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VACUUM BRAZING-GAS QUENCHING NON-FERROUS AND FERROUS ALLOYS

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3 Sheets-Sheet 1

Fig. 2

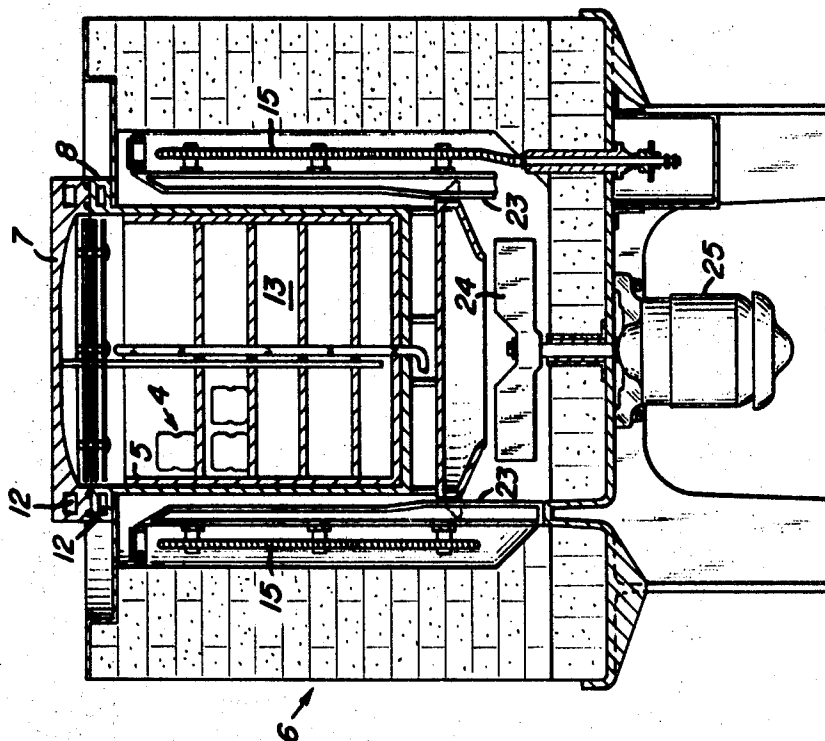
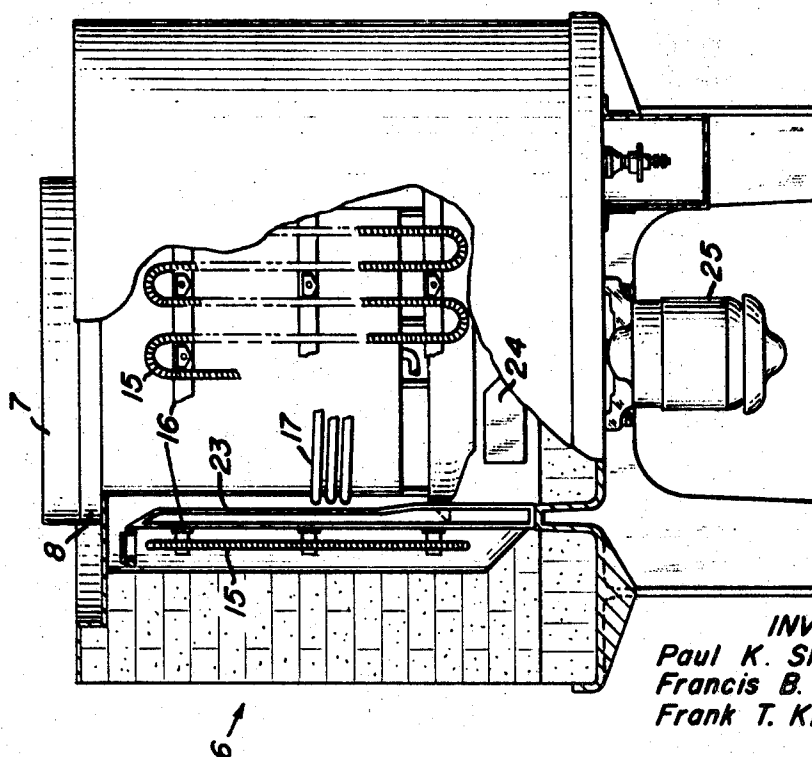


Fig. 1



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Fig. 3

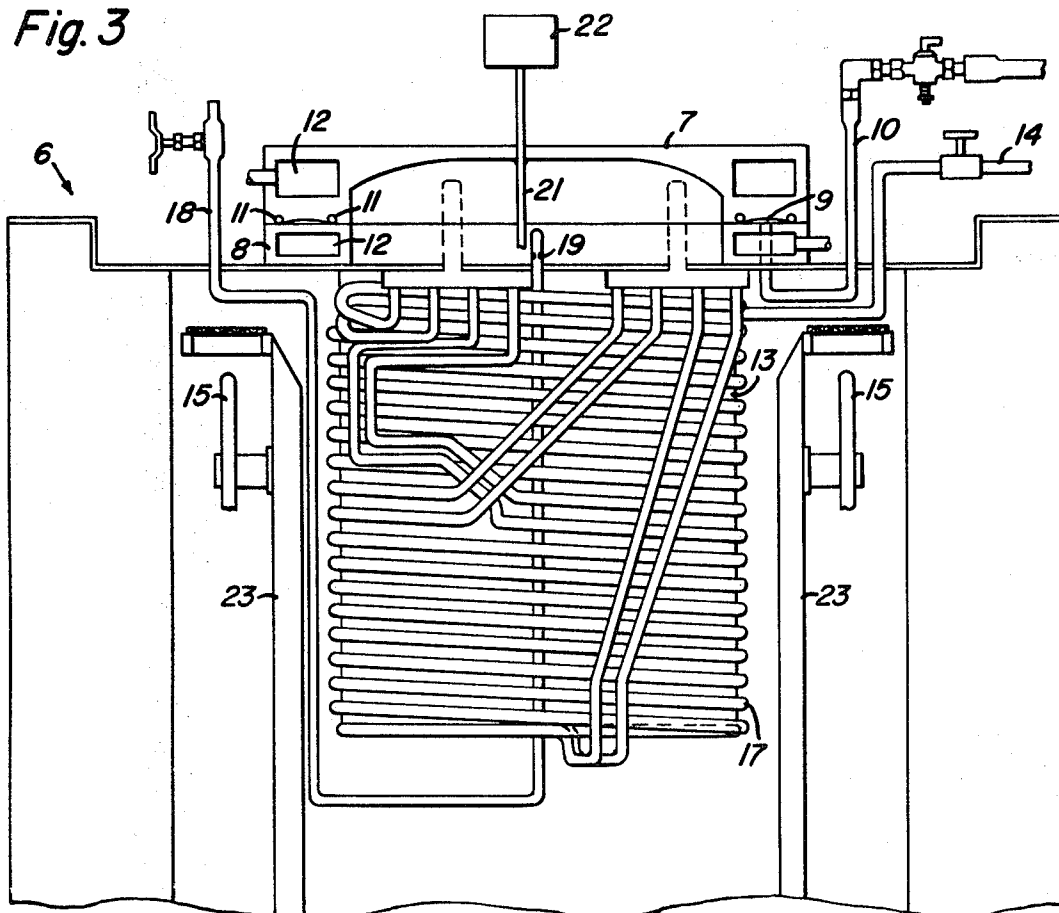


Fig.5

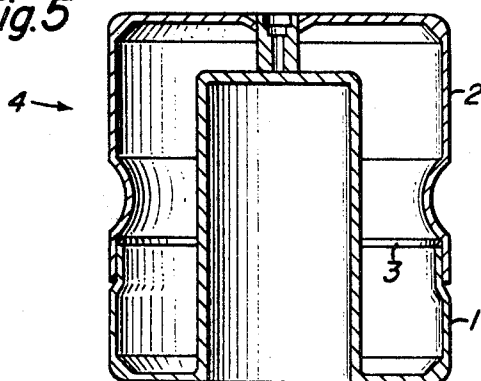
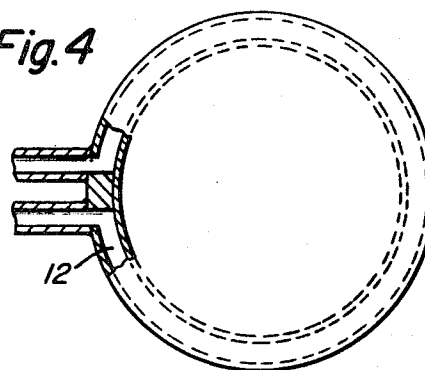


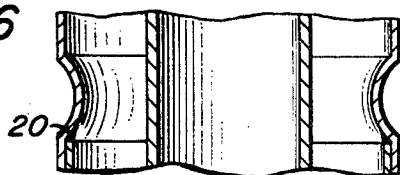
Fig. 4



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Fig.6



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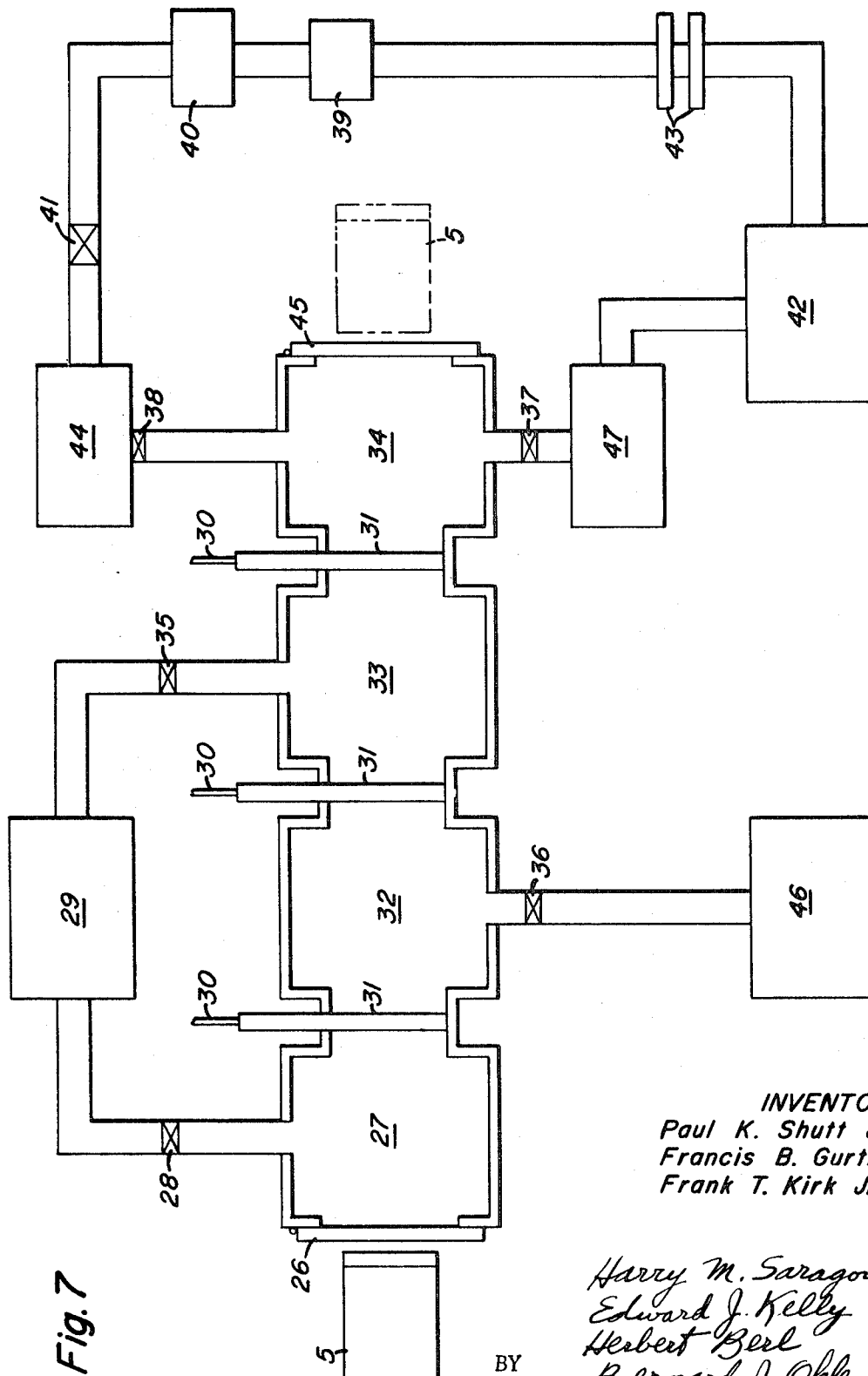
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1

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VACUUM BRAZING-GAS QUENCHING NON-FERROUS AND FERROUS ALLOYS

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2 Claims

ABSTRACT OF THE DISCLOSURE

The disclosure relates to the apparatus and method for joining metal parts together through the utilization of a vacuum brazing-gas quenching technique.

DEDICATORY CLAUSE

The invention described herein may be manufactured, used, and licensed by or for the Government for governmental purposes without the payment to us of any royalty thereon.

SPECIFICATION

Our invention relates to a method and apparatus for joining metal components through the utilization of a vacuum brazing-gas quenching technique and apparatus.

As more and more new metals are being developed, such as the superalloy and refractory-type metals, as stated in the Welding Journal, May 1967, page 423, article titled Vacuum (or Fluxless) Brazing-Gas Quenching of 6061 Aluminum Alloy by M. M. Schwartz, F. B. Gurtner, and P. K. Shutt, Jr.; the potentials and capabilities of prior art joining techniques, such as welding, etc., are being challenged by present-day technology.

A problem has long existed in providing munitions containing toxic agents with a leak-tight assembly means due to oxide formation and contamination and corrosive damage, and our invention was conceived and reduced to practice to solve the assembly problem.

A principal object of our invention is to provide a method and apparatus for joining metal components which eliminates oxide, hydrate, or hydroxide formation and contamination during the joining process.

Another object of our invention is to provide a method and apparatus for joining metal components which eliminate the need for using a flux and the corrosive damage caused by flux.

Other objects of our invention will be obvious or will appear from the specification hereinafter set forth.

FIG. 1 is a view of our apparatus showing the annular heating and cooling systems.

FIG. 2 is a view of our apparatus showing a container therein holding munitions to have the metal components thereof joined by our method.

FIG. 3 is a detailed view of our apparatus showing the cover suction closure system and cooling system and details of the apparatus cooling system, heating system, and quenching system.

FIG. 4 is a view of the cover cooling system.

FIG. 5 is a view of a munition embodiment having one metal component thereof nested within another metal component thereof to form an annular recess and a ring of fluxless brazing composition within the recess.

FIG. 6 is a view of the components in FIG. 5 joined together after application of our vacuum brazing-gas quenching process.

FIG. 7 is a schematic diagram of a production system using our vacuum brazing-gas quenching process and apparatus.

2

Our invention and FIGS. 1 to 7 will now be described in detail as follows.

After any necessary chemical cleaning of the components to be vacuum brazed together in the conventional manner, such as by vapor degreasing, alkaline cleaning, or acid cleaning, the components are arranged together with the braze alloy, which can be any composition required for the particular application, in place at the location where the components are to be joined together, such as shown in FIG. 5. Component 1, in FIG. 5, is nested within component 2 and an annular braze alloy 3 is placed around the edge of component 1 which is nested within component 2 prior to the nesting within component 2 to form metal assembly 4. Metal component assembly 4 is then placed in our vacuum furnace-gas quenching apparatus shown at 6 in FIGS. 1 to 3. Disc cover 7 is then placed on annular flange 8 of our apparatus 6, and recess 9, as shown in FIG. 3, is evacuated by means of vacuum line 10 connected to a vacuum pump, not shown in the drawing, in the conventional manner until a leak-tight seal is produced between cover 7 and flange 8. O rings 11 enable producing the vacuum to cause sufficient vacuum to accomplish the necessary leak-proof seal. A cooling circulation system 12 is provided in cover 7 and flange 8, as shown in FIGS. 2 and 3 and in detail in FIG. 4, for circulation of cooling fluid, which may be any conventional medium such as water, suitable for the particular application and temperature utilized, through flange 8 and cover 7 to avoid deterioration of O rings 11 and stresses in cover 7 and flange 8. Loading space 13, which contains the perforated container which contains assemblies 4, as shown in FIGS. 2 and 3, is evacuated by means of vacuum line 14, as shown in FIG. 3, connected to a vacuum pump, not shown in the drawing, in the conventional manner to the range of 1×10^{-4} to 1×10^{-7} torr. Energy is then supplied from an electrical source, not shown in the drawing, in the conventional manner to annular heating coils 15 fixedly mounted to support means 23 by heater mounts 23 to heat loading space 13 to a suitable temperature for the particular application in the range of 900° F. to 3000° F., depending on the particular braze alloy composition utilized and the particular metal to be joined, to enable converting the braze alloy from the solid to the molten state. Load space 13 is held at the particular predetermined temperature within the 900° F. to 3000° F. temperature range for 5 minutes to 15 minutes, depending on the amount of load being worked upon, electrical energy being supplied to coils 15 is cut off, and cooling fluid, such as water or air, is passed through coils 17 until the temperature of space 13 drops to 700° to 1550° F., depending on the brazing temperature utilized in the 900° F. to 3000° F. brazing temperature range. When the particular temperature for the particular application and material worked upon in the 700° F. to 1550° F. range has been reached, quenching gas, such as CO₂ or any inert gas, is circulated through conduit 18, as shown in FIG. 3, from a gas supply source, not shown in the drawing, and distributed into space 13 by means of fifteen 1/16" diameter orifices 19, as shown in FIG. 3, evenly distributed along the conduit 18 with space 13. The quenching gas circulation continues for one minute to fuse component 1 to component 2 and form joint 20, as shown in FIG. 6. At the end of the quenching cycle, the cooling fluid circulation is stopped, the quenching gas circulation cut off, the vacuum pumps shut down, space 13 and recess 9 exhausted to the atmosphere, cover 7 removed from apparatus 6, and container 5 with brazed assemblies 4 therein removed from space 13. The above described temperatures are monitored by any conventional means, such as thermocouple 21, as shown in FIG. 3, having the joint of the two thermocouple metals located at the center of space 13 and the opposite ends connected to recorder 22.

Uniform heating and cooling throughout load space 13 is provided by circulation fan 24, as shown in FIGS. 1 and 2, activated by motor 25. While FIG. 3 shows the vacuum line 14 entering space 13 at the top only, a branch line from line 14, not shown in the drawing, could also enter the bottom of space 13 to ensure removal of any trapped air at the top and bottom of space 13. The above description is applicable to a single chamber operation, but our apparatus can also be employed in a multiple chamber production set up, as schematically shown in FIG. 7. In the production set up shown in FIG. 7, door 26 is manually opened and perforated container 5 containing assemblies to be brazed is placed within preheater 27 to be controlled at a temperature below the brazing temperature and in the range of 700° F. to 2300° F. Electrical vacuum valve 28 is opened and preheater 27 is evacuated to the range of 1×10^{-1} to 1×10^{-3} torr by vacuum pump 29 which always operates during production. Heat is then supplied to preheater 27 by electrical heating coils as described above in regard to the single chamber operation to raise the temperature of preheater 27 to a temperature below the brazing temperature and in the range of 700° F. to 2300° F. which depends on the amount of material to be brazed in container 5, the particular metal being brazed, and the particular braze alloy's composition. After a predetermined time, dependent on the factors of work load, metal to be brazed, and braze alloy composition described above, a conventional intervalometer simultaneously causes valve 28 to close and exhaust chamber 27 to the atmosphere; close electrical vacuum valve 35 and exhaust metal solution treating and soaking chamber 33 to the atmosphere; close electrical vacuum valve 36 and exhaust brazing chamber 32 to the atmosphere, or alternatively to the range 1×10^{-1} to 1×10^{-3} torr with doors 26 and 45 closed by mechanical means; electrical valves 37 and 38 and exhaust quenching chamber 34 to the atmosphere; activates an electro-pneumatic valve, not shown in the drawing, connected to activating shafts 30 to raise conventional vacuum seal slide gates 31; activates endless flexible metal belts within each chamber 27, 32, 33, and 34 to carry container 5 to the next processing chamber; opens electrical valve 41; and activates pump 39 and compressor 40 to draw the hot quenching gas from hot gas reservoir 42 through filter 43 to be stored as cool gas in reservoir 44. It takes approximately 10 seconds to transfer container 5 from the center of one chamber to the center of the next chamber, and the container 5 is manually removed from the endless belt as it pushes door 45 open. At the end of the 10 second transfer cycle time, the intervalometer causes the above sequences to be reversed so that vacuum pump 29 produces a vacuum in the range of 1×10^{-1} to 1×10^{-3} torr in chambers 27 and 33; vacuum pump 46 produces a vacuum in the range of 1×10^{-4} to 1×10^{-7} torr in chamber 32; vacuum pump 47 produces a vacuum in the range of 1×10^{-1} to 1×10^{-3} torr in chamber 34; electrical valve 38 is opened to cause quenching gas, such as CO₂ or inert gas as described above regarding the single chamber operation, to flow through chamber 35 to hot gas reservoir 42; and to cause heat to be supplied as described in the single chamber operation above so that chamber 27 is controlled to a predetermined temperature in the range of 700° F. to 2300° F., chamber 32 to a particular temperature in the range 900° F. to 3000° F., and chamber 33 to a particular temperature in the range of 700° F. to 2300° F.; the particular temperature for each chamber being selected as described above. The temperature of each chamber is monitored by any conventional means such as a thermocouple located within the chamber and connected to a recording device outside of the chamber as described above regarding the single chamber operation.

We wish it to be understood that we do not desire to be limited to the exact details of construction shown and described for obvious modifications will occur to a person skilled in the art.

We claim:

1. A method of joining metal parts comprising the steps of placing the metal parts to be joined and a brazing composition located adjacent to an area of jointure of the parts in a perforated container in a chamber means having an open end and a closed end; superimposing a cover means on a flange means integral with the open end of the chamber means; evacuating an annular recess in the cover means to hermetically seal the chamber means; evacuating the chamber means to a range of 1×10^{-4} to 1×10^{-7} torr; increasing the temperature within the chamber means to a predetermined temperature within a range of 900° F. to 3000° F. to render the brazing composition molten; reducing the temperature within the chamber means to a predetermined temperature within a range of 700° F. to 2300° F. for a predetermined period of time to permit temperature soaking-solution treating of the metal parts and brazing composition; introducing quenching gas selected from the group consisting of CO₂ and inert gas into the chamber means to reduce the temperature within the chamber means to a temperature within a range of room temperature and less than room temperature; increasing the pressure within the chamber means and the annular recess to atmospheric pressure; removing the cover means from the chamber means; and removing the metal parts from the chamber means, said metal parts having been joined by the vacuum brazing-gas quenching.

2. A method of joining metal parts through a plurality of process steps comprising the steps of placing a perforated container within a preheat chamber means, the container containing the metal parts to be joined and a fluxless brazing composition located adjacent to an area for jointure of the metal parts; closing a chamber door at one end of the preheat chamber means and a first vacuum seal slide gate means at the opposite end of the preheat chamber means; evacuating the preheat chamber means to a range of 1×10^{-1} to 1×10^{-3} torr; heating the preheat chamber means to a predetermined temperature within a temperature range of 700° F. to 2300° F.; maintaining the temperature and vacuum within the preheat chamber means for a predetermined period of time; monitoring the temperature and vacuum within the preheat chamber means during the predetermined period of time; exhausting the vacuum within the preheat chamber means; opening the first vacuum seal slide gate means; transporting the perforated container by means of a first endless belt means from the preheat chamber means to a brazing chamber means; closing the first vacuum seal slide gate means and a second vacuum seal slide gate means at an end of the brazing chamber means opposite to said first vacuum seal slide gate means; evacuating the brazing chamber means to a range of 1×10^{-4} to 1×10^{-7} torr; heating the brazing chamber means to a predetermined temperature within a range of 900° F. to 3000° F.; maintaining the temperature and vacuum within the brazing chamber means for a predetermined period of time; monitoring the temperature and vacuum within the brazing chamber means during the predetermined period of time; exhausting the vacuum within the brazing chamber means; opening the second vacuum seal slide gate means; transporting the perforated container by means of a second endless belt means from the brazing chamber means to a temperature soaking-solution treating chamber means; closing the second vacuum seal slide gate means and a third vacuum seal slide gate means at an end of the temperature soaking-solution treating chamber means opposite to said second vacuum seal slide gate means; evacuating the temperature soaking-solution treating chamber means to a range of 1×10^{-1} to 1×10^{-3} torr; heating the temperature soaking-solution treating chamber means to a predetermined temperature within a range of 700° F. to 2300° F.; maintaining the temperature and vacuum within the temperature soaking-solution treating chamber means for a predetermined period of time; monitoring the temperature and vacuum

5

within the temperature soaking-solution treating chamber means during the predetermined period of time; exhausting the vacuum within the temperature soaking-solution treating chamber means; opening the third vacuum seal slide gate means; transporting the perforated container by means of a third endless belt means from the temperature soaking-solution treating chamber to a quenching chamber means; closing the third vacuum seal slide gate means and a door means at an end of the quenching chamber means opposite to the third vacuum seal slide gate means; evacuating the quenching chamber means to a range of 1×10^{-1} to 1×10^{-3} torr; circulating quenching gas selected from the group consisting of CO_2 and inert gas from a quenching gas reservoir, through the quenching chamber, to a hot gas reservoir; maintaining the quenching gas circulation and vacuum within the quenching chamber until a temperature is reached within a range of room temperature and below room temperature; monitoring the temperature and vacuum within the quenching chamber means; stopping gas circulation to the hot gas reservoir; pumping gas from the hot gas reservoir through a gas filter to a compressor means; compressing the gas from the hot gas reservoir to reduce the temperature of said gas to a temperature adapted to recycle the gas as quenching gas; transporting compressed gas from the compressor means to the gas quenching reservoir; exhausting the vacuum within the quenching chamber means; opening the door means of the quenching chamber means; removing the perforated container from the quenching

6

chamber; cyclically controlling the plurality of process steps by an intervalometer means; and cyclically repeating the plurality of process steps.

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