A plastic head cover of an internal combustion engine having therein two parallel oil mist separator chambers comprises a plastic cover body that is adapted to be mounted on a cylinder head of the engine and includes lower portions of the separator chambers, and a plastic upper body that includes upper portions of the separator chambers and is mounted on and secured to the plastic cover body in such a manner that the upper portions possessed by the plastic upper body are mated with the lower portions possessed by the cover body, thereby forming an entire construction of the two oil mist separator chambers.
PLASTIC HEAD COVER OF INTERNAL COMBUSTION ENGINE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to parts of an internal combustion engine, and more particularly to a plastic head cover of the internal combustion engine. More specifically, the present invention is concerned with a plastic head cover that is equipped with an oil mist separator.

2. Description of the Related Art

Some of head covers of internal combustion engine for motor vehicles are made of an engineering plastic and of a type that is equipped with an oil mist separator for separating and is removing an oil mist contained in a blow-by gas that is produced by the engine. As is known, under operation of the engine, blow-by gas is blown into a crankcase through a minute clearance between each piston and corresponding cylinder wall.

Some of plastic head covers of such type are disclosed in Japanese Laid-open Patent Applications (tokkai) 2003-293853 and 2011-122478. In the plastic head covers of the publications, a partition plate (or baffle plate) or the like is horizontally installed in a lower part of the head cover to constitute an oil mist separator chamber between an upper part of the head cover and the partition plate.

SUMMARY OF THE INVENTION

However, the plastic head covers disclosed by the publications have following drawbacks due to their inherent construction.

First, due to provision of the partition plate that is mounted to the lower part of the head cover, a blow-by gas inlet opening has to be provided in a side wall of the head cover at a position above the partition plate because the oil mist separator chamber is located above the partition plate. The inlet opening has no undercutting for providing the plastic head cover with a sufficient mechanical strength. As is known, molding a plastic head cover that has the above-mentioned inlet opening without undercutting is difficult because of need of employment of a sliding jig in a molding process for forming the blow-by gas inlet opening in a desired position of the side wall of a molded head cover. Of course, difficult molding process lowers a productivity.

Second, if the plastic head cover is of a type, like the head cover disclosed by the above-mentioned '853 publication, that has two parallelly extending oil mist separator chambers and a plurality of aligned openings between the two separator chambers for inserting therethrough ignition plugs, each portion extending between two neighboring openings has a wastefully thicker construction, which brings about increased weight of the products. Furthermore, in case of molding the plastic head cover of the above-mentioned type, it tends to occur that the produced plastic head cover shows some warping in directions perpendicular to an axis of the head cover. Of course, such warping lowers the precision of the products.

It is therefore an object of the present invention to provide a plastic head cover of an internal combustion engine, which is free of the above-mentioned drawbacks.

In accordance with a first aspect of the present invention, there is provided a plastic head cover (10) of an internal combustion engine, the plastic head cover having therein an oil mist separator unit (11, 12) for separating an oil mist from a gas led thereto, the plastic head cover comprising a plastic cover body (21) adapted to be mounted on a cylinder head (1) of the engine, the cover body (21) including a lower portion of the oil mist separator unit (11, 12); and a plastic upper body (23) including an upper portion of the oil mist separator unit (11, 12), the plastic upper body being mounted on and secured to the plastic cover body (21) in such a manner that said upper portion possessed by the plastic upper body (23) is mated with said lower portion possessed by the cover body (21), thereby forming an entire construction of the oil mist separator unit (11, 12).

In accordance with a second aspect of the present invention, there is provided a plastic head cover (10) having therein first and second parallel oil mist separator chambers (11, 12) and adapted to be mounted on an internal combustion engine, the plastic head cover (10) comprising a plastic cover body (21) adapted to be mounted on a cylinder head (1) of the engine, the cover body (21) including a partition plate (22) that is formed with lower portions of the first and second oil mist separator chambers (11, 12); a plastic upper body (23) including upper portions of the first and second oil mist separator chambers (11, 12), the upper body (23) being mated and secured to the cover body (21) in such a manner that said upper portions possessed by the upper body (23) are mated with said lower portions possessed by the partition plate (22) of the cover body (21) thereby forming an entire construction of the first and second oil mist separator chambers (11, 12); a plurality of aligned plug bores (13) formed in an axially extending center zone of an integral unit between the first and second oil mist separator chambers (11, 12), the integral unit consisting of the cover body (21) and the upper body (23); a plurality of closed section structures (33) possessed by the axially extending center zone of the integral unit for increasing the rigidity of the axially extending center zone; and an L-shaped opening (16) that consists of a first portion (25) defined between a part of the cover body (21) and a part of the upper body (23) and a second portion (26) defined between another part of the cover body (21) and another part of the upper body (23).

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects and advantages of the present invention will become apparent from the following description when taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a sectional view of a plastic head cover of the present invention, which is taken along the line A-A of FIG. 3;

FIG. 2 is a somewhat enlarged sectional view of the plastic head cover of the present invention at a portion where a blow-by gas inlet opening is provided, which is taken along the line B-B of FIG. 3;

FIG. 3 is a plan view of the plastic head cover of the present invention;

FIG. 4 is a plan view of an upper body that constitutes an upper part of the plastic head cover of the present invention;

FIG. 5 is a plan view of a cover body that constitutes a lower part of the plastic head cover of the present invention;

FIG. 6 is a back view of the cover body of the plastic head cover of the present invention;

FIG. 7 is a sectional view similar to FIG. 1, but showing a comparative example;
Fig. 8 is a sectional view similar to Fig. 2, but showing the comparative example; and
Fig. 9 is a view similar to Fig. 1, but showing a modification of the present invention.

Detailed Description of the Invention

In the following, a plastic head cover of the present invention will be described in detail with reference to the accompanying drawings. The description will be made with respect to a case in which the head cover is applied to an inline three cylinder internal combustion engine.

For ease of understanding, in the following description, various directional terms, such as right, left, upper, lower, rightward and the like, are used. However, such terms are to be understood with respect to only a drawing or drawings on which a corresponding part or portion is shown.

Referring to Figs. 1 to 6, there is shown a plastic head cover 10 of the present invention.

As will be understood from Fig. 1, the plastic head cover 10 is a united member that is to be mounted on a cylinder head 1 of an internal combustion engine.

As will become apparent as the description proceeds, the plastic head cover 10 of the invention comprises two main bodies, which are a cover body 21 that is mounted on the cylinder head 1 of the engine and an upper body 23 that is bonded to an upper portion of the cover body 21.

As will be understood from Figs. 1 and 3, the plastic head cover 10 is formed with two (or first and second) oil mist separator chambers 11 and 12 that extend in parallel with an axis of the plastic head cover 10. That is, when the head cover 10 is properly mounted on the cylinder head 1, the two oil mist separator chambers 11 and 12 are placed at both sides with respect to a longitudinal axis of the engine.

As is seen from Fig. 3, the plastic head cover 10 is formed, at an axially extending center zone placed between the two oil mist separator chambers 11 and 12, with three circular plug bores 13 that are aligned. Although not shown in the drawing, an ignition plug is passed through each plug bore 13 to engage with a plug bore formed in a ceiling part of the cylinder head 1. The ignition plug may be an ignition plug unit that includes an ignition plug proper and an ignition coil that generates a high voltage needed by the ignition plug proper.

As shown in Fig. 3, near each plug bore 13, the plastic head cover 10 has a mounting bore 18 that is used for fixing the corresponding ignition coil. Near the center plug bore 13, the plastic head cover 10 has a bolt bore 19 that is used to insert there through a connecting bolt (not shown) for fixing the plastic head cover 10 to the cylinder head 1.

As is indicated by arrows in Fig. 3, air in an air induction passage at a position upstream of a throttle valve of an associated internal combustion engine is led into the first oil mist separator chamber 11 through an air inlet opening 14, and then as is shown in Figs. 5 and 6, the air in the chamber 11 is led into the cylinder head 1 and a cylinder block (not shown) through an air outlet opening 15. That is, ventilation is carried out in the engine by the air led into the engine.

As is seen from Fig. 3, due to the ventilation, blowby gas blown into a crankcase from combustion chambers is forced to flow into the second oil mist separator chamber 12 through a blowby gas inlet opening 16, and the blowby gas in the chamber 12 is forced to impinge against a second oil mist separating portion (not shown) installed in the chamber 12. The second oil mist separating portion is constructed of parallel block plates that are arranged to face a direction in which the blowby gas flows. Due to work of the second oil mist separating portion, oil mist is separated from the blowby gas and the oil mist (or oil) is returned back into the cylinder head 1 through a drain pipe (not shown).

As shown in Fig. 3, the gas thus releasing the oil mist is led into the air induction passage of the engine at a position downstream of the throttle valve through a gas outlet opening 17 and a PCV valve (viz., positive crankcase ventilation valve).

While, in a high load condition of the engine, the gas in the cylinder head 1 is led into the first oil mist separator chamber 11 from the air outlet opening 15 (as seen in Fig. 5), and the gas in the chamber 11 is forced to impinge against a first oil mist separating portion (not shown) installed in the chamber 11. The first oil mist separating portion is constructed of parallel block plates that are arranged to face a direction in which the gas flows. Due to work of the first oil mist separating portion, oil mist is separated from the gas and the oil mist (or oil) is returned back into the cylinder head 1 through the drain pipe (not shown).

As shown in Fig. 3, the gas thus releasing the oil mist is led back to the air induction passage of the engine from the air inlet opening 14.

As is understood from Fig. 1, the plastic head cover 10 of the invention comprises a plastic cover body 21 that is to be mounted on the cylinder head 1, and a plastic upper body 23 that is bonded via a vibration welding or the like to an upper portion of the cover body 21. As shown in the drawing, the cover body 21 is integrally formed with a partition plate (or baffle plate) 22 that constitutes lower portions of the first and second oil mist separator chambers 11 and 12, and the upper body 23 constitutes upper portions of the first and second oil mist separator chambers 11 and 12. That is, upon tight coupling by bonding, the two bodies 21 and 23 constitute the two chambers 11 and 12 therebetween.

As is seen from Figs. 1, 5 and 6, the cover body 21 is shaped like a rectangular plate with four side walls 24 projected downward from the partition plate 22, and as is seen from Figs. 5 and 6, the cover body 21 is formed at an axially extending center zone with three circular bores 13 that are aligned. It is to be noted that these circular bores 13 constitute respective lower portions of the above-mentioned three circular plug bores 13, as is seen from Fig. 1.

As is seen from Figs. 1, 2 and 4, the upper body 23 is a plastic member that is bonded via vibration welding to the upper portion of the cover body 21. As shown in Fig. 1, the upper body 23 is formed with upper portions of the first and second oil mist separator chambers 11 and 12, and as is seen from Figs. 1, 2 and 3, the upper body 23 is formed at an axially extending center zone with three circular bores 13 that are aligned. It is to be noted that these circular bores 13 constitute respective upper portions of the above-mentioned three circular plug bores 13, as is seen from Fig. 1. That is, when the upper body 23 is properly bonded to the cover body 21, the three circular bores 13 and the three circular bores 13 are merged to constitute the three circular plug bores 13, as will be understood from Fig. 1.

In order to clarify advantageous features possessed by the plastic head cover 10 of the present invention, a comparative example of plastic head cover 10H will be described with the aid of Figs. 7 and 8.

It is to be noted that in these drawings, viz., Figs. 7 and 8, parts and portions that correspond to those of the
plastic head cover 10 of the invention are indicated by the addition of the letter “H” after each reference numeral.

[0040] As is seen from FIG. 7, the plastic head cover 10H of the comparative example comprises generally a cover body 21H that is to be mounted on the cylinder head 1, and a partition plate (or baffle plate) 22H that is bonded to an inner surface of the cover body 21H to constitute the first and second oil mist separator chambers 11H and 12H. That is, the cover body 21H is formed with upper portions of the chambers 11H and 12H while the partition plate 22H is formed with lower portions of the chambers 11H and 12H, and upon proper coupling between the body 21H and the partition plate 22H, the two oil mist separator chambers 11H and 12H are defined.

[0041] As shown in FIG. 8, in the comparative example, a blowby gas inlet opening 16H is a passage that connects a blowby gas passage 2 formed in a side wall of the cylinder head 1 to the second oil mist separator chamber 12H. As shown, the blowby gas inlet opening 16H is generally L-shaped and comprises a vertical passage part 25H that has a lower end merged with the blowby gas passage 2 and a horizontal passage part 26H that has one end exposed to the interior of the second oil mist separator chamber 12H.

[0042] As is seen from FIG. 8, the plastic head cover 10H of the comparative example has such a construction that the partition plate 22H is bonded to the inner (or lower) surface of the cover body 21H that has a lower peripheral portion mounted on the cylinder head 1. However, for the following reasons, the construction of the plastic head cover 10H brings about a difficulty with which the plastic head cover 10H is produced or molded.

[0043] That is, due to an inherent construction, the partition plate 22H is formed inside the vertical passage part 25H of the blowby gas inlet opening 16H, and thus, the L-shaped blowby gas inlet opening 16H is formed only on the cover body 21H. That is, it is necessary to produce the L-shaped blowby gas inlet opening 16H by only the cover body 21H.

[0044] Accordingly, the cover body 21H has to have such a complex shape as not to permit a corresponding mold (not shown) to move in a releasing direction (viz., a vertical direction in FIG. 8). Thus, actually, for molding the plastic head cover 10H, it is necessary to use a sliding jig 27 for producing the horizontal passage part 26H of course, usage of such sliding jig 27 brings about a complicated production process and thus lowers a productivity.

[0045] While, in the plastic head cover 10 of the present invention, the above-mentioned drawback is solved for the following reasons.

[0046] That is, as is seen from FIG. 2, the plastic head cover 10 of the invention has such a construction that the upper body 23 is bonded to the outer (or upper) surface of the cover body 21 that has a lower peripheral portion mounted on the cylinder head 1. With such positioning of the upper body 23 relative to the plastic head cover 10, the upper body 23 has a lot of flexibility in the shape and layout, and thus the mutually bonded part between the upper body 23 and the cover body 21 can be placed outside the vertical passage part 25 of the blowby gas inlet opening 16, as is seen from FIG. 2. Thus, the L-shaped blowby gas inlet opening 16 can be constituted by both the cover body 21 and the upper body 23, as shown. That is, as seen from FIG. 2, the L-shaped blowby gas inlet opening 16 is neatly provided by a combination between the cover body 21 and the upper body 23. That is, the vertical passage part 25 is formed in the cover body 21 and the horizontal passage part 26 is defined by a combined construction between the cover body 21 and the upper body 23. In other words, the horizontal passage part 26 comprises a part substantially possessed by the cover body 21 and the other part substantially possessed by the upper body 23. More specifically, the L-shaped opening consists of a first portion 25 defined between a part of the cover body 21 and a part of the upper body 23 and a second portion 26 defined between another part of the cover body 21 and another part of the upper body 23. Thus, the two bodies 21 and 23 can have simple constructions without undercutting.

[0047] Accordingly, molding the cover body 21 and upper body 23 can be easily carried out without the aid of the above-mentioned sliding jig 27 (see FIG. 8). Thus, easy production process and increased productivity are expected.

[0048] As is shown in FIG. 7, in case of the comparative example, the three circular plug bores 13H provided between the first and second oil mist separator chambers 11H and 12H are formed by only the cover body 21H. Each plug bore 13H is formed with a sealing lip portion 28H at its upper end to tightly and hermetically receive therein an ignition plug (not shown).

[0049] Furthermore, the cylindrical wall of each plug bore 13H is formed with a sealing groove 29H at its lower end to hermetically receive therein an annular projection (not shown) formed on the cylinder head 1. Due to presence of the sealing groove 29H, the cylindrical wall of each plug bore 13H has a considerable thickness, which causes increase in weight of the product.

[0050] While, in the invention, as is seen from FIG. 1, each plug bore 13 consists of the circular bore 13H possessed by the cover body 21 and the circular bore 13H possessed by the upper body 23.

[0051] As is seen from FIG. 1, each plug bore 13 is formed at an axially middle portion thereof with an enlarged rounded part 31. Denoted by numeral 30 is an imaginary contact surface at which an upper flat surface of the cover body 21 and a lower flat surface of a corresponding portion of the upper body 23 contact to each other. As shown, each plug bore 13 extends in a direction perpendicular to the imaginary contact surface 30. Due to provision of the enlarge rounded part 31, reduction in weight of the plastic head cover 10 is achieved while having the sealing lip portion 28 and the sealing groove 29.

[0052] As will be understood from FIG. 1, during molding, the cover body 21 tends to show such a deformation that as is indicated by the arrows Y1, laterally opposed side walls 24 are flexed inwardly.

[0053] However, in the present invention, such undesired deformation is suppressed or at least minimized by a plurality of reinforcing ribs 32 possessed by the cover body 21, as will be understood from the following.

[0054] As is seen from FIGS. 1 and 6, in the present invention, the partition plate 22 of the cover body 21 is formed at its lower surface with a plurality of parallel reinforcing ribs 32 that extend in a direction perpendicular to the axial direction of the rectangular cover body 21. Each reinforcing rib 32 extends between the laterally opposed side walls 24. These reinforcing ribs 32 are integrally and simultaneously produced on the partition plate 22 when the cover body 21 is molded. Thus, each reinforcing rib 32 has an upper edge integrated with a lower surface of the partition plate 22.
As shown in FIG. 6, each reinforcing rib 32 has both ends integrated with the laterally opposed side walls 24. Some of the reinforcing ribs 32 have middle portions merged with circular ribs (no numerals) that are integrally formed on a lower surface of the cover body 21 in a manner to surround the circular bores 13.

That is, due to provision of such reinforcing ribs 32, the rigidity of the cover body 21 is increased, which prevents or at least minimizes the undesired deformation of the cover body 21 at the time of molding.

In case of the comparative example shown in FIG. 7, due to its inherent construction, more specifically, due to presence of the partition plate 22H, it is impossible to provide the cover body 21H with reinforcing ribs at positions below the partition plate 22H. Accordingly, in case of the comparative example, the undesired deformation of the cover body 21H cab not be prevented.

As is seen from FIGS. 1 and 5, in the invention, around the three plug bores 13, the plastic head cover 10 is formed with a plurality of closed section structures 33 for increasing the rigidity of the axially extending center zone of the plastic head cover 10.

As is seen form FIG. 5, each closed section structure 33 comprises an enclosed rib 34 that is possessed by an upper surface of the cover body 21 and a counter-enclosed rib (not shown) that is possessed by a lower surface of the upper body 23 and bonded to the corresponding rib 34 of the cover body 21.

Due to provision of such closed section structures 33, the axially extending center zone of the plastic head cover 10 where various bores 13, 18 and 19 are provided can exhibit a sufficient rigidity. Actually, such closed section structures 33 compensate for lack of rigidity caused by the provision of the enlarged rounded parts 31 in the three plug bores 13.

As is seen from FIG. 3, the plastic head cover 10 of the invention has the bolt bore 19 formed in the upper body 23. This bolt bore 19 is used to insert therethrough a connecting bolt (not shown) for fixing the plastic head cover 10 to the cylinder head 1.

However, provision of such bolt bore 19 has such a possibility that rain water or the like enters a groove 33g (see FIG. 5) that is provided between a rib of the cover body 21 and a counter-rib of the upper body 23 around the bolt bore 19. Thus, in the invention, for draining such water from the groove 33g to the outside, the groove 33g has a drain passage 36 that extends to a peripheral open part of the plastic head cover 10.

The foregoing description is directed to a plastic head cover including a cover body 21 and an upper body 23 that are bonded to each other via a vibration welding method. However, if desired, coupling the cover body 21 and upper body 23 may be made through screws (or tapping screws) 40 as is seen in FIG. 9. Furthermore, if desired, the coupling may be made by bolt-nut units or snap-fitting technique.


Although the invention has been described above with reference to an embodiment of the invention, the invention is not limited to such embodiment as described above. Various modifications and variations of such embodiment may be carried out by those skilled in the art, in light of the above description.

What is claimed is:

1. A plastic head cover of an internal combustion engine, the plastic head cover having therein an oil mist separator unit for separating an oil mist from a gas led thereinto, the plastic head cover comprising:

   a plastic cover body adapted to be mounted on a cylinder head of the engine, the cover body including a lower portion of the oil mist separator unit; and

   a plastic upper body including an upper portion of the oil mist separator unit, the plastic upper body being mounted on and secured to the plastic cover body in such a manner that said upper portion possessed by the plastic upper body is mated with said lower portion possessed by the cover body, thereby forming an entire construction of the oil mist separator unit.

2. A plastic head cover as claimed in claim 1, in which said lower portion of the oil mist separator unit is provided by a partition plate that is integral with the cover body.

3. A plastic head cover as claimed in claim 2, in which the oil mist separator chamber unit comprises first and second oil mist separator chambers that extend parallelly along a longitudinal axis of an integral unit that consists of the plastic cover body and the plastic upper body, and in which a plurality of aligned plug bores are formed in an axially extending center zone of the integral unit between the first and second oil mist separator chambers.

4. A plastic head cover as claimed in claim 3, in which each of the plug bores is formed at an axially middle portion thereof with an enlarged rounded part.

5. A plastic head cover as claimed in claim 4, in which each plug bore extends in a direction perpendicular to an imaginary contact surface at which an upper flat surface of the cover body and a lower flat surface of the upper body contact to each other.

6. A plastic head cover as claimed in claim 5, in which the cover body is integrally formed, at positions below the partition wall, with a plurality of reinforcing ribs, each reinforcing rib extending between laterally opposed side walls of the cover body.

7. A plastic head cover as claimed in claim 3, in which the axially extending center zone of the integral unit is constructed to have a plurality of closed section structures for increasing the rigidity of the axially extending center zone.

8. A plastic head cover as claimed in claim 7, in which each of the closed section structures comprises an enclosed rib that is possessed by the cover body and a counter-enclosed rib that is possessed by the upper body and bonded to the rib of the cover body.

9. A plastic head cover as claimed in claim 3, further comprising:

   a bolt bore formed in the axially extending center zone of the integral unit; a groove defined between the cover body and the upper body and exposed to the bolt bore; and

   a drain passage defined between the cover body and the upper body and extending from said groove to the outside of the integral unit.

10. A plastic head cover as claimed in claim 3, in which the integral unit is formed with an L-shaped opening that consists of a first portion defined between a part of the cover body and a part of the upper body and a second portion defined between another part of the cover body and another part of the upper body.
11. A plastic head cover having therein first and second parallel oil mist separator chambers and adapted to be mounted on an internal combustion engine, the plastic head cover comprising:

a plastic cover body adapted to be mounted on a cylinder head of the engine, the cover body including a partition plate that is formed with lower portions of the first and second oil mist separator chambers;

a plastic upper body including upper portions of the first and second oil mist separator chambers, the upper body being mounted on and secured to the cover body in such a manner that said upper portions possessed by the upper body are mated with said lower portions possessed by the partition plate of the cover body thereby forming an entire construction of the first and second oil mist separator chambers;

a plurality of aligned plug bores formed in an axially extending center zone of an integral unit between the first and second oil mist separator chambers, the integral unit consisting of the cover body and the upper body;

a plurality of closed section structures possessed by the axially extending center zone of the integral unit for increasing the rigidity of the axially extending center zone; and

an L-shaped opening that consists of a first portion defined between a part of the cover body and a part of the upper body and a second portion defined between another part of the cover body and another part of the upper body.

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