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

(11) **EP 3 696 285 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
24.11.2021 Bulletin 2021/47

(21) Application number: **20156496.0**

(22) Date of filing: **10.02.2020**

(51) Int Cl.:
C21D 1/18 *(2006.01)* ***C21D 7/04*** *(2006.01)*
E01B 7/10 *(2006.01)* ***E01B 7/12*** *(2006.01)*
E01B 7/28 *(2006.01)*

(54) IMPROVED STEEL RAILWAY CROSSING

VERBESSERTER EISENBAHNÜBERGANG AUS STAHL

CROISEMENT FERROVIAIRE EN ACIER AMÉLIORÉ

(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

(30) Priority: **15.02.2019 GB 201902118**

(43) Date of publication of application:
19.08.2020 Bulletin 2020/34

(73) Proprietor: **Progress Rail Services UK Limited**
Eastfield, Peterborough PE1 5FQ (GB)

(72) Inventor: **WESTOBY, Michael**
West Lothian, Lothian EH49 7JR (GB)

(74) Representative: **Harris, Oliver John Richard**
Novagraaf UK
3rd Floor
77 Gracechurch Street
London EC3V 0AS (GB)

(56) References cited:
EP-A1- 0 838 552
EP-A1- 1 555 347
EP-A1- 2 487 293
AT-A1- 505 822
BE-A4- 1 020 879
CA-A- 544 446
CN-A- 100 999 781
CN-A- 105 400 937
DE-A1- 1 945 309
GB-A- 765 305
GB-A- 2 172 234
KR-A- 20030 072 014
RU-C1- 2 007 478
US-A- 2 703 297
US-A1- 2010 224 288
US-A1- 2017 275 717

EP 3 696 285 B1

Printed by Jouve, 75001 PARIS (FR)

Description

Field of the Disclosure

[0001] The disclosure relates to steel railway crossings and the manufacturing thereof.

Background and Prior Art

[0002] Hard steel railway crossings such as high manganese steel railway crossings are commonly used on railway lines with heavy usage due to their work hardening and high toughness properties. The crossings are key components of turn outs and any other places where train wheels have to transfer from one track onto another track. The crossing surface in contact with the train wheels may be pre-hardened using EDH hardening to increase its service life. Current manganese crossing can suffer from failure mechanisms induced by poor support conditions, which leads to vertical movement of the crossing as it "sinks" under the weight of the train which can lead to fractures in the crossing. Repair or replacement of these crossings is generally expensive and disruptive to the rail schedule and hence this disclosure aims to overcome at least some of the known disadvantages.

[0003] EP 2487293 A1 teaches a railway crossing comprising an upper part moulded from austenitic manganese steel, and a base plate made from a steel with a relatively higher fatigue resistance than that of the upper part.

[0004] AT 505822 teaches to weld an intermediate piece in-between a cast manganese steel crossing and a standard rail, wherein the intermediate piece is subjected to EDH over its entire circumference.

[0005] CN 100999781 A, GB 2172234 A, EP 0838552 A1, and BE 1020879 A4 all teach EDH for improving the wear resistance of rolling surfaces of a railway crossing.

Summary of the Disclosure

[0006] Accordingly, the present invention provides a cast steel railway crossing having a body with a top running surface and a bottom support surface. The body has a first hardness and a first UTS. The top running surface has been exposed to a first EDH cycle to achieve a second hardness greater than the first hardness, the bottom support surface having been exposed to a second EDH cycle to achieve a second UTS greater than the first UTS, wherein the second hardness is greater than 240 BHN, and the second UTS is greater than 840 MPa.

[0007] In a further aspect the invention provides a method of manufacturing a railway crossing comprising the steps of: casting at least a section of a steel railway crossing. The at least one section has a top running surface and a bottom support surface. The method further comprises the steps of exposing at least a portion of the top running surface to a first EDH cycle to obtain an increased hardness greater than 240 BHN, to increase wear and deformation resistance of the running surface, and exposing at least a portion of the bottom support surface to a second EDH cycle to obtain an increased UTS of the section greater than 840 MPa.

Brief Description of the Figures

[0008] The disclosure will be described with reference to the accompanying drawings, in which:

Fig. 1 shows an exemplary depiction of a crossing in accordance with the current disclosure;
Fig. 2 is a flow chart of a method of manufacturing the crossing of Fig. 1.

Description of Preferred Embodiments

[0009] Fig. 1 shows an exemplary railway crossing 10 such as a high manganese steel railway crossing. Crossing 10 is provided with a body 20 with a top running surface 30 and a bottom support surface 40. The top running surface 30 is the surface that is in contact with the train wheels (not shown) The bottom support surface 40 is the surface of which portions rest on load bearing members such as bearers (not shown). The top running surface 30 may have various elements such as a nose 60 which is exposed to impacts from the train wheels where the wheel changes from one track onto another and "lands" on the nose 60. Although the wheel contact surface itself will harden over time due to wheel-rail contact known as workhardening, areas like the nose 60 need to be sufficiently hard right at installation to avoid height reduction (due to wheel impact) of the nose 60. If the nose 60 is insufficiently hard the wheel impacts compact the nose 60 thereby inducing sinkage. Sinkage leads to an increase in the drop of the wheel onto the nose 60, resulting into a cycle of ever increasing impacts hence continuing a cycle of deterioration of the nose 60.

[0010] To achieve the desired hardness, the top running surface 30, or at least the relevant sections thereof, may be exposed to a first Explosive Device Hardening (EDH) cycle 100 to change the hardness of metal from a first hardness to a second hardness which is greater than the first hardness. The first EDH cycle 100 includes at least a first EDH event 110 that hardens the metal by severe plastic deformation caused by the shock wave. The explosive used may be any suitable kind such as Semtex or a cyclonite, epoxy resin and ethyl diamine composite. The explosive sheet usually has a thickness in the range of 2 - 5 mm. Both the surface hardness and depth of hardening increase with the thickness of the explosive and number of shots given.

[0011] After an EDH event 110, the body 20 may still have the original first hardness in the range of 180 - 215 BHN whereas the top running surface 30 will have a second hardness greater than 240 BHN, such as up to 270 BHN. In an embodiment the top running surface 30 will have a second hardness of about 255 BHN. The first

EDH cycle 100 may include a second EDH event 120. The second EDH event 120 may raise the hardness of the top running surface 30 to a second hardness of >300 BHN. In an embodiment the top running surface 30 will have a second hardness of about 320 BHN.

[0012] The bottom support surface 40 may have sections 70 which have not been machined after casting. The bottom support surface 40 may be provided with machined sections 80 to provide a precise surface with which the crossing 10 can engage a load bearing member. Transition zones 90 are the areas where a non-machined section 70 and a machined section 80 border.

[0013] The bottom support surface 40, or sections thereof, is or are exposed to a second EDH cycle 200 to increase the Proof Stress (PS) and the Ultimate Tensile Stress (UTS) of the bottom support surface 40. After an EDH event 210, the body 20 may still have the original first UTS in the range of 640 - 690 MPa with a first PS in the range of 295 - 325 MPa whereas the bottom support surface 40 will have a second UTS greater than 840 MPa, in the range up to 880 MPa, with a second PS in the range of 355 - 390 MPa. In an embodiment the bottom support surface 40 has a second UTS of about 860 MPa. In this embodiment the bottom support surface 40 may have a second PS of about 370 MPa.

[0014] The second EDH cycle 200 may include a second EDH event 220. The second EDH event 220 may raise the second UTS of the bottom support surface 40 to > 1070 MPa with a second PS of >465 MPa. In an embodiment the bottom support surface 40 has a second UTS of about 1100 MPa. In this embodiment the bottom support surface 40 may have a second PS of about 485 MPa.

[0015] Accordingly, the crossing 10 has a top running surface 30 with a second hardness greater than 240 BHN and a bottom support surface 40 with a second UTS greater than 840 MPa.

[0016] In an embodiment the crossing 10 further has a body 20 with a first hardness less than 215 BHN and/or a first UTS less than 690 MPa.

Industrial applicability

[0017] The load bearing member is designed to support the crossing 10, however, in cases where the load bearing member itself is not sufficiently supported (e.g. after subsidence or sinkage of the undersoil), the load bearing member will not sufficiently support, or may even pull down, the crossing 10 thereby inducing tensile stresses in the bottom support surface 40. The tensile stresses could cause the bottom support surface 40 to fracture leading to the crossing 10 having to be repaired or replaced. Steel crossings, and high manganese steel crossings in particular may be susceptible to fracturing, given that it is difficult to quality check these crossings after casting due to the open structure of the steel. The open structure does not lend itself for quality examination techniques such as ultrasound. Defects such as microfractures or excessive porosity may therefore go undetected which may lead to failures themselves during use, or may form the starting point for more severe fractures when the load bearing member pulls down on the crossing 10. Areas that may be particularly prone to failures, higher stresses and/or defects are the transition zones 90.

[0018] Exposing at least a portion of the bottom support surface 40 to the second EDH cycle 200 will improve the UTS leading to raised or improved fatigue resistance on the base of the CMX, reducing or delaying risk of cracking under poor support. It will further improve quality inspections of the bottom support surface 40 as defects may be exposed as more readily detectable larger fractures or holes.

[0019] To manufacture a high manganese steel railway crossing 10 in accordance with this disclosure, a method of manufacture such crossing 10 may include the following steps:

Casting at least a section of a steel railway crossing 10 having a body 20, a top running surface 30 and a bottom support surface 40 in step 400. Step 410 comprises exposing (at least a portion of) the top running surface 30 to a first EDH cycle 100 to increase wear and deformation resistance of the top running surface 30. In optional step 420 the bottom support surface 40 may undergo machining to provide machined sections 80. Step 430 comprises exposing (at least a portion of) the bottom support surface 40 to a second EDH cycle 200 in step 430 to increase the UTS of the bottom support surface 40. Optional step 440 comprises inspecting the quality of the crossing 10.

Claims

1. A cast steel railway crossing having a body with a top running surface and a bottom support surface;

   said body having a first hardness and a first UTS;
   said top running surface having been exposed to a first Explosive Device Hardening cycle to achieve a second hardness greater than said first hardness;
   said bottom support surface having been exposed to a second Explosive Device Hardening cycle to achieve a second UTS greater than said first UTS;
   wherein said second hardness is greater than 240 BHN, and said second UTS is greater than 840 MPa.

2. A steel railway crossing according to claim 1 wherein said first hardness is less than 215 BHN and said first UTS is less than 690 MPa.

3. A method of manufacturing a railway crossing comprising the steps of:

casting at least a section of said railway crossing from steel, said at least a section having a top running surface and a bottom support surface;
exposing at least a portion of said top running surface to a first Explosive Device Hardening cycle to obtain an increased hardness of said top running surface greater than 240 BHN; and
exposing at least a portion of said bottom support surface to a second Explosive Device Hardening cycle to obtain an increased UTS greater than 840 MPa.

4. A method of manufacturing a railway crossing according to claim 3, wherein said first Explosive Device Hardening cycle comprises multiple Explosive Device Hardening events.

5. A method of manufacturing a railway crossing according to claim 3 or claim 4, wherein said second Explosive Device Hardening cycle comprises a single Explosive Device Hardening event.

6. A method according to any of claims 3 to 5, further comprising the step of machining portions of the bottom support surface before the second Explosive Device Hardening cycle.

7. A method according to any of claims 3 to 6, further comprising inspecting the crossing for defects exposed by the second Explosive Device Hardening cycle.

Patentansprüche

1. Eisenbahnkreuzung aus Gussstahl, die einen Körper mit einer oberen Lauffläche und einer unteren Stützfläche aufweist;

wobei der Körper eine erste Härte und eine erste UTS aufweist;
wobei die obere Lauffläche einem ersten Sprengkörperhärtungszyklus ausgesetzt wurde, um eine zweite Härte zu erreichen, die größer ist als die erste Härte;
wobei die untere Stützfläche einem zweiten Sprengkörperhärtungszyklus ausgesetzt wurde, um eine zweite UTS zu erreichen, die größer ist als die erste UTS;
wobei die zweite Härte größer ist als 240 BHN und die zweite UTS größer ist als 840 MPa.

2. Eisenbahnkreuzung aus Stahl nach Anspruch 1, wobei die erste Härte kleiner ist als 215 BAN und die erste UTS kleiner ist als 690 MPa.

3. Verfahren zum Herstellen einer Eisenbahnkreuzung, das folgende Schritte umfasst:

Gießen von mindestens einem Teil der Eisenbahnkreuzung aus Stahl, wobei der mindestens eine Teil eine obere Lauffläche und eine untere Stützfläche aufweist;
Aussetzen mindestens eines Abschnitts der oberen Lauffläche einem ersten Sprengkörperhärtungszyklus, um eine erhöhte Härte der oberen Lauffläche von mehr als 240 BHN zu erreichen; und
Aussetzen mindestens einen Abschnitts der unteren Stützfläche einem zweiten Sprengkörperhärtungszyklus, um eine erhöhte UTS von mehr als 840 MPa zu erreichen.

4. Verfahren zum Herstellen einer Eisenbahnkreuzung nach Anspruch 3, wobei der erste Sprengkörperhärtungszyklus mehrere Sprengkörperhärtungsereignisse umfasst.

5. Verfahren zum Herstellen einer Eisenbahnkreuzung nach Anspruch 3 oder 4, wobei der zweite Sprengkörperhärtungszyklus ein einziges Sprengkörperhärtungsereignis umfasst.

6. Verfahren nach einem der Ansprüche 3 bis 5, das vor dem zweiten Sprengkörperhärtungszyklus den Schritt des Bearbeitens von Abschnitten der unteren Stützfläche umfasst.

7. Verfahren nach einem der Ansprüche 3 bis 6, das ferner das Überprüfen der Kreuzung auf Fehler, die durch den zweiten Sprengkörperhärtungszyklus freigelegt wurden, umfasst.

Revendications

1. Croisement ferroviaire en acier moulé ayant un corps avec une surface de circulation supérieure et une surface de support inférieure ;

ledit corps ayant une première dureté et une première UTS ;
ladite surface de circulation supérieure ayant été exposée à un premier cycle de durcissement par dispositif explosif pour obtenir une seconde dureté supérieure à ladite première dureté ;
ladite surface de support inférieure ayant été exposée à un second cycle de durcissement par dispositif explosif pour obtenir une seconde UTS supérieure à ladite première UTS ;
dans lequel ladite seconde dureté est supérieure à 240 BHN, et ladite seconde UTS est supérieure à 840 MPa.

2. Croisement ferroviaire en acier selon la revendication 1, dans lequel ladite première dureté est inférieure à 215 BHN et ladite première UTS est infé-

rieure à 690 MPa.

3. Procédé pour fabriquer un croisement ferroviaire comprenant les étapes suivantes :

mouler au moins une section dudit croisement ferroviaire à partir d'acier, ladite au moins une section ayant une surface de circulation supérieure et une surface de support inférieure ;
exposer au moins une partie de ladite surface de circulation supérieure à un premier cycle de durcissement par dispositif explosif pour obtenir une dureté accrue de ladite surface de circulation supérieure, supérieure à 240 BHN ; et
exposer au moins une partie de ladite surface de support inférieure à un second cycle de durcissement par dispositif explosif pour obtenir une UTS accrue supérieure à 840 MPa.

4. Procédé pour fabriquer un croisement ferroviaire selon la revendication 3, dans lequel ledit premier cycle de durcissement par dispositif explosif comprend plusieurs événements de durcissement par dispositif explosif.

5. Procédé pour fabriquer un croisement ferroviaire selon la revendication 3 ou la revendication 4, dans lequel ledit second cycle de durcissement par dispositif explosif comprend un seul événement de durcissement par dispositif explosif.

6. Procédé selon l'une quelconque des revendications 3 à 5, comprenant en outre l'étape pour usiner des parties de la surface de support inférieure avant le second cycle de durcissement par dispositif explosif.

7. Procédé selon l'une quelconque des revendications 3 à 6, comprenant en outre l'étape pour inspecter le croisement concernant les défauts exposés grâce au second cycle de durcissement par dispositif explosif.

FIG. 1

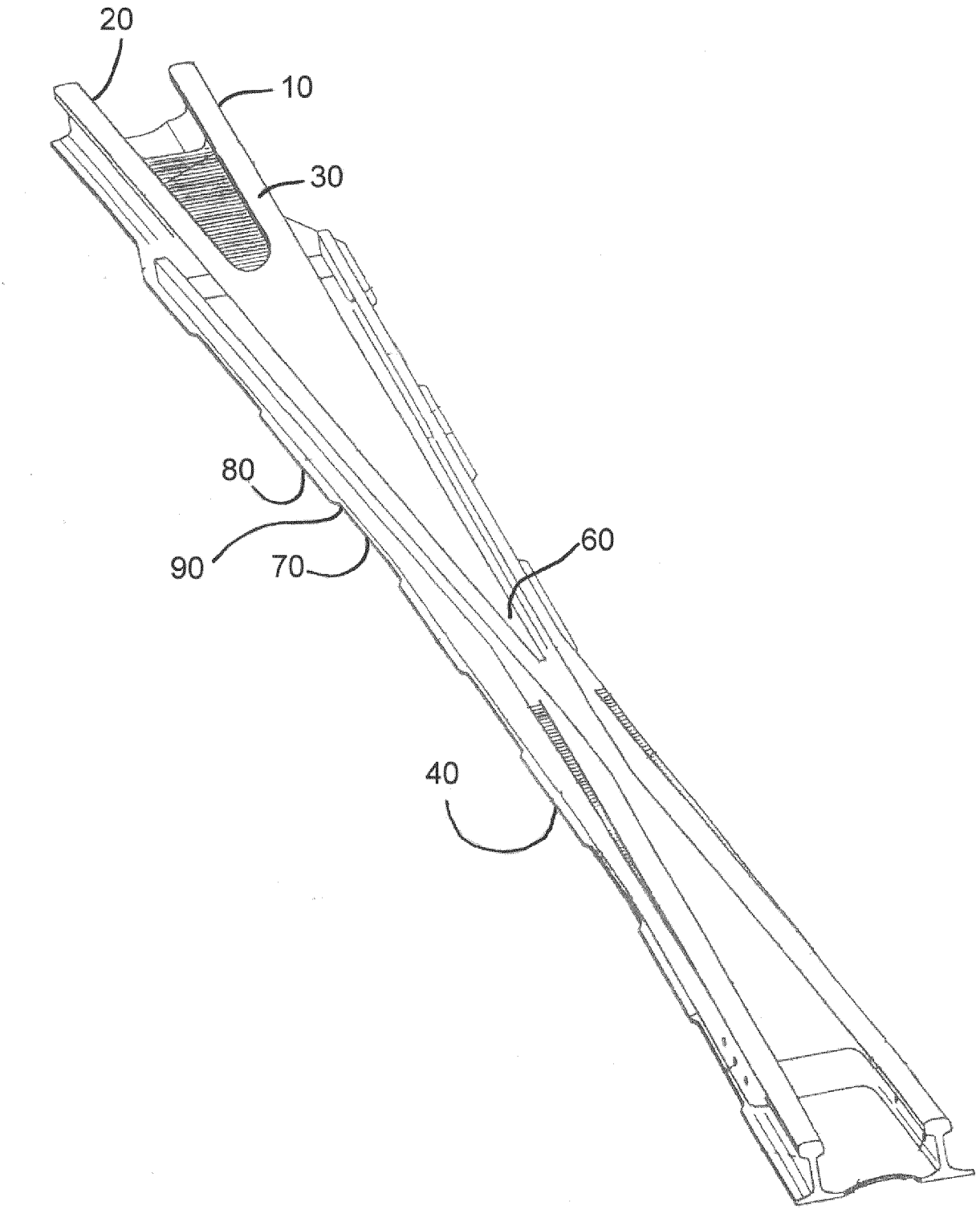
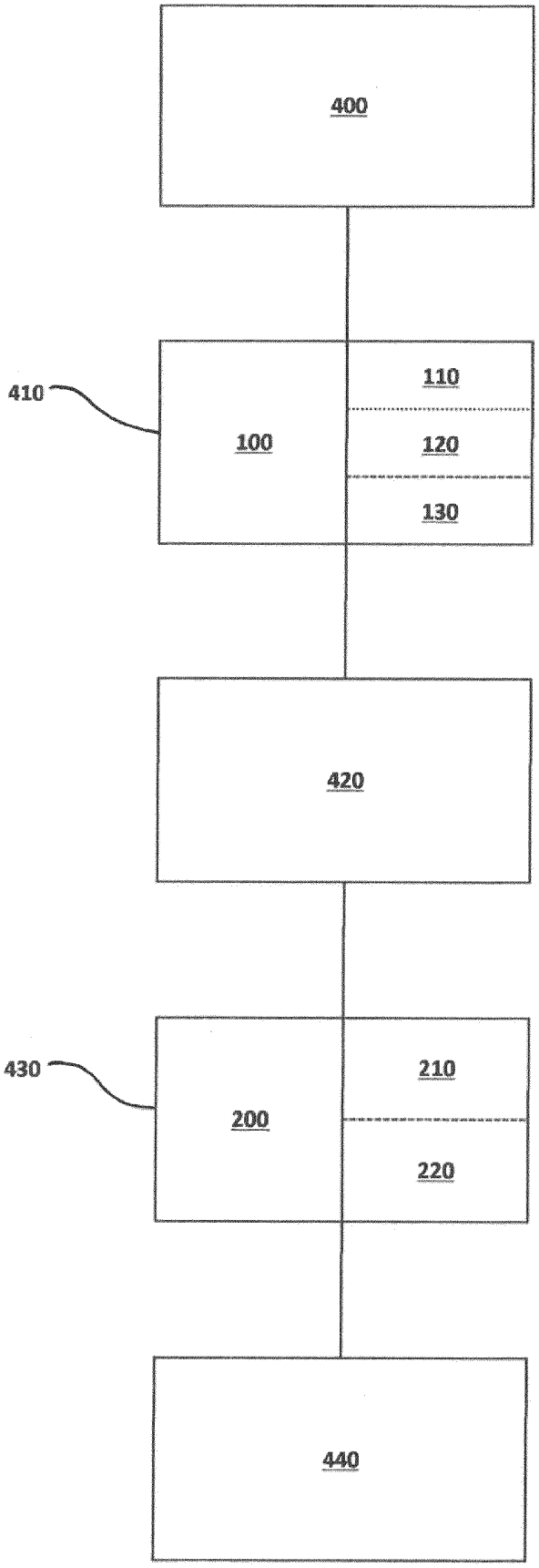


FIG. 2



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

- EP 2487293 A1 **[0003]**
- AT 505822 **[0004]**
- CN 100999781 A **[0005]**
- GB 2172234 A **[0005]**
- EP 0838552 A1 **[0005]**
- BE 1020879 A4 **[0005]**