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THE REBUILDING OF CERTAIN COMPONENTS OF MIXING MACHINES, BY SEMI-MECHANIZED ELECTRIC ARC WELDING

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Abstract: This paper presents a technological solution, based on welding, for the rebuilding of parts that are used in mixing machines. The rebuilding of certain helical or cylindrical components is a present-day concern of specialists working in welding and automation. Electric arc welding in general and especially welding with covered electrodes are quite easy to render universal, being thus applicable to a variety of materials: unalloyed steels, weak and highly-alloyed steels, metals and non-ferrous alloys, as well as cast or laminated parts.

1. INTRODUCTION

The technical solution regarding the design and implementation of a technological system for rebuilding either by electric arc welding or by another procedure, is always the result of a research that was done in relation to the material, the dimensions and the geometry of the part. Considering the geometry of the part to be rebuilt (Figure 1), the authors of this paper have designed a semi-mechanized system, made of a positioning-revolution element, a welding source and a piece of equipment for setting the welding parameters.

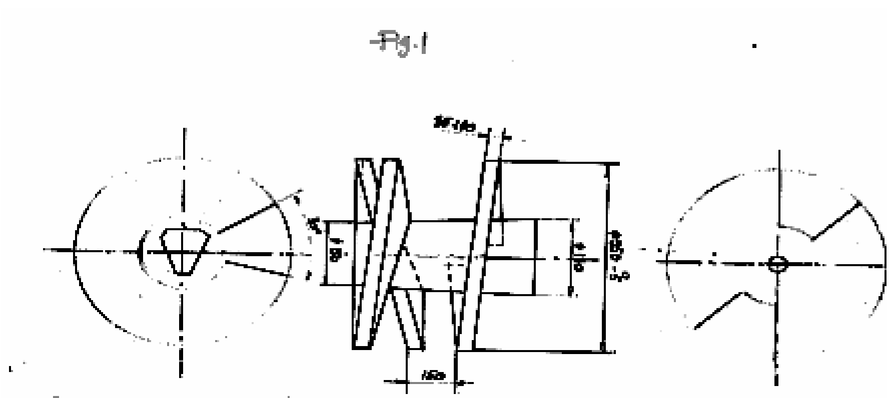

Fig. 1 A snail undergoing the process of rebuilding by welding.

The specifics of this paper are to be found in the particular way of achieving a co-working of the device where the spiral is fixed – further named "positioning-revolution equipment" and the welding operator who loads the helix and the source which supplies the electric arc.

By combining the characteristics of the positioning-revolution equipment, of the welding arc feeding source and of the welding operator's movements, a semi-mechanized rebuilding procedure applied to spiral parts used in the cement industry was implemented at the beneficiary end. Besides the constant quality of welding, this ensures a good productivity of the process as well.

When determining the rebuilding parameters, the authors have first and foremost taken into consideration the dimensional and geometrical characteristics, as well as the weight of the parts that underwent rebuilding, thus achieving, in principle, the technical solutions for a technological semi-mechanized system.

2. PRESENTATION OF THE PART THAT UNDERGOES REBUILDING

The half-finished product that undergoes rebuilding by welding has the geometry and dimensions as presented in figure 2, positions a and b.

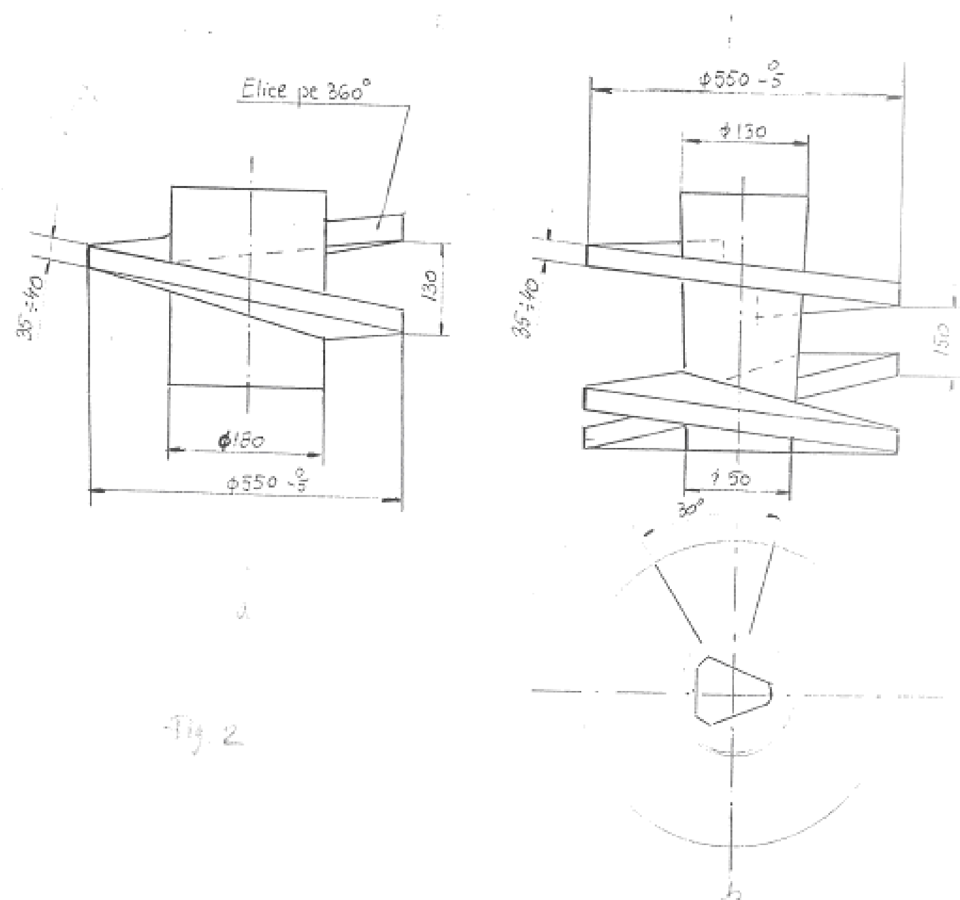

Fig. 2 Helical parts: a – with one helix; b – with two or more helixes

The half-finished part is made of low-alloy steel, by casting.

According to STAS 1773-82 and EN 10027-1, low-alloy or alloy cast-steel used for the building of machines has a chemical composition as presented in table 1 and main mechanical characteristics as presented in table 2.

Table 1. Chemical composition of the cast steel

Steel brand		Chemical elements								
STAS 1773-82	EN 10027-1	C %	Mn %	Si %	P %	S %	Cr %	Ni %	V %	Spiral variant
T35Mn14	G35Mn5	0.30÷0.40	0.20÷1.60	0.20÷0.42	0.01	0.04	-	-	-	Fig.2.b
T40VM17	G40MnV7-2	0.35÷0.45	1.60÷1.90	0.20÷0.42	0.04	0.04	-	-	0.10÷0.20	Fig.2.a

Table 2. Main mechanical and TT (thermal treatment) characteristics

Steel brand	Charac - teristic	Flow limit (min) N/mm2	Breaking limit (min) N/mm2	Elonga -tion (min) %	Impact ductility (J)		Thermal treatment (°C)		Improvement TT (°C)	
					KCU (min)	KCU (max)	Normal	Return	Chilling	Return
G35Mn5		350	550	18	30	35	850÷ 900	600÷ 650	850÷860	600÷650
G40MnV7-2		510	850	8	-	-	-	-	860÷870	640÷660

The specifications require that the main characteristics of the spiral/worm and of the layer that is deposited by welding – including the breaking limit and the abrasion hardness. For these reasons, it is difficult to obtain a layer with only one type of addition metal.

By means of the welding technology that was developed, an intermediary buffer-layer will be deposited between the base material (the spiral's helix) and the resistance layer. This intermediary layer has the role of chemically connecting the two materials.

3. THE TECHNOLOGICAL SYSTEM OF REBUILDING

The technological system of rebuilding conveying spirals used in the cement industry by welding consists of:

- positioning-revolution device
- feeding source for the electric arc
- equipment for setting the welding parameters
- the welding operator.

3.1. The positioning-revolution device

The positioning-revolution device used by the authors of this paper and recommended to the beneficiary is one of the DPR-1000 type, as can be seen in figure 3. This device ensures both the spinning speed of the spiral, on a circular path, in one sense or another, and its vertical tipping.

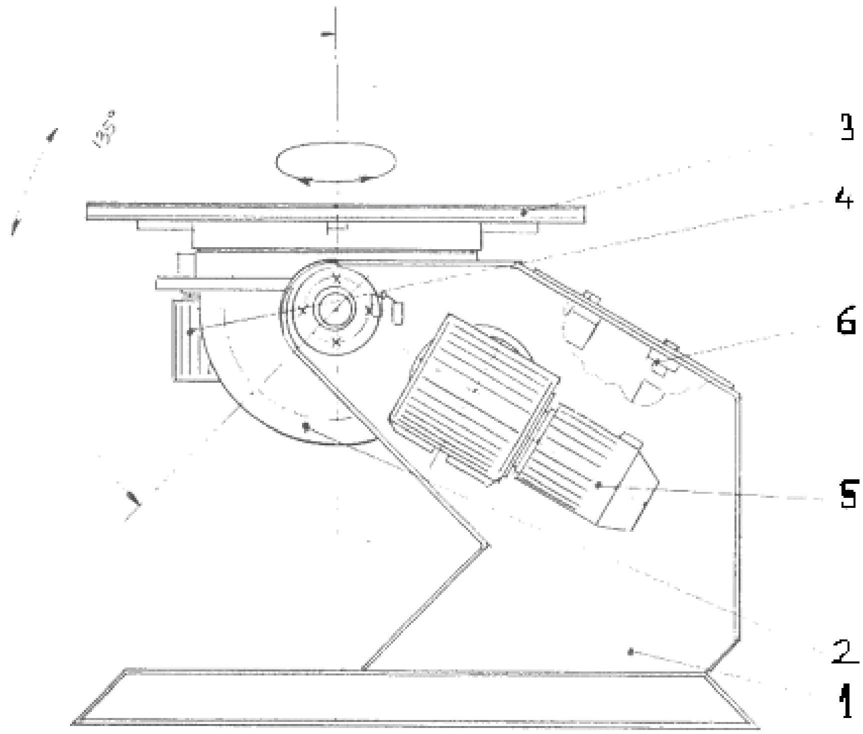

Fig. 3 The positioning-revolution device: 1- chassis; 2- tipping assembly; 3 – platform; 4 and 5 – three-phase motors; 6 – control panel

The main characteristics of DPR-1000 are presented in Table 3.

Table 3. The main characteristics of DPR-1000

Main characteristics	Maximum weight (kg)	Platform diameter (mm)	Platform rotating speed (rpm)	Maximum tipping angle (degrees)	Remarks
Values	1000	900	0.1 ÷ 1.1	135	Fixed tipping speed

The gear motor for tipping the platform is equipped with an electric brake that ensures its blocking in a specific position that the operator desires. The brake acts upon motor 5 when the braking coil is not supplied by the mains, as shown in figure 4.

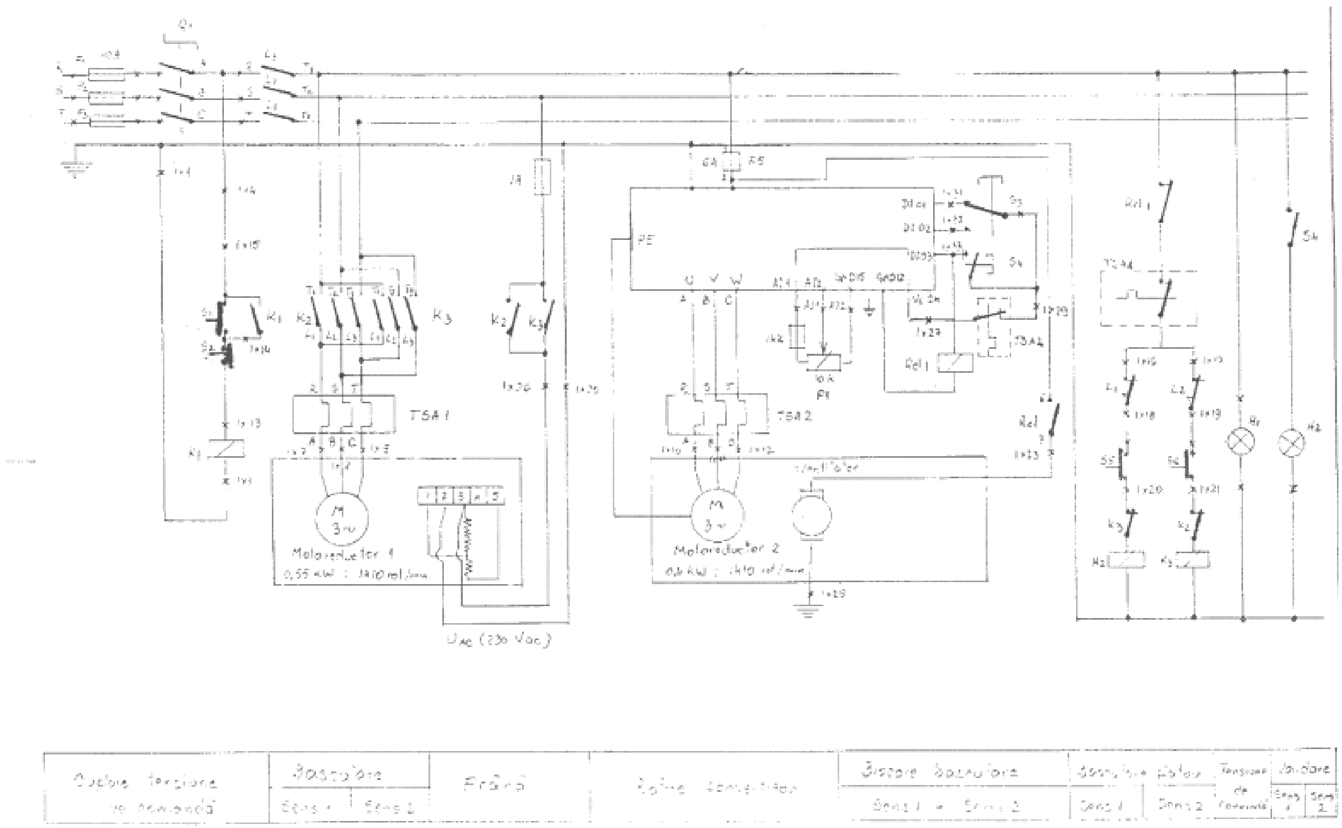

Fig. 4 The detailed electrical scheme of the DPR -1000 device

It is to be noted that, both for the revolution in the first or second sense and for the up-and-down tipping, the commands are doubled by a complex pedal, controlled by the welding operator. Thus, the operator permanently intervenes into the command of the DPR-1000.

3.2. The welding equipment

The welding source used has been of the inverter type STICK-350, being equipped with the special functions used for the arc ignition and with an adjustable dynamic, namely the "HOTSTART" and "ARC FORCE" functions.

Table 3 shows the characteristics of the inverter STICK-350 equipment.

Table 3. The main characteristics of the STICK-350 source

Charact.	U_1 (V)	C_s (A)	I_s (A)		I_{smax} (A) HOTSTART	Uo (V)	Time (s) HOTSTART	Adjusting field (A/V)
			DA=60%	DA=100%				
Values	3x400	20 ÷ 350	350	270	20 ÷ 350	109	0.1 ÷ 1.5	5/20.2 ÷ 350/34

By an adjustment of the arc dynamics and of the current polarity, this source may be used for any type of electrode and for welding in any position.

4. EXPERIMENTAL TESTS

4.1. Choosing the addition material

The parts that were rebuilt were fixed on the DPR-1000 platform, after the flanks of the spiral had been previously cleaned by polishing, until they got the metallic shine. The surfacing of the spiral was done in two layers: the first layer, named “buffer”, is an intermediary one, connecting the base material of the spiral/worm and the resistance layer. The rebuilding technology was developed as presented in the figure 5 scheme. The addition materials were chosen in accordance with the chemical composition of the base metal and with the resistance conditions required for the upper layer. The chemical composition of the electrodes is presented in table 3.

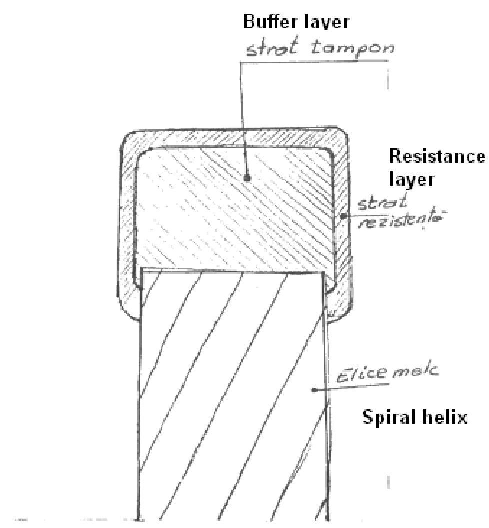

Fig. 5 The level of the helix that is surfaced

Table 3. Chemical composition of the electrodes used when surfacing

Electrode/ Elements	Cmax (%)	Mn max (%)	Si max (%)	P max (%)	S max (%)	Cr max (%)	$Ti_{min.}$(%)	V/W max (%)	Layer
ElCr9Si3									Buffer
ElGW86									Resistance

4.2. Establishing the rebuilding technology

The main parameters for surfacing of the spiral helixes are: the welding current (Is), the arc voltage (Ua), the welding speed (Es) and the linear energy (El). The secondary parameters are: the diameter of the electrode wire (de), the type of the electrode shell, as well as aspects connected to the thermal treatment before and after welding.

Table 4 presents the parameters of the welding technology both for the buffer layer and for the resistance layer.

Table 4. Main parameters of surfacing

Electrode type/ Parameters	Is (A)	Ua (V)	Es (cm/min)	El (J)	de (mm)	Shell type	Therm. treatment
ElCr9Si3							
ElGW86							

In figure 6 we can see the parts after they have been surfaced with the buffer-layer.

a. b.

Fig. 6 The spiral, after having been surfaced with the buffer-layer: a – only one helix; b – with two helixes

The parts that were completely rebuilt (buffer-layer and resistance layer) look like in figure 7, and after the thermal treatment they look like in figure 8.

a. ***b.***

Fig. 7 The rebuilt parts: a – spiral with one helix; b – spiral with two helixes

a. ***b.***

Fig. 8. The parts, after surfacing and thermal treatment: a – with one helix; b – with two helixes

5. CONCLUSIONS

The rebuilding, by welding, of strongly stressed elements – both from a mechanical and from a utilitarian point of view – used in the cement industry is useful and motivated because of the following reasons:

- the cost of a rebuilt part is about 50-60% of the price of a new part;
- if the rebuilding technology is well-established and well-applied, the life span of the surfaced parts is almost double when compared with new ones;
- the beneficiary needs to invest less and may apply elements of the investment to other products as well;
- the applied technology does not require highly qualified personnel.

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