

Semiautomatic machine for turning inside out industrial leather gloves

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Abstract. The last step in the industrial leather gloves manufacturing is to turn the inside out so that the sewing be in the inside of the glove. This work presents the design and testing of a machine for that purpose. In order to quantify the relevant variables, testing was performed with a prototype glove. The employed devices and the testing proceeding were developed experimentally. The obtained information was used to build the turning inside out machine. This machine works with pneumatic power to carry the inside out turning by means of double effect lineal actuators. It has two independent work stations that could be operated simultaneously by two persons, one in each station or in single mode operating one station by one person. The turning inside out cycle is started by means of directional control valves operated with pedals. The velocity and developed force by the actuators is controlled with typical pneumatic resources. The geometrical dimensions of the machine are: 1.15 m length; 0.71m width and 2.15m high. Its approximated weight is 120 kg. The air consumption is 5.4 fps by each working station with 60 psig work pressure. The turning inside out operation is 40 s for each industrial leather glove.

1. Introduction.

An industrial glove manufacturing company located in Jalisco, Mexico, has been turning the inside out of the gloves they manufacture in a manual fashion. Even with top skilful workers this is a slow operation, which could turn out to be a bottleneck in the process. Therefore, a machine that could perform the turning inside out operation in less than 50 s, for all the variety of manufactured industrial gloves, was asked to the PDPA. Another design constraint was that the building of the machine be economically feasible and its construction be made with elements readily acquired in the Mexican market. This work describes the technological solution that was proposed to perform the turning inside out of the gloves in an automatic fashion.

The work started experimenting with a prototype driven with fluid power, in order to identify the steps involved in the process to turn the inside out of a glove by means of a machine. In this way the fundamental variables for the functioning of the machine were identified. After a long process of



experimentation and modification of the prototype a simple technological solution was chosen. This solution is presented in the present work.

2. The manufacture of an industrial leather glove.

The factory can produce 300 different glove models, although the core production only span about 30 similar models as could be seen in the Figure 1. The manufacturing process is not much different between the models, therefore it could be said that a general method of manufacture exists [1].

2.1 Cut. The first step of the process is the cutting of all the pieces that form the glove model selected. The amount of pieces depends on the model and the thickness of the leather used is variable. The master cutter selects the material and decides upon the way of cutting, since the thickness is an important factor in the function of a particular section of the glove. The cutting is done with a hydraulic press to which the proper die-cutter is mounted.

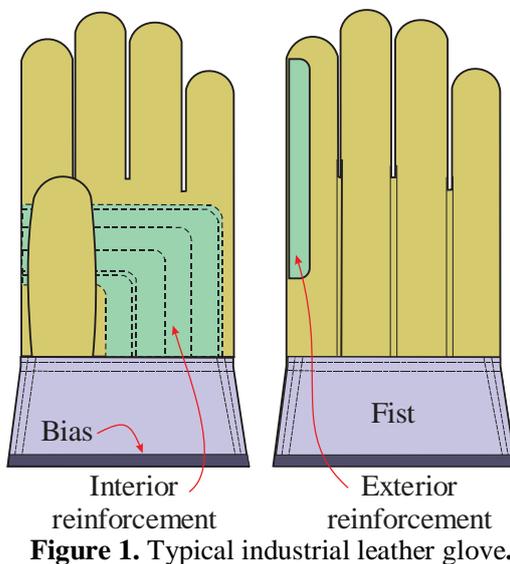


Figure 1. Typical industrial leather glove.

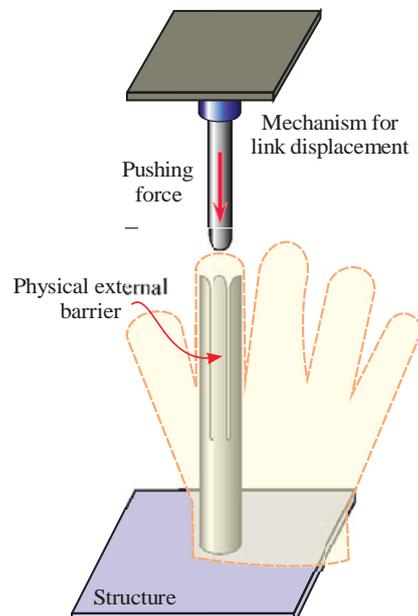


Figure 2. Basic concepts to invert the glove.

2.2 Sewn. The second step is carried after the pieces that form a complete glove is set. The sewing is realized by means of industrial sewing machines. The joining of the pieces is quit similar for all the models. It starts by sewing the palm with the interior reinforcement, then the fingers to the palm and then the fist is sewn. If the model requires a bias, this is sewn last.

2.3 Turn inside out. After the sewing is completed the process of turning the inside out is performed, since all the sewing is done in a way as to locate the seams in the inside of the finished glove. This operation is realized in a manual fashion, with the help of a cold rolled pipe upon which each finger of the glove is located, one by one; then, with the help of a thin bar, a force is applied as to induce the inside out of each finger. When the last finger is finished and before the bar is removed the palm is turned inside out by manually pulling the fist.

2.4 To press. After each glove is finished with the turning inside out operation it is convenient to press the glove. This is accomplished introducing an appropriate flat steel bar to each finger in a way as to accommodate the seams of every finger.

3. Develop of the solution.

After analysing the manual process, in order to identify the relevant variables and their quantification, the following result was obtained:

There are three relevant variables that should be controlled if an automatic solution is to be implemented:

- a) The insertion into each finger of a physical barrier, which will guide the turning inside out of the leather that forms the glove.
- b) The force required to push a solid cylindrical bar, so that the leather of the glove slides over the hollow flexible barrier. The leather of the glove is forced into the hollow barrier when the force is applied.
- c) A mechanism that moves back and forth the link that applies the force, and a structure to support all of these elements; Figure 2.

Some machines have been developed earlier, to perform the turning inside out operation. But these machines were conceived to attend knitting, fabric or leather soft gloves manufacturing [2] [3] [4] [5]. All of them are unsuitable to work with stiff industrial leather gloves, or do not allow to be adjusted to receive many different glove models.

By experimenting with a physical model it was possible to reproduce and improve the turning inside out process. A power fluid system with the appropriate control elements was used. A design with two working stations was reached as is shown in the Figure 3. The geometrical arrangement to locate the mechanisms, the fixing systems, the actuators and the gloves were defined so that the gloves turning inside out were performed in a short time as possible.

The turning inside out operation was conceived thinking that one or two operators could work in two parallel stations. The turning inside out will be carried in three steps: a) in the first station all the central fingers will be turned; b) in the second station the thumb and the little finger will be turned and in a third station the cuff will be turned inside out.

3.1 Turning inside out mechanism. This device was built in two parts. Two or three support basis holding the flexible barriers are located over the guide plates and the whole assembly is on top of the workers table. (See Figure 3) In the upper part there is the second assembly: the pushing bars fixed to the actuators rods by means of a height and positioning sliding railing (see Figure 4). The flexible barriers are formed by a pair of slender bars with a ring attached to the upper end. The bars of the flexible barriers can slide vertically thru the bases that uphold them. Their height could be adjusted by mean of screws. In the upper part of the machine there is a rail that allows regulating the height and position of the pushing bars.

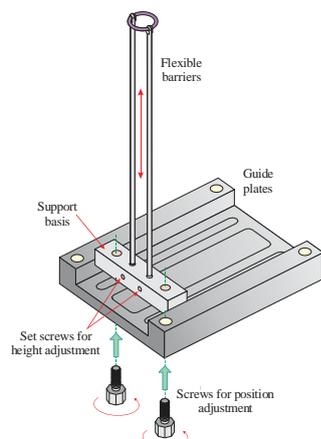


Figure 3. Guide plates with flexible roads.

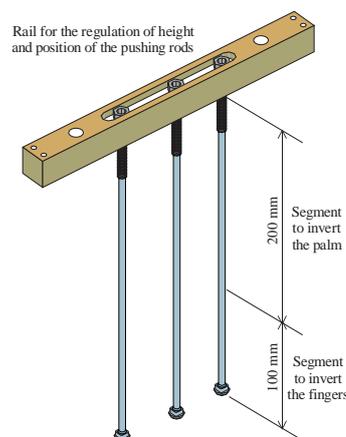


Figure 4. Rail with pushing bars.

3.2 Machine configuration. The machine was built as a table with three horizontal levels. In the upper level, the pneumatic actuators are located; the working area is located at the medium level and in the third level the starting pedal. Figure 5, shows the arrangement of the three levels in relation with the body of the operator.

The shape of the table, the positioning of the workstations and the location of the column that supports the head of the machine, are shown in the Figure 6. The two work stations of the machine could be operated turning inside out two or three fingers of the glove according to what is needed. In each case, some arrangement should be made as to match the flexible barriers with the corresponding pushing rods.

3.3 Structure. The machine rests on three columns made with steel pipe. The central column is larger so that it could support the head of the machine. The head of the machine is built with a section of pipe to which two arms were welded. The arms support the pneumatic actuators and each one has a bar, which serves to reinforce the anchoring of the actuators.

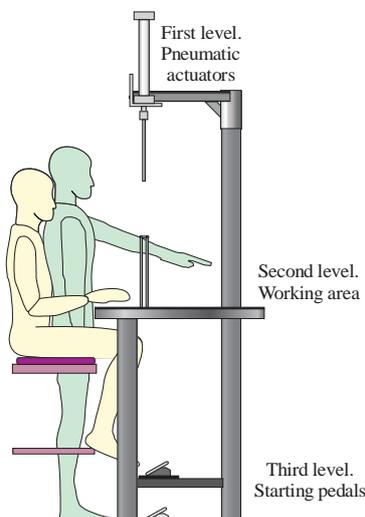


Figure 5. The machine is organized with three horizontal levels.

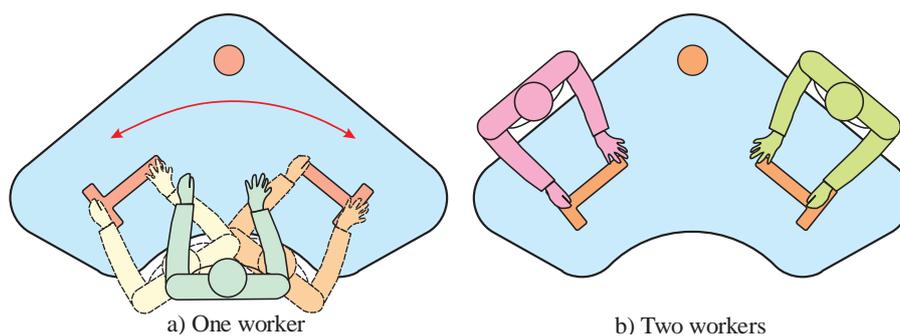


Figure 6. Work spaces distribution on the table.

3.4 Pneumatic power system. The force developed by the pushing bars is controlled with pressure regulators. The velocity at which the movements of the machine are carried is controlled with flow regulating valves. The machine is set in motion by means of a start pedal, which controls the inside out cycle. The buttons for controlling are located in places that are reached easily by the operator and their functioning is simple. This aspect was carefully considered mainly for the pressure

regulators and for the start pedal, since these elements are operated with more frequency than the others. The machine is equipped with two lineal actuators placed in parallel for each working station. Thus turning of the riel with the pushing rod is avoided. Moreover, the applied force is increased twice and the mounting of the tracks is carried in a simple way.

The advance and retiring velocity is fixed by the regulation of the air discharge, from the actuators ports to the atmosphere. In the control system limiting valves were used, which are controlled by the displacement of the rods. It is through these limiting valves that the change in pressure is ordered. The pressure during the piston displacement is diminished at first but increases at the end of the stroke. The operation with differentiated pressures produces a saving in the net consumption of compressed r. The air used in one turning inside out cycle is 5.4 scfm for each working station. The necessary force for turning inside out the three central fingers, for the most demanding glove, take 58 kgf.

4. Conclusions

The proposed arrangement used in the machine is simple but shows excellent performance to make the task. The process takes 40 s for the most rigid glove, without damaging it. The prototype shows many advantages that put their performance above the manual procedures used in the factory.

Among their advantageous characteristics are: its versatility to turn inside out a great variety of gloves b) the fluid power allows the easy regulation of the force and velocity of the linear actuators c) the machine is operated by one or two workers, d) energy consumption is reduced, e) their structure is light but strong, f) their fabrication cost is low and the maintenance requirements are simple, h) the risk of accidents during its operation is almost inexistent.

Every machine that works through an automatic cycle has gone by improvement steps, in order to obtain better performance. This machine is no exception. The use of other materials and the improvement of the process using the observed results will produce betterment to the presented design.

5. Reference

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