ULTRAVIOLET IRRADIATION BONDING APPARATUS

BACKGROUND OF THE INVENTION

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1. Field of the Invention

This invention relates to an ultraviolet irradiation bonding apparatus which makes a light-curing bonding agent harden by ultraviolet irradiation to joint at least two parts.

2. Description of the Related Art

Bonding by ultraviolet irradiation depends upon the atmosphere where the parts to be joined are placed. That is to say, if oxygen is present in the atmosphere at the time of ultraviolet irradiation, the start of the curing reaction of a light-curing resin bonding agent is adversely affected, and the length of time required for the curing reaction becomes longer.

To eliminate such a problem, for instance, as shown in Japanese published unexamined patent application No. 59-136371 (hereinafter referred to as prior art 1), Japanese published examined patent application No. 57-13334 (hereinafter referred to as prior art 2) and Japanese published examined patent application No. 57-49262 (hereinafter referred to as prior art 3), it is known that inert gas is introduced into an ultraviolet irradiation chamber to intercept the parts from the oxygen in the atmosphere so as to accelerate the curing action.

Any of the first embodiment of prior art 1, prior art 2 and prior art 3 makes the entire ultraviolet irradiation chamber in an inert gas atmosphere. As a result, a large amount of inert gas is required. In addition, the efficiency of removing the oxygen adhered to the parts is poor. In this respect, in the second embodiment of prior art 1, the inert gas is directly injected to the joint, and, therefore, the oxygen adhered to the parts is efficiently removed. However, in the second embodiment of prior art 1, the inert gas is simply injected onto the upper sides of the parts being joined and, therefore, a part having a recess facing the conveyor belt has a problem that because the oxygen in the recess is not removed, the

curing reaction is slow, and as the case may be, the ultraviolet bonding agent remains in a non-hardened or half-hardened condition even after a long ultraviolet irradiation. This problem is common to all of prior art 1, 2 and 3.

Furthermore, none of the above-mentioned prior art gives any consideration to the control of oxygen concentration of the ultraviolet irradiation chamber, and since the parts being joined are successively fed into the ultraviolet irradiation chamber, some parts whose bonding agent has not been hardened take place, when the oxygen concentration exceeds the limit.

In addition, all of the prior art continues to supply the inside of the ultraviolet irradiation chamber with a fixed amount of inert gas. Thus, if a large amount of inert gas is supplied so as to reduce the waiting time at the time of start, the large amount of inert gas must be unnecessarily supplied even during the normal operation. This is uneconomical. On the other hand, however, if the supply amount of inert gas is reduced, there causes another problem that the waiting time at the time of start becomes longer.

Also, no consideration is given to the unnecessary heat caused by the ultraviolet lamp or to the cooling of the parts. In addition, in prior art 2, since only the parts and the reflector are directly cooled by the cooling pipe, prior art 2 has the problem that the accumulation of excess heat radiated from the ultraviolet lamp may have a detrimental effect on the illumination of the ultraviolet lamp. Also a liquid is used for cooling, which makes the structure complicated and requires a complete seal mechanism so as to prevent liquid leakage. On the other hand, in prior art 3, since the cooling is only made by an exhaust blower, the cooling efficiency for the ultraviolet lamp and the parts is not sufficient.

The object of the invention is to provide an ultraviolet irradiation bonding apparatus which eliminates the problems of the above-mentioned prior art.

SUMMARY OF THE INVENTION

According to this invention there is provided an ultraviolet irradiation bonding apparatus comprising:

an outer chamber having an ultraviolet lamp therein;

an inner chamber provided within said outer chamber;

an air duct formed below said ultraviolet lamp outside the inner chamber;

said inner chamber being formed with an inlet and an outlet for parts being joined;

an ultraviolet transmission plate provided on said inner chamber for covering an opening formed in the upper surface of said inner chamber;

a conveyor belt arranged to traverse from said inlet through said inner chamber to said outlet;

at least one nozzle for supplying inert gas into said inner chamber;

cooling means for feeding air into said duct formed outside said inner chamber and around said ultraviolet lamp; and

said conveyor belt being formed of mesh and said at least one nozzle being located along the traverse of said belt so that said inert gas is injected from one side of said conveyor belt toward the other side of said belt.

Preferably within said inner chamber, there is provided a purge nozzle for injecting a larger amount and higher pressure of inert gas than that from said at least one nozzle, and an oxygen concentration sensor is provided for detecting the oxygen concentration in said inner chamber, whereby said purge nozzle is controlled by a detection signal from said sensor.

Advantageously said inlet is provided with an input nozzle for injecting inert gas toward said belt so as to block the inflow of oxygen. In a preferred embodiment a plurality of nozzles are provided for injecting different amounts of inert gas.

According to a feature of this invention there is provided an ultraviolet irradiation bonding apparatus comprising:

an outer chamber having an ultraviolet lamp therein;

an inner chamber provided within said outer chamber;

an air duct formed below said ultraviolet lamp outside the inner chamber;

said inner chamber being formed with an inlet and outlet for parts being joined;

an ultraviolet transmission plate provided on said inner chamber for covering an opening formed in the upper surface of said inner chamber;

a conveyor belt arranged to traverse from said inlet through said inner chamber to said outlet, said conveyor belt being formed of mesh ;

a first nozzle and a second nozzle having flow rates which are different from one another and which are both located below said conveyor belt for injecting said inert gas from the under side of said belt toward the upper side of said belt;

a purge nozzle located on the under side of said belt for injecting inert gas of a larger amount and higher pressure than that of said first and second nozzles from the under side of said belt toward the upper side of said belt;

an input nozzle located on the inlet of said inner chamber for injecting inert gas toward said belt so as to block the inflow of oxygen; and

cooling means for feeding air into said air duct formed outside said inner chamber and around said ultraviolet lamp.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be described by way of example with reference to the accompanying drawings in which:-

FIG. 1 is a vertical sectional view illustrating one embodiment of an ultraviolet bonding apparatus according to the invention; FIG. 2 is a sectional view taken along the line A-A of FIG. 1; FIG. 3 is a sectional view taken along the line B-B of FIG. 1; and FIG. 4 is a vertical sectional view illustrating one embodiment of the parts to be joined.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Now, one of the embodiments of the invention will be described with reference to FIGS. 1 to 3. In a nearly middle portion of the outer chamber 10, a horizontally extending inner chamber 11 is provided. At both sides of the inner chamber 11, air ducts 12 are formed. The inner chamber 11 is provided with an inlet 11a and an outlet 11b. The opening for the outlet 11b is made narrow so that the conveyor belt 13 and the parts mounted on the conveyor belt 13 are allowed to only just pass the opening. On the other hand, the opening for the inlet 11a formed of a size for inserting an illuminometer into the inner chamber 11 for measuring the illumination of an ultraviolet lamp 31 which will be discussed later. The inlet portion of the inlet 11a is provided with a shutter 14 for opening and closing the inlet, and when the shutter 14 is in its lowered position, a clearance is formed for passing the conveyor belt 13 and the parts mounted on the conveyor belt 13. Secured onto the lower surface of the inner chamber 11 is a partition 15 which is open at opposing ends. The conveyor belt 13 is formed of mesh and passed over a drive drum 16 and a follower drum 17 so that the forward run of the belt 13 can be positioned in the inner chamber 11 and that the return run can be positioned between the inner chamber 11 and the partition 15.

On the outside walls of the inner chamber 11 are cooling fins 20, and on the side of the outlet 11b within the inner chamber 11 is an oxygen concentration sensor 21. Furthermore, the inlet 11a of the

inner chamber 11 is provided with an inlet nozzle 22 at the inner portion of the belt 13, and the injection of inert gas blocks the inflow of oxygen. At the lower side of the conveyor belt 13 within the inner chamber 11, a first nozzle 23, a second nozzle 24 and a purge nozzle 25 are arranged so as to inject inert gas such as nitrogen gas upward, and the first nozzle 23 and the second nozzle 24 are provided near the inlet 11a. The inlet nozzle 22 is about 2 kg/cm^2 in pressure and about 2 lit/min in flow rate, the first nozzle 23 is about 1 kg/cm^2 in pressure and about 3 lit/min in flow rate, the second nozzle 24 is about 1 kg/cm^2 in pressure and about 4 lit/min in flow rate, and the purge nozzle 25 is about 3 kg/cm^2 in pressure and about 10 lit/min in flow rate, thus injecting inert gas, respectively.

In this regard, the inert gas pressures and the flow rates in the embodiment are conditioned to keep the oxygen concentration less than 0.1% (a specified value) and simultaneously to economically use inert gas. Also it will be understood that the setting of pressure and flow rate of inert gas and the setting of concentration of the oxygen concentration sensor can be arbitrarily selected.

The inner chamber 11 has an opening 11c in the upper surface, and an ultraviolet transmission plate 30 such as silica glass and Pyrex glass is detachably mounted on the upper surface of the inner chamber 11 so as to cover the opening 11c. Above the ultraviolet transmission plate 30 within the outer chamber 10, the ultraviolet lamp 31 and a reflector plate 32 are located. These ultraviolet lamp 31 and reflector plate 32 are secured to an exhaust duct 33 which extends outside so as to cover the ultraviolet lamp 31 and the reflector plate 32. An exhaust section 33a of the exhaust duct 33 is provided with an exhaust fan (not shown). At the lower portion of the outer chamber 10 near the inner chamber 11 are air inlets 10a and 10b in which suction fans 34 and 35 are arranged, respectively.

Near the follower drum 17 of the ultraviolet irradiation bonding apparatus thus constructed, an intake

belt 40 is arranged, and between the intake belt 40 and the follower drum 17, a delivery belt 41 is arranged for delivering the parts smoothly. Near the intake belt 40, application devices 42 for applying a light-curing bonding agent to the parts are arranged. Near the drive drum 16, an ejection belt 43 is arranged and between the ejection belt 43 and the drive drum 16, a chute 44 is arranged for delivering the parts smoothly.

Now, the operation will be described. As shown in FIG. 4 as one example, the description will be given of a watch case 1 in which a case body 2 and a glass plate 3 are being joined by a light-curing bonding agent 4. As the ultraviolet irradiation bonding apparatus starts, inert gas is injected from the nozzles 22 to 25, and as soon as the ultraviolet lamp 31 lights, the exhaust fan within the exhaust section 33a and suction fans 34 and 35 start to rotate. When the inert gas is injected from the nozzles 22 to 25, the inside of the inner chamber 11 is filled with an inert gas atmosphere. When the oxygen concentration is less than a fixed value, the oxygen concentration sensor 21 outputs a signal, and by this signal the injection of the inert gas from the purge nozzle 25 stops, and at the same time the intake belt 40 and the delivery belt 41 start.

In addition, when the exhaust fan and suction fans 34 and 35 start to rotate, air from air inlets 10a and 10b is sucked into the outer chamber 10. This air passes through air ducts 12 between the outer chamber 10 and the inner chamber 11 to the exhaust duct 33 and is exhausted outside through the exhaust section 33a. By this air flow, the inner chamber 11 is cooled through cooling fins 20, and the unnecessary heat by the ultraviolet lamp 31 is cooled.

In this embodiment, an oxygen concentration sensor like the one attached to the known Zirconia Oxygen Analyzer Model LC-700M made by Toray Engineering Co., Ltd. has been used.

When the light-curing bonding agent 4 is applied to the case body 2 by the application devices 42 and the watch case 1 in which the glass plate 3 is mounted on the case body 2 is placed on the intake belt 40, then, from the

intake belt 40, the watch case 1 is fed by way of the delivery belt 41 to the conveyor belt 13. From the inlet 11a, the watch case 1 passes through the inner chamber 11 to the outlet 11b. As mentioned above, the inside of the inner chamber 11 is filled with an inert gas atmosphere, and the light-curing bonding agent 4 is illuminated by the ultraviolet light of the ultraviolet lamp 31 and hardened immediately under the condition where oxygen is completely blocked.

Also, the conveyor belt 13 is formed of mesh, and the first and second nozzles 23 and 24 inject inert gas from the lower side of the conveyor belt 13 toward the upper side of the belt 13. Therefore, the oxygen collected in the recess inside the watch case 1 is blown off. Thus an inner end 4b of the light-curing bonding agent 4 is completely blocked off the oxygen, and the inner end 4b is hardened immediately. The watch case 1 in which the glass plate 3 has been joined to the case body 2 through the light-curing bodning agent 4 is ejected from the conveyor belt 13 by way of the chute 44 to the ejection belt 43.

On the other hand, if the oxygen concentration within the inner chamber 11 is more than the fixed value during operation, the oxygen concentration sensor 21 outputs a signal and the purge nozzle 25 is switched on to inject a large amount of inert gas. In addition, if the oxygen concentration abnormally exceeds a fixed limit, a warning alarm sounds and the intake belt 40 stops. When the oxygen concentration within the inner chamber 11 is below the fixed limit, the oxygen concentration sensor 21 outputs a signal again, the injection of inert gas from the purge nozzle 25 stops and the intake belt 40 starts.

In this way, the inner chamber 11 is provided in the outer chamber 10 and within this chamber 11, only the forward run of the intake belt 13 is provided. Therefore, the inner chamber 11 is considerably reduced in size and the only areas connecting to the atmosphere are the inlet 11a and the outlet 11b in the inner chamber 11.

That is to say, the capacity of the chamber for introducing inert gas can be small and inert gas leaking portions can be small, thereby extremely reducing the consumption of inert gas. Furthermore, since air flows through air ducts 12 formed outside the inner chamber 11 and through around the ultraviolet lamp 31, there is no possibility that the parts being joined are excessively heated, and at the same time the unnecessary heat by the ultraviolet lamp 31 is cooled.

Also, the conveyor belt 13 is formed of mesh, and the first and second nozzles 23 and 24 inject inert gas from the lower side of the conveyor belt 13 upward. Therefore, in a part having a recess inside like the watch case 1, the oxygen collected in the recess can be blown off, and the inner end 4b of the light-curing bonding agent 4 can soon be hardened.

As already mentioned, there are provided the low flow rate nozzles 23 and 24; the high flow rate purge nozzle 25; and the oxygen concentration sensor 21 within the inner chamber 11 so that the purge nozzle 25 can be controlled by means of the oxygen concentration sensor 21. As a result, the inside of the inner chamber 11 can be made a specific inert gas atmosphere in a short time and simultaneously, the consumption of the inert gas can be greatly reduced. Also by the use of the oxygen concentration sensor 21, the intake belt 40 is controlled to stop the feed of the parts onto the conveyor belt 13, in the event of a malfunction.

* C L M S *

CLAIMS:

1. An ultraviolet irradiation bonding apparatus comprising:

an outer chamber having an ultraviolet lamp therein;

an inner chamber provided within said outer chamber;

an air duct formed below said ultraviolet lamp outside the inner chamber;

said inner chamber being formed with an inlet and an outlet for parts being joined;

an ultraviolet transmission plate provided on said inner chamber for covering an opening formed in the upper surface of said inner chamber;

a conveyor belt arranged to traverse from said inlet through said inner chamber to said outlet;

at least one nozzle for supplying inert gas into said inner chamber;

cooling means for feeding air into said duct formed outside said inner chamber and around said ultraviolet lamp; and

said conveyor belt being formed of mesh and said at least one nozzle being located along the traverse of said belt so that said inert gas is injected from one side of said conveyor belt toward the other side of said belt.

2. The ultraviolet irradiation bonding apparatus according to claim 1, wherein within said inner chamber, there is provided a purge nozzle for injecting a larger amount and higher pressure of inert gas than that from said at least one nozzle, and an oxygen concentration sensor is provided for detecting the oxygen concentration in said inner chamber, whereby said purge nozzle is controlled by a detection signal from said sensor.

3. The ultraviolet irradiation bonding apparatus according to claim 1 or 2, wherein said inlet is provided with an input nozzle for injecting inert gas toward said belt so as to block the inflow of oxygen.

4. The ultraviolet irradiation bonding apparatus according to claim 1, wherein a plurality of nozzles are provided for injecting different amounts of inert gas.

5. An ultraviolet irradiation bonding apparatus comprising:

an outer chamber having an ultraviolet lamp therein;

an inner chamber provided within said outer chamber;

an air duct formed below said ultraviolet lamp outside the inner chamber;

said inner chamber being formed with an inlet and outlet for parts being joined;

an ultraviolet transmission plate provided on said inner chamber for covering an opening formed in the upper surface of said inner chamber;

a conveyor belt arranged to traverse from said inlet through said inner chamber to said outlet, said conveyor belt being formed of mesh ;

a first nozzle and a second nozzle having flow rates which are different from one another and which are both located below said conveyor belt for injecting said inert gas from the under side of said belt toward the upper side of said belt;

a purge nozzle located on the under side of said belt for injecting inert gas of a larger amount and higher pressure than that of said first and second nozzles from the under side of said belt toward the upper side of said belt;

an input nozzle located on the inlet of said inner chamber for injecting inert gas toward said belt so as to block the inflow of oxygen; and

cooling means for feeding air into said air duct formed outside said inner chamber and around said ultraviolet lamp.

6. An ultraviolet irradiation bonding apparatus substantially as herein described with reference to and as illustrated in Figures 1 to 4 of the accompanying drawings.