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DESIGN SOLUTION FOR AUTOMATED INSTALLATION SYSTEM OF WASHERS ON FIXING PINS

ROZWIĄZANIE KONSTRUKCYJNE ZAUTOMATYZOWANEGO SYSTEMU MONTAŻU PODKŁADEK NA KOŁKACH USTALAJĄCYCH

Abstract

The article presents a design solution for a tool for the automatic release and assembly of washers on ISO pins in order to prevent a heating mat from moving during tank forming. This solution minimizes the risk that washers get displaced. It also ensures safe and controlled release of washers without the assembly process.

Keywords: automation, assembly, control

Streszczenie

W artykule przedstawiono rozwiązanie konstrukcyjne urządzenia służącego do zautomatyzowanego wydawania i montażu podkładek na kołkach ustalających w celu zabezpieczenia maty grzejnej przed przesunięciem w trakcie procesu formowania zbiornika. Rozwiązanie to minimalizuje ryzyko obecności podkładek poza miejscami do tego przeznaczonymi. Zapewnia również możliwość bezpiecznego kontrolowanego wydania podkładek bez realizacji montażu.

Słowa kluczowe: automatyzacja, montaż, kontrola

1. Introduction

There is a growing tendency for various manufacturing companies manufacturing to automate basic, auxiliary and service processes. This trend can also be observed with respect to assembly processes, though, undoubtedly, the advancement of automatic system implementation in assembly processes is not yet as intense as in other manufacturing processes. There are many reasons for that, the most important being [6]:

- increased design and functional complexity of various electromechanical products, the assembly of which would require special, expensive and often unreliable devices,
- limited possibility of series production, which makes it unprofitable to implement automatic assembly devices,
- great diversity of product types (e.g. standard, modular and functional), which requires considerable flexibility of automatic assembly devices,
- insufficient manufacturability of product design due to automated assembly requirements,
- lack of series production of typical modules for automatic assembly that would allow easy configuration of automatic assembly devices depending on the assembly need,
- necessity to produce specialized assembly units dedicated for a specific use.

Despite the above-mentioned factors that limit the use of automated systems in machine assembly, such systems are gradually becoming more and more popular, thus contributing to repeatability and automatic control of the assembly process.

A technological process can be automated if operations performed in this process are mechanized. Mechanization means that physical human work is replaced with machine work. To achieve it, it is

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necessary to use proper mechanical devices which will work under human supervision. One can distinguish four basic groups of driving elements: mechanical, pneumatic, electric and hydraulic. Following mechanization, the process can be automated so that the machines perform planned operations either without or with limited human participation [2]. This is possible thanks to the use of control systems such as programmable microprocessor controllers.

The most frequent reasons for assembly automation include:

- the limitation of production capacity in defined assembly operations, which makes it impossible to fully use the technological possibilities of other mechanized and partially automated manufacturing techniques on a manufacturing line,
- the necessity to ensure that a given process can be completed within a defined time, which forces the need for process automation [1],
- the need to offer competitive solutions that reduce the probability of manufacturing faulty products.

Such situations create opportunities for the companies specializing in the design and manufacture of semi-automated and automated assembly machines, as well as for the suppliers producing components for these machines.

According to the opinion of the author of [6], in order to make the most of opportunities which increase during the times of economic prosperity and diminish in a crisis period, it is necessary to:

- have experienced, creative and innovative team of designers able to promptly solve complex problems,
- have proper information systems supporting designers works, activities of planners implementing these projects (supplying, prioritizing and ordering tasks, using production capacities and resources, etc.),
- have proper technical infrastructure enabling fast and qualitative implementation of projects and have good connections with suppliers, co-operators and sub-contractors facilitating performance of these works.

The need for creativity results mainly from the fact that assembly automation does not always reflect operations that are performed manually. In such situations, problems must be solved in an innovative way, one that guarantees high efficiency, stable quality, work safety, and functional reliability of the automated assembly system.

To meet the above requirements, it is necessary to conduct basic, applied and development research [4, 5]. The aim of these research efforts is to elaborate and propose various solutions, methods, tools, instruments as well as other elements for effective and reliable process automation.

2. Project requirements

The project task included building a station for an automated assembly of washers for attaching a mat to fixing pins. Dimensions of the mat are presented in Fig. 1. The mat is made of high-density polyethylene (PE-HD).

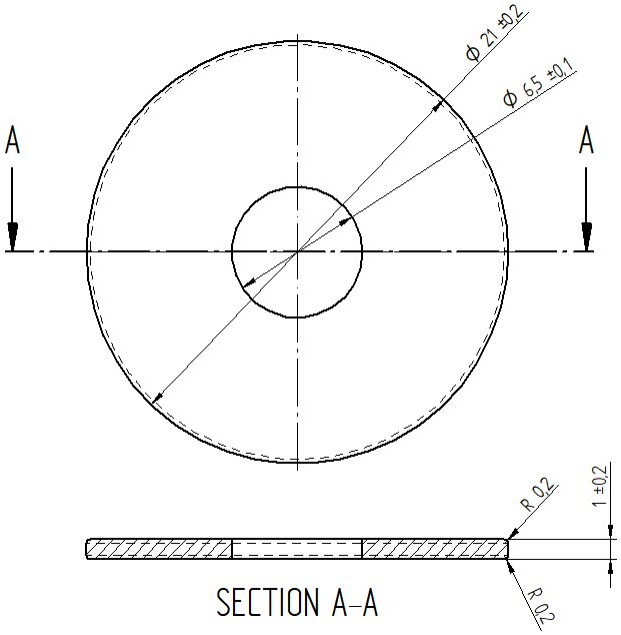

Fig. 1. Dimensioned drawing of a securing washer

Dimensions of the fixing pin are presented in Fig. 2.

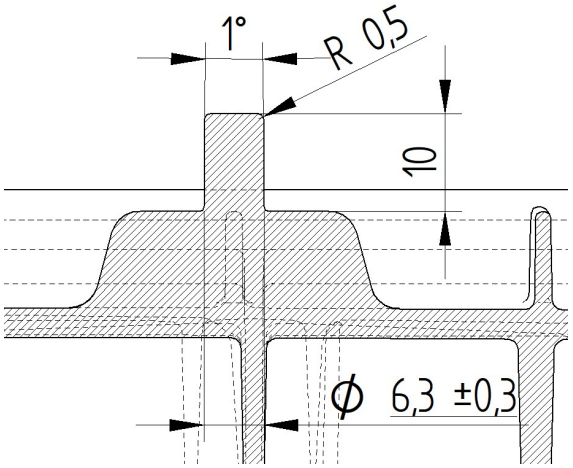

Fig. 2. Dimensions of an fixing pin

The washer is automatically assembled on the pin after putting the mat on. The operator sets an

assembling head on the assemble position, and after detecting the proper setting the device assembles the washer automatically. Fig. 3 presents the status of the product before and after assembling the protection (washer).

The number of released washers is automatically defined based on product identification. The device is equipped with a storage of washers in the amount enabling to assemble a full set of washers for one product (max. 13 pieces), without the need to refill it. The storage is refilled when the product is exchanged in a work nest. The washers are added to the main hopper automatically from a tray located at the height of the working table. Product is identified based on a barcode placed thereon.

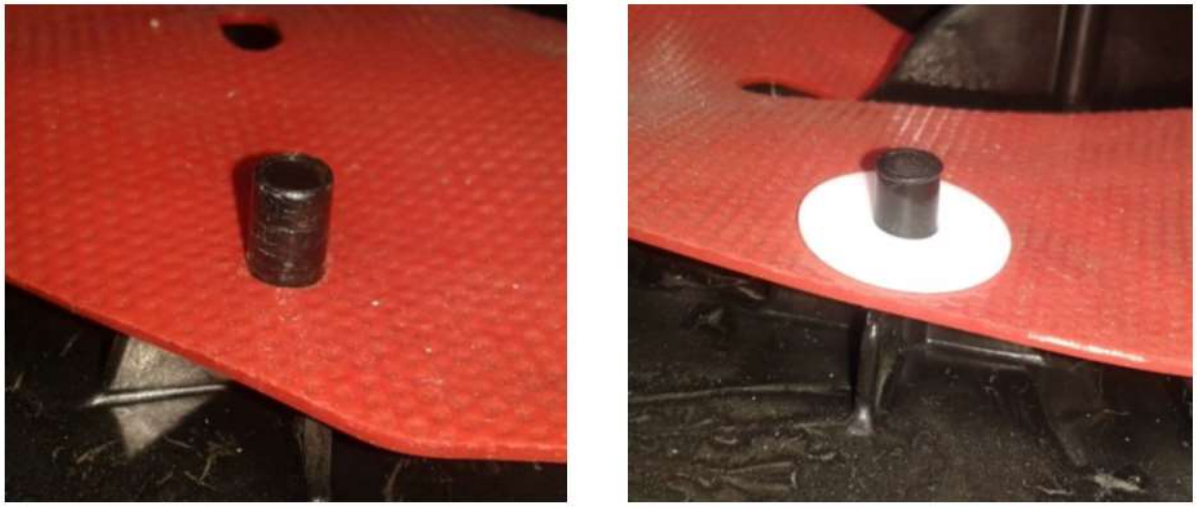

Fig. 3. Product before and after protection assembly

A simplified view of the product with assembled washers is shown in Fig. 4.

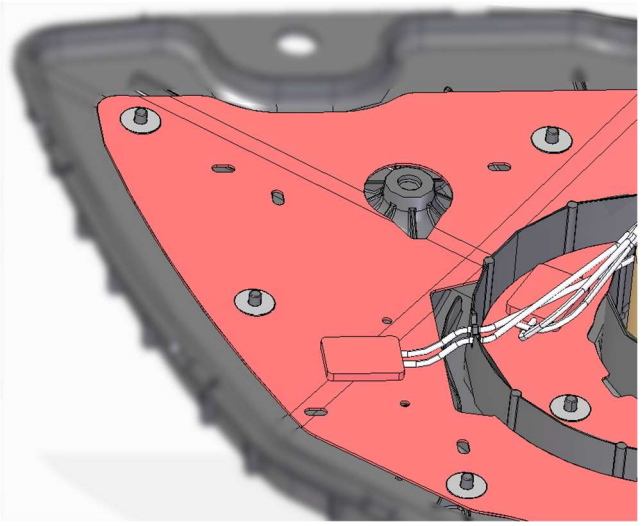

Fig. 4. Simplified view of a product with assembled washers

3. Technical solutions

Based on the presented requirements, a technological solution for a washer assembly station was devised (Fig. 5).

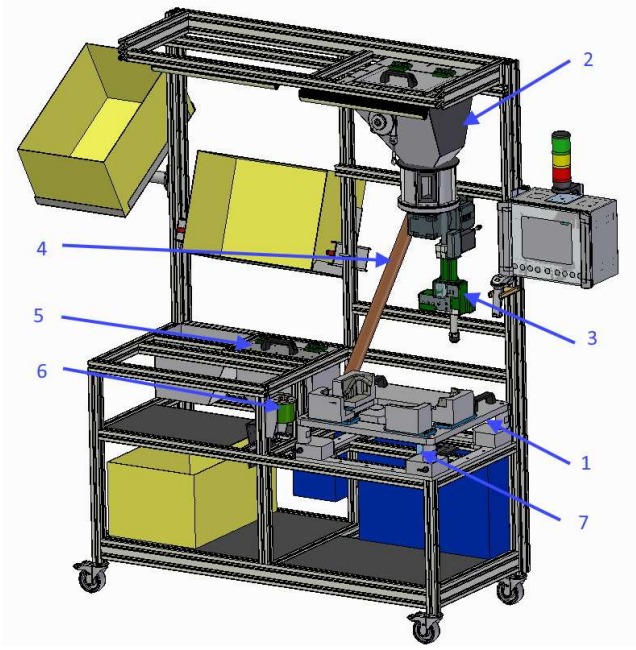

Fig. 5. View of an assembly station

The designed station is mobile thanks to transportation wheels. The frame of the station is made of aluminium profiles. The station has a changeable assembly nest (1), which makes it possible to assemble

products of different geometries. Under the assembly nest there is a barcode scanner (7) for product identification and automatic setting of the number of released washers per one assembly cycle. The average height of the assembly table is 950 mm, which ensures ergonomic work conditions for the operator [7] (Fig. 6). The station also consists of a space for mat containers, an additional manual scanner for mats, and a pin (6) that allows the device to complete the washer release cycle in case of assembly error. The ergonomics of the workstation arrangement was checked based on the reach ranges presented in Fig. 7.

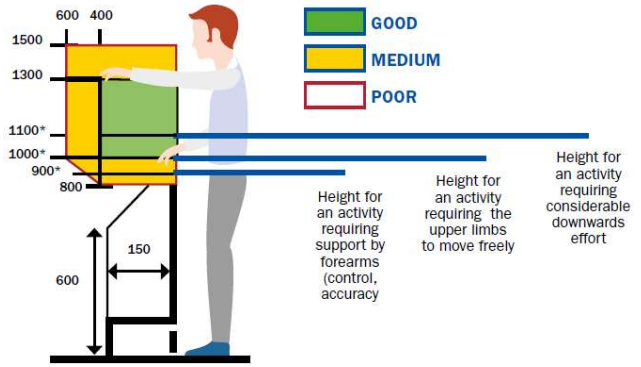

Fig. 6. Ergonomic windows for a standing workstation (side view)

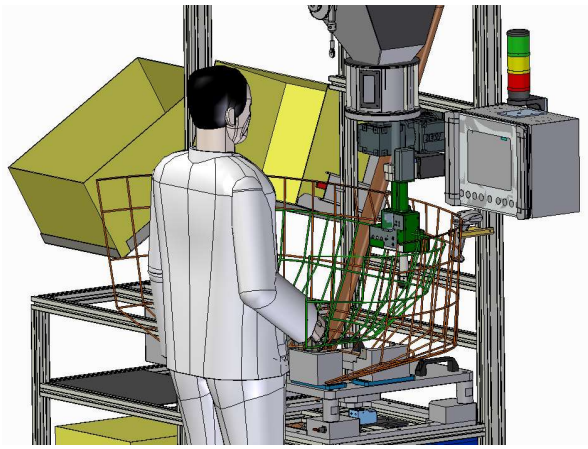

Fig. 7. Analysis of compliance with ergonomic conditions

Washers are fed into a feeder (5) and through a pipe (4) transported to a dispenser (2) by means of an air amplifier. The dispenser also includes an intake hopper with separating plates (Fig. 8) At the bottom of the hopper there is a dosing disc powered by a motoreducer. The disc has cut-out holes, thanks to which the washers are transported to the feed pipe which is closed with a valve (2) driven by a pneumatic actuator (3). A coupling (4) makes it possible to connect tools. The presence of a tool is signalled by a cased sensor which makes the valve open if the storage needs to be refilled.

The tool shown in Fig. 9 is hung up on a spring balancer in order to minimise the power that is necessary to move it. The tool has a 3D printed casing and a profiled clamp for the washer storage.

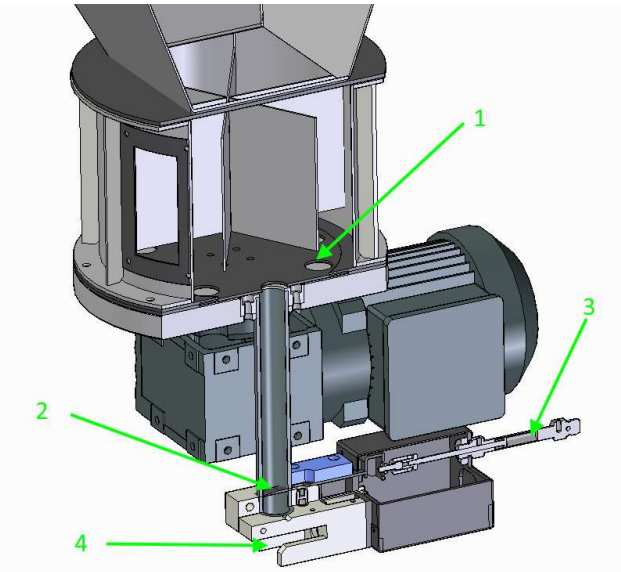

Fig. 8. Washer feeder

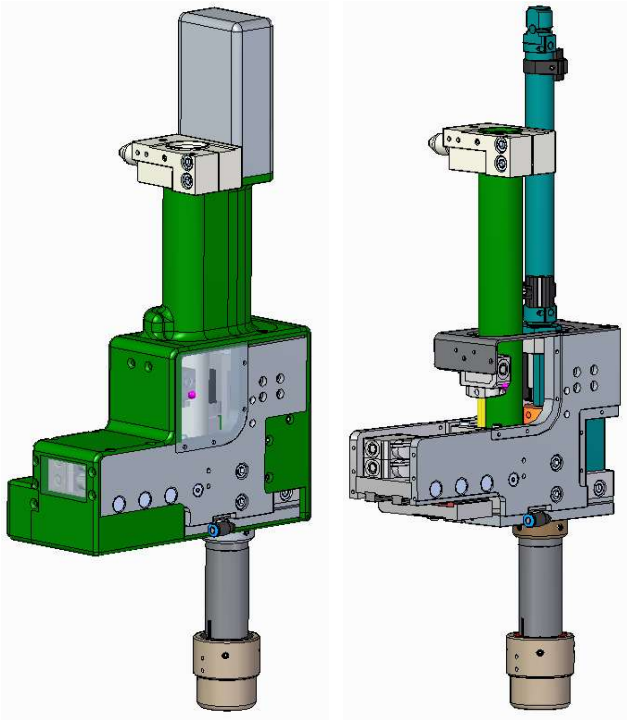

Fig. 9. View of an assembly tool

Fig. 10 illustrates the principle of tool operation. Washers are fed into the storage which is connected with the feeder. The minimum feed amount is controlled by a sensor (1). On launching the assembly readiness procedure, the tool is activated automatically. A slider (2) moves in direction A. As it is moving, a light gate confirms that the washer is in the

slider hole. Once the washer is put under a pusher (3), the pusher is moved downwards (motion B) by an actuator (4). The washer is moved to the bottom of the head and supported on a bush necking (5). When the actuator (4) reaches the maximum position, the slider returns to the washer loading position (motion C). It should be noted that the position of the washer in the slider hole is maintained by negative pressure, which prevents washer displacement due to the action of external forces. When the operator puts the tool on a pin and sensors (6) detect the pin in the slider hole, the main assemble motion D is started – the motion is induced by an actuator (7). The washer is pushed out of the bush and assembled on the pin. When the operation is complete, the pusher returns to the initial position, and the entire cycle is repeated.

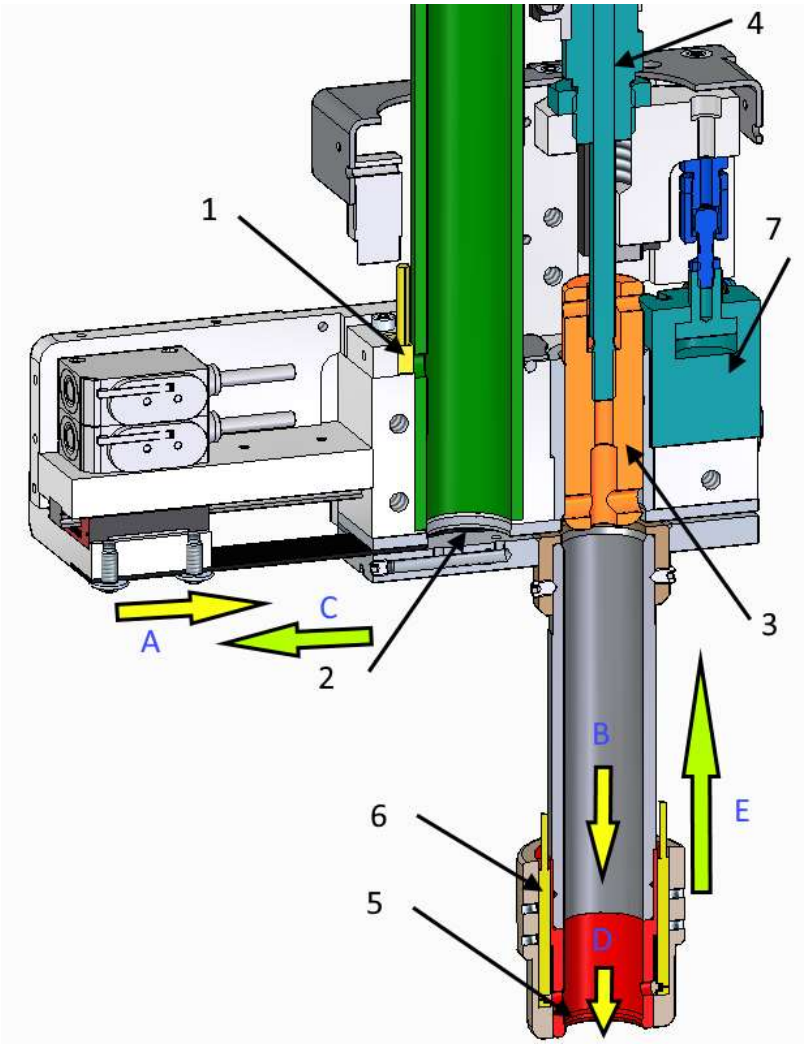

Fig. 10. Schematic diagram of tool design

4. Conclusion

The proposed design solution for the automated assembly of washers on ISO pins made it possible to meet the following requirements defined by the customer:

- automated assembly of washers,
- control of the number of released components,
- simple reconfiguration of the station to assemble products of different geometries,
- mobility of the station,
- ergonomic work conditions for the operator.

All the above-mentioned factors led to increased efficiency of the assembly process. The applied technological solutions ensured the repeatability of the process. The use of tools for product identification enabled automatic reversing of the machine to the required work conditions, which considerably reduced the probability of manufacturing a faulty product.

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