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SPECIFIC ACHIEVEMENTS IN THE DIRECTION OF THE AUTOMATED ASSEMBLY THROUGH ADHESION OF HOUSEHOLD MACHINES

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Abstract: For the purpose of manufacture of competitive products, automation and robotics is an important task in the series production and assembly of household cooking machines. Automation and robotics assembly through adhesion solves the problems assembling the oven windows on cooking machines and built in ovens, also issues of assembling glass with metal or plastic parts. The technology of automated and robotics can be successfully applied to assemble the ceramic parts in the case of vitroceramic cookers and induction cookers. Silicone is the glue between glass and stainless steel sheet metal frame, enameled steel frame, painted frame with high-temperature resistance of sheet metal or plastic frame. In Electrolux Satu-Mare (RO) they are manufacturing gas, electric, mixed and induction cooking machines. The work will present specific aspects of the design of the programming of these automated manufacturing lines and actual achievements that have led to increased productivity and product quality.

Keywords: assembly through sticking, oven door, induction grill plate, vitroceramic grill plate (for cooking machines)

1. INTRODUCTION – GENERAL NOTIONS ABOUT COOKERS FROM ELECTROLUX-SATU MARE

The most widespread means of food preparation was a wood stove after which followed the classic stove with natural gas supply.

At that time the wood and natural gas was a source of cheap energy.

Currently modern man can choose the most suitable source of energy to cook by choosing between gas, electricity or induction.



Figure 1. Cookers from Electrolux-Satu Mare

In the last period using cooking machines based on the source of electricity.

The upper part of the machine is called a cooking grill plate and is made of a vitroceramic or induction, out of two major parts:

- ≡ support for heating elements;
- ≡ the actual grill plate.

Even if the source of power of the cooking machine is electric, their plates can be differentiated into three kinds:

- ≡ the oldest type of plates are the hot plates;
- ≡ those with advanced vitro-ceramic-technology type;
- ≡ the most advanced induction hotplate-type.

The grill plate itself is composed of three parts:

- ≡ metal frame, frame VTC;
- ≡ glass that differs depending on the source of the heat of the grill plate;
- ≡ the adhesive and silicone between glass and metal frame.

2. THE FUNCTIONING OF INDUCTION COOKERS

While cooking machines with gas heater element is the burner, cooking machines with induction use an high frequency electromagnet, which generates a magnetic field beneath the surface of the ceramic grill plate. When a metallic material that can be a pot or pan is placed in the magnetic field it induces heat energy in the metal. The metal will become hot as a result of energy transfer. By controlling the level of the magnetic field you can control the heat generated in the cooking vessel and change it instantly. This process is shown in Figure 2.

Materials such as: aluminum, copper, etc. cannot be used on an induction stove. But that doesn't mean that you can use any type of iron or steel pot. The induction grill plates have the best ratio of energy versus heat emitted. The fact that the surface does not burn after the dish was taken off the hob, make it to have a high degree of safety and security for children.

Electric vitroceramic grill plates don't have to warm up as burners and gas hobs. Instead use electricity to warm the dish as it cooks. As an advantage over gas hobs, Electric grill plates buttons can be integrated into its body so starting, stopping and regulating temperature can be done just by pressing with one finger, the desired button. Electric grill plates can be equipped with sensors that automatically releases when the radiant zone is not used.

A disadvantage from the standpoint of the security of children is that the electric grill plates surfaces cools harder than gas burners. To avoid injury it should be avoided touching heated surfaces.

3. EXPERIMENTAL ASSEMBLY TECHNOLOGY BY GLUING OF GRILL PLATES AND OVEN DOORS

There are trends for replacing classical technologies specific to manufacturing household cooking machines. There have been taken into account the specific development challenges by replacing the assembly methods with screws and sealing gaskets by using gluing assembly that replaces the two conventional processes.

Solder materials that are used: epoxies, urethane, silicone, heat-resistant materials, materials that flow under thermal action.

New manufacturing techniques were developed using as a bicomponentsilicone adhesive which instantly hardens after application, or one in which silicone hardens in polymerization ovens after application.

For a first impression about the advantages and disadvantages of this technology, for research with respect to reliability, performance, aspect, it began the manual assembly by gluing some parts in a section created for this purpose:

- » the operator in the silicone workshop puts the metal frame in a solder device after applying the adhesive, using a pneumatic gun. The silicone layer is applied to the surface of the metal frame;
- » once the silicone is applied the operator put the gun into the holder and put glass in metal frame, to ensure the centering of the glass in the frame spacers are inserted;
- » after these operations, the operator will place the grill plate on a palette that is brought into a polymerization room for 72 hours.

Figure 3 represent the phases of manual assembly by sticking to the grill plate made of ceramic glass.

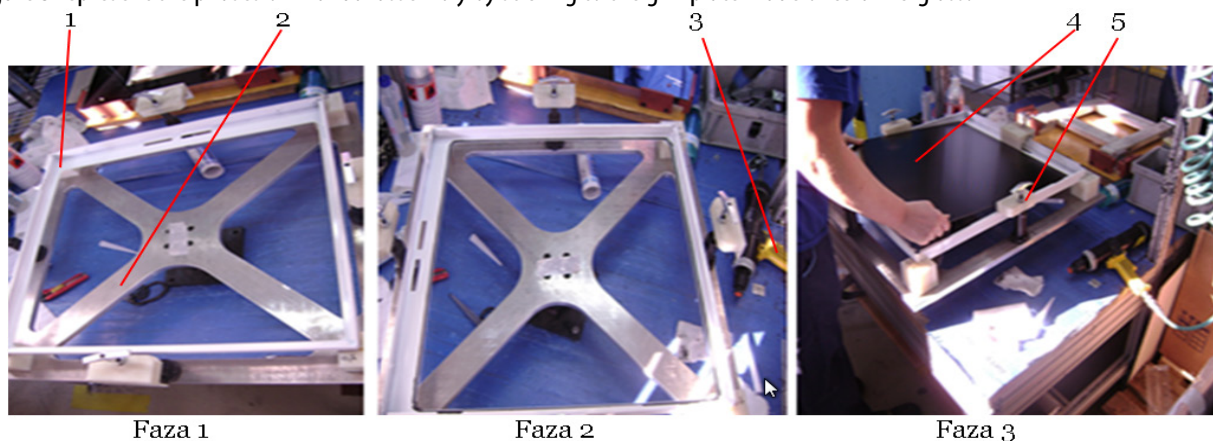


Figure 3. Gluing operation phases for vitroceramic plate. 1-enameled metallic frame; 2- rotating device for fastening the metal frame; 3-pneumatic gun for silicone dispersion; 4-ceramic glass; 5-securing clips.

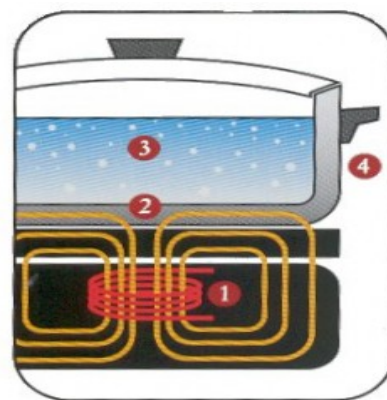


Figure 2. The operating principle of the induction grill plate. 1-electric element is the coil that produces high-frequency magnetic field; 2-the field comes into contact with the cooking vessel and produce electric current, which generates heat; 3-the heat generated in the cooking vessel is transferred to its content; 4-anything outside of this system is not affected. As soon as the vessel is taken off the grill plate or interrupt its electric current, the heat generated is terminated.

After this period of time the grill plate is cleaned of excess silicone remaining after pasting, then the hob is mounted on the cooking machine.

The disadvantages of this method were: inadequate dosing of adhesive silicone that depended on the skill of the operator, low productivity, excess silicone that had to be removed after drying, the operator ergonomics problems related to the height of the support of the Assembly.



Figure 4. Metal framed hob which is to be mounted on the cooking machine

4. ASSEMBLY TECHNOLOGIES THROUGH GLUING THE GRILL PLATES AND OVEN DOORS ON ASSEMBLY LINES WITH ROBOTIC EQUIPMENT

4.1. Robotic assembly equipment of the grill plate by gluing

Taking into account the higher demand in the market of electrical cooking machines, the company has invested in the purchase of equipment for the soldering vitroceramic grill plates and oven doors.

The basic requirements of the new equipment were based on the experience gained through manual soldering.

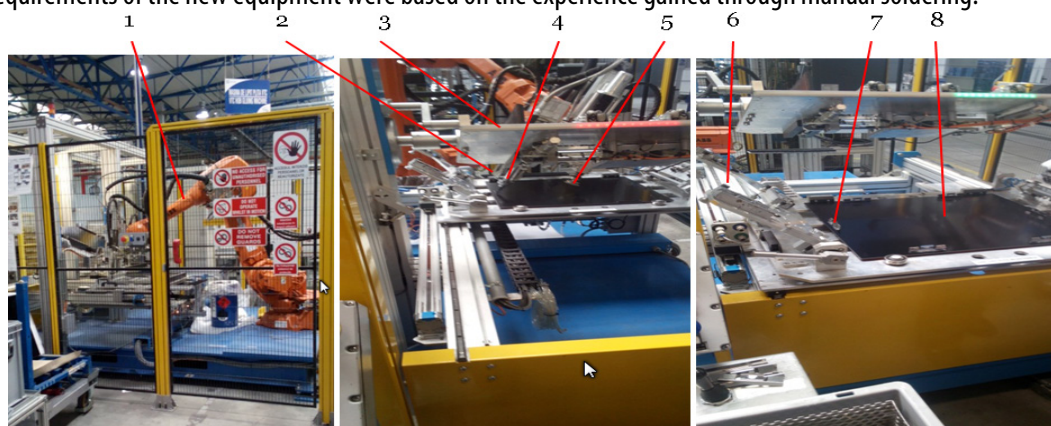


Figure 5. Robotised Assembly equipment of the grill plate by gluing. 1-spherical robot; 2- plasma cleaning hose for weakening the link between surface atoms to be bonded; 3-support for ceramic glass; 4-hose for dispersion of adhesive and silicone; 5-vacuum suction cup for the handling of support from top to the bottom of the semi-finished product; 6-device for positioning the metalelements for assembly; 7- metal assembly parts; 8-glass for oven.

This equipment is intended for gluing the grill plate and the outer door oven glass. The equipment uses the technology of sticking with a bicomponent adhesive and silicone.

The advantages of this equipment are: high productivity, low power consumption, low production cycle, in 18 seconds the product can already be handled, small space requirements, space for equipment is of 4 m X 4 m, assembles a thousand parts in 8 hours.

4.2. Assembly equipment for gluing the oven door

Automated Assembly offers several benefits compared with manual assembly: higher productivity, reduced material waste, reducing labor costs, faster transfer between phases, almost totally eliminated scrap subassemblies.

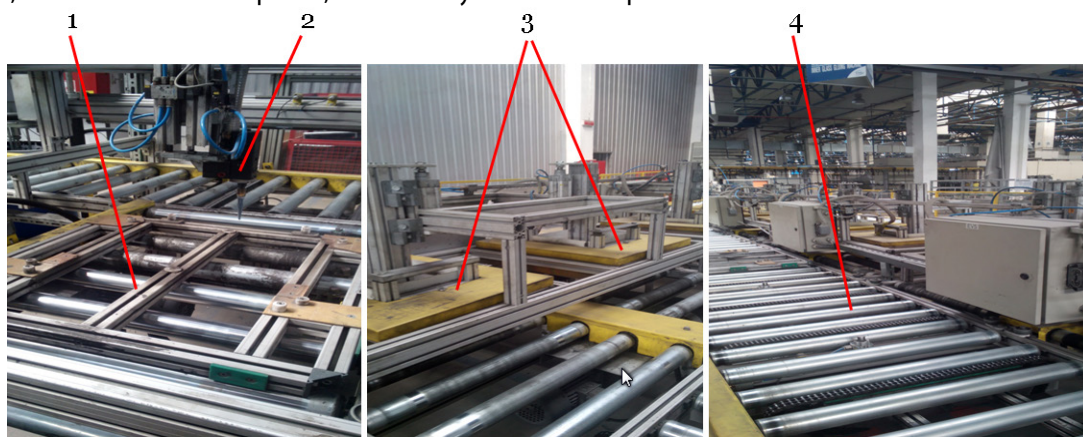


Figure 5. Oven door assembly line through gluing. 1-support for assembly and transport rollers to the polymerization ovens of the oven doors; 2- dispersion hose; 3-polymerization ovens; 4-conveyor rollers.

Oven door gluing equipment, which uses a monocomponent adhesive technology. The advantages of this equipment are the following: it is easy to maintain, it is easy to operate, it is very reliable and has high productivity.

The disadvantages of this equipment are as follows: a large space requirements considering the size of machine: 17 m x 5 m, very high power consumption due to the ten polymerization ovens with which it is equipped. The temperature in polymerization ovens should reach 600 °C. The cycle time is relatively high, for a piece from the starting point till the end it takes 20 minutes.

The equipment is serviced by an operator that loads and then unloads the semi-finished product because after the assembly the conveyors lines bring back the semi-finished product to the operator that loaded then. In 8-hours the equipment assembles eight hundred parts.

4.3. The equipment for assembling the outer oven door glass. This equipment uses the technology of sticking with a bicomponent adhesive.

The advantages of this equipment are: high productivity, low power consumption, low production cycle, in 18 seconds the piece already can be handled, small location, the space intended for the equipment is of 4 m x 4 m.

The disadvantages of this equipment are the following: cumbersome maintenance because the dispersion hose is complicated and very the components are very small, difficult operation in order to prevent maintenance problems, the operator is obliged to clean up the dispersion hose if the production stops for more than 5 min.

The equipment working in co-ordinated scale is served by a single operator, assembles eight hundred parts in 8 hours.

4.4. Automation of the gluing process of the vitroc ceramic grill plates

Based on experimental studies it was established that the losses of heat energy are the most significant due to leaks from the doors of the cooking ovens at the combining components from sheet metal with the inner and outer glass. For this the oven doors were redesigned by replacing metal parts with plastic heat-resistant materials and assembling components with soldering technology using industrial robots.

Industrial robots, regardless of the environment, will become increasingly more advanced and more efficient. Robotics is currently used in the car industry, household appliances, automobiles, medicine, agriculture. Robots equipped with various sensors and transducers try or in many cases manage to increasingly better copy the senses and the skill of the operators.

Taking into account the higher demand on the induction cooking machines market, the company has invested in the acquisition of other equipment for soldering of the cooking machine parts.

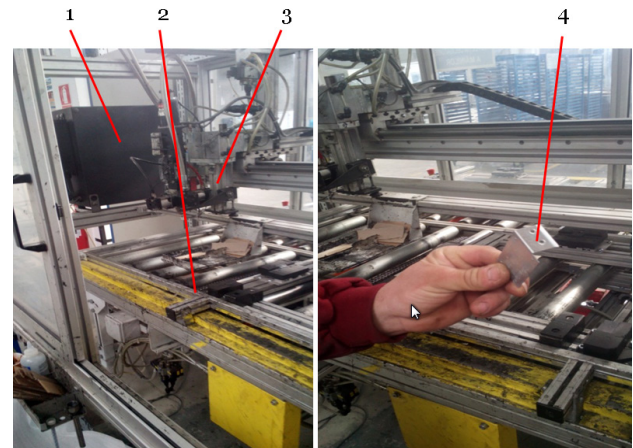


Figure 6. Equipment designed for bonding of metal components for assembly on the outside of the door of the oven
1- loading place for the window; 2-supplying support with metal assembly elements; 3-bicomponent silicone dispersion hose; 4- metallic element for the assembly which can be pasted on the glass.

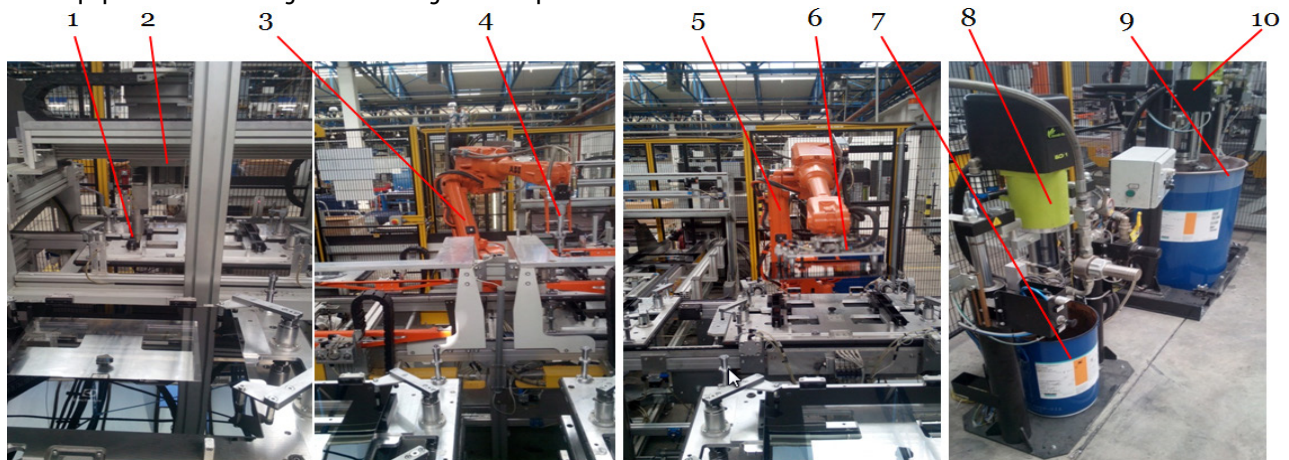


Figure 7. Assembly line of the inner oven glass. 1-plasma cleaning hose for weakening the link between surface atoms to be bonded; 2-scalorobot; 3-spherical robot; 4- dispersion hose for adhesive and silicone removers; 5-spherical robot; 6-glass for the oven to be seated on plastic lining with silicone; 7-adhesiveripient; 8-pump with pneumatic drive; 9-silicon recipient; 10-pump with pneumatic drive.

The requirements for the new equipment on the part of the recipient are the following:

- ≡ space intended for the machine to be as small as possible;
- ≡ high productivity;
- ≡ dead time till the possibility of handling the product as low as possible;
- ≡ maintenance costs as low as possible.

At the moment on the international market are found several companies dealing with designing and carrying out of soldering equipment. Some companies names: *ITW Dynatec, BF Micro Aplicator, Sonderhoff, Graco.*

Spherical robots for handling subassembly components are manufactured by the ABB company, which guarantees function without requiring maintenance.

The equipment uses bicomponent adhesive and silicon, which has the advantage over the monocomponent that it doesn't require assembly line for polymerization ovens (600°C) to reinforce the silicone, being needed just a moving storage space included in the assembly line.

Subassembly assembled by gluing after this route which lasts twenty minutes is ready for mounting.

Italian company *Constructa* has designed and built the assembly line with the mentioned parts above.

The equipment is serviced by two operators:

- ≡ the first operator loads the plastic lining for the oven door on the assembly line and unload them because the components from the moving magazine where the strengthening of silicone is achieved end up back at the operator who now unload semi-finished product;
- ≡ the second operator loads the glass for the oven on a secondary line that via an scalar transporter meets at the furnace window to be assembled by gluing the plastic lining by a spherical robot ABB. This operator ensures the transport to the assembly line.

Figure 7 represent aspects of the assembly phases formed by the inner glass and plastic lining. In the interval time of 8 hours the equipment sticks a thousand parts.

5. CONCLUSIONS

Automated assembly of sub-assemblies for cookers offer many benefits compared to manual assembly: higher productivity, reduced material waste, reducing labor costs, faster transfer between phases, scrapped subassemblies almost totally eliminated.

Automated equipment ensures the operator an ergonomic working place without jeopardizing the integrity of the body and health. Thus the operator will be less prone to absence due to illness which results in savings of money, especially if it has a productive effect in society where is calculated to the minimum required.

Robots on the assembly lines are productive, reliable, does not require maintenance.

With the assembly through gluing you obtain clean parts, nice looking, which retain the shape and dimensions as well as the dimensional accuracy, no tensions remain after assembly

The disadvantages of the assembly through gluing would be: the low resistance assembly, because the tasks are taken over by layers of adhesive material, soldering components colour is different from that of the basic parts, little resistance to corrosion.

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