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ELECTRO-CERAMICS CANDAL, V.N. GAIA; THE PRODUCTION OF ELECTRICAL APPARATUS

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ABSTRACT

The company Electro-Ceramic Candal, founded in 1914 and in operation until the late 1980s, today's business park, Candal Park, SA, was an important ceramic production company of the city of Vila Nova de Gaia (Portugal), either by the diverse number of products it produced, and the electrical apparatus production of high and low voltage, or the role it played nationally, at the height of national electrification, and internationally, with the supply to European cities in the post-World Wars of electric equipment for the reconstruction of their cities.

Around 1948, Electro-Ceramics possessed an important laboratory for testing the production of high voltage electrical apparatus and this is well documented. Not so with the production of small electrical porcelain appliance (lamp holders, various switches, ceiling rosettes, junction boxes, components of electrical panels, etc.), which we try to study, as main goal of this research.

The lack of written documentation led us to look for other sources of information, including oral information, interviews with a former engineer of the company, and access to non-printed documentation from former directors. We will present some results, although it is a work still in progress, and our goal is to continue this study, deepening better knowledge of this company, yet so little explored.

KEYWORDS Production; Electrical Apparatus; Museology; Industrial Heritage

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Introduction

The Electro-Ceramics Candal factory has labored with the production of ceramic parts made for electric circuit components and many other different products in Vila Nova de Gaia, Portugal, for more than half of the 20th century. It is, nowadays, an important example of conversion of industrial areas, with different purposes and uses: Candal Park - Company and Business Center, a park holding more than a hundred and ten resident enterprises. The study of its history and memory is yet to be expanded, and this is important due to the importance of preservation of technical and industrial heritage in its multiple aspects: communication and availability, benefits and development of the several communities. In a time where international innovation and economy do not sympathize with the existing stagnation, Candal Park may become part of the group of exemplary agents who show us that it is possible to conciliate new functions in converted areas with heritage value, which are not, none the less, not devoid of memory or context regarding its industrial past.

Purpose

The purpose of this contributory for the celebration of the International Year of Light intends to be the one of making it possible to get to know the company Electro-Ceramics Candal, especially its production of small electrical apparatus made of porcelain. This contribution presents itself as the means of initiating a larger study which is intended to be carried out. We intend to contribute towards the preservation of memory and towards the marketing of the industrial and cultural heritage left to us by Electro-Ceramics, towards the study and the collection's characterization, which is composed by the Candal Park's own administrative facilities, by small electrical apparatus, incomplete parts of electric switchboards, telephony appliance, domestic pottery, coins minted out of porcelain and other ceramic objects, as well as by documentation, in the form of record books, guest and dedication books, high and low voltage catalogs, photo albums and graphic catalogs of ordinary pottery.

Notes on the company's history

In 1942, a limited company was founded, with the designation of Mourão & Cª.,Lda. Its deed dated from the 17^{th} of January. Its manager, Joaquim Pereira Ramos had already created, in his own individual name, a small workshop on the street "Rua 24 de Janeiro", in Lisbon, with the purpose of producing electrical apparatus, acquiring the raw porcelain that he required for production from the factory of Porcelain factory of Vista Alegre, in Ílhavo, Portugal. The hardship in the creation of this small workshop and in the acquisition of the porcelain he required, made him purchase, in the name of this already referred company's name, a new land property, in a place called "Lugar da Fonte das Regadas" in Candal, Vila Nova de Gaia. In this place, he based the headquarters of a small facility in Quinta das Regadas, where he assembled his small industrial factory, with only 40 employees. He, then, started to produce electric porcelain in an area of just $1200m^2$ (Guimarães, 2009, p.13).

In 1915, the company Mourão & Cª, Lda gives rise to "Empreza Electro-Cerâmica, Limitada". Having a distinct designation, the company Empreza Eletro-Cerâmica, Lda, had the purpose of *"practicing the industrial and business trade of porcelain articles, spare parts, electric devices and any other objects that its partners may deem convenient for the company to produce"* (Guimarães, 2009, p.14).

The First World War imposes its hardships upon Electro-Ceramics, as well as upon the other industries in the country: many financial hardships due to, above all, the national market's protections, to the lack of raw materials and difficulties in importing coal. However, and despite these hardships, the company expands its territory and gives rise to a growing Industry: producing electrical apparatus for low voltage facilities. These were, at the time and due to the difficulty in importing this type of appliance, in great need (Saraiva, 1985)[2].

In 1919, the already referred hardships lead to a new company reorganization and the company "Empreza Electro-Cerâmica", S.A (referred as E.C)", is formed. From this day forward, the company gains new energy and starts to produce, besides the already usual small appliance, the Bergmann tube[3]. A small laboratory is also built with the purpose of designing and producing high voltage isolators, equipped in 1922, for tests of up to 222 000 volts. A laboratory that was already by then acknowledged as the best laboratory in the Iberian Peninsula, and one of Europe's best, under supervision of the engineer Augusto Bastos Ferreira do Amaral. The E.C.'s management also had the ambition of making different products. For this, they acquire, in 1920, some old rustic facilities in Regadas, for the construction of a department containing packaging and new offices. They acquire also new land with the purpose of establishing two new industrial production units for electric lamps and electric conductor wires.

[2] Saraiva, José Nicolau Vilar (1985), *Apontamentos sobre a vida da empresa Electro Cerâmica desde a sua fundação até à sua compra pela fábrica de porcelanas da Vista Alegre*. Non-printed document, lent by the management of Candal Park. José Nicolau Vilar Saraiva was incorporated in the E.C. in the year of 1924 to work in the metallurgical department, which he then began to lead in 1926, among other roles. Around the year of 1926, he starts to work as the company's Technical Manager. Data provided by the author in his own notes.

[3] The Bergmann tube was made of a tube of soaked paper, covered in wrought iron bands or zinc, destined for the protection of electric wires in a distribution system, with a high level of security (Saraiva, 1985).

However, these new projects are not carried out due to financial difficulties (Saraiva, 1985).

In 1926, the company faces a big crisis and is forced to get a loan in the bank Companhia de Crédito Predial Português, in the amount of 9.000.000$00. In 1936, the company establishes an agreement with the porcelain factory "Fábrica de Porcelanas da Vista Alegre", in which each of them acquires 50% of the Porcelain Society's capital and agrees not to carry out sales in certain regions of the country, so that the society is made feasible in those regions (Saraiva, 1985).

The E.C. was, without doubt, one of the most modern enterprises of its time and one of the first companies to produce electricity for its own consumption and for the production of its own porcelain. It had a power station with synthesis gas and two engines, an Otto horizontal model of 100HP, and a vertical one of 4 cylinder with 300HP of the Campbell brand. These would activate an alternator of 65 kVA and another one of 210 kVA. It even provided electric energy for the little public illumination of the municipality, while the negotiations between the Gaia City Council and the hydroelectric station of Varosa were taking place, as a response to the local councilor's request, who was at that time (1920/21) Armindo Ramos, Secretary of the General Assembly of the E.C.. The power station recovered its full strength during the Second World War, when there was an urge to control the usage of electric energy (Saraiva, 1985).

In 1945, the E.C. was once again highly indebted and its creditor, the Companhia Geral de Crédito Português bank executes its last guarantee, which corresponded to 99,98% of the company's stock, to settle the debt. Thus, the Companhia Geral de Crédito Português and the porcelain factory of Vista Alegre make an agreement in which all company debts are settled and a new loan for the economic reorganization in the amount of 5.000.00$00 was requested (debt settled in 2005). This way, the Grupo Vista Alegre became the only domestic and decorative porcelain producer, as well as of electrotechnical porcelain and small electric appliance. The E.C. starts focusing the production on small electrical apparatus, isolators, plastic and Bergmann tubes, as well as of PVC (polyvinyl chloride) pipes, while the table's porcelain is focused on the Porcelain Society. An economic reorganization of the company takes place, now equipped with new and more modern technology, favored by the country's new strength in electrification and by the openness of international markets (Guimarães, 2009).

In 1964, a new company branch is inaugurated in Luanda, Angola, whose production was mostly based on PVC, but also in small electrical apparatus and new products in the growing market, particularly the hard PVC pipes. This product starts being greatly adopted throughout the whole country for water supply and sanitation systems. The following decade is marked once again by strong movements, especially after 1974, due to various factors, such as the loss of the colonial markets, the opening of national borders, the competition from big economies, the process of finalizing national electrification and the strong demanding spirit of the time, with the ongoing salary raises and collective contracts.

With Angola regaining his independence in 1975, the branch in Luanda is lost. This phase is only overcome by the end of the 1980's, with a new reorganization. In 1989, the company's activities are split into different individual companies, thus being born the Ecoplás, Empresa de Plásticos Técnicos, S.A. (PVC pipe production), the EC-Electric Appliance, S.A. (small electric appliance production), and the Cerisol, Ceramic Isolators. This last one is the only company who is still active nowadays. On a second phase, Ecoplás, S.A. is sold to the Finnish group NESTE and the EC- Electrical Apparatus, S.A. is sold to GE Power Controls Portugal (Guimarães, 2009).

From 1989 onwards, the E.C, owner of the facilities and company land, transforms the area in an Industrial Park, whose first residents are the E.C. Electrical Apparatus, S.A. and the Cerisol Ceramic Isolators, S.A., who rented their facilities there. And it is thus that "*located in Vila Nova de Gaia, in an area fit between the highway and an urban yet rural town(...) the built area of Empresa Eletrocerâmica do Candal is going to develop itself throughout time and through transformations of a farm territory into a factory territory, until the actual setting of Industrial Park."* (Oliveira, 1998, p.233).

The Candal Park -Company and Business Center of today as we know it, has transformed itself into a reorganization area, as well as an area of urban industrial memory conservation.

Elements for characterization of production

Throughout the various decades of Electro-Ceramics existence, its production has been very varied. We will not here refer to the production of every article individually, but we shall focus on a few relevant aspects of the company's production and on its most relevant products, important for its characterization.

The company first focused on the production of porcelain for electric components and having, for said purpose and according to the engineer Saraiva (1985), four production systems: pressing process, joules, turning and slip process. We will refer only to the production through pressing process, for it is the one that constitutes the foundation of small apparatus, which is our object of study. We underline the lack of documentation and data about the process, at least until the present day, and the importance of oral sources, such as engineer Vasques de Carvalho's testimonial.

The crushing system was the most used system for the production of compressors, small isolators, ceiling rosettes and small entries, or components used in small electric devices, which after being metallized, were used in switches, commutators, junction boxes, power sockets, extension cords, etc.

The production of these components was of high relevance to Portugal, due to the ongoing phase of electrification of the country. It was also important for exportation. The E.C. was exporting to Spain, Belgium, Italy, Switzerland, the US, Argentina and Brazil, as well as to the Portuguese colonies in Africa (Soeiro, et al., 1995). After the two great wars, most European countries had multiple problems with production insufficiency, for they had to rebuild their cities and provide for their markets.

In 1920, it was necessary to increase the pressing process section, and it began to occupy a building from the old factory (Fábrica de Fitas do Aranha[4]). Here, they installed 120 presses and, in 1942, around 50 male employees were working there. With the expansion, it was necessary to hire more employees due to the needs created by exportation. Until the First World War, the production of small apparatus was focused only on raw apparatus. This increase of exportation led to the need of metal installation and the correspondent component metallization. Then it was built a facility of two floors: the ground floor, meant for metal production, and top floor, with the purpose of its assembling (Saraiva, 1985).

[4] This is the reason why they still refer to the E.C.'s factory as "fábrica do Aranha".

The electric installations, made in the 1920's, were all external and visible because they were being made in already finished facilities. Thus, in 1924, the major consumption was of the following products: switches, lamp supports, mignon supports, power outlets, ceiling rosettes, air fuses and fuses for E.C. distribution boards. The products that were mostly exported to Brazil were the ceiling rosettes, of a different model than those sold in Portugal. The orders were of around 50 000 to 100 000 units. The small apparatus sector kept growing. In 1924, the production was of around 500 pieces, but, by 1944, this number was above 2 000. And, naturally, we refer to the beginning of the national electrification process, adding up to the exportations (Saraiva, 1985).

The metal section was exclusively executed by women. From 1924 onwards, under the engineer Saraiva's command, the metal cutting process started to have two punctures with inverted positions instead of just one, for he thought that, this way, one could save more brass in the production of multiple pieces. The results were so positive that Mr. Saraiva was congratulated for the intervention, in spite of the company's financial difficulties, as he wrote in his own notes (Saraiva, 1985).

Small apparatus was always marketed through resellers, mostly in the cities of Lisbon and Porto. The agreement held between the reselling firms was the following: the company was limited to selling only to firms who would be part of the contract; these sales were done in minimal amounts, fixed for each article, and the reselling firms could not buy any material from the competitors, be it national or foreign. This agreement was in effect at least until 1935. With the purchase of the Porcelain Society's by the Vista Alegre group and by Electro-Ceramics in equal share, a new agreement was signed, more profitable for both companies, or, at least, in benefit of common interest. However, after the Second World War, the agreement was no longer valid due to the hardships in stocking of raw material. For this reason, the small apparatus business is passed on to storekeepers (Saraiva, 1985).

The isolator tube of Bergmann type started being produced in 1919 and had an exclusive period of 10 years, since it consisted in the introduction of a new type of industry. The acceptance of the national pipe took some time until it reached the buyers, but its qualities quickly stood out, and they were not behind the previously used pipes with Spanish origins. Also regarding the production of the Bergmann tube, hardships were felt in acquiring ribbon/tapes of wrought iron, meant for the soaked paper covering, which is part of the pipe (Saraiva, 1985). Thus, it was necessary to resort to the utilization of zinc strips, initially imported, and later obtained through zinc plate lamination (Saraiva, 1985).

Of great importance for the company's production was also the high voltage isolators production, backed up by the existence of a first lab in 1921, equipped for 220 000 volt tests, which was under the leadership of the electrotechnical engineer Augusto Bastos Ferreira do Amaral. The laboratory was equipped with two electrical transformers, one of them with 50KVA at 220 000 volts, a spherical spark gap, devices for artificial rain production and three electric test tables. In this laboratory, many isolator tests were conducted for power lines, mostly for the firm Companhia Hidro-Elétrica do Varosa (Saraiva, 1985).

In a well performed attempt of securing the production of competitive ceramic isolators in the country, a study and test laboratory (GLE) was created in 1948, whose purpose was to research raw material, ceramic clay, and the raw material handling processes, in order to be able to create high and controlled quality products. It is still possible to see the laboratory facilities in Candal, which was under the design and management of the engineer Prof. Manuel Corrêa de Barros. The building englobes two parts: the first one has two floors, and the second one, destined for high voltage lab. When construction of the GLE was finished, it contained a study room, offices, a design room, a library, an electrotechnical lab to perform electric isolator tests, a laboratory for physic and chemical tests, the study of raw material and ceramic clay, and a small ceramic lab, for the study of ceramic production methods (Guedes, 2003). The official inauguration of this laboratory was on the 15th of February in 1952 (Barros, 1952).

Production of ceramic clay in the General Laboratory of Studies

According to Saraiva (1985), the production of pottery in the E.C. was motivated by the competitors that the group Vista Alegre made in the production of electrical apparatus, in 1921. The painting section only turned active in 1922. The raw materials used in the paste for pottery production were china clay, feldspar and clay from Pombal, and, for the glass, feldspar, quartz and calcium carbonate. The pottery business was handled through storekeepers, who would frequently evaluate the decoration of pieces that would need to be replaced after a while, in order to fulfill the market's demands. On the other hand, the pottery color in the E.C. was not as white as of the Vista Alegre group, and was, for that, less successful. This was due to the use of china clay from a place called Senhora da Hora, which did not provide a color as white as the china clay from deposits in Ovar/Vila da Feira, and those were used by the Vista Alegre group. So, the E.C. decided to acquire their china clay from these deposits and their paste began to contain 1/3 of china clay from Ovar and 2/3 of china clay from Senhora da Hora, resulting in an improvement in the pottery coloring. It would not, however, match the whiteness of the Vista Alegre group's pottery.

It is also due to Saraiva (1985) that we know that tests were made for the production of Bakelite (Polyoxybenzylmethylenglycolanhydride)[5] and the E.C. started producing it for small electrical apparatus and for small ceramic electrical apparatus lids. By the end of 1940's decade, the production of PVC is included in the production of electrical conductors, and later, accessories and liquid conductor pipes.

The mintage of porcelain coins is noteworthy of recognition, due to its significance and high relevance. After the First World War, the nation had a generalized lack of coins for change, namely of 1, 2, 4 and 10 cents. For this reason, municipalities were authorized to issue paper notes, who would be rendered useless after a few uses, due to the lack of paper quality. Thus, the Gaia municipality placed an order to the E.C. for ceramic coins. The coins had a crown with King Ramiro's mural in the backside, and at the end, the year. On the front and middle, the amount and the unit: cents (centavos). By the end of 1922, the Tax office, by command of the Portuguese Bank, began collecting the coins once again. The municipality proceeded onto the exchange of the coins which were active in its treasury (Saraiva, 1985).

The production of small electrical apparatus

Much of the paste that exceeds from the production of high voltage isolators was used for the production of small appliance.

The preparation of the ceramic paste for electrical apparatus required multiple phases. Taking Professor Corrêa de Barros' description (1952)

[5] Synthetic resin formed by combination, through polymerization, of phenol (C_6H_5OH) and formaldehyde.

into account, the raw-material grinding process was made through ball mils, also known as "alsings". Before inserted in the mills, the raw materials were weighted, as well as the used silex pebbles, and the required water was measured. The amounts were previously defined, in order to provide the thinness required for grinding. Then, the paste would follow to the pressing filters, after making it through vibrating screen/sieve, which would separate the particles of excessive diameter, and through magnet splitters, which would eliminate any iron that it could contain. After the paste left the pressing filters, it would go through an aging period and would be sent into a vacuum kneader machine, where it would be mechanically disaggregated and, when in a high state of thinness, forced into a vacuum chamber, in order to remove all the existing air. It would be extracted from the chamber by a screwing system, making it go through a nozzle which would calibrate it in cylinders, adjusting it for the next phase, "balling" (Barros, 1952).

The cylinders that would leave the kneader would be cut by a wire and put over a zinc covered table, where parallel and equidistant wires would lay, in order to cut the paste into sufficiently sized pieces that would fit their respective parts. The pieces of paste would, then, be hand mashed into balls and put in the geometric containers to be sent to the press machines. The press machines were manual, with warmed rotatory cleat (Barros, 1952).

The production of small apparatus in which our study focuses was fundamentally done through pressing, as already referred. In this production, according to engineer Vasques de Carvalho's testimonial, they used something called dry grinded paste, which would then be mixed with a lubricator (fuel-oil), put in the geometric containers and then pressed. The excess of paste would be expelled from the mold. It would then move on to the deburring phase, where all imperfections would be deburred before moving on to the next phase, consisting of the laying of ceramic glaze. Next, it would be sent into the oven, where it would cook with a temperature of 1 100°C. This process would be called moist pressing/wet integration. There was also dry pressing, but its use was not that common. In this case, the pastes would be rich in talcum (magnesium silicate). The talcum would be put in the molds in the right amount (there is no exact data of this amount) and then the paste would be pressed, and, unlike the moist pressing/wet integration process, nothing would be extracted from the mold, and no excess would exist. In this situation, the paste would come out of the press machine already dry, moving immediately on to the glazing and oven section.

This whole section was set up, in order to save room. The paste would move between processes from one table to the other, where it would be moved by the next employee (Barros, 1952).

In the drying section, the dryers were set according to pressure and humidity levels, to make sure that this process would go on uninterrupted. The heating process was accomplished through steam. The dryers had a psychrometer that allowed verification of temperature and humidity of outside weather. Then the glazing by immersion would follow. The ceramic glaze's main purpose is to provide a hard shell, non-absorbing and easy to clean (besides the aesthetic purposes, of course), thus contributing towards the improvement of mechanical and electrical properties (Barros, 1952).

After the glazing, the pieces would be sent to the ovens, which could be a tunnel-like oven or an intermittent coal furnace, shaped like a bottle. The cooking conditions were inspected with thermoelectric and optic pyrometers and with pyrometric bars called "Holderoft", put in different spots of the oven.

Right after leaving the oven, the pieces would be sent to the picking section, where each and every one of them would be inspected to minimum detail and a book would be filled, where the approved stock would be listed, as well as the ones that would be considered garbage and their respective flaws. The flawed pieces would be put on a table and reexamined, in order to make sure the flaw they contained would interfere with the piece's behavior or if it could be excluded from flawed condition. On the other hand, it was necessary to verify if the flaws were a product of bad manufacturing or poor choice of cleaning methods, poor usage of oven, etc. After the selection, the pieces would follow to the assemblage of metallic components' section. Lastly, they would be packed in boxes of different amounts, according to the buyer's needs (Saraiva, 1985).

It was not possible to characterize the production of metals and copper alloys (bronze and brass) and iron alloy due to lack of information. However, according to Eng. Vasques de Carvalho's testimonial, there were lathes, press and cutting machines, as well as screw making machines and those who preceded the bronze plates bending machines, such as in the case of production of cylinder thread of lightbulb supports. The bronze plates would go in a machine and, through multiple bending processes, it would provide the plate its cylindrical aspect. Those processes would have to be highly supervised, since the bronze, as a sensible alloy (copper and tin), could break if pushed or stretched too far. The cutting machines would mostly do the cut in small plates, in order to fit the molds for the necessary parts.

And to be concise, the screwing machines would receive the wires, which would be hit on the top, to form the heads. Then, they were cut more up ahead, with the intended size, originating a head with a lean body. They would go through two iron cylinders, which as they rolled would originate the thread.

Engineer Vasques de Carvalho refers to the existence of nickel in the copper alloys, namely in bronze, and of screws in nickeled iron alloys, as well as silver wires for the fuses in the small electrical metallized apparatus. According to Carvalho (2014), phosphor bronze was also used in small appliance metallization. Because it had more elasticity than tin bronze, it could be used in the places where a bigger elasticity was required, without impairing the resilience. The thinner parts were, in fact, usually made of phosphor bronze. They could also use aluminum, just for its cheap cost, but it was also used in less amount due to low conductivity compared to copper and bronze, and for its bigger oxidation potential. Iron and steel were also used as electric conductors, but as to what the E.C. concerns, these materials were more used in alloy, in production of screws for the parts' assemblage process, although few examples of its usage in small electrical apparatus are found.

Conclusion

The purpose of this research was to make a preliminary contribution towards the appreciation and preservation of technical and industrial heritage, more particularly the heritage connected to circuits and illumination systems, through the study of the company Electro-Ceramics Candal and part of its collection. This way, we tried to share knowledge about the most relevant historical facts and of the main production aspects of small apparatus with porcelain, detailing it as much as possible. Far from being finished, our purpose is to expand it and develop it, identifying, locating and exploring other sources of information, in order to contribute towards the preservation of this city's inhabitants' collective memory and towards a future legacy of the old industry's work spaces.

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