(19) DANMARK

(10) **DK/EP 3180547 T3**

Patent- og Varemærkestyrelsen

(12)

Oversættelse af europæisk patentskrift

(51) Int.Cl.: ***F 16 H 55/06 (2006.01)*** ***F 16 F 15/30 (2006.01)***

(45) Oversættelsen bekendtgjort den: **2019-07-29**

(80) Dato for Den Europæiske Patentmyndigheds bekendtgørelse om meddelelse af patentet: **2019-06-05**

(86) Europæisk ansøgning nr.: **15745423.2**

(86) Europæisk indleveringsdag: **2015-07-21**

(87) Den europæiske ansøgnings publiceringsdag: **2017-06-21**

(86) International ansøgning nr.: **EP2015066662**

(87) Internationalt publikationsnr.: **WO2016023715**

(30) Prioritet: **2014-08-13 DE 102014111581**

(84) Designerede stater: **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**

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(54) Benævnelse: **Fremgangsmåde til fremstilling af et svinghjul**

(56) Fremdragne publikationer:
EP-A1- 1 467 122
EP-A2- 2 511 566
US-A1- 2004 255 719

METHOD FOR FLYWHEEL PRODUCTION

The present invention relates to a method for producing a flywheel intended for a starter of a motor vehicle, in which a damping plate part is produced by permanently connecting at least one first metallic plate element provided for the flywheel and at least one additional material layer into a sandwich component, wherein the first plate element and at least one second, parallel plate layer are connected into a disk-shaped structural unit by means of a joining process such that they lie on top of one another without an intermediate viscoelastic layer.

Flywheels for the purposes of the present invention are in particular flywheels for vehicles, such as cars and trucks, as they are used, for example, in the start-stop system of motor vehicles, but also flywheels used in vehicles without start-stop system, that is, standard flywheels or flywheels for any other transmission variants.

A disadvantage of the known flywheels used for starting are the disturbing noises arising during the starting process.

In DE 602 19 270 T2, a sound-damping starting flywheel is described in which, between radial surface located on the outer peripheral end section of a support and a radial counter surface located on the inner peripheral end section of a gear rim, there is arranged an element made of a viscoelastic material, which is placed under compressive stress in the radial and axial directions. This element is a ring seal, which is pressed into a groove of the support and thereby put under tension.

DE 600 08 991 T2 describes a flywheel of an internal combustion engine having a starter gear rim. In order to reduce the noise level during starting, a ring of a deformable elastomeric material is attached between a peripheral surface of a support of the flywheel and a complementary peripheral surface of a gear rim, mounted on the flywheel, by gluing. In addition, a liner of made of elastomer or plastomer may be attached to a radial surface between the support and gear rim, which extends approximately perpendicularly to the peripheral surface so as to allow sliding contact between the support and the gear rim. The noise reduction is thus to be achieved by permitting deformation of the gear rim radially to the shaft of the flywheel.

In DE 10 2011 001 881 A1, a method for producing a flywheel with the features of the aforementioned type is described, in which a damping plate part, made of a composite material, comprising a layer of a steel plate and a viscoelastic damping layer, is permanently, fixedly joined with a metallic base element, provided as a flywheel firmly, in a joining process under pressure and partial deformation to form a sandwich component. Alternatively, a damping layer and/or an adhesive with similar material properties may be used. Here, the component for the flywheel is constructed from several layers in sandwich construction, of which at least one layer, preferably an inner layer, is a viscoelastic damping layer. The damping plate part made of the composite material/damping layer must be manufactured separately in this known method. Experiences with this known method have shown that bonding of the tools by the material of the viscoelastic damping layer disadvantageously occurs. The forming and joining tools must be cleaned in such a case, resulting in additional effort and delays in the manufacturing process.

Furthermore, tests with the sandwich components known from DE 10 2011 001 881 A1 have shown that no forces are transmitted via the damping plate part with the viscoelastic damping layer. In addition, the rigidity of the sandwich component was disadvantageously increased.

In US 2004/0255719 A1, a dual-mass flywheel is described, in which a primary mass is attached to a crankshaft of the engine and the secondary mass is connected to the clutch. The two masses are torsion elastically connected. It is proposed to connect the two plate parts of the masses by means of a rivet connection or screw connection. Other known connection methods, such as soldering, gluing, welding, or clinching, are also mentioned, but a connection of the two plate parts by deformation, i.e., a tight fit by means of a press is not disclosed. Document EP 1 467 122 A1 discloses all features of the preamble of claim 1.

Based on the aforementioned prior art, the object of the present invention is to provide an alternative method for producing a flywheel having the features mentioned above, resulting in a flywheel with vibration-damping and sound-damping properties and avoiding the disadvantages mentioned. The object of the present invention is further to provide a flywheel having these properties.

This object is achieved by a method for producing a flywheel of the aforementioned type with the characterising features of the main claim or by a flywheel having the features of claim 8.

According to the invention, it is provided that, during the joining process in a press, a contact pressure, dependent on the respective material of the plate layers and their material thickness, is exerted on the plate layers to be joined and that the two plate layers are deformed and affixed to one another by clinching.

In contrast to the prior art, the disk-shaped sandwich component of the drive plate of a flywheel is now joined from two or more plate layers without the interposition of a viscoelastic material, i.e., a double plate or multiple plate is produced. This double plate principle means that the force transmission from the crankshaft to the converter is henceforth not transmitted by only one, as before, but by two or more superimposed plate layers.

By producing such driving plates according to the double plate principle, advantages results in the area of sound, on the one hand. Due to the reduced load on the adjacent components, disturbing resonance noises are minimised. For this purpose, good sound damping is achieved by the two- or multi-layered structure. Noises that occur in a flywheel by the retracting starter pinion are significantly attenuated and are perceptible only muffled. This is particularly advantageous in a flywheel for a modern start-stop system.

Furthermore, economic benefits arise in the production of the flywheel. The previously required sound damping plate with viscoelastic layer is eliminated. In the known method mentioned in the introduction, such a sound damping plate had to be produced in a separate operational step and joined together with the plate part of the driving plate. The method according to the invention reduces the number of necessary operational steps and is therefore less expensive.

Furthermore, it is advantageous that in the solution according to the invention, the load on other engine components is lowered. Due to the double plate principle, a higher axial and radial flexibility is achieved with the same power transmission. Due to the significantly lower rigidity achieved, this leads to reduced loads on the bearings in the gearbox and engine. Also, the total weight of the drive plate is reduced by eliminating the previously used sound damping plate with a viscoelastic layer. The resulting lower mass moment of inertia relieves the adjacent components, which in turn can be dimensioned smaller.

The damping according to the invention, unlike in previous solutions, is no longer between the support and gear rim of the flywheel, but essentially in the support component (now corresponding to the sandwich-like damping plate part) of the flywheel itself and occurs across the entire surface so that the support part is formed to be vibration and noise dampening substantially over its entire surface range. During the joining process, two or more basically round plate elements with a disk-shaped basic shape in the direction of their axis are joined such that they subsequently form a multilayer composite, wherein they connect to one another with their mutually facing surfaces. The metal layers to be joined together each have an approximately similar disk-shaped geometric basic shape in outline, but may differ from each other in details. In addition, they may additionally also have mutually corresponding or different deformations perpendicular to the plane of the disk shape.

Preferably, the procedure is such that the sandwich component, which comprises the first plate element, the second plate layer and optionally additional plate layers, is at least partially deformed out of the principal plane of the disk-shaped sandwich component in accordance with the shape of the flywheel and holes or cutouts are optionally produced therein. The two plate layers can be joined under pressure to form one component. The entire assembly is usually pressed together in this joining process such that the starting layers are permanently and firmly joined.

The joining process of the plate layers may also comprise, for example, an additional mutual fixation of the plate layers in the radial direction by clipping.

According to a preferred embodiment of the invention, for example, only one plate layer of the disk-shaped sandwich component is in a radially outer edge region provided with an upturn or fold, which the second or additional plate layers do not comprise.

According to a preferred alternative of the invention, the plate layers of the disk-shaped sandwich component, which lie on top of one another, are not mutually fixed on one another and microscale position changes of the plate layers relative to one another are possible in the radial direction and/or in the axial direction.

The basic shape of the flywheel or the driving plate of the flywheel can be defined, for example, by a first plate layer of the sandwich component, and in the joining process, the second or further plate layers nestle to this basic shape in a tight fit so that a flywheel in the desired shape, having an at least two-layer structure, is subsequently obtained.

It may also be advantageous if the joining process of the plate layers comprises an additional fixation of both components by retaining tabs.

In the context of the present invention, the most diverse material combinations come into consideration. The plate layers of the sandwich component preferably consist of a non-alloy cold-formable steel plate.

The joining of the plate layers is done under a press, wherein the pressure to be exerted during the joining process naturally depends on the material pairing as well as the material thickness of the plate layers used. The contact pressure applied to the plate layers to joined can thus vary over wide ranges and may be, for example, in the range of one or more bar or be significantly higher.

After the joining process, further operational steps usually follow, for example forming and trimming operations, whereby such process steps can of course also take place before the joining process. As a rule, an external gear rim is also attached to the flywheel after the joining process. Other components of the flywheel can be riveted, welded, or screwed, for example.

Another subject matter of the present invention is a flywheel provided for a starter of a motor vehicle, which is manufactured according to a method as described above. Such a flywheel can be used in a motor vehicle, for example in the area of a start-stop device. Due to the noise damping according to the invention, the disturbing noise arising during starting is greatly reduced in an advantageous manner, which is particularly advantageous in motor vehicles having these devices since start processes occur significantly more often in these vehicles than in conventional vehicles. However, the use of the flywheels according to the invention is also useful in motor vehicles with conventional starters.

The features described in the dependent claims relate to preferred developments of achieving the object according to the invention. Further advantages of the invention result from the following detailed description.

The present invention is described in more detail by means of embodiments with reference to the accompanying drawings. It can be seen that:

Figure 1 shows a perspective view of an exemplary flywheel according to the invention;

Figure 2 shows a schematically simplified sectional view through a part of a flywheel according to the invention.

Reference is first made to Figure 1. It shows a perspective view of a flywheel, generally designated by the reference numeral 10, which was manufactured by the method according to the invention. In principle, such a flywheel 10 has a disk-shaped main body 11 made of sheet metal, which is also referred to herein as a drive plate. At its outer periphery a, gear rim 12 is attached, for example, welded around the disk-shaped base body 11.

The disk-shaped base body 11 has holes 19 with irregular outline shape distributed in different regions, usually distributed over the circumference. In addition to larger holes 19, smaller holes 18, for example, may also be present at other positions. In the context of the present invention, the hole pattern, the shape, and number of the various holes 19 do not matter because what matters, in principle, is the mode of manufacture and the structure of the flywheel according to the invention. A centric region 17 of the flywheel is deformed out of the plane of the disk-shaped main body 11 by a forming process so that this central region 17 is raised with respect to the regions adjoining radially outwards. This central region also has a central hole 16 and a perforated ring with multiple smaller holes concentrically surrounding the central hole 16. However, these structural details concerning the structure of the flywheel are not critical for the present invention since what rather matters is the mode of manufacture of the disk-shaped main body 11, which, as can be already seen in outlines in the region of the holes 19 in Figure 1, is a sandwich-like component made from at least two plate layers.

This sandwich-like structure of the disk-shaped base body will be explained in more detail below with reference to the sectional view according to Figure 2. As is clearly visible there, the disk-shaped base body 11 consists of a double plate, i.e., there are two plate layers 13, 14, which are parallel to each other in most regions and which are arranged one upon the other and essentially abut each other.

In a joining process under pressure, these two superimposed plate layers 13, 14 are permanently and firmly connected to one another to form a sandwich component. Experiments with regard to the noise-damping properties of such a flywheel in operation during a starting operation have shown that such a sandwich-type double plate responds more softly under the action of forces than a single plate. In operation, the flywheel is connected with the transmission by means of the gear rim 12 on the outside. A pinion, for example, not shown, engages in the gear rim 12 when the flywheel is used in a start-stop device of a starter. In the central region 17, the drive plate of the flywheel is connected to the crankshaft of the engine (these engines/transmission elements are known per se and not shown in the present application).

In case of deformation of a flywheel of the invention, for example, 1 mm in the axial direction, a force of only about 1080 N must be applied, whereas this force is about twice as large in a conventional flywheel according to the prior art. As a result, in important components, such as in the bearings, significantly lower wear achieved and the load on the crankshaft is much lower.

By omitting a viscoelastic layer, weight is saved compared to conventional solutions, the flywheel is lighter, and has a lower moment of inertia. The noise-damping effect of the double plate is nevertheless very good. Instead of two superimposed plate layers, even three or more plate layers can be used if the respective application requires it.

The connection of the double plate with the two plate layers 13, 14 on the outer circumference with the gear rim can be achieved, for example, by means of a weld 15, as shown in Figure 2. In their respective outer edge region, the two plate layers 13, 14 may each be formed differently. In the example of Figure 2, the lower plate layer 14 has a smaller diameter, whereby it ends at a small distance from the inner edge of the gear rim 12, whereas the upper plate layer 13 has a slightly larger diameter and is formed upwards at the edge so that a radial outer upturn 20 results, in the region of which the upper plate layer 13 extends over a shorter distance, for example in the axis-parallel direction, i.e., approximately perpendicular to the main plane of the plate layer of the drive plate and at the same time approximately parallel to the axially aligned inner edge of the gear rim 12.

The two plate layers 13, 14 additionally also additionally be deformed, for example, by clinching to achieve better mutual fixation. This type of connection facilitates, for example, the transport of the components until joining by welding.

According to a preferred method, the production of a damping plate part according to the invention as well as a flywheel may be carried out, for example, with the following sequence of method steps:
The first plate layer and the second plate layer are placed in a press together and are formed together therein, in accordance with the desired shape of the drive plate to be produced, in one or more steps;

If one of the plate layers receives an upturn or fold in its radially outer area - which is not mandatory - this has the advantage that it results in a stiffening and a smoothing of the plate layer in the plane of the drive plate;

the two plate layers are mutually affixed by clinching; this step is optional and not essential;

the two plate layers are then punched together, according to the required hole pattern for the drive plate to be produced;

the two plate layers are then preferably welded together in their radially outer region, both with each other and with a gear rim surrounding the plate layers radially outwards;

in the radially inner region, the drive plate with gear rim thus obtained, which thus forms a flywheel, is connected to a crankshaft by a screw connection.

<u>Reference list</u>

10 flywheel, driving plate
11 disk-shaped base body
12 gear rim
13 first (upper) plate layer
14 second (lower) plate layer
15 welding seam
16 central hole
17 raised central region
18 smaller holes
19 holes
20 upturn, fold

Fremgangsmåde til fremstilling af et svinghjul

Patentkrav

1. Fremgangsmåde til fremstilling af et svinghjul beregnet til en startmotor på et motorkøretøj, hvor man fremstiller en dæmpende pladedel, idet mindst et første metallisk pladeelement (13) beregnet til svinghjulet forbindes permanent med mindst et yderligere materialelag (14) til en sandwichkomponent, hvor man ved hjælp af en sammenføjningsproces forbinder det første pladeelement (13) med mindst et andet parallelt pladelag (14), liggende oven på hinanden uden et mellemliggende viskoelastisk lag, til en skiveformet strukturel enhed (11), kendetegnet ved, at der under sammenføjningsprocessen på de pladelag (13, 14), der skal forbindes, i en presse udøves et kontakttryk, som afhænger af de respektive pladelags materiale og disses materialedimensioner, og de to pladelag (13, 14) deformeres og fikseres gensidigt ved hjælp af clinch-sammenføjning (clinching).

2. Fremgangsmåde ifølge krav 1, kendetegnet ved, at man deformerer sandwichkomponenten, som omfatter det første pladeelement (13), det andet pladelag (14) og i givet fald yderligere pladelag i det mindste delvist ud af den skiveformede sandwichkomponents primære plan i overensstemmelse med svinghjulets (10) form samt i givet fald udfører huller (18, 19)) eller udstansninger heri.

3. Fremgangsmåde ifølge krav 1 eller 2, kendetegnet ved, at kun et af den skiveformede sandwichkomponents pladelag (13) får en ophøjet kant (20) eller en ombøjning i et radialt udvendigt kantområde, som det andet eller de yderligere pladelag (14) ikke har.

4. Fremgangsmåde ifølge et af kravene 1 til 3, kendetegnet ved, at sammenføjningsprocessen for pladelagene (13, 14) omfatter en ekstra gensidig fiksering af pladelagene i radial retning via klemning.

5. Fremgangsmåde ifølge et af kravene 1 til 4, kendetegnet ved, at den skiveformede sandwichkomponents pladelag (13, 14), der ligger oven på hinanden, ikke har en gensidig fiksering til hinanden, og at der i radial retning og/eller i aksial retning i mikroområdet er mulighed for relative positionsændringer af pladelagene i forhold til hinanden.

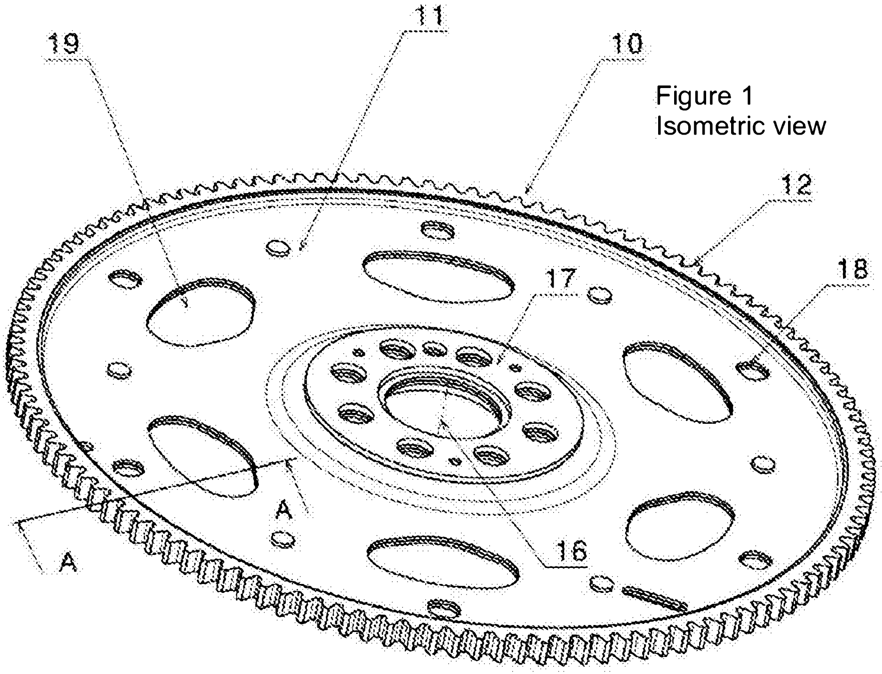
6. Fremgangsmåde ifølge et af kravene 1 til 5, kendetegnet ved, at mindst et pladelag (13, 14) består af en fortrinsvis ulegeret stålplade, der kan kolddeformeres.

7. Fremgangsmåde ifølge krav 1 til 6, kendetegnet ved, at der efter sammenføjningsprocessen anbringes en udvendig tandkrans (12) på den skiveformede sandwichkomponent (10), hvilken tandkrans forbindes integreret med kun et pladelag eller med begge pladelag, hvor fortrinsvis også de to pladelag forbindes integreret med hinanden i et radialt udvendigt område.

8. Svinghjul beregnet til en startmotor på et motorkøretøj, kendetegnet ved, at dette er fremstillet i henhold til en fremgangsmåde ifølge et af kravene 1 til 7.

9. Svinghjul ifølge krav 8, kendetegnet ved, at dette er beregnet til et motorkøretøj med start/stop-automatik.

Figure 1
Isometric view



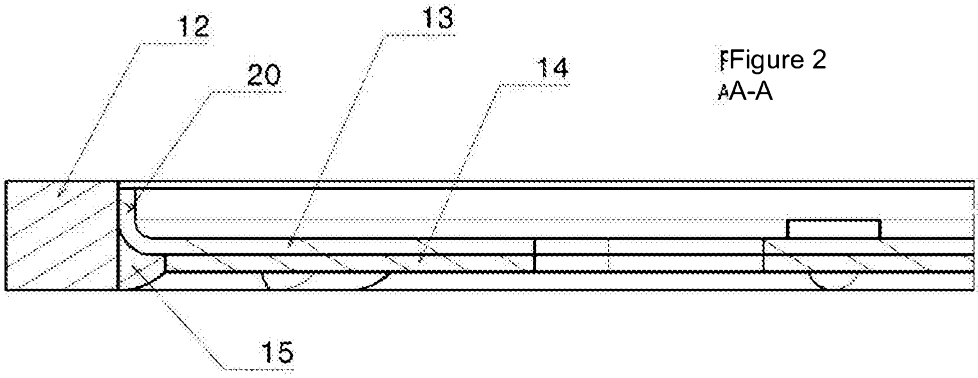


Figure 2
A-A