A NOVEL CONCEPT OF AGILE ASSEMBLY MACHINE FOR HOUSINGS OF MOTOR WINDSCREEN WIPERS

Ricardo Costa, F.J.G. da Silva(*), Raúl D.S.G. Campilho
Departamento de Engenharia Mecânica, Instituto Superior de Engenharia do Porto, Portugal
(*)Email: fgs@isep.ipp.pt

ABSTRACT
Automotive industry has been changing considerably in the last decades, requiring lesser quantities by order and increasing the products variety, due to new market demand and the need to become the product characteristics closer to the customer needs. Thus, production paradigms have been changing, requiring an increased flexibility of the systems and equipments used in the industry. Hence, full-dedicated equipments to some products and tasks are being replaced gradually by others following the currents market trends.

This situation gives rise to engineering exchanges, which can only be overcome with the automation aid. Indeed, studying conveniently the geometry of the parts involved and if there are common shapes those can be used as reference in all of them, equipments should be designed in order to take advantage of the benefits offered by automation and allow a better universality of the tasks to develop in the equipment. Thus, it is up to the designer to define all the degrees of freedom required for the equipment to enable their use as widely as possible. A proper integration of the mechanical design and automation allows infinite possibilities to solve the major part of the existing concerns. Furthermore, the design concept should also realize the system production needs, facilitating by this way the equipment designers’ action. The use of jigs provided with fast fixing systems, adapted to the product changes, can also be a considerable help in this process.

This work was developed with a view to increasing flexibility in assembly systems of components for the automotive industry, drawing a novel procedure to develop new products able to be produced in the equipments already in service. Furthermore, a case study was developed showing how this concept can be put on the shop-floor. Car windshield wipers motor housing is usually doted of some fixing elements whose allow its assembly in the car chassis. The previous motor housings are in metallic alloys but, currently, many of them are in polymer due to its lower weight and cost, whose have slots where must be assembled rubber washers and metallic bushings. There are a lot of different models, requiring smaller quantities per order and permanently production changes. Thus, the equipment needs to be able to assemble the larger volume of different part numbers, providing the minimum setup time possible. The equipment designed allows producing more than twenty different part number of the same family, requiring a simple jig change in the equipment and the bar code reading in order to get ready to other part number assembly task.

Keywords: Full-automated equipments, Assembly process, Flexible production, Agile manufacturing, Automation, Windshield wipers cover housing.
INTRODUCTION

Nowadays, the automotive industry is a very competitive market, which has a global scope, leading to strategic changes by the automakers and the suppliers' facilities. The use of strategies such as modularization, platforms and shared components, subcontracting companies, among others, allows the building of economies of scale and assembly efficiency but mainly split or share responsibilities with suppliers in terms of design, development and manufacture [1].

As time goes by and with the consequent development of technology, industries have chosen mostly to replace manpower by capital-intensive models, making massive use of technologies such as robots and fully automated assembly equipment. If we think of the United States of America as an example, with industries of an underdeveloped nation, we find that its economy is based on intensive capital. This clearly is a consequence of the introduction of more advanced technology and equipment, which resulted in an increase in productivity [2].

With the use of automated systems, in contrast to fixed systems (manpower), one guarantees greater production flexibility, as well as greater diversification of demand and market segmentation [3]. However, not always the need appears linked to competitiveness factors: in many situations, it is necessary to implement such systems due to tasks with high hazard index, as they may endanger the physical or psychological integrity of workers [4]. However, the evolution of the automobile sector and of the automation goes side by side, since the large number of components that make up a vehicle involve the development of automatic systems capable of contributing to a significant increase of productivity and flexibility [5]. The factors that, usually, take companies to bet on the increase of the automation’ level are the following [6]: increase productivity; reduce production costs; increase the product quality; reduce delivery times; perform tasks that cannot be performed manually; avoid costs of non-automation; reduce or eliminate manual routines. It is highly important to have a rapid response capability that is reliable and trust worthy regarding to the requests of customers for new products [7].

The increased use of automation in the industry, particularly in robotics, is due to the significant improvement of product quality, to the improved working environment, to the improved cost efficiency and to a high increase in process flexibility, so to cover the various references of articles [8]. Comparing the work done by a human to one made by a robot, it is easily seen that the last one provides a much higher accuracy. This is because robotics is used when they are needed: high positioning accuracy, high repeatability and high accuracy inspection. To meet the requirements stated previously, human being needs high concentration levels for extended periods of time, which may affect the production and quality due to fatigue [9], [10]. Many jobs are hostile to the human body, such as the painting stations, which may be carcinogenic; or printing equipment that have high levels of noise, which may affect hearing. In these situations, the implementation of robots eliminates all these problems, since they can easily cope with these environments without threatening themselves. The use of this equipment is exemplified in nuclear power stations and repair reactors; this environment, of course, excludes the use of human beings in this work. Accordingly, they are replaced by robots [9], [11]. However, the use of automated equipment and robots becomes also advantageous when it is necessary to have high flexibility and speed. Thus, the solution is reprogrammable by automation, thereby giving the use of dedicated tools [11].

To perform hard and dirty work during extensive working hours is wearing and can cause injury, a fact which may lead to a very quick fall of motivation. For these reasons, companies
like BMW and VW have robots that help workers on the assembly lines. The aim of this type of implementation is not to substitute the human being with robotic equipment but to help workers in their daily tasks, making them safer and more productive [12]. In these cases, the robot is an important factor to increase productivity without the worker being susceptible to unnecessary risks, which can be redirected to other nobler functions or activities. The success of an industry depends on the capability of its productive system to be flexible and to be able to reconfigure itself in accordance with the requirements from the market [13].

The fascination for robotics arises not only for its content of technological development, but with the desire to realize how evolved is the thought of human beings since the beginning. Robotics has always been associated with something that belongs to the realm of fantasy or which originated in the darkest humanity desires [14], [15]. Thus, it is easily understood that automation and robotics are synonyms of flexibility, agility, ergonomics, quality and production time, among others. In fact, these aspects are highlighted for the design of this project, because this equipment will be implemented in an automotive industry in order to do the assembly of rubbers and bushings into a hull of a widescreen washer engine, which requires different levels of competitiveness to increase productivity and to optimize the manufacturing cost.

This work intends to create novel equipment able to assemble a series of different sets belonging to the same family but having a lot of specificities in terms of geometry. The flexibility to be able to easily adjust the equipment to the existing and future geometrical variations in this kind of assembly processes without the use of expensive robots is the real contribution of this study to make agiler this assembly process, using a lot of standard devices that can be used for other issues at the end of the life cycle of this product or being easily adapted for other kind of assembly process.

METHODS

This chapter is divided into two sections: first, it will be presented the identification of the problem and the characteristics of the widescreen washer engines housings; then the first approach will be presented, taking into account the basic concepts (requirements and conceptual solutions) for the planned equipment.

THE PROBLEM

Plastic housings (Figure 1) are intended to protect and support all components necessary for the proper operation of a widescreen washer engine. These housings adopt a wide variety of shapes, as well as the number of fixtures (rubber or bushings), whose may be round or oval (Figure 2).

The work associated with the assembly of these components is currently completely "handmade", that is, done by manpower. Therefore, the equipment must be able to adapt itself to all the housing references and to have enough flexibility to allow the assembly of new housing models with different geometries. As shown in Figure 3, the equipment must have the ability to be positioned angularly in relation to the part (a) and height adjustment to the accessories introduction (b).

Although they have a very complex geometry, the housings can also provide similarity bridges, as depicted in Figure 4, which have become particularly useful in equipment development.
In Figure 5, one can observe the assembly sequence of the rubbers and bushings. Thus, the developed device has to perform this same sequence, in order to have a bigger competitiveness when compared to the assembly system carried out by workers currently.
REQUIREMENTS

- **Flexibility** – As already mentioned, currently, the entire process is made manually; therefore, the equipment designed should replace manual labour. Thus, it is understood that this equipment should be fully flexible to cover all existing references and some that may appear. Thus, the machine must have enough setups: for each reference associated to each housing, there is a setup that will make the machine to adapt itself to be able to make the introduction of the accessories into the housing in terms of angular and height position. It is extremely important that this equipment is fully automatic, to ensure its full independence from the worker;

- **Agile manufacturing** – Thus, the agility and the adaptability of the components associated with the equipment become fundamental for this to happen, because it is essential that the feeders are positioned with high accuracy and the actuators work with great precision and as quickly as possible.

- **Quality** – First, the quality of the work to be done, which should be as accurate as possible in order to reduce/eliminate the amount of nonconforming parts, thereby obtaining greater profitability of the process; then the quality associated with the worker (ergonomics), whose presence is only required for the equipment supply and maintenance.

- **Material reutilization** – The material used in this equipment such as actuators, sensors, guides, among others, can be reused for other equipments, if it is dismantled because it no longer fulfil the manufacturing needs of the company, and this can happen for two reasons: the production of these housings stop due to the emergence of other models that the machine cannot produce or due to commercial or financial reasons.

RESULTS

ADOPTED SOLUTION

The equipment shown in the following picture was developed to comply with the requirements above. The machine is all automated, allowing the reduction of the constant presence of manpower and ensuring the operator satisfaction, whom can focus his attention in other activities worrying only with the equipment feeding.
The first and second stages refer, respectively, to the introduction of the rubbers and of the bushings in the plastic housings. In order to reduce the cycle time, the vibratory bowl feeders are positioned angularly in relation to the housing position (Figure 7), and motion transmission is performed using a servo motor, a pinion and a rack. Subsequently, these feeders should be positioned vertically, that is, the feeders must raise its position with the aid of two electric cylinders (Figure 8). When all feeders are properly positioned, an index conveyor provided with jigs corresponding to the housing geometry begins to charge with housings so as to move all together along the assembly line – when the first housings reaches the work center of stage 1, all electrical cylinders introduce a rubber, and these are introduced simultaneously into the hull.

The equipment setup comprises as well the jigs assembly, whose carry the housings along the equipment. These jigs will be provided with proper and easy fixture systems, can be easily mounted or extract from the conveyor in each setup. The jigs will be made in Polyamide, made my machining operation and will be provided with the adequate geometry in order to ensure an accurate holding system during the carrying process along the equipment.
When the first housing, already equipped with the rubber, reaches the stage 2, the bushings are assembled vertically. It should be noted that the two stages work simultaneously, that is, when the first housing that was inserted in the conveyor reaches the stage 2, the rubbers and bushings assembly is performed simultaneously, thereby ensuring a reduction of the cycle time. Concerning the pick-and-place for the introduction of the rubbers (Figure 9), it is important to note that these are electronic. The pneumatic cylinders would also be a good choice and would decrease the costs associated therewith. However, it would be necessary to change the limit switches manually. Therefore opting for electronic cylinders, we guarantee that these will expand just enough to each case and that the cylinders are able to work without human intervention. This is because the rubber location changes from hull to hull, when choosing the reference to manufacture; the cylinders are also enabled to work independently, as the limit is given by data that the cylinder controller has stored in memory for each reference.

Both pick-and-place that equip the feeders of rubbers and bushings are setup in the same way, as shown in the Figure 10. They only differ in the motion sequence associated with each stage. Lastly, it is necessary to say that all the feeders can be interchanged, i.e., normally, the pick-and-place is set up at the inner side of the feeder, which would lead to a necessary deduction of the feeder diameter and would cause an angle limitation; in order to solve this, it was decided to leave the feeder container in a way that can be dismantled, because, if a larger angle is necessary, one can change the containers and pick-and-place’s position, getting them on the opposite side from its original position.
In order to ensure a high level of quality and reduce the amount of non-conforming parts, a camera was installed at the end of the production line to make a comparison of produced parts with images of a well assembled set that this equipment stores in memory.

Thus, the parts are compared one by one. However, it was stipulated two parameters for stop the equipment production in order to avoid large quantities of non-conforming parts. These parameters are:

- The machine must stop if five consecutive parts are non-compliant – it is assumed that if this happens, the machine may not have been well positioned and some accessories are not being properly seated in the housings;
- The machine must stop if, for one minute, twenty pieces are evaluated as non-compliant. This aspect comes only to cover the possibility of accessories (rubbers and bushings) have some kind of defect. However, if this aspect is found, it is necessary the operator to check what is wrong in the machine.

After the parts have been inspected, they fall into a box that the worker responsible for inspection, maintenance and for the switch on/off the machine, should be emptied when it reaches the limit of its capacity, allowing the housings to be always accommodated within boxes and facilitating transportation for later packaging. After reach the number of sets previously programmed, the machine will alert the worker to change the box through a light signal.
CONSTRUCTIVE SOLUTIONS

EQUIPMENT CONTROL (DISPLAY)

All the equipment is controlled by a display, which has a touch screen. In this screen, all the references are presented, so that, by choosing a reference, the organization of the machine starts. During the production time, will be presented on the screen the amount of accessories used, the amount of accessories that each feeder still has (if the operator wishes to add accessories in a particular bowl, must pause the machine, add accessories and enter in the screen how many he added) and the amount of produced parts, that is, whenever a piece is successfully completed increases a unit in the successfully completed carcasses counter.

In addition to presenting information on the production, the touch screen will display information concerning possible anomalies that may occur. These anomalies (ERROR) can be one of the following types:

- Lack of round rubbers;
- Lack of oval rubber;
- Lack of round bushes;
- Lack of oval bushes;
- Error in servomotor X;
- Error in the pick-and-place X;
- Error on the index conveyor;
- Error in the lifting cylinder X;
- Failure in the visual inspection.

It should be noted that when an error appears associated with a component – for example a cylinder or the lack of accessories in the container X – his position will appear on the screen, marked in red, in order to inform its location. The worker should try to correct the error on the display, if it is a computer error (no error present). If the error is of mechanical origin (error present), will appear a troubleshooting with all the necessary information to try to correct the problem, from measurement values, wiring diagrams and, ultimately, there will be the option that presents the correct method to remove the broken part.

![Display](image)

Fig. 12 - Display
This equipment has proximity sensors on all windows to ensure that this will only work if completely closed, protecting the workers who are in the same area as the machine. The emergency buttons are positioned on the sides of the machine, in order to facilitate their access and viewing.

INDEX CONVEYOR

The index conveyor works on the table, turning around below it. This position ensures that the entry of the hulls is performed when the conveyor pallet is completely horizontal. Accordingly, and as mentioned earlier, the hulls will fall into a bin. As can be seen in the following picture, this index conveyor has four holes on the pallet. These should position and secure the gabarits, ensuring that all pieces positions are valid. Thus, as it is possible to change the position of gabarits and even gabarit itself, if new models of parts appear, it is sufficient to design a new gabarit so that the piece can be manufactured, always ensuring that the accessories entry plans remain. If this happens, it is necessary that the worker removes the gabarits and places new supports. However, the projected gabarits can cover a range of approximately 25 different references.

VIBRATORY BOWL FEEDERS

The vibratory bowl feeders were designed to ensure the constant feeding of the hulls. As can be seen from the displayed picture, the structure which supports the vibratory feeder was designed to that it could move vertically with the aid of two electric cylinders and angularly with the aid of a servomotor placed on the bottom sheet. This movement is allowed due to a round rack with outer teeth and a curved guide. However, this guide is only intended to support the entire weight of the feeder. To reduce the friction between the bottom sheet and the guide, a roller with four wheels was installed, also reducing the noise.
In order to produce the vibration, it was decided to use a four-sided Vibratory Drive Base, able to work at 230V. To avoid the manufacturing of the bowl, it was decided to choose a bowl and a Vibratory Drive Base whose measures were the same, in order to facilitate their assembly. By default, was selected a cylindrical bowl (instead of a conical bowl or a stepped bowl), because the outer measures and their diameters are constant, thus occupying less space. This proves to be advantageous, because it was possible to place the feeders substantially together, thereby ensuring the coverage of a larger number of angles.

To ensure the perfect alignment of the pick-and-place with the output track, a table fixed in the structure that supports the feeder was thought, solving two problems: the alignment and the movement of the pick-and-place, i.e., whenever a given feeder moves, the associated pick-and-place will also move, angularly or vertically.

The measure of the interior track of the bowl is uniform, that is, it is equal for round and oval rubbers, because the difference between them is little or with no significance. Thus, one can supply any bowl with either oval rubbers or round rubbers, being only necessary to be careful not to feed phase 1 (introduction of the rubbers) with the phase 2 (introduction of the bushings), because the movements associated with the pick-and-place vary depending on the type of accessories, i.e., it is necessary to respect the equipment sequence.
DRIVE SYSTEMS

As shown above in the requirements, this equipment should be fully flexible to operate autonomously. Therefore, the most reasonable solution would be to use drive systems. In this case, it was decided to use servo motors which, as stated above, are intended to move the vibratory feeders angularly to the housing.

The choice of servo motors became obvious by the fact that they can be controlled by a computer program. So, after choosing the product that will be produced, the feeders will self-adjust in order to start manufacturing. Thus ensures the most accurate alignment when compared to the alignment done by a worker.

Fig. 18 - Servomotor

The choice of the motor used in the index conveyor passes through a step motor, because the movement will be constant in a given period of time.

The solution could be electric motors. However, these do not have a constant speed unlike the adopted solutions, because their speed can be adjusted, varying in a given speed range in which these drive systems can work.

ACTUATORS

As shown previously, the geometry of each housing is quite abstract and complex and varies with each reference. Thus, the cylinders that introduce both rubbers and bushings need to extend enough to enter the accessories without damaging the hulls. Therefore, the options are:

- pneumatic Actuators;
- electronic Actuators.
Pneumatic Actuators

This type of actuators could be a good choice, taking into account that would be more economic and, with their smaller dimensions, would occupy less space. However, as the geometry of the housings is variable, the cylinder would have to extend just enough to insert the rubber. This would not occur because, by default, this type of actuators, when used, extend to the maximum, unless they were equipped with position sensors that would limit their movement. However, the position of these sensors would vary depending on the reference. The only solution would be to manually change the sensors position, which would increase the equipment setup time. Therefore, despite its advantageous aspects, this option was rejected.

Electronic Actuators

The electric actuators were the solution used. Despite its size being relatively larger than the pneumatic actuator and the fact that they are considerably more expensive, this type of actuators is controlled by a servomotor that is incorporated. Thus, the expansion of the cylinder is more easily controlled as well as its speed and labour strength. Another advantage is the fact that if there is a cylinder malfunction, the worker will know quickly through the information available on the display.

The electrical axes are also electronically controlled, because the motion control is more thorough, the faults detection is displayed on the screen and thus the machine is standardized relatively to the type of actuators used.

However, this equipment has a pneumatic actuator, the gripper, because, when compared with an electric gripper, the dimensions of the pneumatic one are considerably smaller than the electric one. The control of the gripper opening is irrelevant since it is expected to open to the maximum to hold the accessories and close completely when it finalizes their introduction. The gripper will only work when it receives the electric actuator signal, in order to open or close according to the step in which is the pick-and-place movement.
INSPECTION

The inspection is the last operation the machine must perform before depositing the hull in the box. Who never played the game to find the differences in two similar figures? This phase is constantly performed in order to identify the parts and to count the compliant and non-compliant parts. However, the visual check that the camera executes is too fast, in order to analyse the housing in the time that the index conveyor is stopped.

In order to protect the workers from the constant flashes that this camera makes, black acrylic plates were applied to reduce the intensity of light emitted, functioning as a pair of sunglasses or as a welding mask, protecting the eyes of the human beings and avoiding injuries.

USED MATERIALS

To build the structure of this equipment, it was decided to use aluminium sheets and an aluminium square tube. Thus, it withdrew some weight from the whole equipment while maintaining the structural stability. However, this equipment will not suffer many solicitations and even the constant movement of the index conveyor will not be felt throughout the structure.

For superior and lateral protection, it was used clear acrylic to facilitate visualization into the machine and protecting the worker who is near this equipment from any possible object that can be thrown.

Finally, two windows with net were built, that are easy to remove and to attach, in case of the operator needs to access the inside of the machine for different sides.

HOUSINGS FEEDER - AN IDEA UNDER CONSTRUCTION

As the housings have a very complex geometry, a conveyors system has been designed that will supply the index conveyor to subsequently introduce rubbers and bushings. Thus, it is
possible to eliminate all manpower linked to the equipment supply, making it more ergonomic and allowing the workers to devote themselves to other activities, since their presence is only required for supplying the vibratory bowl feeders, the housings feeder and for starting the equipment setup.

It should be noted that this equipment (Figure 23) is intended for the housings feeding and it is removable so as to facilitate the access to the feeders related to Stage 1 – introduction of the rubbers.

**MOVEMENTS SEQUENCE**

The housings must be deposited in the tank, which will drop a few in a given time schedule, in order to control their output. When the housings are in the inclined conveyor, they proceed until they are deposited on the next conveyor, and so we reach to the main assembly line: at the end of this conveyor, there is a metal sheet which will prevent the housings that are in the wrong position to enter into the actual machine. These housings will pass beneath the metal sheet, following the path in the "Rail 2", which will lead them back to the tank. The housings that are considered in the correct position will be placed in the index conveyor holder, will go down the rail, where they will wait for their turn to be placed on the assembly line.

When the housings are in the "Rail 1", their position will be given by the reading performed by a camera, which transmits that reading data to a rotating pick-and-place (Figure 24) in order to pick up the housing and place it in the index conveyor.
RESULTS AND DISCUSSION

After finalizing the project design, it can be said that its main goal was successfully fulfilled, because all the initially imposed requirements were satisfied by the used methods. It was possible to make the equipment flexible enough to cover all existing references and the possible new models that may appear on the market, because, for each reference, there is a setup that automatically organizes the equipment without human intervention, thereby ensuring a high alignment accuracy level between the feeder and the input plane of the accessories. In relation to the different rubber input plans, this has been solved by applying two actuators in order to move the vibratory bowl feeder vertically. Since it was decided to use electronic actuators, it is possible to assemble housings of any material (composite or aluminium), because the force required to the actuator varies depending on the material, which is jointly controlled with the expansion of the actuator, depending on the reference type.

As the equipment setup is done electronically, the time for the adjustments is small and accurate when compared to manpower. It can be said that the time for the amount of parts that were imposed a priori was fulfilled, that is, when one compares the time stipulated for the manufacture of a unit in this equipment to a unit produced by a worker, it is noted that the production increases dramatically. Thus, this equipment is competitive taking into consideration the production base used nowadays. Competitive enterprises have better positioning and get better benefits. Therefore, as already mentioned a fast machine with low setup time can give a faster response and optimize the cost and final price of the assembly process, in order to meet the customer needs, since the consumer appreciates that his requests are attended on schedule and with the lowest associated cost.

As the equipment only requires power and maintenance, the necessary number of workers changed to just one (shared). The job that is currently performed is quite wearing physically and emotionally, which leads to an increased probability of error and the amount of non-conforming parts, which would slow down the manufacturing process. As it is a very repetitive process and the working position is practically the same, physical, cognitive and organizational ergonomics will be affected, causing discouragement and lack of will, affecting the production, the people around the worker and the company. The novel equipment allows the responsible worker to be able to perform other activities during the manufacturing time, contributing to the production increasing and the worker’s satisfaction and motivation.

Associated with ergonomics, comes the quality, because, if the first is affected, the production and quality will suffer together. With this equipment, the quality is extremely rigorous. If not, the final consumer would be affected and would be dissatisfied. With the increase of the quality, the amount of non-conforming parts is reduced, leading the process to its maximum profitability. Although the accuracy level of the positioning and the introduction of rubbers and bushings is high, it does not mean that there is not the possibility of failure; however, if an error occurs during the production line, the inspection machine will check the assembly and quickly rejects the housing.

CONCLUSION

This study concludes that automation is the best option to enhance and improve both the production and the quality of manufactured products, allowing as well a high grade of
flexibility, which leads to a better production management regarding the new market requirements: medium or low series and fast delivery, with an elevated grade of customization. This work also proves that it is possible to the mechanical designer to concept novel equipments taking into account the new market requirements: several similar parts/sets produced in small quantities. A carefully analysis of the products family and finding out the geometrical similarities, it is possible use automation devices and programming techniques leading to the desired goals without the mandatory use of robotics. Furthermore, several devices used to build the equipment can be reutilized in new equipments and tools, increasing by this way the life-cycle of these components, thus competing with the robotic systems.

Using the equipment developed as case study in this work, the production will increase to about 1000 parts per hour, enough to monetize the process compared to the production currently used (work carried out only by workers). Therefore, the expected production time per unit manufactured has been achieved, thereby ensuring a very low cycle time.

The flexibility of this machine allows easy adaptation to new models that may arise, under the condition that the accessories (rubbers and bushings) have to be assembly into the housing in the same sequence.

The permanent presence of a worker is not required, one only needs to be aware of the warning signs (luminous and/or sonorous) to fill the feeders and resolve any unforeseen problems.

In order to further reduce the presence of the workers and improve the equipment, a sub-equipment could be thought to feed the vibratory bowl feeders, dosing and controlling the amount of accessories to be deposited in them.

Concerning the equipment for the housing feeding, this could undergo some changes in order to reduce their dimensions as well as the circuit that the housings have to go, in order to make it a more flexible and efficient equipment, such as repositioning the housings that are in the wrong position, eliminating altogether the percentage of housings rejected by the feeder.

In order to avoid that the final result would be deposited in a box, it could be studied a way to the housings, after passing the inspection, to be immediately packaged and labelled.

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