

FLYWHEEL AND METHOD OF MANUFACTURING THE SAME

This invention relates to a flywheel and a method of manufacturing the same, and more particularly, to a moulded flywheel and a method for manufacturing thereof.

As is well known, a rotating body such as a capstan employed in a magnetic tape driving mechanism of audio cassette tape recorders and/or video tape recorders usually includes a flywheel. The flywheel is used for regulating the rotation speed of capstans at a constant value. The flywheel is usually formed of a metal such as zinc or brass so as to obtain prescribed rotational inertia, as shown in Figure 1 of the accompanying drawings which is a side view of a conventional flywheel. The metal material is diecast roughly in a form of a flywheel with a disc shape and then trimmed to an accurate shape of the flywheel. The diecast flywheel 11 is optionally formed with a groove 11a in which a belt can be accommodated, so that the flywheel 11 is used as a pulley. Further, the flywheel 11 is optionally combined with a gear 12 which is moulded by synthetic resin such as polyacetal so as to transfer a rotation to a driving system (not shown) such as a tape driving mechanism. The diecast flywheel 11 and the synthetic resin gear 12 are fitted to a shaft 13 together and rotatably supported on a prescribed chassis (not shown). The shaft 13 is used with its one end 13a as the capstan for keeping a tape speed constant.

The manufacturing process of the diecast flywheel 11, however, needs a lot of time; that is, the diecast flywheel 11 usually requires to be trimmed after diecasting. Consequently the diecast flywheel 11 is not fully suitable for mass production and is insufficient financially.

Recently, therefore, a flywheel made of pressed

iron plate, as shown in side in Figure 2 of the accompanying drawings, has become popular. The pressed iron plate flywheel 14 is advantageous for simplifying the manufacturing process thereof and reducing the cost thereof. The pressed iron plate flywheel 11 is then usually combined with a pulley 11b and/or a gear 12 made of synthetic resin and fitted together to a shaft 13.

The pressed iron plate flywheel 11 has a drawback in that a rotation irregularity may arise and a relatively large amount of wow flutter be present on rotation of the flywheel 11. This is because the thickness of a usual iron plate is not fully uniform. In this case, the non-uniformity is limited during making the flywheel 11 by pressing the usual iron plate so precisely as to keep the thickness of the iron plate uniform. One problem is that an order of the wow flutter may be affected by the uniformity of thickness of the iron plate. Further, the pressed iron plate flywheel 11 has another drawback in that the pressed iron plate flywheel 11 requires additional processing when being combined with another rotational body such as a pulley 11b and/or a gear 12.

Further, the pressed iron plate flywheel 11 has a drawback in that the wow flutter will be exacerbated by the rotation irregularity which may arise from an inaccurate positioning between the pressed iron plate flywheel 11 and the other rotational body such as the pulley 11b and/or the gear 12, when the pressed iron plate flywheel 11 is used with the pulley 11b and/or the gear 12.

According to one aspect of the present invention, there is provided a flywheel formed of a composition formed from a base moulding material obtained by mixing a metal powder, coated with bonding agent, and synthetic resin powders, and all of:

a melt flowability promoting agent;
a heat resistance stabilizer; and
a silane coupling agent.

According to another aspect of the present
5 invention, there is provided a composition suitable for
making a flywheel, formed from a base moulding
material, obtained by mixing a metal powder, coated
with bonding agent, and synthetic resin powders, and
all of:

10 a melt flowability promoting agent;
a heat resistance stabilizer; and
a silane coupling agent.

According to a further aspect of the present
invention, there is provided a method of manufacturing
15 a moulded flywheel, comprising:

a first step of mixing metal powders, coated with
bonding agent, and synthetic resin powders to form a
base moulding material;

20 a second step of mixing all of a melt flowability
promoting agent, a heat-resistance stabilizer and a
silane coupling agent into the base moulding material
to form a composition with a specific gravity greater
than 4.0;

25 a third step of forming the composition, obtained
from the second step, into granules, and drying the
granular composition;

a fourth step of melting the granular composition
obtained from the third step and kneading the melting
composition; and

30 a fifth step of injecting the kneaded melting
composition obtained from the fourth step and moulding
the injected compound to form a flywheel.

The present invention also makes it possible to
provide a flywheel which has a high rotational inertia.

35 The present invention also makes it possible to
provide a flywheel with a reduced wow flutter in

rotation, and at a reduced cost.

Preferably the flywheel is formed of a composition with specific gravity of more than 4.0.

Preferably the metal powder is iron powder.

5 For a better understanding of the present invention and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which :

10 Figure 3 shows a side elevation view of an embodiment of the moulded flywheel according to the present invention;

Figure 4 shows an axial section through an injection moulding machine which may be used for manufacturing an embodiment of the moulded flywheel according to the present invention;

15 Figure 5 shows a radial section through the cylinder of the injection moulding machine of Figure 4; and

Figure 6 shows a diagrammatic view for illustrating a transfer-mix system kneading process as performed in the injection moulding machine of Figure 4.

DESCRIPTION OF THE PREFERRED EMBODIMENT

25 The present invention will be described in detail with the reference to the accompanying drawings, namely Figures 3 to 6. Throughout the drawings, like reference and letters are used to designate elements like or equivalent to those used in Figures 1 and 2 (Prior Art) for the sake of simplicity of explanation.

30 Referring now to the Figure 3, an embodiment of the flywheel according to the present invention will be described. First of all, 80 to 95 % (or 80 to 85%) by weight of metal powders, such as iron powders, coated with bonding agent are mixed with 20 to 5% (or 20 to 35 15%) by weight of synthetic resin powders, for example, PBT (polybutylene terephthalate) resin powders. As a

result, a base moulding material (referred as Material A hereafter) is obtained. To the Material A is further added 0.01 to 0.02 % by weight of plasticising additive agents including all of: a melt flowability promoting agent; a heat-resistancy stabilizer; and a silane system bonding agent or silane coupling agent. The heat-resistancy stabilizer can achieve its stabilizing effect on the resistance to heat by acting as, for example, an anti-oxidant agent, anti-hydrolysis agent and/or heavy-metal inert agent.

The Material A, as defined above, is mixed with the plasticising agents including the silane system bonding agent, or silane coupling agent, in an amount of 0.001 to 0.01 % by weight (or several hundreds ppm) and several %s in weight to several dozen %s in weight of alcohol. As a result, a moulding material (referred as Material B hereafter) is obtained. The Material B is then mixed with polyester system binder and made into granules, in other words pellets for moulding, and then dried. The pellets of Material B have a high specific gravity of around 4.0 or more.

Referring now to the pellets of Material B, some physical properties will be described. As a result of measurements for a sample in which the pellets of Material B include 84% by weight of iron powders, the specific gravity was 4.3, the tensile strength was 352 kg/cm², the extensibility was 1.24%, the flexural strength was 618 kg/cm, the modulus of rupture in bending was 11.6 x 10 kg/cm and the Izod value was 3.76 kg/cm.

A flywheel is obtained by melting, kneading and injection-moulding the pellets of Material B. In this case, an injection-moulding machine, as shown in Figure 4, is used. The injection-moulding machine has a mixing and kneading device based on a so-called transfer mix principle. When the pellets of Material B

with the high specific gravity are supplied into a hopper 15, the pellets of Material B are fed in a cylinder 16 and melted therein by heaters 18. The melted Material B is then transferred in the cylinder 16 from right to left in the drawing by operation of a screw 17. The melted Material B is subjected to repeated compressions and shearing by co-operation of the screw 17 and specific grooves formed on the cylinder 16, so that the melted Material B is sufficiently kneaded.

The cylinder 16 has a plurality of the grooves, e.g. four grooves 16a, as shown in Figure 5, which are formed along the longitudinal direction of the cylinder 16. The screw 17 also has four or five grooves in its feed zone A, as shown in Figure 4. The grooves of the screws each may operate in conforming to the principle of transfer mix, so that the Material B can be uniformly kneaded.

Referring now to Figure 6, the kneading operation in the injection-moulding machine will be described. In Figure 6, B1 and B3 denote the melted Materials B at some transferred stages in order of B1, B2 and B3. Ring lines in B1 to B3 diagrammatically show distribution conditions of the melted Material B. Line C shows a shearing position for the melted Material B by the screw 17.

The melted Material B is thus well sufficiently kneaded in the injection-moulding machine. The well kneaded Material B is then injected through a nozzle 19 and supplied into a mould-die (not shown) which is provided on a left end of the cylinder 16. The injecting direction of the kneaded Material B is shown by an arrow AR in the drawing of Figure 4. Therefore, as shown in Figure 3 a moulded flywheel 20, which is substantially shaped in disc form, is obtained. The moulded flywheel 20 may optionally have a groove 20a to

be wound by a belt around a periphery of the moulded flywheel 20, so that the moulded flywheel 20 can operate as a pulley. Further, the moulded flywheel 20 can be optionally moulded integrally with a gear 21, that is, the flywheel 20 and the gear 21 are moulded as a moulded body of one piece.

The one piece moulded body of the flywheel 20 and the gear 21 is fitted to a shaft 22. One end 22a of the shaft 22 is used as a capstan.

According to the embodiment as described above, the flywheel has the high specific gravity of more than 4.0. Therefore, a sufficiently high rotation inertia can be obtained. As a result, the moulded flywheel according to the present invention can reduce its wow flutter in rotation to a sufficiently low level.

Further, the material with such high specific gravity of 4.0 or more forms the flywheel by, e.g., an injection moulding. The material is well kneaded in the transfer-mix system so as that the metal powders are dispersed uniformly in the moulded flywheel. The weight of the moulded flywheel is well balanced so that a preferable rotation with a reduced wow flutter can be performed. Further, another rotational body such as a gear or a pulley can be easily formed together with the flywheel. Therefore, the manufacturing process of the flywheel can be simplified.

While there has been illustrated and described what are at present considered to be preferred embodiments of the present invention, it will be understood by those skilled in the art that various changes and modifications may be made, and equivalents may be substituted for elements thereof without departing from the true scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teaching of the present invention without departing from the central

scope thereof. Therefore, it is intended that this invention not be limited to the particular embodiment disclosed as the best mode contemplated for carrying out this invention, but that the invention include all
5 embodiments falling within the scope of the appended claims.



CLAIMS

1. A flywheel formed of a composition formed from a base moulding material obtained by mixing a metal powder, coated with bonding agent, and synthetic resin powders, and all of:
 - a melt flowability promoting agent;
 - a heat resistance stabilizer; and
 - a silane coupling agent.
2. A flywheel according to claim 1, wherein the composition has a specific gravity greater than 4.0.
3. A flywheel according to claim 1 or 2, wherein the metal powder is iron.
4. A flywheel according to claim 1, 2 or 3, wherein the metal powder constitutes from 80 to 95% by weight of the composition from which the flywheel is formed.
5. A moulded flywheel according to claims 1, substantially as herein described with reference to, and as shown in, Figure 3 of the accompanying drawings.
6. A composition suitable for making a flywheel, formed from a base moulding material, obtained by mixing a metal powder, coated with bonding agent, and synthetic resin powders, and all of:
 - a melt flowability promoting agent;
 - a heat resistance stabilizer; and
 - a silane coupling agent.
7. A composition according to claim 6, having a specific gravity greater than 4.0.
8. A method of manufacturing a moulded flywheel, comprising:
 - a first step of mixing metal powders, coated with bonding agent, and synthetic resin powders to form a base moulding material;
 - a second step of mixing all of a melt flowability promoting agent, a heat-resistance stabilizer and a silane coupling agent into the base moulding material



to form a composition with a specific gravity greater than 4.0;

5 a third step of forming the composition, obtained from the second step, into granules, and drying the granular composition;

a fourth step of melting the granular composition obtained from the third step and kneading the melting composition; and

10 a fifth step of injecting the kneaded melting composition obtained from the fourth step and moulding the injected compound to form a flywheel.

9. The flywheel manufacturing method according to claim 8, wherein the metal powders are iron powders in the first step.

15 10. The flywheel manufacturing method according to claim 8 or 9, wherein the fourth step of melting and kneading the composition is made in transfer-mix system.
