

This invention relates to an operating process for manufacturing a boiling or cooking utensil with a round receiver vessel for the material to be boiled or cooked, which receiver vessel comprises a receiver vessel base, a bottom plate of thermally conducting bottom plate material and an encapsulating cover for the bottom plate, which encapsulating cover is shaped with convex curvature with its encapsulating cover base up to the receiver vessel, and with an encapsulating cover collar on the round receiver vessel in a curved transition region between the receiver vessel base and the receiver vessel sidewall, wherein the receiver vessel and the encapsulating cover consist of stainless steel and the bottom plate is intermetallically bonded to the receiver vessel base and the encapsulating cover, wherein, for the purpose of producing the intermetallic bond in the encapsulating cover, a bottom plate is introduced which leaves an annular flow space free up to the preformed encapsulating cover collar, and the aggregate comprising the receiver vessel base, bottom plate and encapsulating cover is intermetallically bonded in its centred state to the receiver vessel between the punch and the die of a press by single or multiple impulse pressing with the shaping of the convex curvature of the encapsulating cover base and integral formation of the rim of the encapsulating cover collar, and wherein during the impulse pressing the bottom plate is pressed into the flow space by flow deformation and in the course of this procedure is also intermetallically bonded in this region to the encapsulating cover base, to the encapsulating cover collar and to the corresponding region of the receiver vessel. It should be understood that the process can be carried out at ambient temperature or as a hot forming process. The impulse energy is adjusted according to the temperature which the receiver vessel is at, at least in the region of the receiver vessel base, and to the temperatures of the encapsulating cover and of the bottom plate. These temperatures are generally selected so that they are in the region of, but sufficiently below, the melting temperature of the bottom plate material. One very common bottom plate material is aluminium in the form of technically pure aluminium. Copper is also a commonly used bottom plate material. The boiling or cooking utensils may be pots, pans or utensils of this type, particularly boiling and steaming vessels. The bottom plate serves to improve the heat transfer from a ceramic hob or a hot plate to the material to be boiled or cooked. This heat transfer is adversely affected if the intermetallic bond is impaired. This also applies if an impairment occurs in the region of the encapsulating cover collar. It should be understood that the tooling, i.e. the punch and die, with which impulse pressing is effected in a press is designed so that the aforementioned slightly convex deformation of the encapsulating cover base is also produced. The receiver vessel base mostly has a slight outward convex curvature. It should further be understood that the geometric relationships with respect to the receiver vessel base, the encapsulating cover and the bottom plate are adjusted so that in the finished boiling or cooking utensil the bottom plate completely fills the intermediate space between the receiver vessel base and the encapsulating cover, i.e. it enters and fills the flow space during the production of the intermetallic bond. A defined, unimpaired flow process of the material of the bottom plate is important for the intermetallic bond. The bottom plate may be constructed as a flat plate, or also with a lenticular cross-section or a stepped cross-section, as it were. It falls within the scope of the invention to arrange the surface of the encapsulating cover and of the receiver vessel base which faces the bottom plate so that the intermetallic bond is promoted. Etching, roughening or the like may be employed for this purpose. Moreover it is of particular importance that the rim of the encapsulating cover collar adjoins the receiver vessel without defects. If bottom plate material emerges here, the receiver vessel has to be

discarded for reasons of appearance and of susceptibility to corrosion. If a gap occurs, water can enter in use or during washing and can initiate undesirable corrosion processes.

In the known process from which the present invention stems (EP 0 209 745) the procedure is as follows: The bottom plate is fastened in the centre of the encapsulating cover base by spot welding. The aggregate comprising the encapsulating cover, the bottom plate and the receiver vessel base or receiver vessel is heated to a temperature which is close to the melting point of the bottom plate material but which remains below this melting point. The initial thickness of the bottom plate is at least 20% greater than the final thickness of the bottom plate after producing the intermetallic bond. In a first impulse pressing phase pressure is progressively applied from the centre of the aggregate to the edge of the aggregate, whereupon a particular degree of convexity is produced, in such a way that the overall curvature of the convexity of the deformed bottom plate and of the receiver vessel is greater than or equal to 0.25% of the average diameter of the receiver vessel base in its final form. In this manner the air is pressed out from the aggregate comprising the receiver vessel base, bottom plate and encapsulating cover, from the centre outwards. However, due to the applicable conditions, namely firstly that the initial thickness of the bottom plate has to be at least 20% greater than the final thickness of the bottom plate after producing the intermetallic bond, and secondly that the convexity has to be adjusted as described above, this known procedure leads to constraints which restrict the applicability of the process measures described. Moreover it cannot be ensured under all operating conditions that the spot welded joint between the bottom plate and the encapsulating cover remains fixed during impulse pressing. If it is torn off during impulse pressing, displacements during impulse pressing cannot be ruled out, and thereafter it cannot be ensured that the bottom plate is subjected to intermetallic bonding in its rim region and at the encapsulating cover collar which satisfies all the requirements.

The underlying object of the present invention is to provide a process for manufacturing a boiling or cooking utensil of the construction described at the outset which ensures that the bottom plate is subjected to intermetallic bonding in its rim region and at the encapsulating cover collar which satisfies all the requirements and that defects do not occur at the rim of the encapsulating cover collar.

In order to achieve this object, the invention teaches that a bottom plate with a bottom plate base body which is circular in horizontal projection is employed, which has at least three centring edge projections along its circular periphery, that the bottom plate is centred in the encapsulating cover so that it remains fixed during impulse pressing by contact of the centring projections with the encapsulating cover collar and/or with a transition region between the encapsulating cover base and the encapsulating cover collar, and that the impulse pressing is conducted so that simultaneously with the formation of the intermetallic bond a flow bond is achieved with material interlocking of the bottom plate material of the bottom plate base body and of the centring projections, and during further flow deformation the bottom plate material is pressed as a homogeneous ring into the rim region of the encapsulating cover collar. In addition, a central spot weld may also be provided which merely needs to have a fixative character. This may be effected for reasons of manipulation, in association with the loading of a press set up for carrying out the process. According to a preferred embodiment of the invention a bottom plate is employed which has uniformly distributed centring projections around its periphery.

The invention is based on the recognition that by centring the bottom plate, which is prefabricated to close tolerances, via the centring projections on the bottom plate which were described above, defects during impulse pressing which impair heat transfer can be avoided in the intermetallic bond at the encapsulating cover collar, which is preformed with high precision, and the occurrence of gaps between the rim of the encapsulating cover collar and the receiver vessel can also be prevented. Doubts must have arisen in the art and in their own right in relation to proceeding in the manner described, because the flow deformation, which proceeds uniformly from the centre of the bottom plate and which is necessary for a satisfactory intermetallic bond, could be impaired in the region of the centring projections. Surprisingly, this is not the case, because impulse pressing can be carried out as regards its energy, i.e. as regards its impact pulses, so that simultaneously with the formation of the intermetallic bond a flow bond is achieved with material interlocking of the bottom plate material of the bottom plate base body and of the centring projections, and during further flow deformation the bottom plate material can be pressed as a homogeneous ring, which has practically no inhomogeneities over its periphery, into the rim region of the encapsulating cover collar. The fact that a material interlocking flow joint can be achieved, between the bottom plate material of the bottom plate base body and the centring projections, was unexpected. However this can be achieved even though the centring projections can be identified as a structure, as it were, in a micrograph of a polished section; this does not impair the formation of the intermetallic bond. The centring and the support of the bottom plate which this provides on the encapsulating cover collar during impulse pressing with flow deformation are so accurate that neither a disruptive gap appears nor does bottom plate material emerge at the edge of the encapsulating cover collar which is against the receiver vessel. It should be understood that the receiver pot and the encapsulating cover with the bottom plate are positioned and centred with sufficient accuracy in the tooling of the press in which impulse pressing is carried out. It should also be understood that the volume of the bottom plate and the interior space of the encapsulating cover are matched to each other sufficiently accurately, and that the flow space is adjusted so that adequate flow deformation is ensured, and so that an intermetallic bond which satisfies all the requirements is ensured by way of the flow deformation.

In detail, numerous possibilities exist within the scope of the invention for further developing the process according to the invention. A bottom plate is preferably employed which has centring projections which extend for a few millimetres in the radial direction and also in the peripheral direction and which are formed in the shape of arcs, preferably circular arcs, facing the encapsulating cover collar or facing the transition region between the encapsulating cover collar and the encapsulating cover base. Within the context of this invention the expression "a few millimetres" means dimensions of the order of 5 to 10 millimetres. Due to the arcuate shape of the centring projections a point or a line contact is created at the commencement of contact between the bottom plate and the encapsulating cover. This promotes the flow joint between the bottom plate material of the bottom plate base body and the centring projections, and also promotes the intermetallic bond as far as the region of the encapsulating cover collar.

When carrying out the process according to the invention it is surprisingly not necessary to accept the constraints which were described at the outset in connection with the process from which the present invention stems (EP 0 209 745). Rather, a bottom plate can be employed, the thickness of which before flow deformation in the cold state is greater by a maximum of

16 % than that after flow deformation. This reduces the consumption of material during the manufacture of boiling or cooking utensils and at the same time results in flow behaviour which is particularly favourable for the intermetallic bond, if the procedure is otherwise conducted according to the invention. Within the scope of the invention it can be ensured, by means of a seal, as it were, that bottom plate material cannot escape via the rim of the encapsulating cover collar. In practice this can be achieved in that the rim of the encapsulating cover collar or an edge at the rim of the encapsulating cover collar is pressed against the receiver vessel with the formation of a seal during impulse pressing with the ensuing flow deformation and by this means a permanent deformation is produced at the vessel and/or at the encapsulating cover collar. This measure at the same time improves the intermetallic bond in the region of the rim of the encapsulating cover collar. On the finished boiling or cooking utensil the gap between the encapsulating cover and the receiver vessel is so narrow that even water from washing media cannot enter. Undesirable corrosion phenomena in the encapsulated region have not been observed. Within the context of the invention the expression "pressed against ... with the formation of a seal" means sealed with respect to the "flowing" metal which is undergoing flow deformation, but sufficiently permeable to air. It can be ensured without difficulty that air inclusions, which interrupt the intermetallic bond and which impair heat transfer, do not occur. This can be achieved in that during impulse pressing the air is first pressed out of the region between the receiver vessel base and the encapsulating cover and thereafter the rim of the encapsulating cover collar or an edge at the rim of the encapsulating cover collar is pressed against the receiver vessel with the formation of a seal.

The invention offers numerous possibilities with regard to the selection of materials and design. A very wide range of stainless steels can thus be employed for the receiver vessel and for the encapsulating cover. In terms of design considerations, a preferred embodiment of the invention is characterised in that an encapsulating cover is employed, the sheet metal thickness of which approximately corresponds to the sheet metal thickness of the receiver vessel. The sheet metal thickness of the encapsulating cover should be a maximum of 20 % less than the sheet metal thickness of the receiver vessel. This prevents deformations and/or stresses similar to those of bimetallic strips occurring during use. As mentioned above, bottom plates made of technically pure aluminium can be employed.

Although the process according to the invention can be carried out cold, i.e. at ambient temperature, a preferred embodiment of the invention is characterised in that the impulse pressing with respect to the receiver vessel, the encapsulating cover and the bottom plate is effected at a temperature which is in the region of the melting point of the bottom plate, although somewhat below it, and that a temperature of the impulse pressing tools is employed which is in the range between 100 and 350°C, e.g. with the die in the range from 100 to 150°C and the punch in the range from 200 to 350°C.

The present invention also relates to boiling or cooking utensils of the construction described initially, which have been manufactured by the process according to the invention.

The invention is described in more detail below with reference to the drawings, which merely illustrate examples of embodiments, and where:

- Figure 1 is a partial vertical section through a tool comprising a die and punch, with the receiver vessel, encapsulating cover and bottom plate of the boiling or cooking utensil, during a process step according to the invention;
- Figure 2 illustrates another embodiment of the subject of Figure 1;
- Figure 3 is a section in the direction A-A through the subject of Figure 1;
- Figure 4 is a partial vertical section through a boiling or cooking utensil manufactured by the process according to the invention, in the region of the encapsulating cover;
- Figure 5 illustrates an enlarged portion B from the subject of Figure 4; and
- Figure 6 is a section C-C through the subject of Figure 4.

The Figures firstly show portions of the components of a boiling or cooking utensil comprising a receiver vessel 1, a receiver vessel base 2, a bottom plate 3 made of a material with good flow properties, and the encapsulating cover 4 of the bottom plate 3. As illustrated in Figures 1 to 4, the receiver vessel base 1 and the encapsulating cover 4 of the boiling or cooking utensil are facing upwards. The receiver vessel 1 and the encapsulating cover 4 consist of stainless steel. The bottom plate 3 may consist of an aluminium alloy. It is intermetallically bonded to the receiver vessel base 2 and the encapsulating cover 4 by the process according to the invention. In detail, the process is carried out as described above. Figures 1 and 2 show that in this embodiment a die 5 is employed which has a de-aeration formation 7 in the region of the encapsulating cover collar 6, through which air can be expelled from the aggregate comprising the receiver vessel base 2, the bottom plate 3 and the encapsulating cover 4 during impulse pressing. These Figures also show that due to the shape of the die 5 and/or punch 8 and/or encapsulating cover 4 in the region of the encapsulating cover collar 6, air is first expelled during impulse pressing and thereafter the encapsulating cover collar 6 is placed on the receiver vessel 1 or on the transition region between the receiver vessel 1 and the receiver vessel base 2. In the embodiment illustrated in Figure 1, a die is employed which has de-aeration formations 7 arranged as bores in the transition region between the encapsulating cover 4 and the encapsulating cover collar 6. In contrast, a die 5 is employed in the embodiment illustrated in Figure 5 which leaves an annular gap 7 for de-aeration in the region between the un-deformed encapsulating cover collar 6 and the die excursion. At the rim of the encapsulating cover collar this annular gap 7 widens in the shape of a wedge as viewed in cross-section. As a result, the arrangement is effected so that the encapsulating cover collar 6 is pressed on to the receiver vessel 1 during impulse pressing and on the finished boiling or cooking utensil is seated against the receiver vessel 1.

A comparative examination of Figures 1 and 3 firstly shows that the bottom plate 3 is held fixed and is centred free from play on the encapsulating cover 4 by centring projections 9 integrally formed at the edge of the bottom plate 3. In this manner the bottom plate 3 is disposed in the encapsulating cover 4 so that it remains fixed during impulse pressing. The bottom plate 3 thus consists of a bottom plate base body 3a and the centring projections.

A comparative examination of Figures 4 to 6 shows that impulse pressing is conducted so that simultaneously with the formation of the intermetallic bond a flow bond is achieved with material interlocking of the bottom plate material of the bottom plate base body 3a and of the centring projections 9, and moreover that during further flow deformation the bottom plate material is pressed as a homogeneous ring 10, which has a very uniform cross-section over its entire periphery, into the rim region of the encapsulating cover collar 6. The term "flow bonding" means that the bottom plate material no longer has separating gaps or the like, even though in the finished boiling or cooking utensil a certain structure can be identified in a micrograph of a polished section of the region of a preformed centring projection 9. Impulse pressing is effected so that an edge 11 at the rim of the encapsulating cover collar 6 is pressed against the receiver vessel 1 with the formation of a seal during impulse pressing with the ensuing flow deformation and by this means a permanent deformation 12 is produced at the receiver vessel 1 and at the encapsulating cover collar 6. Reference is made in this respect to Figure 5 and the enlarged circular portion of Figure 5 which is also illustrated. The expression "pressed against ... with the formation of a seal" means sealed with respect to the "flowing" bottom plate material which is undergoing flow deformation, but so that air can escape to a sufficient extent, as described previously.



Claims:

1. An operating process for manufacturing a boiling or cooking utensil with a round receiver vessel (1) for the material to be boiled or cooked,

which receiver vessel comprises a receiver vessel base (2), a bottom plate (3) of thermally conducting bottom plate material and an encapsulating cover for the bottom plate, which encapsulating cover is shaped with convex curvature with its encapsulating cover base up to the receiver vessel, and with an encapsulating cover collar on the round receiver vessel in a curved transition region between the receiver vessel base and the receiver vessel sidewall, wherein the receiver vessel and the encapsulating cover consist of stainless steel and the bottom plate is intermetallically bonded to the receiver vessel base and the encapsulating cover,

wherein, for the purpose of producing the intermetallic bond in the encapsulating cover, a bottom plate is introduced which leaves an annular flow space free up to the preformed encapsulating cover collar (6), and the aggregate comprising the receiver vessel base, bottom plate and encapsulating cover is intermetallically bonded in its centred state to the receiver vessel between the punch and the die of a press by single or multiple impulse pressing with the shaping of the convex curvature of the encapsulating cover base and integral formation of the rim of the encapsulating cover collar, and wherein during the impulse pressing the bottom plate is pressed into the flow space by flow deformation and in the course of this procedure is also intermetallically bonded in this region to the encapsulating cover base, to the encapsulating cover collar and to the corresponding region of the receiver vessel, characterised in that a bottom plate with a bottom plate base body which is circular in horizontal projection is employed, which has at least three centring edge projections (9) along its circular periphery,

that the bottom plate is centred in the encapsulating cover so that it remains fixed during impulse pressing by contact of the centring projections with the encapsulating cover collar and/or with a transition region between the encapsulating cover base and the encapsulating cover collar,

and that the impulse pressing is conducted so that simultaneously with the formation of the intermetallic bond a flow bond is achieved with material interlocking of the bottom plate material of the bottom plate base body and of the centring projections, and during further flow deformation the bottom plate material is pressed as a homogeneous ring into the rim region of the encapsulating cover collar.

2. A process according to claim 1, characterised in that a bottom plate is employed which has uniformly distributed centring around its periphery.

3. A process according to either one of claims 1 or 2, characterised in that a bottom plate is employed which has centring projections which extend for a few millimetres in the radial direction and also in the peripheral direction and which are formed in the shape of



arcs, preferably circular arcs, facing the encapsulating cover collar or facing the transition region between the encapsulating cover collar and the encapsulating cover base.

4. A process according to any one of claims 1 to 3, characterised in that a bottom plate is employed, the thickness of which before flow deformation in the cold state is greater by a maximum of 16 % than that after flow deformation.
5. A process according to any one of claims 1 to 4, characterised in that the rim of the encapsulating cover collar or an edge at the rim of the encapsulating cover collar is pressed against the receiver vessel with the formation of a seal during impulse pressing with the ensuing flow deformation and by this means a permanent deformation is produced at the vessel and/or at the encapsulating cover collar.
6. A process according to any one of claims 1 to 5, characterised in that during impulse pressing the air is first pressed out of the region between the receiver vessel base and the encapsulating cover and thereafter the rim of the encapsulating cover collar or an edge at the rim of the encapsulating cover collar is pressed against the receiver vessel with the formation of a seal.
7. A process according to any one of claims 1 to 6, characterised in that an encapsulating cover is employed, the sheet metal thickness of which approximately corresponds to the sheet metal thickness of the receiver vessel.
8. A process according to any one of claims 1 to 7, characterised in that an encapsulating cover is employed, the sheet metal thickness of which is a maximum of 20 % less than the sheet metal thickness of the receiver vessel.
9. A process according to any one of claims 1 to 8, characterised in that bottom plates of commercially pure aluminium are employed.
10. A process according to any one of claims 1 to 9, characterised in that the impulse pressing with respect to the receiver vessel, the encapsulating cover and the bottom plate is effected at a temperature which is in the region of the melting point of the bottom plate, and that a temperature of the impulse pressing tools is employed which is in the range between 100 and 350°C.