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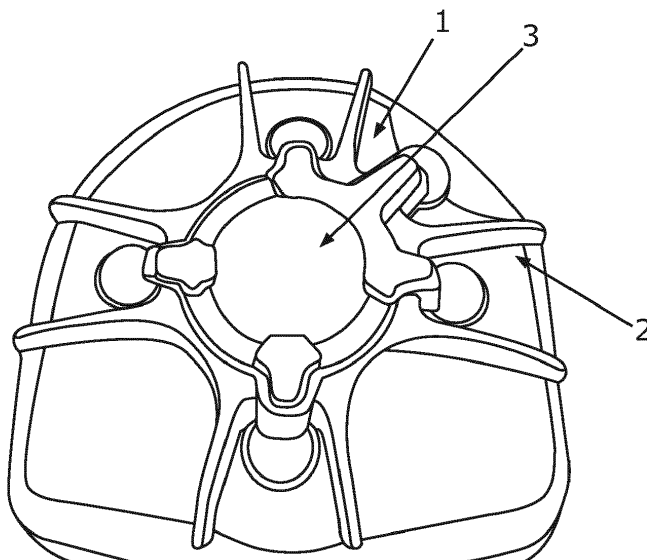
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(54) **STEEL ALLOY, USE OF SUCH A STEEL ALLOY, AND COMPONENT**

(57) The invention relates to a steel alloy comprising, in percent by mass:  
- 0.17 to 0.23 carbon;  
- 1.40 to 1.60 silicon;  
- 0.50 to 0.60 manganese;  
- up to 0.020 phosphor;  
- up to 0.020 sulfur;

- up to 0.30 chrome;  
- up to 0.12 molybdenum;  
- up to 0.80 nickel;  
- up to 0.30 copper;  
- up to 0.03 vanadium;  
the remainder being iron and incidental impurities.



*Fig. 1*

## Description

**[0001]** The invention relates to a steel alloy, a use of such a steel alloy, and a component.

**[0002]** Steel alloys such as, for example, G20Mn5 according to DIN EN 10293 are well-known from the prior art.

**[0003]** It is an object of the present invention to provide a steel alloy, a use of such a steel alloy, as well as a component so that the component can be manufactured from said steel alloy in a particular advantageous way.

**[0004]** This object is solved by a steel alloy having the features of patent claim 1, by a use having the features of patent claim 4, and by a component having the features of patent claim 10. Advantageous embodiments of the invention are indicated in the dependent claims.

**[0005]** A first aspect of the present invention relates to a steel alloy comprising, in percent by mass, 0.17 to 0.23 carbon (C). The unit or specification "percent by mass" is also referred to as "percentage by mass", "percentage by weight", "percent by weight", "weight percent", "weight percentage" or "mass fraction". In the context of the present invention, the percentage by mass of a substance within a mixture or an alloy such as the steel alloy according to the present invention is the ratio of the mass of that substance to the total mass of the mixture or the alloy respectively. With respect to an alloy such as the steel alloy according to the present invention, said substance can be an alloying element such as carbon. In other words, said carbon is a substance of the steel alloy according to the present invention.

**[0006]** Furthermore, the steel alloy according to the present invention comprises, in percent by mass, 1.40 to 1.60 silicon (Si), 0.50 to 0.60 manganese (Mn), up to 0.020 phosphor (P), up to 0.020 sulphur (S), up to 0.30 chrome (Cr), up to 0.12 molybdenum (Mo), up to 0.80 nickel (Ni), up to 0.30 copper (Cu) and up to 0.03 vanadium (V), the remainder or balance being iron (Fe) and incidental or unavoidable impurities. This means the carbon, the silicon, the manganese, the phosphor, the sulphur, the chrome, the molybdenum, the nickel, the copper and the vanadium are substances, in particular alloying elements, of the steel alloy according to the present invention. Moreover, said iron and said impurities are substances of the steel alloy according to the present invention. Particularly, said impurities can be conditional of manufacturing. Preferably, the steel alloy according to the present invention comprises at least 90 percent by mass, in particular at least 95 percent by mass and preferably at least 95.5 percent by mass of iron. Preferably, the steel alloy according to the present invention comprises at least 95.78 percent by mass of iron. In other words, preferably, the steel alloy comprises a mass fraction of at least 90 percent, in particular at least 95 percent, preferably at least 95.5 percent and preferably at least 95.78 percent of iron, the remainder being incidental or unavoidable or inevitable impurities.

**[0007]** It has surprisingly been found that the steel alloy

according to the present invention can be processed, in particular cast, in a particular advantageous way so that components can be made of the steel alloy according to the present invention in a particular advantageous, time- and cost efficient way. It has particularly been found that silicon, in particular its mass fraction or percentage by mass according to the present invention, helps create a particularly good flowability of a molten mass made from the steel alloy according to the present invention. Moreover, the mass fraction of silicon according to the present invention helps realize an advantageously low solidus temperature. Furthermore, it has been found that manganese and its mass fraction according to the present invention help avoid an excessive or unwished reactivity, in particular during processing the steel alloy.

**[0008]** In a particular advantageous embodiment of the invention, the steel alloy according to the present invention is a steel cast alloy. It has been found that the steel alloy according to the present invention can be cast in a particular advantageous way due to said substances and their respective mass fractions. In other words, the steel alloy according to the present invention can be processed particularly advantageously by casting.

**[0009]** In a further advantageous embodiment of the invention, the steel alloy as cast has a Brinell hardness of at least 190 HBW 5/750 and/or a yield point ( $R_{p0.2}$ ) of at least 300 megapascal (N/mm<sup>2</sup>). Thus, particular advantageous characteristics of the steel alloy and, thus, a component made from the steel alloy can be realized.

**[0010]** A second aspect of the present invention relates to a use or usage of the steel alloy according to the present invention, wherein at least one component is made from the steel alloy, in particular by casting, i.e. by a casting method or a casting process. In other words, the second aspect of the present invention relates to a method for manufacturing at least one component. In said method the component is manufactured or made from the steel alloy according to the present invention. Preferably, in said method, the component is made from the steel alloy by casting, i.e. by a casting method or a casting process. Thus, the component can be made in a particular easy and time- and cost-efficient way. In particular, a particularly low wall thickness of the component can be realized by manufacturing the component from the steel alloy according to the present invention. Advantages and advantageous embodiments of the first aspect of the present invention are to be regarded as advantages and advantageous embodiments of the second aspect of the present invention and vice versa.

**[0011]** In a particularly advantageous embodiment of the invention, the component is subjected to a heat treatment after the casting. For example, the component is subjected to at least or exactly one heat treatment after the casting. Thus, particular advantageous characteristics of the component can be realized.

**[0012]** In a further advantageous embodiment of the invention, the heat treatment comprises a normalizing of the component. Preferably, the heat treatment is a nor-

malizing of the component.

**[0013]** In order to realize particularly advantageous characteristics of the component, in a further embodiment, the normalizing is carried out in a temperature range extending from 900 degrees centigrade to 980 degrees centigrade.

**[0014]** Preferably, after the heat treatment the steel alloy has a tensile strength ( $R_m$ ) of at least 560 megapascal and/or a yield point ( $R_{p0.2}$ ) of at least 370 megapascal and/or an elongation at break ( $A_{5.65}$ ) of at least 20% and/or a Vickers hardness of at least 180 HV10 and/or a viscosity or ductility (KV) of at least 27 joule, wherein the ductility has been or can be determined by an impact test. Said tensile strength, said yield point, said elongation at break, said ductility and said Vickers hardness as well as said Brinell hardness are mechanical characteristics or properties of the steel alloy or the component respectively, wherein said properties and their mentioned characteristic values have been or can be determined according to DIN EN ISO 6892-1, in particular by means of a tensile test according to DIN EN ISO 6892-1. Particularly, said properties and their mentioned characteristic values have been or can be determined by means of a sample or probe which can be taken or drawn according to DIN EN ISO 377. The probe or sample is also referred to as a specimen. If possible, the specimen type E according to DIN 50125 should be chosen. Particularly, the standards, in particular the DIN EN standards mentioned herein are or have been valid on June 29<sup>th</sup>, 2017.

**[0015]** In order to realize particularly advantageous characteristics of the steel alloy or the component respectively, in a further advantageous embodiment of the invention, a homogeneous perlite-ferritic structure or micro structure is created by the heat treatment, wherein during the heat treatment, a carbonization and a decarbonisation of the component or steel alloy respectively are omitted.

**[0016]** A third aspect of the present invention relates to a component which is, preferably, a cast component. Said component is made from the steel alloy according to the invention, i.e. the steel alloy according to the first aspect of the present invention. Preferably, the component is manufactured by means of said use or method for manufacturing the component. Advantages and advantageous embodiments of the first and second aspects of the present invention are to be regarded as advantages and advantageous embodiments of the third aspect of the present invention and vice versa.

**[0017]** Preferably, the component is a body component for a body in white or an integral body of a vehicle, in particular a passenger vehicle. The body in white or the integral body are also referred to as a self-supporting body, body work or shell. Preferably, the body component is a dome such as a suspension-strut dome. In this regard, the dome has a particularly low wall thickness which can be realized by using the steel alloy according to the present invention.

**[0018]** Further details of the invention derive from the

following description of preferred embodiments as well as from the drawings. The drawings show in:

- Fig. 1 part of a schematic and perspective view of a component according to the present invention;
- Fig. 2 part of a further schematic and perspective view of the component; and
- Fig. 3 a flow diagram illustrating a method for manufacturing the component.

**[0019]** In the figures the same elements or elements having the same functions are indicated by the same reference signs.

**[0020]** Figs. 1 and 2 show a component 1 for a vehicle such as a car or an automobile. In particular, said vehicle is a passenger vehicle having, in its completely assembled state, a body in white which is also referred to as a body, an integral body, a self-supporting body, a body-work or a shell. In this regard, the component 1 is a body component of the body in white. Particularly, the component 1 is a dome in a form of a suspension-strut dome of the body in white. The component 1 has a particularly low wall thickness. Moreover, the component 1 has a rib structure 2 stiffening the component 1. Moreover, preferably, the component 1 is formed in one piece. In other words, the component is integrally formed. As can be seen from Figs. 1 and 2, the component 1 has a recess 3 which is, preferably, a through opening. For example, a spring and/or damper element such as a suspension-strut can be supported on the component 1 in the vertical direction of the vehicle upwardly. Alternatively or additionally, the spring and/or damper element can be arranged partially in the recess 3.

**[0021]** In order to manufacture the component 1 in a particular easy and time- and cost-efficient way the component 1 is made from a steel alloy by casting, i.e. by a casting method. Said steel alloy is a steel cast alloy which can be processed by casting in a particularly easy and time- and cost-efficient way. Said steel alloy comprises at least the following substances, given in mass fractions in the unit %:

- 0.17 to 0.23 carbon (C)
- 1.40 to 1.60 silicon (Si)
- 0.50 to 0.60 manganese (Mn)
- up to 0.020 phosphor (P)
- up to 0.020 sulphur (S)
- up to 0.30 chrome (Cr)
- up to 0.12 molybdenum (Mo)
- up to 0.80 nickel (Ni)
- up to 0.30 copper (Cu)
- up to 0.03 vanadium (V)
- the remainder or balance being iron (Fe) and incidental, unavoidable or inevitable impurities.

**[0022]** This means the steel alloy comprises the afore-

mentioned substances, in percent by mass or percentage by mass. In particular, due to the mass fractions of silicon and manganese respectively, the steel alloy can be processed very well, in particular by casting.

**[0023]** Preferably, after casting the component 1, the component 1 is subjected to a heat treatment, which is, preferably, a normalizing of the component 1. The normalizing is also referred to as a normalization and should be performed in a temperature range of 900 to 980 degrees centigrade. For example, the component 1 is normalized in an oven. A temperature and an atmosphere in the oven during the normalizing should be chosen in a way that a homogeneous perlite-ferritic grain structure of the component 1 is accomplished and neither carbonisation nor decarbonisation of the component 1 or the steel alloy respectively occurs. This can be proven by means of a grain structure analysis.

**[0024]** Preferably, in a state or condition after the heat treatment and before an optional or possible further heat treatment to which the component 1 is possibly subjected, the component 1 or the steel alloy has a tensile strength (TS) of at least 560 megapascal and /or a yield point or yield strength (YS) of at least 370 megapascal and/or an elongation at break or a fracture elongation ( $A_{5.65}$ ) of at least 20 percent and/or a tensile ductility or toughness (KV) of at least 27 joule and/or a Vickers hardness of at least 180 HV10. A measurement to determine said toughness is preferably carried out according to ISO 148-1:2016 which, preferably, is or has been valid on June 29<sup>th</sup>, 2017. Alternatively or additionally, a measurement for determining said hardness is carried out according to DIN EN ISO 6507-1. Said tensile strength, said yield strength, said fracture elongation, said toughness and said Vickers hardness are mechanical properties or mechanical characteristics in normalized condition of the component 1, i.e. after said normalizing.

**[0025]** Preferably, after the casting and after the heat treatment the component 1 is cleaned, preferably by centrifugal blasting. Preferably, the component 1 is cleaned by means of airless blast cleaning after the casting and after the heat treatment.

**[0026]** Fig. 3 shows a flow diagram illustrating a process or process sequence which is carried out after the casting and after the heat treatment and, preferably, after said cleaning of the component 1. The process sequence shown in Fig. 3 is carried out in order to realize a particularly high quality of a surface of the, in particular completely manufactured, component 1.

**[0027]** In a first step S1 of the process sequence, the component 1 is degreased, preferably by means of an alkaline fluid. In a second step S2 the component 1 is subjected to a first purging in which, preferably, the component 1 is purged by means of deionised water. Preferably, the second step S2 is carried out after the first step S1. In a third step S3 of the process sequence the component 1 is subjected to an ultrasonically cleaning in which, preferably, the component 1 is cleaned by means of the deionised water. Preferably, the third step S3 is

carried out after the second step S2. In a fourth step S4 of the process sequence the component 1 is subjected to a first chemical polishing which is preferably carried out after the third step S3. In the fourth step S4 at least or exactly one layer having a thickness of 10 to 15 micrometres is abased from the component 1.

**[0028]** In a fifth step S5 the component 1 is subjected to a second chemical polishing. The fifth step S5 is an alternative to the fourth step S4 so that either the fourth step S4 or the fifth step S5 is carried out. In the fifth step S5 at least or exactly one layer having a thickness of 25 to 30 micrometres is abased from the component 1. Preferably, the fourth or fifth step respectively is carried out after the third step.

**[0029]** In a sixth step S6 which is preferably carried out after the fourth step S4 or the fifth step S5 respectively, the component 1 is subjected to a second purging in which the component 1 is purged by deionised water. In a seventh step S7 of the process sequence the component 1 is subjected to an ultrasonically cleaning, wherein, preferably, the seventh step S7 is carried out after the sixth step S6. In the seventh step S7, the component 1 is ultrasonically cleaned by means of deionised water. In an eighth step S8 of the process sequence the component 1 is subjected to a pickling which is also referred to as a pickling. Preferably, by means of the pickling the component 1 is cleaned. Preferably, the eighth step S8 is carried out after the seventh step S7.

**[0030]** In a ninth step S9 of the process sequence the component 1 is subjected to a galvanising process in which the component 1 is galvanised. Preferably, the ninth step S9 is carried out after the eighth step S8. In the ninth step S9, the component 1 is furnished or provided with at least one layer by means of galvanising. Said layer is made of zinc (Zn) in order to protect the component 1 from corrosion. Since the galvanising in the ninth step S9 is carried out after the pickling carried out in the eighth step S8, the layer adheres particularly advantageously or strongly to the surface of the component 1. In other words, by means of the pickling carried out in the eighth step a particularly advantageous surface of the component 1 can be realized, wherein the layer created in the galvanising process carried out in the ninth step S9 can adhere very advantageously and strongly to said surface created by the pickling.

**[0031]** In a tenth step S10 of the process sequence the component 1 is provided with a corrosion protection oil, in particular by spraying. In other words, in particular and preferably, said corrosion protection oil is sprayed on said zinc layer and, thus, on a surface formed by said layer which is a zinc layer. Preferably, the tenth step S10 is carried out after the ninth step S9.

**[0032]** Preferably, the component 1, in particular in its completely manufactured state, has a surface having a surface roughness fulfilling the following demands: Ra max. 10 micrometres, Rz max. 50 micrometres and Rt max. 75 micrometres. Preferably, said surface roughness is determined or measured according to DIN EN

ISO 4288:1997.

**[0033]** The ninth step S9 is a coating or coating process which is also referred to as a galvanic zinc coating or galvanic zinc coating process, said layer being a zinc layer is a coat or a zinc coat. The zinc coat is also referred to as a sink coating which is, preferably, at every position of the component 1 and, thus, completely closed. Preferably, the layer has a thickness of 7 to 15 micrometres.

List of reference signs

**[0034]**

|     |               |
|-----|---------------|
| 1   | component     |
| 2   | rip structure |
| 3   | recess        |
| S1  | first step    |
| S2  | second step   |
| S3  | third step    |
| S4  | fourth step   |
| S5  | fifth step    |
| S6  | sixth step    |
| S7  | seventh step  |
| S8  | eighth step   |
| S9  | ninth step    |
| S10 | tenth step    |

## Claims

1. A steel alloy comprising, in percent by mass:

- 0.17 to 0.23 carbon;
- 1.40 to 1.60 silicon;
- 0.50 to 0.60 manganese;
- up to 0.020 phosphor;
- up to 0.020 sulfur;
- up to 0.30 chrome;
- up to 0.12 molybdenum;
- up to 0.80 nickel;
- up to 0.30 copper;
- up to 0.03 vanadium;

the remainder being iron and incidental impurities.

2. The steel alloy according to claim 1,  
**characterized in that**  
the steel alloy is a steel cast alloy.

3. The steel alloy according to claim 1 or 2,  
**characterized in that**  
the steel alloy as cast has a Brinell hardness of at least 190 HBW 5/750 and/or a yield point of at least 300 megapascal.

4. A use of a steel alloy according to any one of claims 1 to 3, wherein at least one component (1) is made from the steel alloy, in particular by casting.

5. The use according to claim 4,  
**characterized in that**  
after the casting the component (1) is subjected to a heat treatment.

6. The use according to claim 5,  
**characterized in that**  
the heat treatment comprises a normalizing of the component (1).

7. The use according to claim 6,  
**characterized in that**  
the normalizing is carried out in a temperature range extending from 900 degrees centigrade to 980 degrees centigrade.

8. The use according to any one of claims 5 to 7,  
**characterized in that**  
after the heat treatment the steel alloy has a tensile strength of at least 560 megapascal and/or a yield point of at least 370 megapascal and/or an elongation at break of at least 20% and/or a Vickers hardness of at least 180 HV10 and/or a tensile ductility .

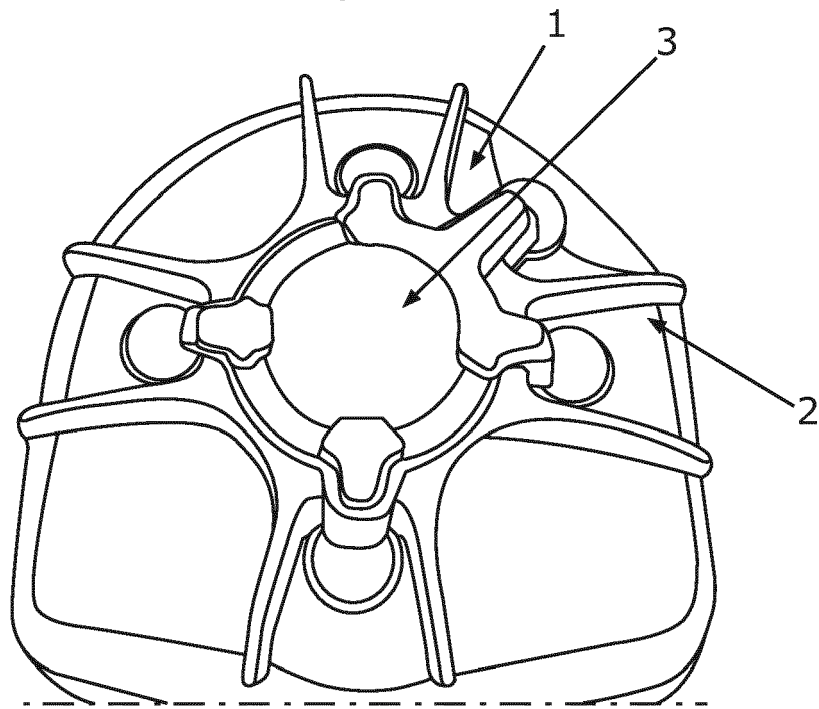
9. The use according to any one of claims 5 to 8,  
**characterized in that**  
by the heat treatment a homogeneous perlitic-ferritic structure is created, wherein, during the heat treatment, a carbonization and a decarbonization of the component are omitted.

10. A component (1), in particular cast component, made from a steel alloy according to any one of claims 1 to 3.

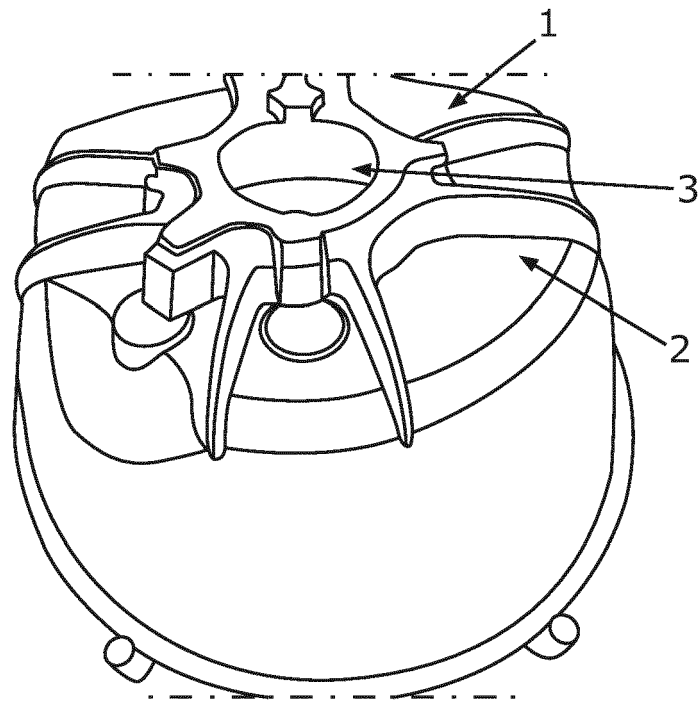
11. The component according to claim 10,  
**characterized in that**  
the component (1) is a body component for a body in white or an integral body of a vehicle.

12. The component (1) according to claim 11,  
**characterized in that**  
the body component (1) is a dome.

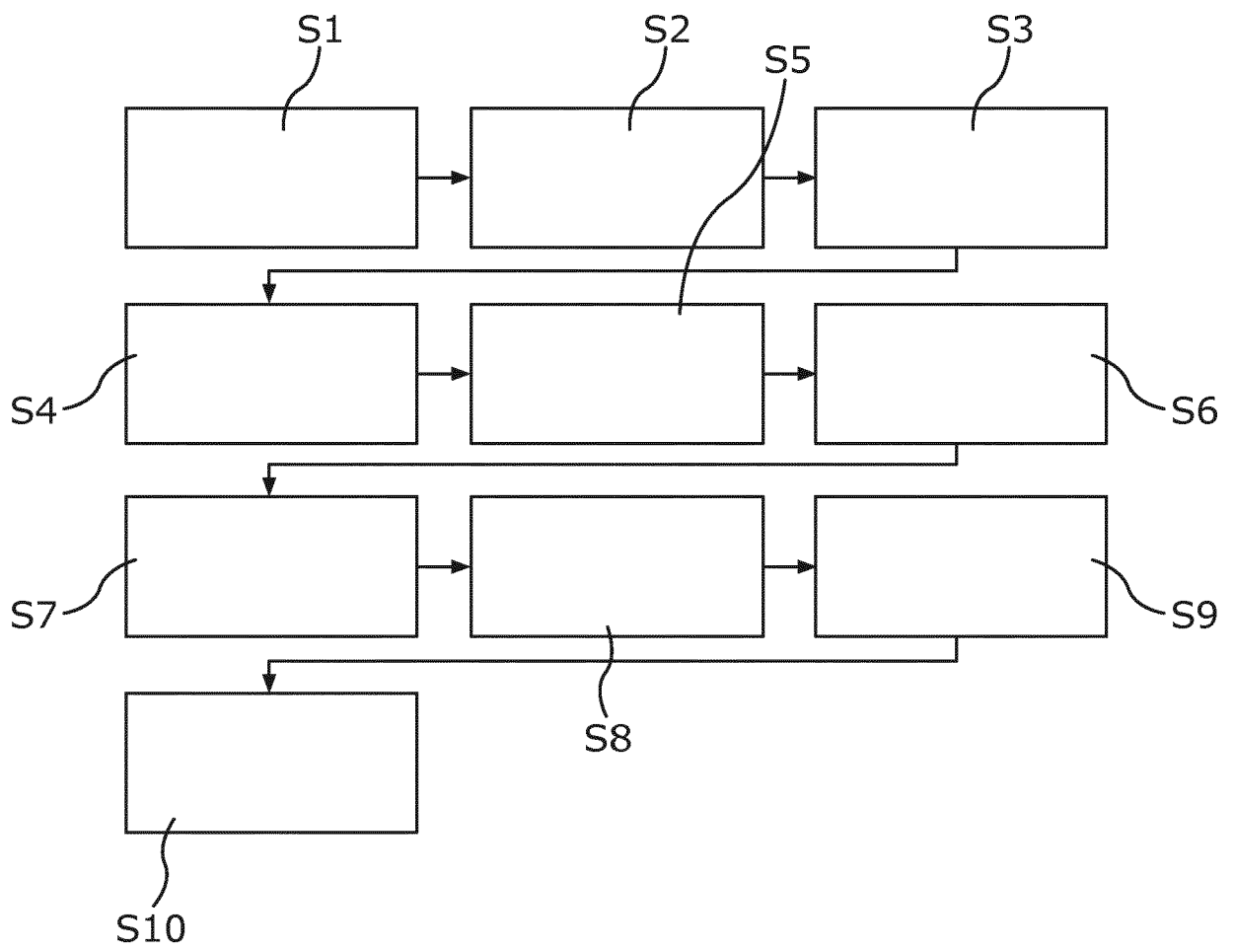
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*Fig. 1*



*Fig. 2*



*Fig.3*



## EUROPEAN SEARCH REPORT

Application Number  
EP 19 16 6206

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| DOCUMENTS CONSIDERED TO BE RELEVANT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                       |                                                              |                                                                                                                                                    |
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| Category                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Citation of document with indication, where appropriate, of relevant passages                                                         | Relevant to claim                                            | CLASSIFICATION OF THE APPLICATION (IPC)                                                                                                            |
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| The present search report has been drawn up for all claims                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                       |                                                              |                                                                                                                                                    |
| Place of search<br><b>The Hague</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                       | Date of completion of the search<br><b>13 September 2019</b> | Examiner<br><b>Martinavicius, A</b>                                                                                                                |
| <p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone<br/>Y : particularly relevant if combined with another document of the same category<br/>A : technological background<br/>O : non-written disclosure<br/>P : intermediate document</p> <p>T : theory or principle underlying the invention<br/>E : earlier patent document, but published on, or after the filing date<br/>D : document cited in the application<br/>L : document cited for other reasons<br/>&amp; : member of the same patent family, corresponding document</p> |                                                                                                                                       |                                                              |                                                                                                                                                    |

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**ANNEX TO THE EUROPEAN SEARCH REPORT  
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EP 19 16 6206

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.  
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