

OVERMOLDED FERRITE BUSBAR ASSEMBLY

TECHNICAL FIELD

[001] Various embodiments of the present disclosure relate generally to inverters and/or ferrite busbar assemblies, and, more particularly, to an overmolded ferrite busbar assembly.

BACKGROUND

[002] An inverter may convert direct current (DC) power to alternating current (AC) power for use in a motor device such as an electric vehicle motor. The inverter may change a rotational speed of the motor by adjusting a frequency of the alternating current and/or may change a power or torque of the motor by adjusting an amplitude of a signal.

[003] The inverter may include protruding electrical terminals (e.g., busbars or pins) that connect to devices external of the inverter. The inverter may also include a ferrite core. Manufacturing the inverter may include assembling electrical terminals to a plastic housing and manually coupling the ferrite core and other components to secure the ferrite core to the electrical terminals and housing. Such a structure may be susceptible to leaks from fluids such as oil, fuel, or water.

[004] The overmolded ferrite busbar assembly of the present disclosure may solve one or more of the problems set forth above and/or other problems in the art.

SUMMARY OF THE DISCLOSURE

[005] According to certain aspects of the disclosure, a ferrite busbar assembly may include a ferrite core having an inner space, a terminal extending through the inner

space, and a housing enclosing the ferrite core to the terminal. The housing may be made out of an elastomeric material, the housing may be configured to seal the inner space, a first end of the terminal may protrude from a first side of the housing, and a second end of the terminal may protrude from a second side of the housing.

[006] The housing may be made out of thermoplastic elastomer (TPE) or silicone. The housing may be unitary. At least a portion of the housing and a portion of the terminal may together fill the inner space of the ferrite core.

[007] The housing may be unitary. The housing may surround and contact an outer surface of the ferrite core, the outer surface being opposite to an inner surface that defines the inner space. At least a portion of the ferrite core may be exposed at the second side of the housing.

[008] The ferrite core may have a first side and a second side opposite the first side. The second side of the ferrite core may be flush with at least a portion of the housing at the second side.

[009] The second side of the housing may cover at least a portion of a bottom surface of the ferrite core. A bracket may be coupled to and protrude from the housing.

[0010] The bracket may include a first extension that protrudes from a third side of the housing which is opposite the first side of the housing such that the first extension of the bracket and the first end of the terminal may extend in opposite directions.

[0011] The bracket may include a second extension and a third extension which protrude from opposite sides of the housing.

[0012] The ferrite busbar assembly may not include any seals or gaskets separate from the housing. The ferrite busbar assembly may not include any clips or fasteners coupling the ferrite core to the housing.

[0013] The housing may be unitary and may be overmolded over the terminal and the ferrite core to fill the inner space of the ferrite core and cover an outer surface of the ferrite core. The housing may be overmolded at a pressure of less than 20 megapascals (MPa).

[0014] According to certain aspects of the disclosure, a ferrite busbar assembly may comprise a ferrite core, a terminal, a housing, and a bracket. The ferrite core may have an inner space, an inner surface defining the inner space, and an outer surface opposite the inner surface. The terminal may extend through the inner space and have a first end and a second end. The housing may be configured to fill the inner space to secure the terminal to the ferrite core and cover the inner and outer surfaces of the ferrite core. The first end of the terminal may protrude from a first side of the housing. A second end of the terminal may protrude from a bottom side of the housing. The bracket may include a plate protruding from a second side of the housing. The first and second sides of the housing may be perpendicular to the bottom side of the housing. The plate may have a fastener hole configured to receive a fastener. The ferrite core, the terminal, and the bracket may be embedded in the housing. The housing may be made out of an elastomeric material to seal the inner space of the ferrite core.

[0015] According to certain aspects of the disclosure, a method of manufacturing a ferrite busbar assembly may include positioning a terminal through an inner space of a ferrite core, maintaining a position of the ferrite core with respect to the terminal, and

injecting an overmold material at a predetermined pressure to cover an outer side of the ferrite core and to fill the inner space of the ferrite core to seal the inner space and secure the terminal to the ferrite core. The overmold material may be a thermoplastic elastomer (TPE) or silicone. The predetermined pressure may be less than 5 megapascals (MPa). The predetermined pressure may be 2 MPa.

[0016] Additional objects and advantages of the disclosed embodiments will be set forth in part in the description that follows, and in part will be apparent from the description, or may be learned by practice of the disclosed embodiments. The objects and advantages of the disclosed embodiments will be realized and attained by means of the elements and combinations particularly pointed out in the appended claims.

[0017] It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory only and are not restrictive of the disclosed embodiments, as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate various exemplary embodiments and together with the description, serve to explain the principles of the disclosed embodiments.

[0019] FIG. 1 depicts a perspective view of a ferrite-busbar assembly according to an exemplary embodiment.

[0020] FIG. 2 depicts an exploded perspective view of the ferrite-busbar assembly of FIG. 1.

[0021] FIG. 3 depicts a cross-sectional view of the ferrite-busbar assembly of FIG. 1.

[0022] FIG. 4 depicts a cross-sectional view of the ferrite-busbar assembly of FIG. 3 along line 4-4.

[0023] FIG. 5 illustrates an exemplary method of manufacturing a ferrite-busbar assembly.

DETAILED DESCRIPTION OF EMBODIMENTS

[0010] Both the foregoing general description and the following detailed description are exemplary and explanatory only and are not restrictive of the features, as claimed. As used herein, the terms “comprises,” “comprising,” “has,” “having,” “includes,” “including,” or other variations thereof, are intended to cover a non-exclusive inclusion such that a process, method, article, or apparatus that comprises a list of elements does not include only those elements, but may include other elements not expressly listed or inherent to such a process, method, article, or apparatus. In this disclosure, unless stated otherwise, relative terms, such as, for example, “about,” “substantially,” and “approximately” are used to indicate a possible variation of $\pm 10\%$ in the stated value. In this disclosure, unless stated otherwise, any numeric value may include a possible variation of $\pm 10\%$ in the stated value.

[0011] Various embodiments of the present disclosure relate generally to ferrite busbar assemblies of an inverter and, more particularly, to an overmolded ferrite busbar assembly.

[0012] The terminology used below may be interpreted in its broadest reasonable manner, even though it is being used in conjunction with a detailed description of certain specific examples of the present disclosure. Indeed, certain terms may even be emphasized below; however, any terminology intended to be interpreted in any

restricted manner will be overtly and specifically defined as such in this Detailed Description section.

[0013] Referring to FIGS. 1-2, a ferrite-busbar assembly 100 may alternatively be referred to as an inverter component assembly. The ferrite-busbar assembly 100 may include a housing 200, a ferrite core 300 including a ferromagnetic material, and a busbar or terminal assembly 4.

[0014] The busbar assembly 4 may include at least one busbar or terminal 5 and may alternatively be referred to as a busbar array. The busbar assembly 4 may include a conductive material such as copper or aluminum. As shown in the Figures, the busbar assembly 4 may be a three-phase output busbar which includes three terminals 5, but aspects disclosed herein are not limited to a number of terminals 5.

[0015] The busbar assembly 4 may have a first or upper portion or extension 8 and a second or lower portion or extension 9. The first portion 8 may extend in a different direction (e.g., perpendicular direction or at least offset) than the second portion 9. Each terminal 5 may have a first end at the first portion 8 and a second end at the second portion 9. At the second portion 9, the terminals 5 may be parallel to one another. At the first portion 8, the terminals 5 may extend in different directions. For example, an inner terminal may be provided between two outer terminals among the terminals 5. The inner terminal may extend in a first or forward direction, while the outer terminals of the terminals 5 may extend away from the inner terminal. The first portion 8 may include a transitional section 82 and an end section 84 bent or curved from the transitional section 82. For example, the second portion 9 may extend in a first plane. The transitional section 82 may extend from the second portion 9 at an angle (e.g.,

acute angle) to lie in a plane different from the first plane. The end section 84 may be extend from the transitional section 82 at an angle (e.g., obtuse angle) to lie in a plane different from (e.g, perpendicular to) the first plane. However, aspects disclosed herein are not limited to an orientation of the terminals 5. A central or middle portion of each terminal 5 between the first and second portions 8 and 9 of the busbar assembly 4 may include a tooling hole 14, which may align or overlap with the inner space 306 of the ferrite core 300 during assembly.

[0016] The housing 200 may be integrally formed of or otherwise include an elastic, flexible, or elastomeric material (e.g., rubber, silicone, or a thermoplastic elastomer or TPE) to be unitary. The housing 200 may be configured to be overmolded over the busbar assembly 4 and also over the ferrite core 300. As will be described in more detail hereinafter, the housing 200 may be molded using a low pressure molding technique configured to enhance sealing between the housing 200, busbar assembly 4, and ferrite core 300, reduce a number of manufacturing parts and costs, and enhance a performance of the ferrite-busbar assembly 100. The first portion 8 of the busbar assembly 4 may protrude from an upper portion of the housing 200, and the second portion 9 of the busbar assembly 4 may protrude from a lower portion of the housing 200.

[0017] The ferrite core 300 may have an inner surface 310 defining an inner space 306, and the second portion 9 of the busbar assembly 4 may extend through the inner space 306 of the ferrite core 300. The ferrite core 300 may be made out of iron oxide formed with other metals that may include nickel, zinc, manganese, aluminum, barium, magnesium etc. (e.g., manganese zinc or MnZn).

[0018] In some embodiments, the ferrite core 300 may be brittle and susceptible to quick temperature changes or tensile loads. The ferrite core 300 may have a tensile strength (e.g., 20-30 megapascals or MPa, or $2-3 \times 10^7$ Newton per square meter or N/m^2) that is not configured to withstand typical injection molding or overmolding pressures (e.g., 50 MPa or more). The ferrite core 300 may be configured to be compliant with Electromagnetic Compatibility (EMC) standards and/or to suppress or reduce high-frequency noise. The ferrite core 300 may have a compressive strength of $60-80 \times 10^7 \text{ N/m}^2$ (e.g., 70 N/m^2), a Vickers hardness of 500-700 HV (e.g., 600-700 HV), a flexural strength of $8-12 \times 10^7 \text{ N/m}^2$ (e.g., $9 \times 10^7 \text{ N/m}^2$), a Young's modulus of $0.8 - 1.5 \times 10^{11} \text{ N/m}^2$ (e.g., 1.2 N/m^2), a density of 4.7-5.0 g/cm^3 , a Poisson's ratio of 0.2-0.3 (e.g., 0.2 or 0.25), a thermal expansion coefficient of $9-13 \times 10^{-4}/\text{K}$ (e.g., $12 \times 10^{-4}/\text{K}$), a specific heat of 400-800 J/kgK (e.g., 600 J/kgK), a thermal conductivity of $8-12 \times 10^{-3} \text{ J/mmSK}$ (e.g., $9.5 \times 10^{-3} \text{ J/mmSK}$), and a thermal resistance of surface of 10-30 K/W .

[0019] Aspects disclosed herein are not limited to characteristics of the ferrite core 300, however. The ferrite core 300 may have an oval-shaped or stadium-shaped cross-section (e.g., rectangular with semicircular ends), but aspects disclosed herein are not limited to a shape of the ferrite core 300. Overmolding techniques described herein may be used in combination with alternative ferrite cores.

[0020] The busbar assembly 4 may be configured to withstand an overmolding pressure of 30, 40, or 50-60 MPa or more. However, when the ferrite core 300 has a tensile strength in a range of 20-30 MPa, molding pressures of greater than 30 MPa (e.g., 50 MPa or more) may cause the ferrite core 300 to fracture. In addition, a difference in coefficients of thermal expansion (CTE) between the ferrite core 300 and

an automotive grade plastic (e.g., polybutylene terephthalate or PBT 30GF (glass-filled), PPA 30GF, PPS 30GF, etc.) may also cause fracturing during thermal shock or cycling.

[0021] The ferrite core 300 and busbar assembly 4 may therefore be overmolded together at a low pressure (e.g., less than 20 MPa, less than 10 MPa, less than 5 MPa, in a range of 1 MPa – 5 MPa, or 2 MPa), and the housing 200 may be formed of the overmolded material. The material for overmolding to create the housing 200 may be an elastomeric and sealing material such as rubber, ethylene propylene diene monomer rubber (EPDM), thermoplastic elastomer (TPE) or silicone, which may result in a relatively compliant housing 200. The housing 200 may have a lower Young's modulus and allow for higher strain. The lower Young's modulus of the overmolding material may reduce stresses on the ferrite core 300, while the properties allowing the higher strain may prevent the overmolding material from tearing due to a CTE difference during thermal cycling.

[0022] Molding the housing 200 over the ferrite core 300 and busbar assembly 4 at lower pressures may create a sealing interface between the housing 200, ferrite core 300, and busbar assembly 4. Overmolding the housing 200 over the ferrite core 300 may reduce or eliminate a need for separate seals, sealing interfaces, and/or dispensing materials (e.g., at positions where the busbar assembly 4 protrudes from the housing 200), gaskets, clips, compression springs, and other devices or parts configured to maintain a sealed inner space of the housing 200 and to maintain a positioning of the ferrite core 300. In some embodiments, the ferrite-busbar assembly 100 completely omits separately formed seals, sealing materials, or gaskets other than the housing 200. In other embodiments, the ferrite-busbar assembly 100 may include

additional seals or sealing materials. In some embodiments, ferrite-busbar assembly 100 omits more expensive materials, sealants, dispensing materials, and/or sealing liquids (e.g., flourosilicone) and reduces costs.

[0023] Referring to FIGS. 2-3, the ferrite core 300 may include an outer surface 320 opposite the inner surface 310 to define an outer side of the ferrite core 300. The ferrite core 300 may also include an upper surface 330 defining an upper side (FIG. 3) of the ferrite core 300 and a lower surface 340 defining a lower side (FIG. 3) of the ferrite core 300. The first portion 8 of the busbar assembly 4 may protrude from the inner space 306 at the upper side of the ferrite core 300, and the second portion 9 of the busbar assembly 4 may protrude from the inner space 306 at the lower side of the ferrite core 300.

[0024] During overmolding, the overmolded material may cover or surround and contact the outer surface 320 and upper surface 330 of the ferrite core 300 to seal and protect the ferrite core 300. At least a portion of the bottom surface 340 of the ferrite core 300 may remain exposed. In some embodiments, portions of the ferrite core 300 at the upper surface 330 and/or outer surface 320 may remain exposed, such as where tooling 520 and/or 540 described later were provided during the overmolding process. In other embodiments, the upper surface 330 and/or the outer surface 320 may be completely covered by the overmolding material and/or filled in. The tooling hole 14 of the busbar assembly 4 may be provided inside of the inner space 306 of the ferrite core 300 before overmolding, and the overmolded material may seep into or be injected into the inner space 306 and the tooling hole 14 of the ferrite core 300 to seal the inner

space 306 and to secure the busbar assembly 4. The ferrite core 300 and busbar assembly 4 may be embedded into the housing 200 after the housing 200 has cured.

[0025] Because the ferrite-busbar assembly 100 does not require separate seals or sealing material at portions where the busbar assembly 4 protrudes from the housing 200, the ferrite core 300 may be longer in the Z-direction than might otherwise be possible. For example, a length of the ferrite core 300 in the Z-direction may be 75% or more of a length of the housing 200 in the Z-direction (e.g., 80 or 90%). The length of the ferrite core 300 in the Z-direction may be 80% or more (e.g., 90% or 95%) of a length of the busbar assembly 4 in the Z-direction.

[0026] The bottom surface 340 of the ferrite core 300 may define at least a portion of the bottom surface of the ferrite-busbar assembly 100, rather than a bottom seal. Alternatively, the housing 200 may be formed to cover an entirety of the bottom surface 340 of the ferrite core 300. In some embodiments, the bottom surface 340 of the ferrite core 300 may be flush with at least a portion of a bottom surface of the housing 200.

[0027] The housing 200 may include a bottom protrusion 202 formed during an overmolding process. The bottom protrusion 202 may surround or cover at least a bottom portion (including a portion of the bottom surface 340) of the ferrite core 300 to form an integrated face seal. In some embodiments, bottom protrusion 202 may be omitted. In other embodiments, bottom protrusion 202 may be formed to cover the entirety of the bottom surface 340 of the ferrite core 300 so that the ferrite core 300 is not exposed to an outside of the housing 200.

[0028] In some embodiments, the ferrite-busbar assembly 100 omits screws, bolts, and fasteners configured for press-fitting to maintain a position of the housing 200. In addition, the ferrite-busbar assembly 100 may not require (and in fact, omits in some cases) a steel clamp, fasteners and clips, or compression springs to maintain a position of the ferrite core 300 in the housing 200. For example, in some embodiments, the ferrite-busbar assembly 100 does not require any clips to keep pieces of housing 200 in place because housing 200 may be unitary. In some embodiments, the ferrite-busbar assembly 100 does not require a face seal under the bottom surface 340 of the ferrite core 300 because the housing 200 may be overmolded directly on the ferrite core 300 to provide a sealing interface. In some embodiments, the ferrite-busbar assembly 100 does not require a compression spring inside of the housing 200 that urges the ferrite core 300 against the housing 200 because overmolding the housing 200 over the ferrite core 300 may reduce or eliminate space in which the ferrite core 300 may rattle. The ferrite-busbar assembly 100 may use fewer parts than inverter assemblies having a multi-part, non-unitary housing and/or where the ferrite core 300 is not overmolded and instead coupled separately to a housing. The ferrite-busbar assembly 100 may enhance security and reduce rattling of the ferrite core 300 within housing 200.

[0029] The ferrite-busbar assembly 100 may include tooling 520 and 540 and bracket 600. Tooling 520 and 540 may maintain a position of the ferrite core 300 during overmolding, and the housing 200 may be overmolded over the tooling 520 and 540. Tooling 520 and 540 may be retractable core pins (e.g., metal pins) which are configured to pneumatically or elastically retract (e.g., via a pneumatic or spring system). Tooling 520 may be provided on an upper side (or in the +Z-direction) of the

ferrite core 300 at a side (e.g., in a +X-direction) opposite to which the first portion 8 of the busbar assembly 4 extends. Tooling 520 may be configured to clamp on or be urged against the ferrite core 300 in the –Z-direction to maintain a position in the Z-direction. Tooling 520 may, for example, be part of a mold cavity used during the overmolding process. Tooling 540 may be provided at an outer side of the ferrite core 300 to maintain a position of the ferrite core 300 in the X-direction and/or to center the ferrite core 300 around the terminals 5. Tooling 540 may include two retractable core pins at opposite sides of the ferrite core 300 (e.g., in the X-direction). Tooling 540 may be provided at a lower side (in the –Z-direction) of the ferrite core 300 under the bracket 600. Tooling 540 may be part of a mold core used during the overmolding process. After overmolding, tooling 520 and/or 540 may be retracted and removed from the housing 200. For example, tooling 520 may move away from the mold cavity along with the overmolded housing 200, while tooling 540 may move sideways with respect to the ferrite core 300 so that the overmolded housing 200 may be ejected out of the mold.

[0030] The bracket 600 may include a rigid (e.g., metal such as copper, aluminium, steel, etc.) bracket or fastener overmolded with the busbar assembly 4 and ferrite core 300. The bracket 600 may be configured to fasten the ferrite-busbar assembly 100 to other devices or components, such as in an installation environment (e.g., an inverter housing). The bracket 600 may have a thickness which is similar to or thinner than a thickness of the terminals 5 of the busbar assembly 4. The bracket 600 may include a tooling hole 602 configured to receive overmolding material during the overmolding process to secure the bracket 600 within the housing 200. The bracket 600 may include a plurality of extensions or wings 604, 606, and 608 which protrude

from a middle or central location of the housing 200 with respect to the Z-direction, and the housing 200 may be thicker at a portion that secures the bracket 600.

[0031] FIG. 4 depicts a cross-sectional view of the ferrite-busbar assembly 100 of FIG. 3 along line 3-3. Referring to FIG. 4, the extensions 604, 606, and 608 may have a plate shape. At least one side (e.g., a bottom side) of the extensions 604, 606, and 608 may have a flat surface to facilitate coupling. Each extension 604, 606, and 608 may include a fastener hole 610 configured to receive a fastener (bolt, screw, etc.) to facilitate coupling to another structure (e.g., inverter housing).

[0032] For example, the bracket 600 may include a first extension 604, a second extension 606, and a third extension 608. The first and second extensions 604 and 606 may be provided at opposite sides of the housing 200 with respect to the Y-direction. The first and second extensions 604 and 606 may have a similar size and shape (e.g., square or rectangular) to be symmetrical across an axis extending in the X-direction. The third extension 608 may protrude from the housing 200 at a side of the housing 200 opposite to a side from which the upper portion 8 of the busbar assembly 4 protrudes (FIG. 4) in the X-direction (e.g., a left side). The third extension 608 may be larger (e.g., longer in the Y-direction and/or Z-direction) than the first and second extensions 604 and 606, but aspects disclosed herein are not limited to a dimension of the first, second, and third extensions 604, 606, and 608 of the bracket 600.

[0033] The bracket 600 may be sleeker and thinner than other devices (e.g., steel clamp and/or the bushings) used with non-overmolded and/or non-unitary housings, and because the bracket 600 may be overmolded with the busbar assembly 4 and the ferrite core 300, the bracket 600 may facilitate a strong and sturdy coupling to an external

structure. Like the ferrite core 300 and busbar assembly 4, the bracket 600 may be embedded into the housing 200 after curing.

[0034] FIG. 5 depicts a method 5000 of manufacturing the ferrite-busbar assembly 100. Referring to FIGS. 5, the method may include positioning steps 5010, 5020, and/or 5030, an overmolding step 5040, and a curing step 5050.

[0035] Step 5010 may include positioning or inserting the terminals 5 of the busbar assembly 4 through the inner space 306 of the ferrite core 300. This positioning step 5010 may occur before the overmolding step 5040.

[0036] Step 5020 may include maintaining a position of the ferrite core 300 with respect to the terminals 5. A position of the ferrite core 300 may be maintained using tools configured for a low-pressure molding process, such as tooling 520 and 540. The position of the ferrite core 300 may be maintained to be centered around the terminals 5 with respect to the X-direction, and may also be maintained such that the tooling holes 14 of the terminals 5 overlaps or aligns with, in the Z-direction, the inner surface 310 of the ferrite core 300.

[0037] Steps 5010 and/or 5030 may include placing the terminals 5 and the ferrite core 300 into a mold for the housing 200. A position of the terminals 5 and/or ferrite core 300 may be maintained in the mold using tooling configured for low pressure molding applications. The mold and/or the terminals 5 and/or ferrite core 300 may be coated in a release agent to facilitate easy removal from the mold after overmolding in step 5040.

[0038] Step 5030 may include positioning the bracket 600 with respect to the outer surface 320 of the ferrite core 300. The bracket 600 may align with a middle or

central location, with respect to the Z-direction, of the outer surface 320 of the ferrite core 300. The bracket 600 may include the tooling hole 602, and a position of the bracket 600 may be maintained with retractable tooling, which may be temporary. Step 5030 may occur before the overmolding step 5040. Alternatively, step 5030 may occur after the overmolding step 5040, and an additional overmolding step may be performed to further secure the bracket 600 to the housing 200. Step 5030 may also include positioning, the terminals 5, ferrite core 300, and/or bracket 600 together in a mold.

[0039] Step 5040 may include injecting an overmold material at a predetermined pressure to form the housing 200. The overmold material and resulting housing 200 may cover an outer side of the ferrite core 300 and fill the inner space 306 of the ferrite core 300. The predetermined pressure may be a lower pressure than typically used to overmold electronic components and/or busbars; for example, the predetermined pressure may be less than 20 MPa or less than 10 MPa. The predetermined pressure may be in a range of 1-3 MPa or 1-5 MPa. The predetermined pressure may be 2 MPa. The predetermined pressure may be configured to reduce or prevent fracturing of the ferrite core 300 during the overmolding step 5040. Step 5040 may be performed using an injection molding or overmolding machine, manually with an injection needle and separate mold, etc.

[0040] Step 5050 may include allowing the housing 200 to cure. After step 5040 and/or during or after step 5050, tooling 520 and/or 540 may be retracted from the housing 200 and removed.

[0041] The finished and/or cured housing 200 may be a rubber or elastomeric material to seal the inner space and secure the terminals 5 to the ferrite core 300. A

material of the cured housing 200 may reduce a CTE-induced stress against the ferrite core 300 to reduce or prevent fracturing during thermal cycling. In addition, a material of the cured housing 200 and the overmolding of the housing 200 around the ferrite core 300 may reduce or prevent a rattling of the ferrite core 300 within the housing 200, enhancing performance and quality.

[0042] The low-pressure overmolded housing 200 over the busbar assembly 4 and ferrite core 300 may reduce costs by requiring fewer parts, softer toolings, and reduced labor and/or time in assembling the ferrite-busbar assembly 100. With fewer parts, there may be a lower risk of losing parts during the manufacturing process. In addition, the low pressure overmolding process, as described with reference to FIG. 5, may enhance quality of the ferrite-busbar assembly 100 by reducing a rattling of the ferrite core 300 within the housing 200 and enhancing security and sealing of the ferrite core 300 with the housing 200. The low-pressure overmolding process may facilitate a reduction or elimination of other assembly parts, which may allow for a longer ferrite core 300 while a centralized ferrite position within the housing 200 is made possible via tooling 540. A longer and centered ferrite core may enhance EMC performance.

[0043] Aspects disclosed herein, in some embodiments, do not require plastic, multi-part housings. Aspects disclosed herein, in some embodiments, do not require multi-step assembly processes where, for example, a busbar or terminal assembly is overmolded with a first housing, the ferrite core is attached (e.g., via screws, clamps, clips, etc.), and then a rigid, already molded plastic second housing is coupled (e.g., screwed, clamped, clipped, etc.) to the first housing to enclose the busbar and ferrite

core. Aspects disclosed herein may reduce or eliminate fasteners to maintain a secured state of a ferrite core and/or busbar within a housing in an inverter assembly.

[0044] Aspects disclosed herein may reduce or prevent leaks and enhance sealing between a housing, busbar assembly, and ferrite core. In some embodiments, aspects disclosed herein do not require various other sealing materials, seals, dispensing materials, etc. For example, some embodiments omit face seals at a bottom of a housing and/or seals surrounding terminals of a busbar assembly.

[0045] Aspects disclosed herein may reduce or eliminate empty spaces within a housing and/or spaces between a busbar assembly, ferrite core, and/or inner surfaces of housings. Some embodiments require only one step to form a housing and do not require molding of a housing to include recesses, grooves, etc. for seals, gaskets (e.g., an Ethylene Propylene Diene Monomer or EPDM face seal or silicone face seal), sealing or dispensing material (e.g., silicone or fluoro-silicone dispensing material), clips, springs, or other devices.

[0046] Aspects disclosed herein, in some embodiments, do not require devices (e.g., compression springs, tapping/bolting mechanisms, or screws) configured to deform and/or compress seals and/or maintain a sealed state inside of a housing. Some techniques disclosed herein do not require any devices that remain within the housing 200 after overmolding except the busbar assembly 4 and the ferrite core 300.

[0047] Other embodiments of the disclosure will be apparent to those skilled in the art from consideration of the specification and practice of the invention disclosed herein. It is intended that the specification and examples be considered as exemplary only, with a true scope and spirit of the invention being indicated by the following claims.

CLAIMS

1. A ferrite busbar assembly, comprising:
 - a one-piece ferrite core having an inner space;
 - a terminal extending through the inner space; and
 - a housing enclosing the ferrite core;
 - a bracket coupled to and protruding from the housing,wherein the housing is unitary and integrally formed from an overmold material that when cured is configured to:
 - secure a portion of the bracket embedded within the housing; and
 - secure and seal the ferrite core within the inner space;wherein at least a portion of the housing and a portion of the terminal together fill the inner space of the ferrite core;
 - wherein the housing surrounds and contacts an outer surface of the ferrite core, the outer surface being opposite to an inner surface that defines the inner space;
 - wherein a first end of the terminal protrudes from a first side of the housing and a second end of the terminal protrudes from a second side of the housing;
 - wherein the ferrite busbar assembly does not include any seals or gaskets separate from the housing;
 - wherein the ferrite busbar assembly does not include any clips or fasteners coupling the ferrite core to the housing; and
 - wherein the ferrite core is 75% to 100% of a length of the ferrite busbar assembly in a z-axis direction, the z-axis direction extending from the second side of the housing to a third side of the housing opposite of the second side of the housing.
2. The ferrite busbar assembly of claim 1, wherein the overmold material is a thermoplastic elastomer (TPE) or silicone.
3. The ferrite busbar assembly of claim 1, wherein at least a portion of the ferrite core is exposed at the second side of the housing.
4. The ferrite busbar assembly of claim 1, wherein the ferrite core has a first side and a second side opposite the first side, and the second side of the ferrite core is flush with at least a portion of the housing at the second side.

5. The ferrite busbar assembly of claim 1, wherein the second side of the housing covers at least a portion of a bottom surface of the ferrite core.
6. The ferrite busbar assembly of claim 1, wherein the bracket includes a first extension that protrudes from a third side of the housing which is opposite the first side of the housing such that the first extension of the bracket and the first end of the terminal extend in opposite directions.
7. The ferrite busbar assembly of claim 1, wherein the bracket includes a second extension and a third extension which protrude from opposite sides of the housing.
8. The ferrite busbar assembly of claim 1, wherein the housing is integrally formed of by injecting the overmold material at a predetermined pressure that is less than 5 megapascals (MPa).
9. The ferrite busbar assembly of claim 1, wherein the predetermined pressure is 2 MPa.
10. The ferrite busbar assembly of claim 1, wherein the second side of the housing includes a protrusion that surrounds or covers a portion of the ferrite core.