

Metallic Evacuated Double-Walled Vessel and Production Method Therefor

BACKGROUND OF THE INVENTION

The present invention relates to a metallic double-walled vessel such as a portable thermos, pot, jar or the like.

As a method for producing a metallic evacuated double-walled vessel, there are available such conventional methods as, for example, a method wherein the evacuation of the space between an inner and an outer vessel is carried out by means of a chip tube attached to the outer vessel, and the chip tube is then pressure welded and sealed (Japanese Patent Application, laid open number Sho 59-37914, Japanese Patent Application laid open number Sho 59-103633); a method wherein an evacuation opening is provided to the outer vessel, a brazing metal material is piled around the periphery of the evacuation hole, a sealing member is placed on top of this with an interval of space being maintained between the sealing member and the evacuation hole, heat evacuation is carried out in a vacuum heating furnace, after which, the temperature is raised to the melting temperature of the brazing metal material, the sealing member is brazed, and the vessel is thus vacuum sealed (Japanese Patent Application laid open number Sho 58-192516); and a method wherein a small hole or cut-out is punched in the outer vessel, a brazing metal material is disposed in the vicinity thereof, heat evacuation in a vacuum heating furnace is then performed, the temperature is raised to the melting temperature of the brazing metal material causing the it to melt and flow into the small hole or cut-out, thus vacuum sealing the vessel (Japanese Patent Application Hei 1-106925 (U.S. Patent No. 5,153,977), Utility Model Application Hei 2-26837)).

In the above described method using a chip tube, because the chip tube projects out from the bottom of the outer vessel, it is necessary to attach a bottom cover in order to protect the chip tube. Accordingly, this is problematic because the height of the

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produced article becomes higher by the length of this protecting cover. Moreover, in the case of large capacity production, because it is necessary to seal and cut the chip tube for each article produced, operations become complicated. Moreover, as it is essential that the process for this sealing technique be highly accurate, great skill is required in the operation. Additionally, the seal is occasionally insufficient, giving rise to the problem that the degree of vacuum deteriorates and the thermal insulating ability is lost over time. Further, in a sealing method using a chip tube, in the case where evacuating the space between the inner and outer vessels, when stimulating the desorption of gas absorbed by the metallic surface by heating the entire vessel, the outer surface of the vessel is exposed to the atmosphere, and a reaction occurs with the oxygen in the atmosphere causing violent oxidation. Because the esthetic appearance and anti-corrosive character of the oxidized surface are impaired, it is necessary to provide a process step to eject such sub-standard articles. Accordingly, costs are increased.

On the other hand, in a sealing method using brazing material, in order to achieve good wettability of the sealant with respect to the material of the outer vessel, it is necessary to remove any superficial oxidants in the material of the evacuation opening periphery. As a method therefor, there is available a method wherein heating is carried out at a temperature of 950° C or above and at a pressure of 1×10^{-3} torr or less on stainless steel, which is preferably used in, for example, metallic thermoses. In this case, a special vacuum heating furnace of the type which can be used at high temperatures of 950° C and above is necessary. Accordingly, this too is problematic because equipment costs become very expensive.

Figure 14 is provided in order to explain an example of the production method of a conventional metallic evacuated double-walled vessel. This figure shows the state of a metallic evacuated double-walled vessel prior to vacuum sealing. This prior to vacuum sealing vessel consists of an inner casing 1 which is cylindrical in shape and has a bottom, and an outer casing 4



which consists of a cylindrical outer casing body portion 2 and an outer casing bottom portion 3. The mouth portion of outer casing body portion 2 is air tightly joined to the mouth portion of inner casing 1. At the same time, outer casing bottom portion 3 is air tightly joined to the opening at one end of the vessel which is opposite the mouth portion of the outer casing body portion 2. Further, in the approximate center of the outer casing bottom portion 3, a concavity 6 which is indented inward toward inner casing 1 is formed. In the approximate center portion of this concavity 6, a small hole 7 (evacuation hole) or slit for evacuation is formed passing through a cavity 5 between the inner casing 1 and the outer casing 4.

In order to produce a metallic evacuated double-walled vessel by vacuum sealing this prior-to-sealing vessel, the vessel is inverted with the mouth portion of the prior-to-sealing vessel directed downward, a sealing hot charge 8, such as metallic brazing material, in a paste form is disposed in concavity 6, and the prior-to-sealing vessel is placed in a vacuum heating furnace. Melting and heating of the sealing hot charge 8 is carried out as the inside of the vacuum heating furnace is evacuate to a fixed degree of vacuum. The melted sealing hot charge 8 flows from the periphery therearound into the evacuation hole 7, plugging evacuation hole 7. Following this, sealing hot charge 8 is cooled and hardens, vacuum sealing evacuation hole 7. In this manner, a metallic evacuated double-walled vessel having an evacuated thermal insulating layer between the inner casing 1 and the outer casing 4 is produced (Utility Model Application Hei 2-26837).

However, in this conventional sealing method, a sealing hot charge 8 in a paste form is disposed about the periphery of concavity 6, the sealing hot charge 8 is melted during vacuum sealing, and flows along the incline of concavity 6 provided to evacuation hole 7, sealing evacuation hole 7. Accordingly, the manner of flow of the melted sealing hot charge 8 changes due to the quantity used, or as a result of the inclination or surface features of the outer casing bottom portion 3 and the concavity 6, the flow of hot charge 8 into evacuation hole 7 becomes unstable,



resulting in insufficient sealing. In order to prevent such inconveniences, more sealing hot charge 8 than actually necessary must be used, causing production costs for the vessel to increase.

BRIEF DESCRIPTION OF THE FIGURES

Figure 1 is a front cross sectional view of a double-walled vessel prior to sealing, showing a first embodiment of the present invention.

Figure 2 is a view of the bottom surface of the same prior-to-sealing vessel.

Figure 3 is a cross sectional view of an essential component of the same prior-to-sealing vessel.

Figure 4 is a cross sectional view of an essential component showing the state following vacuum sealing of the same vessel.

Figure 5 is a front cross sectional view of a vessel prior to sealing, showing a second embodiment of the present invention.

Figure 6 is a front view of an essential component of the same prior-to-sealing vessel.

Figure 7 is a cross sectional view of an essential component of the same prior-to-sealing vessel.

Figure 8 is a front cross sectional view of a double-walled vessel prior to sealing, showing a third embodiment of the present invention.

Figure 9 is a view of the bottom surface of the same prior-to-sealing vessel.

Figure 10 is an enlarged cross sectional view of an essential component of the evacuated double-walled vessel obtained by carrying out vacuum sealing to the same double-walled vessel.

Figure 11 is a front cross sectional view of a double-walled vessel prior to sealing, showing a fourth embodiment of the present invention.

Figure 12 is a bottom view showing an enlargement of an essential component of the same double-walled vessel.

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Figure 13 is a front cross sectional view of the double-walled vessel prior to sealing showing a fifth embodiment of the present invention.

Figure 14 is a front cross sectional view of a prior-to-sealing vessel which is provided to explain the conventional art related to the present invention.

SUMMARY OF THE PRESENT INVENTION

The present invention was conceived taking into consideration the aforementioned circumstances, and has as its objective the provision of a metallic evacuated double-walled vessel for which it is possible to carry out with surety the placement in an evacuation hole of a sealing hot charge for sealing the evacuation hole, and the sealing of the evacuation hole with the sealing hot charge, at a low cost, thus making possible a reduction in production costs.

The first invention of the present invention is a production method for a metallic evacuated double-walled vessel characterized in that, in a method for making a metallic evacuated double-walled vessel wherein the vessel consists of a metallic inner and outer vessel and an evacuated thermal insulating layer is formed in the cavity between the inner vessel and the outer vessel, the method comprises the steps of: forming a prior-to-sealing double-walled vessel by joining the mouth portions of the metallic inner and outer vessels to each other in a unitary fashion, forming a concavity in one of either the inner vessel and the outer vessel, and punching an evacuation hole for vacuum evacuation in the concavity; disposing at the time of vacuum heating, a sealing hot charge in a solid form at a position vertically above the evacuation hole leaving a space therebetween; placing the prior-to-sealing vessel in a vacuum heating furnace, and performing vacuum evacuation of the cavity between the inner vessel and the out vessel via the evacuation hole until a fixed degree of vacuum is reached; vacuum sealing the vessel by heating and melting the sealing hot charge causing the melted sealing hot charge to drop

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down directly onto the evacuation hole and the vicinity therearound and fill the inside of the evacuation hole, and allowing the sealing hot charge to harden.

This first invention allows vacuum sealing to be carried out with greater surety than that provided by the conventional method wherein vacuum sealing is performed through the flowing of the melted sealing hot charge. Accordingly, by means of this first invention it is possible to lower the rate of defective vacuum sealings, and to improve yield.

Moreover, because vacuum sealing is carried out by allowing the melted sealing hot charge to drop directly down into the evacuation hole, such sealing defects as insufficient plugging of the evacuation hole by the sealing hot charge due to the surface tension forces of the sealing hot charge are eliminated, and the quantity of sealing hot charge required may be reduced, thus permitting a reduction in production costs.

The second invention of the present invention is a production method for a metallic evacuated double-walled vessel characterized in that, in a method for making a metallic evacuated double-walled vessel wherein the vessel consists of a metallic inner and outer vessel and an evacuated thermal insulating layer is formed in the cavity between the inner vessel and the outer vessel, the method comprises the steps of: forming a double-walled vessel by joining together an inner vessel and an outer vessel, one of either the inner vessel and the outer vessel having an evacuation hole; disposing a sealing material consisting of low temperature melting glass, the softening temperature of which is from 200°C to 600°C, in the vicinity of the evacuation opening; placing the double-walled vessel inside a vacuum heating furnace, and vacuum evacuating the cavity between the inner and outer vessels at a temperature lower than the softening temperature of the sealing material; heating the double-walled vessel to a temperature higher than the softening temperature of the sealing material, and sealing the evacuation hole by the allowing the softened sealing material to flow into the evacuation hole.

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In this second invention, because the evacuation hole punched in one of either of the inner vessel or the outer vessel of the metallic double-walled vessel is sealed using a sealing material which consists of low temperature melting glass which softens at a temperature of from 200°C to 600°C, it is possible to reduce the temperature for vacuum sealing as compared to the conventional brazing method. For this reason, the temperatures used in the vacuum heating furnace can be lowered, equipment costs are reduced, and the production costs for the article are lowered. The low temperature melting glass used in the present invention is advantageous in that, even if oxidants are present on the surface of the metallic double-walled vessel, wettability is not impaired, making it possible to carry out a preferable sealing. Accordingly, it is also possible to omit the process of removing oxidants are removed by heating the surface of the metallic double-walled vessel to a high temperature. Production costs for the evacuated double-walled vessel are thereby further reduced.

Further, when compared to the convention method using a chip tube, it is possible to produce a more compact article as there is no remnant of the chip tube to protrude out. Moreover, with regard to the sealing process, because the treatment in the vacuum heating furnace may be carried out with stability for a large number of articles simultaneously without the introduction of human labor, large capacity production is easily achieved and it is possible to reduce production costs. Moreover, with regard to the process of vacuum evacuation of the space between the inner and outer vessels, because the entire vessel is heated under a vacuum, there is no notable oxidation of the outer surface of the vessel, thus a final removal step may be omitted. Costs can therefore be reduced.

Further, all vacuum evacuation and sealing operations can be carried out at a comparatively low temperatures in the range of from 200°C to 600°C, and the hardness of metallic material such as stainless steel or the like which constructs the vessel can be increased by low temperature annealing. As a result, using a metallic material having a high degree of hardness, the vessel can



be made thinner, and the overall weight of the evacuated double-walled vessel can be reduced.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS
OF THE PRESENT INVENTION

Embodiment 1

In the production method for a metallic evacuated double-walled vessel according to this embodiment, prior to vacuum sealing, the vessel (hereinafter, referred to as prior-to-sealing vessel 10) shown in Figures 1 through 3 is first prepared.

This prior-to-sealing vessel 10 consists of a metallic inner casing 11 which is cylindrical in shape and has a bottom, and a metallic outer casing 14 which similarly is cylindrical in shape and has a bottom, the inner casing 11 and outer casing 14 being joined at the mouth portions thereof. Outer casing 14 is formed from an outer casing body portion 12 which has a shoulder portion 19 the diameter of which as it approaches the mouth portion gradually reduces in the vicinity of the outer end portion of the mouth portion, and an outer casing bottom portion 13 which is air tightly joined to the opening of outer casing body portion 12 which is opposite the mouth portion thereof. Stainless steel is, in particular, preferably used as the metallic material which composes inner casing 11 and outer casing 14.

A semi-spherical concavity 16 is indented inward toward inner casing 11 at the approximate center portion of outer casing bottom portion 13. The diameter D_o of concavity 16 is preferably 3 to 15 mm. An evacuation hole 17 consisting of a small hole having a diameter A of 0.1 to 2 mm is formed in the approximate center of concavity 16. Furthermore, a cylindrical solid sealing hot charge 18 is disposed in concavity 16. The diameter d of this solid sealing hot charge 18 is preferably 0.3 to 3 mm, and the length L thereof is within the limits such that $A < L < D_o$.

In the state for vacuum heating prior-to-sealing vessel 10, namely in the state where the opening of the vessel is directed downward, this solid sealing hot charge 18 is attached in

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concavity 16 so as to be positioned vertically above evacuation hole 17, with an interval of spacing therebetween.

Next, a metallic double-walled vessel is produced by vacuum sealing prior-to-sealing vessel 10.

The above described prior-to-sealing vessel 10 is contained within a vacuum heating furnace in a state such that the mouth portion is directed downward. The vacuum heating process is then carried out. Namely, following vacuum evacuation of cavity 15 to a fixed degree of vacuum via evacuation hole 17 at a temperature below the melting temperature of sealing hot charge 18, the temperature is raised above the melting temperature of sealing hot charge 18, melting sealing hot charge 18 and causing it to drop down onto evacuation hole 17 which is positioned vertically thereunder, and onto the vicinity thereabout.

Sealing hot charge 18 which has dropped down onto evacuation hole 17 and the vicinity thereof collects on evacuation hole 17, and enters within evacuation hole 17 as a result of capillary phenomenon. Following this, sealing hot charge 18 cools and hardens, sealing evacuation hole 17 with surety. Figure 4 shows the state where evacuation hole 17 has been sealed in this manner by sealing hot charge 18.

If hole diameter A of evacuation hole 17 is less than 0.1 mm, then it is possible that the evacuation of cavity 15 will not be sufficient. Likewise, if hole diameter A is larger than 2.0 mm, due to the surface tension of the melted sealing hot charge 18, it is possible that the hole will not be plugged sufficiently by sealing hot charge 18. Further, provided that sealing hot charge 18 is in a solid form, a metallic brazing material or a low temperature melting glass may also be utilized.

As described above, a metallic evacuated double-walled vessel which consists of metallic inner casing 11 and an outer casing 14 and has an evacuated thermal insulating layer formed between inner casing 11 and outer casing 14, is produced.

In this embodiment, in the state for vacuum heating prior-to-sealing vessel 10, in other words in the state where the opening of the vessel is directed downward, a cylindrical, solid sealing

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hot charge 18 is attached in concavity 16 so as to be positioned vertically above evacuation hole 17, and the prior-to-sealing vessel 10 is contained then within a vacuum heating furnace. First, cavity 15 is vacuum evacuated to a fixed degree of vacuum via evacuation hole 17 at a temperature below the melting temperature of sealing hot charge 18. Following this, the temperature is raised above the melting point of sealing hot charge 18, melting sealing hot charge 18 and causing it to drop down under its own weight onto evacuation hole 17 positioned vertically thereunder and onto the vicinity thereabout. By carrying out vacuum sealing in this manner, it is possible to carry out vacuum sealing with greater surety than that provided by conventional methods of vacuum sealing which rely on the flow of a paste form melted sealing hot charge. Moreover, it is also possible to improve product yield by reducing the rate at which defective vacuum sealings arise. Further, because the melted sealing hot charge 18 drops directly down onto evacuation hole 17, vacuum sealing it, such sealing defects as sealing hot charge 18 not plugging evacuation hole 17 sufficiently due to the surface tension of the melted sealing hot charge 18 are eliminated, and the amount of sealing hot charge 18 used can be reduced. Thus, product costs can be lowered.

Additionally, the position for the provision of concavity 16 is not limited as aforementioned to the outer casing bottom portion 13, but may be provided to the inner casing 11 or to the shoulder portion 19 of outer casing body portion 12, as is the case in a later embodiment. Further, in addition to being a curved concavity such as in the preceding embodiment, the bottom portion of concavity 16 may also be level or inclined. Moreover, the shape of evacuation hole 17 which is punched in concavity 16 may be a slit shaped long hole, or may comprise several small aligned holes. The position at which evacuation hole 17 is punched in concavity 16 is not limited to the approximate center of concavity 16, but may be elsewhere about the vicinity thereof. Furthermore, solid sealing hot charge 18 may be other than a cylindrical shape, provided that it is a solid material the length



of which is longer than the diameter of evacuation hole 17, and that the shape of which has dimensions which do not interfere with vacuum evacuation when it sealing hot charge 18 disposed directly above evacuation hole 17. Moreover, the cubic volume of sealing hot charge 18 is not limited to a cubic volume as calculated from the above described dimensions. Rather, provided that the cubic volume is with limits which proscribe a minimum value for the cubic volume for the sealing hot charge 18 such that the sealing hot charge 18 has at least a thickness of 0.1 mm and can cover twice the diameter of the minimum cubic volume of evacuation hole 17, and a maximum value for the cubic volume of sealing hot charge 18 such that it does not exceed the inner cubic volume of the concavity so that external impacts are not locally concentrated.

Embodiment 2

The prior-to-sealing vessel 20 used in this embodiment differs from the prior-to-sealing vessel 10 used previous embodiment in that a pocket shaped concavity 21 is formed to shoulder portion 19 of the outer casing body portion 12, small evacuation hole 22 is punched in concavity 21, and a cylindrical sealing hot charge 18 is attached vertically above the evacuation hole 22.

Because, with prior-to-sealing vessel 20 in an upright state, solid sealing hot charge 18 is positioned vertically above evacuation hole 22 with spacing therebetween, in order to carry out vacuum sealing of prior-to-sealing vessel 20, prior-to-sealing vessel 20 is placed upright, namely placed with the mouth portion of the vessel directed upward, and contained within a vacuum heating furnace. Vacuum heating is then carried out. In this vacuum heating treatment, cavity 15 is first vacuum evacuated to a fixed degree of vacuum via evacuation hole 22 at a temperature below the melting temperature of sealing hot charge 18. Then, the temperature is raised above the melting temperature of sealing hot charge 18, melting sealing hot charge 18 and causing it to drop down onto evacuation hole 22 which is positioned directly therebelow, and onto the vicinity around evacuation hole 22.



Sealing hot charge 18 which has dropped down onto evacuation hole 22 and the vicinity therearound collects on evacuation hole 22 and enters into evacuation hole 22 as a result of capillary phenomenon. Following this, sealing hot charge 18 cools and hardens, sealing evacuation hole 22 with surety.

In the production method according to this embodiment, in addition to obtaining the same effects as those obtained in the previous embodiment, because prior-to-sealing vessel 20 is placed in a vacuum heating furnace with the mouth portion thereof directed upward during vacuum heating, a support device for supporting the prior-to-sealing vessel in the vacuum heating furnace is unnecessary. Thus, the operations of inserting and removing the vessel for vacuum heating are facilitated.

Embodiment 3

Figures 8 through 10 are provided to explain a third embodiment of the production method for a metallic evacuated double-walled vessel according to the present invention. The metallic evacuated double-walled vessel produced here is a portable thermos which consists of a stainless steel inner vessel 31 and a stainless steel outer vessel 34 which are joined together, with a cavity 35 between the inner vessel 31 and the outer vessel 34 forming an evacuated thermal insulating layer.

In outer vessel 34, outer vessel bottom member 33 is joined air tightly to the bottom end of approximately cylindrical outer vessel body 32. Concavity 40 which is indented to form a semi-spherical shape is formed to the approximate center portion of outer vessel bottom member 33. A small evacuation hole 41 is punched in the center of concavity 40. The mouth diameter of evacuation hole 41 is preferably 0.1 to 2.0 mm.

In order to produce this thermos, inner vessel 31 and outer vessel body 32 are air tightly joined at the mouth portions thereof, while at the same time, outer vessel bottom member 33 is air tightly joined to outer vessel body 32, forming prior-to-sealing double-walled vessel A (hereinafter, referred to as double-walled vessel). Next, as is shown in Figures 8 and 9, the

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mouth portion of double-walled vessel A is directed downward, and a rod shaped sealing material 42 is attached inside concavity 40 of outer vessel bottom member 33 with a interval of space maintained between sealing material 42 and evacuation hole 41.

A low temperature melting glass, the softening point of which is from 200°C to 600°C is used in sealing material 42. Solder glass derived from B_2O_3 -PbO, B_2O_3 -ZnO, PbO- B_2O_3 -ZnO-SiO₂, PbO- B_2O_3 -Al₂O₃-SiO₂, PbO- B_2O_3 -SiO₂, or PbO- B_2O_3 -BaO-SiO₂ may be used as the low temperature melting glass. In particular, a material having a coefficient of thermal expansion similar to that of stainless steel which is the material of the double-walled vessel is preferable.

To attach rod shaped sealing material 42 in concavity 40, sealing material 42 may be simply pushed into concavity 40. However, in order to prevent positional displacement of sealing material 42, it is also possible to coat an adhesive agent to both ends of sealing material 42 and thereby fix it firmly inside concavity 40. Moreover, the shape of sealing material 42 is not limited to a rod shape, but may also be a solid shape.

Next, double-walled vessel A, to which sealing material 42 is attached, is transferred to and disposed within a vacuum heating furnace in an inverted position. Vacuum heating is carried out by vacuum evacuating the inside of the furnace while heating is performed. The temperature for the vacuum heating is set so as to be within the range of 200°C to 600°C and such that sealing material 42 does not soften. The gas in the cavity between inner vessel 31 and outer vessel 34 is expelled through evacuation hole 41. After evacuating to a pressure of 1×10^{-2} torr or less, the temperature inside the furnace is raised to a temperature which is in the range from 200°C to 600°C and which is a temperature above the softening point of sealing material 42. Sealing material 42 is softened and drops down under its own weight onto evacuation hole 41 and the vicinity thereabout, sealing evacuation hole 41. Following this vacuum sealing, the vessel is removed from the furnace. As a result, as shown in Figure 10, evacuation hole 41 is sealed with sealing material 42 which consists of low

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temperature melting glass, thus obtaining a stainless steel thermos (metallic evacuated double-walled vessel) having an evacuated thermal insulating layer 36 between inner vessel 31 and outer vessel 34.

Via this vacuum sealing process, the double-walled vessel is heated at a temperature in the range of 200°C to 600°C, and the hardness of the stainless steel, which is the material of the double-walled vessel, is increased by low temperature annealing. Accordingly, the thickness of the stainless steel necessary to obtain the required shock and impact resistance is reduced. Thus, the vessel can be made thinner.

In the production method according to the present embodiment, by sealing the evacuation hole of the metallic double-walled vessel by using a sealing material consisting of a low temperature melting glass which has a softening temperature in the range of 200° to 600°C, it is possible to reduce the temperature of vacuum sealing as compared to the convention brazing method. For this reason, the temperature utilized within the vacuum heating furnace can be lowered, equipment costs are reduced, and the production costs for the article can be lowered. This low temperature melting glass is advantageous in that wettability is not impaired even if oxidants are present on the surface of the double-walled vessel, making it possible to carry out a preferable sealing. Accordingly, it is possible to omit the process for removing oxidants by heating to a high temperature the surface of the double-walled vessel. Thus, the production costs for an evacuated double-walled vessel can be reduced.

Further, when compared to the convention method using a chip tube, it is possible to produce a more compact product as there is no remnant of the chip tube to protrude out. Moreover, with regard to the sealing process, because treatment in the vacuum heating furnace may be carried out with stability for a large number of articles simultaneously without the introduction of human labor, large capacity production is easily achieved and it is possible to reduce production costs. Moreover, with regard to the process of vacuum evacuation of the space between the inner



and outer vessels, because the entire vessel is heated under a vacuum, there is no notable oxidation of the outer surface of the vessel, therefore, a final removal process can be omitted. Thus, costs can be reduced.

Further, all vacuum evacuation and sealing operations can be carried out at comparatively low temperatures in the range of from 200°C to 600°C, and the hardness of the metallic material such as stainless steel or the like which composes the vessel can be increased by low temperature annealing. As a result, using a metallic material having a high degree of hardness, the vessel can be made thinner, and the overall weight of the evacuated double-walled vessel can be reduced.

Embodiment 4

Figures 11 and 12 are provided to explain a fourth embodiment of the production method for a metallic evacuated double-walled vessel according to the present invention. The double-walled vessel B shown in these figures is equipped with almost entirely the same structural elements as those shown in Figures 8 and 9. Structural elements shown in Figures 11 and 12 which are identical to those in Figures 8 and 9 have been labeled with the same symbols. In the double-walled vessel B shown in Figures 11 and 12, a long groove 43 is formed in the center portion of the bottom surface side of outer vessel bottom member 33, and a slit-shaped long hole 44 (evacuation hole) is formed in the bottom of long groove 43. As is shown in Figure 12, a rod shaped sealing material 42 consisting of low temperature melting glass and having a length which is shorter than the length of the slit shaped long hole 44 is disposed inside long groove 43 of the double-walled vessel B. Following this, as in the previous example, double-walled vessel B is placed inside a vacuum heating furnace, and vacuum heating is carried out while heating to a temperature which is within the range of 200°C to 600°C and is below the temperature at which sealing material 42 softens. After evacuating to a pressure of 1×10^{-2} torr or less, the temperature inside the furnace is raised to a temperature which is in the range of from

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200°C to 600°C and which is a temperature above the softening point of sealing material 42. Sealing material 42 is softened and flows onto slit shaped long hole 44, sealing it, and a stainless steel thermos (evacuated double-walled vessel) is thereby obtained.

Embodiment 5

Figure 13 is provided to explain a fifth embodiment of the production method for a metallic evacuated double-walled vessel according to the present invention. The double-walled vessel C shown in these figures is equipped with almost entirely the same structural elements as those shown in Figures 8 and 9. Structural elements shown in Figure 13 which are identical to those in Figures 8 and 9 have been labeled with the same symbols. In the double-walled vessel C shown in Figure 13, a pocket shaped concavity 40 is provided to the shoulder portion of the outer vessel body 32, and a small evacuation hole 41 is formed inside concavity 40.

To seal this double-walled vessel C, the opening of double-walled vessel C is directed upward, and a rod shaped sealing material 42 consisting of low temperature melting glass and is attached inside concavity 40. Double-walled vessel C is then placed inside a vacuum heating furnace, and, as in the previous example, vacuum heating is carried out while heating to a temperature which is within the range of 200°C to 600°C and is below the temperature at which sealing material 42 softens. After evacuating to a pressure of 1×10^{-2} torr or less, the temperature inside the furnace is raised to a temperature which is in the range of from 200°C to 600°C and which is above the softening point of sealing material 42. Sealing material 42 is softened and drops down under its own weight directly onto evacuation hole 41 and the vicinity therearound, sealing evacuation hole 41. After vacuum sealing, the vessel is removed from the furnace, and a stainless steel thermos (evacuated double-walled vessel) is thereby obtained.

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What is claimed is:

1. A method for making a metallic evacuated double-walled vessel wherein said vessel consists of metallic inner and outer vessels and the space between said inner vessel and said outer vessel forms an evacuated thermal insulating layer, the method comprising the steps of:

(a) forming a prior-to-sealing double-walled vessel by joining said metallic inner vessel and said metallic outer unitarily together at the respective mouth portions thereof, forming a concavity in one of either said inner vessel and said outer vessel, and punching inside said concavity an evacuation hole through which to carry out vacuum evacuation;

(b) disposing prior to vacuum heating a solid shaped sealing material at a position directly above said evacuation hole of said prior-to-sealing double-walled vessel with an interval of space therebetween;

(c) placing said prior-to-sealing double-walled vessel inside a vacuum heating furnace, and vacuum evacuating via said evacuation hole said cavity between said inner vessel and said outer vessel to a specified degree of evacuation; and

(d) carrying out vacuum sealing by heating and melting said sealing material, causing said melted sealing material to drop down onto and fill said evacuation hole and the vicinity thereabout, and hardening said sealing material.

2. A method for making a metallic evacuated double-walled vessel according to claim 1, wherein, a concavity and an evacuation hole are formed in the bottom portion of the outer vessel of a double-walled vessel, a sealing hot charge comprising one of either a solid brazing material and a low temperature melting glass is disposed within said concavity at a position so as to be directly above said evacuation hole when said double-walled vessel is inverted with an interval of spacing being maintained between said sealing hot charge and said evacuation hole, said double-walled vessel is inverted so that the mouth portion thereof is directed





downward and is placed in a vacuum heating furnace, and vacuum evacuation and vacuum sealing are carried out.

3. A method for making a metallic evacuated double-walled vessel according to claim 1, wherein a concavity and an evacuation hole are formed in the shoulder portion of the outer vessel of a double-walled vessel, a sealing hot charge comprising one of either a solid brazing material and a low temperature melting glass is disposed within said concavity at a position so as to be directly above said evacuation hole with an interval of spacing being maintained between said sealing hot charge and said evacuation hole, said double-walled vessel is placed upright so that the mouth portion thereof is directed upward in a vacuum heating furnace, and vacuum evacuation and vacuum sealing are carried out.

4. A metallic evacuated double-walled vessel produced by a method for making a metallic evacuated double-walled vessel according to one of claims one through 3.

5. A method for making a metallic evacuated double-walled vessel wherein said vessel consists of metallic inner and outer vessels and the space between said inner vessel and said outer vessel forms an evacuated thermal insulating layer, the method comprising the steps of:

(a) forming a double-walled vessel by joining together said inner vessel and said outer vessel, one of either said inner vessel and said outer vessel having an evacuation hole;

(b) disposing a sealing material consisting of a low temperature melting glass having a softening temperature in the range of 200°C to 600°C to the vicinity of said evacuation hole;

(c) placing said double-walled vessel inside a vacuum heating furnace, and vacuum evacuating the cavity between said inner vessel and said outer vessel at a temperature lower than the softening temperature of said sealing material;

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(d) heating said double-walled vessel to a temperature above the softening temperature of said sealing material, causing said sealing material to melt and flow into said evacuation hole, to seal said evacuation hole.

6. A method for making a metallic evacuated double-walled vessel according to claim 5, wherein, a concavity and an evacuation hole are formed in the bottom portion of said outer vessel of said double-walled vessel, a sealing material comprising low temperature melting glass is disposed within said concavity at a position so as to be directly above said evacuation hole when said double-walled vessel is inverted with an interval of spacing being maintained between said sealing material and said evacuation hole, said double-walled vessel is inverted so that the mouth portion thereof is directed downward and is placed in a vacuum heating furnace, and vacuum evacuation and vacuum sealing are carried out.

7. A method for making a metallic evacuated double-walled vessel according to claim 5, wherein a long groove is formed in the bottom portion of said outer vessel of said double-walled vessel and a slit shaped long hole is formed in the bottom of said long groove, said double-walled vessel is inverted so that the mouth portion thereof is directed downward, a rod shaped sealing material comprising low temperature melting glass is inserted inside said long groove, said double-walled vessel is placed inverted inside a vacuum heating furnace, and vacuum evacuation and vacuum heating are carried out.

8. A method for making a metallic evacuated double-walled vessel according to claim 1, wherein a concavity and an evacuation hole are formed in the shoulder portion of said outer vessel of said double-walled vessel, a low temperature melting glass sealing hot charge is disposed within said concavity at a position so as to be directly above said evacuation hole with an interval of spacing being maintained between said low temperature melting glass sealing hot charge and said evacuation hole, said double-walled

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vessel is placed upright so that the mouth portion thereof is directed upward in a vacuum heating furnace, and vacuum evacuation and vacuum sealing are carried out.

9. A metallic evacuated double-walled vessel, said vessel consisting of metallic inner and outer vessels and the space between said inner vessel and said outer vessel forming an evacuated thermal insulating layer, wherein an evacuation hole formed in one of either said inner vessel and said outer vessel is vacuum sealed with a sealing material consisting of low temperature melting glass which softens at a temperature of from 200°C to 600°C.



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