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Survey Concerning the Improvement of Superficial Hardening for IMCA Sets

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This paper approaches the issue of superficial hardening through electromagnetic induction applied to big size revolution parts used in tool machines building.
The paper shows a series of theoretic and practical researches leading to the improvement of superficial hardening for IMCA type sets by equipping the hardening machines with highly efficient and precise devices in point of synchronism adjustment and maintain between the rotation movement and the longitudinal advance.

1. INTRODUCTORY NOTIONS

Hardening machines are those induction hardening set parts on which the part is fastened that are hardened and carry out relative movements (translation, rotation) between the part and the inductor depending on the hardening method, the shape of the part, and the power of the set. The basic machines used for induction hardening that are manufactured and used on an industrial scale in our country are made up of a bed frame on which the mass is assembled; it sets up a longitudinal translation movement that may be adjusted to the following steps: 38, 85, 130, 260, and 300 mm/s. Flat surfaces are hardened due to these machines.

Considering that in most enterprises superficial hardening is needed for cylindrical shape parts, the machine may be equipped with fastening, carrying away and automation movement devices. The correlation of the rotation movement with the longitudinal translation movement has the role of homogenizing the structure after hardening, as well as the possibility to harden cylindrical parts through the rotation-translation successive method.

2. IMPROVING THE FASTENING AND CARRYING AWAY DEVICES

The fastening and carrying away device may be improved by using a geared engine with an asynchronic triphasic engine (position 1, figure 1) fuelled by a frequency converter that allows frequency variation from 5 to 100 Hz. The geared engine will replace the transmission through engine, redactor, and belt transmission by simplifying the set. Speed adjustment is very easy by adjusting the frequency from 5 to 100 Hz.

In this case, we use the triphasic asynchronic engine at a speed n = 1500 rotations/minute and the reduction gear in relation with transmission i = 1/750.

The speed of the part at 50 Hz will be the following:

$$n = n_{mot\ 50Hz} \times i = 1500 \times 1/750 = 2\ [rot/min] \quad (1)$$

By adjusting the converter frequency, the following speed may result:

$$n_{min\ mot} = n_{mot\ 50Hz} \times 5/50 = 1500 \times 5/50 = 150\ [rot/min]$$

$$n_{max\ mot} = n_{mot\ 50Hz} \times 100/50 = 1500 \times 100/50 = 3000\ [rot/min]$$

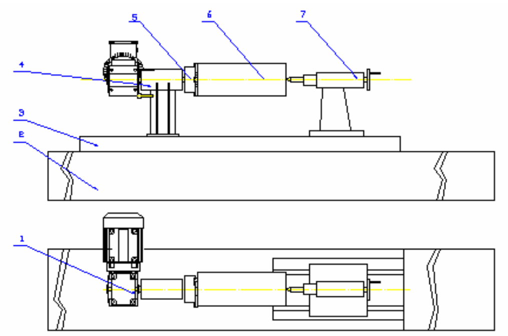

Fig. 1 Improved fastening and carrying away device [2]
1 – geared engine; 2 – bed frame; 3 – mass; 4 – fix stock; 5 – jaw chuck;
6 – part; 7 – mobile stock

Consequently, the variable speed of the part will have the following limits:

$$n_{max} = i \times n_{min\ mot} = 1/750 \times 150 = 0{,}2[rot/min]$$

$$n_{max} = i \times n_{max\ mot} = 1/750 \times 3000 = 4\ [rot/min]$$

The speed, which is variable within these limits, allows the use of the set to a wide range of parts and a more precise adjustment of the hardening speed.

3. Programme to automatically synchronise the movements needed for the superficial hardening through successive methods

Considering the necessary movements, rotation and translation as performed by the part during the successive hardening through the rotation, or rotation-translation, method, the machine may be equipped with an automation and synchronism system of the two movements. As it is not necessary a micron level precision, just like the tool machines equipped with C. N. (numerical command), in the case of this machine, a cheaper solution is chosen by using the frequency converters and triphasic asynchronic engines.

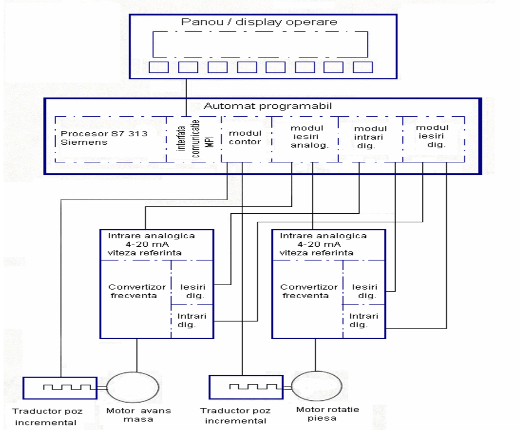

Fig. 2. Block diagram for the automation of the IMCA type part carrying away device

Figure 2 presents the block diagram of the automation set.

The diagram is made up of the following:

- Control panel with display and functional keys, for instance OP 17, or Siemens S7 313;
- Programmable machine (PM) with the following modules:
    - Counter module (to read the incremental translators pulses);
    - Analogical output module to transmit the speed value of the two converters (as an analogical signal 4-20 mA);

- Digital entry module to take over different information from the converters (alarms, and so on);
- Digital output module for converter turn on, turn off, etc., commands;

- Two frequency converters for triphasic asynchronic engines with the possibility of varying the frequency from 5 to 100 Hz providing speed between 0,2-4 rot/min;
  - at 5 Hz $n_{min} = n_{ieşire} \cdot f_{min} /50 = 2 \cdot 5/50 = 0{,}20$rot/min
  - at 100 Hz $n_{max} = n_{ieşire} \cdot f_{max} /50 = 2 \cdot 100/50 = 4$ rot/min.
- Two assembled incremental rotation translators:
  - One on the jaw chuck axis;
  - One on the advance slide screw.

The block diagram of the two movements synchronism programme is shown in figure 4.

The functioning principle consists of the entry data insertion (rotation speed, part diameter, and inductor length) at the control panel. It relays data to the programmable machine (PM). Knowing the rotation speed, the PM will calculate and relay the speed as an analogical signal 4-20 mA to the converter that carries away the part to a rotation movement. The programmable machine will read/calculate from the position translator the effective speed; knowing the inductor length, it will then calculate the necessary advance speed. This speed will be relayed to the frequency converter for the advance movement.

The adjustment and maintenance of the synchronism speed of the two movements are based on the adjustment functions (Integrative Derivative Proportional) of the analogical values. These functions are included in the programmable machine S7 313 Siemens. The IDP functions for the Siemens programmable machine have as entry data the values of the effective speed (previously measured and calculated) and the imposed value. These values are calculated as percentage relative values (0 – 100) as compared to a maximal value that is pre-established by both the programme and the frequency converter.

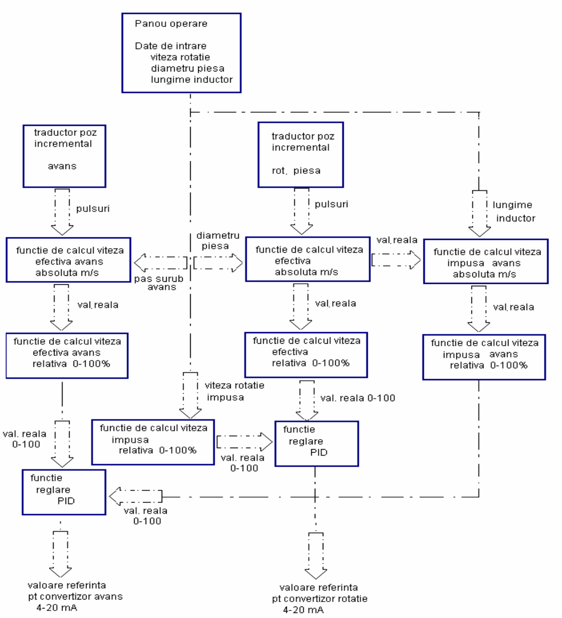

Fig. 3. Automatic synchronism programme of the two rotation-translation successive hardening movements

The result of the function will be the speed output value as an analogical form, so that the measured (effective) value may be equal to the imposed value.

Practically, in 2 – 3 s, a PM will succeed to stabilize and maintain the two movements with the IDP functions as long as the large diameter parts on the IMCA set are hardened at the Stimin Industries S.A. Oradea.
By using the automation system as described above, the hardening machine may be used for parts larger than the one considered.

4. Practical experiments

The uniform effects of the induction superficial hardening entail the mechanisation, or even automation, of the part movement at different stages of the hardening technology, irrespective of the hardening method.

The correlation of the rotation movement with the longitudinal translation one during the radial drilling machine columns hardening has been carried out by improving and automating the movements as shown in figures 1, 2 and 3.

To validate the hardening technological process, we considered the following:[1,4,5]

- Stabilising and optimising the technological parameters;
- Stabilising and optimising the thermic parameters;
- Macroscopic and microscopic study of the hardened layer.

Fig. 4 Successive hardening through the rotation translation method

Fig. 5. Macroscopic study of the hardened part.

CONCLUSIONS

1. The fastening and carrying away device may be improved by using a geared engine with an asynchronic triphasic engine (position 1, figure 1) fuelled by a frequency converter facilitating the variation of the frequency from 5 to 100 Hz.
2. After the theoretic and practical experiments, one may notice that the IMCA hardening set at the Stimin Industries S.A. Oradea may be used to superficial hardening of cylindrical parts with a larger diameter than the one considered (320 mm) provided it is improved and automated.
3. The adjustment and maintenance of the synchronic speed of the two movements are based on the adjustment functions (Integrative Derivative Proportional) of the analogical values.

Bibliography

[1]. Firețeanu, V (1995) - *Procesarea electromagnetică a materialelor*, Editura Politehnica, Bucureşti.
[2]. Iancu, D.V., Mada M., Mihăilă Şt. (2006) - *The simulation of the shallow hardening process by the method of finite element*, Acta Technica Napocensis, Series: App, Applied Mathics and Mechanics, Nr. 49, Vol.5, pag. 7-17, ISSN 1221-5872.
[3]. Mada, M., Buran, C., Mihăilă, Şt.(2006) - *Improving the calculation of technological parameters for flame of large size gray cast iron parts through modern computer method,* Conferința Internațională TMCR 2006, Iaşi, Tomul LII, Fasc. 5B, ISSN 1011-2855, pp.713-716.
[4]. SREN 1561 / 1999 - Fontă cu grafit lamelar
[5]. Udrescu,Livius(2005) – Tratamente de suprafață şi acoperiri, Editura Politehnică, Timişoara.