell before rolling in a continuous rolling mill and favors the reduction of the number of defects on the inner tubes surface during the insertion and removal of the mandrel, as well as during rolling. If the generatrix angle is less than 10 degrees, there can be difficulties when the mandrel is inserted into a hollow shell and when the extractor takes a mother tube out, in addition defects on the inner surface of the rolled material are formed in the form of scratches and imprints. If the generatrix angle is more than 70 degrees, the possibility of cracks formation increases at the mandrel ends and in areas of blind openings, designed to

connect with the machine-tool attachment, which reduces the reliability of the connection. In addition, after regrinding of worn mandrels outer diameter to a smaller size, the angle of the bevelled surfaces generatrix remains in the specified range, difficulties do not occur when the mandrel is inserted into a hollow shell and there is practically no formation of defects on the inner surface of a hollow shell.

[0020] At the working position, the opening at the front mandrel end is plugged with the plug fitting 6 to protect from external influences and prevent clogging with scale and lubricant materials during rolling. Thread connections of all the elements of the mandrel assembly are made comparable to the connection of casing tubes and have a tapered trapezoidal thread or, for example, a Buttress thread. Before screwing, a lubricant is put on threads. Such constructive design of the mandrel assembly allows increasing the mandrels service life, the quality of the inner tube surface and preventing accidents during rolling.

EMBODIMENT OF THE INVENTION

[0021] The proposed method for the continuous tubes rolling with the use of the mandrel assembly is as follows. In the rolling process, the mandrel assembly is inserted into a hollow shell and then, together with the hollow shell, is set into a continuous mill. The hollow shell is deformed into a mother tube strictly on the cylindrical mandrel part, located between two sections with beveled side surfaces. The wear of the cylindrical part section of the mandrel is formed mainly closer to the front end, and the section of the mandrel near to the opposite end practically does not wear out. After the front section of the cylindrical mandrel is worn at least 25% of the critical wear value, the plug fitting is removed from the opening at the front end of the mandrel, the mandrel is disconnected from the attachment, connected by the other end with the attachment and the plug fitting is inserted into the opening at the other mandrel end. The operation of connecting and disconnecting components of the mandrel assembly can be carried out on a machine for screwing and unscrewing mandrels. After that, during the next cycle, the rolling process is carried out on the unworn section of the mandrel until it reaches a critical wear value at least of 25%. After wear of the cylindrical mandrel almost the entire length of at least 25% of the critical, the mandrel can be reground along its entire length to another outer diameter, which increases the service life of the mandrel and improves the quality of the finished tube. When implementing this method for rolling tubes, the mandrel is easily inserted into a hollow shell and removed, which leads to a significant reduction in the number of defects on the inner surface of the rolled material.

[0022] When the pre-schedule removal of mandrels from operation, for example, when the wear value does not exceed 25% of the critical value, and its subsequent regrinding to another outer diameter, the operational mandrels life is significantly reduced, since in this case the average specific mandrels consumption increases from 2 to 40 times. Furthermore, the service life increases due to the possibility of using a plug fitting made without a thread, which reduces thread wear in the thread openings due to a smaller number of screwing and unscrewing operations.

EXAMPLE OF THE EMBODIMENT OF THE INVENTION

[0023] The proposed method for the tubes production was tested on a PQF continuous tube mill. During industrial rolling processes, mandrels with the diameter of 149.20 ÷ 179.55 mm and with an angle of 25 degrees for the beveled surfaces generatrix at the both ends were used. Tubes were rolled using the 190 mm PQF mill calibration system. The most significant mandrels wear occurred at the section located at a distance of up to 5000 mm from the front mandrel end. The mandrel section, located at a distance from 5,000 and up to 11,500 mm (rear end) from the front end, was almost not subjected to wear. After the front mandrel section was worn by a value equal to 75% of the critical value, the plug fitting was removed from the opening at the mandrel front end, the mandrel was joined to the extension element by another end, in particular, on an equipment for the mandrel screwing on and unscrewing, then, the mandrel was put into operation again. Thereafter, the mandrel was operated until its other end working section was worn at 75% of the critical value. During the mandrel operation, the wear occurred along the entire length of the working sections; both rolling cycles was characterized by stable operation of the mandrel assembly, without damage to the mandrel and threaded connections. On the tubes inner surface, the depth of single defects of various types did not exceed critical values, the tubes quality was satisfactory. As a result of the performed industrial rolling processes, the mandrels service life was increased by an average of 45.6%, emergency situations did not occur on a continuous rolling mill and mill-extractor. The use of the proposed method for continuous tube rolling with the use of the mandrel assembly reduces tool cost by increasing its service life, reducing the formation of various types of defects on tubes inner surface, and eliminating the risks associated with emergency situations during the rolling process.

Claims

1. The continuous tube rolling method includes the deformation of the tubular hollow shell using a cylindrical mandrel with identical coaxial blind openings at the ends, control of mandrel dimensions and mandrel regrinding. The mandrel is connected with the mandrel assembly attachment alternately to deform tubular hollow shell at its working sections from dif-

ferent end of the mandrel. According to the Invention, the deformation of the tubular hollow shell is carried out up to the wear value at least 25% of the critical value for the working section of one mandrel end. However, the mandrel regrinding is carried out after changing the mandrel end connection with the mandrel assembly attachment, subsequent deformation of the tubular hollow shells and when value of the wear of the working section on the other mandrel end is at least 25% of the critical value.

2. The mandrel assembly of a continuous tube rolling mill, including a cylindrical mandrel made with a beveled side surface from one end, designed with the identical coaxial blind thread openings for connecting the mandrel to the mandrel assembly attachment alternately, is characterized that the opposite mandrel end is made with a beveled side surface, the angle of the beveled surfaces generatrix with the longitudinal axis of the mandrel at both ends is the same and ranges from 10 to 70 degrees, whereas at the working position the opening at the front end of the mandrel is plugged.

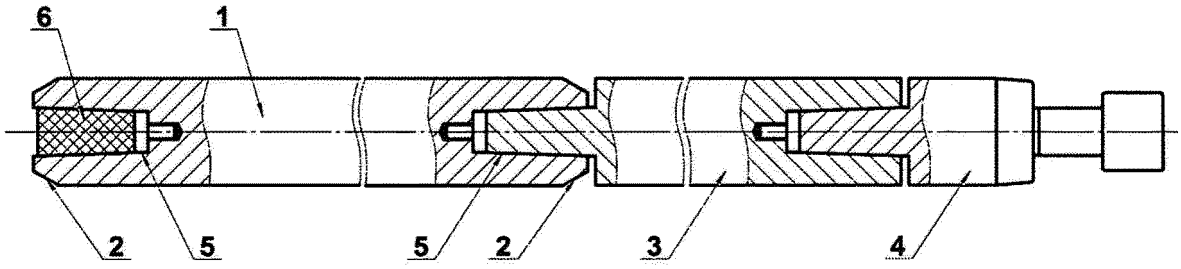

Fig.1

INTERNATIONAL SEARCH REPORT

International application No.
PCT/RU 2017/000296

A. CLASSIFICATION OF SUBJECT MATTER
B21B25/00 (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B21B 25/00–/06, 19/00–/10, 17/00–/12

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
RUPAT, RUPAT OLD, ESP@cenet, PatSearch, USPTO

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
D, A	RU 2486976 C1 (OTKRYTOE AKTSIONERNOE OBSHCHESTVO «ROSSIISKII NAUCHNO-ISSLEDOVATELSKII INSTITUT TRUBNOI PROMYSHLENNOSTI») 10.07.2013, the abstract, p. 3-5	1-2
A	SU 121425 A1 (M.A.KOSTENKO et al.) 30.11.1958, p.1-2	1-2
A	RU 2322318 C2 (OAO «CHELIABINSKII TRUBOPROKATNYI ZAVOD») 20.04.2008, the abstract	1-2
A	RU 2587702 C1 (FEDERALNOE GOSUDARSTVENNOE AVTONOMNOE OBRAZOVATELNOE UCHREZHDENIE VYSSHEGO OBRAZOVANIIA «NATSIONALNYI ISSLEDOVATELSKII TEKHNOLOGICHESKII UNIVERSITET «MISIS») 20.06.2016, the abstract	1-2
A	RU 2449845 C1 (OTKRYTOE AKTSIONERNOE OBSHCHESTVO «SINARSKII TRUBNYI ZAVOD») 10.05.2012. the abstract	1-2

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Date of the actual completion of the international search	Date of mailing of the international search report
17 January 2018 (17.01.2018)	07 February 2018 (07.02.2018)
Name and mailing address of the ISA/ RU	Authorized officer
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/RU 2017/000296

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	RU 2333053 C1 (OTKRYTOE AKTSIONERNOE OBSHCHESTVO «ELEKTROSTALSKII ZAVOD TIAZHELOGO MASHINOSTROENIIA») 10.09.2008, the abstract	1-2
A	US 8082768 B2 (SUMITOMO METAL INDUSTRIES, LTD.) 27.12.2011	1-2

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REFERENCES CITED IN THE DESCRIPTION

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- GB 1092718 A **[0003]**
- US 3120139 A **[0004]**
- RU 2486976 **[0010]**