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PRESENT STATUS OF THE ELECTRICAL EQUIPMENT  
MANUFACTURING INDUSTRY IN BRAZIL

by Carlos Berenhauser

NOTE: This text is subject to editorial revision.

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## 1. Introduction

### (a) Initial efforts

The development of the economy of any country is fundamentally dependent on the expansion of its electric power production. Obviously, this requires increasing quantities of all classes of electrical apparatus and equipment.

In the special case of Brazil, the electric power programme cannot be implemented through imports of equipment alone. For this reason the Brazilian Government, since 1944, has consistently encouraged the establishment of manufacturing facilities in this very important key industry.

The original studies were made (1944-1946) by the Comissao da Indústria de Material Elétrico (CIME). They were continued by the Comissao Executiva da Indústria de Material Elétrico (CEIME) and the Comissao de Indústria Pesada (CINPE), created by the Federal Government, respectively on April 4, 1952, and April 16, 1955. In 1956, the studies were continued by a working group of the Development Council (Conselho de Desenvolvimento).<sup>x/</sup>

All these Commissions were unanimous in their conclusion that it is necessary to encourage and sponsor, as much as possible, the manufacture in Brazil of a complete line of electrical apparatus and equipment, specially of the heavy classes.

### (b) Situation during the Second World War

Looking back to the Second World War, Brazil was practically paralysed in the development of its electric power programme because of its dependence on imports from America and Europe. After the war, in spite of the very favorable foreign exchange situation, Brazil still could not be supplied with its power needs until the war torn countries were rebuilt. Electric power was rationed all over the country. The only way to avoid a repetition of this situation in the future is for Brazil to become more dependent on its own electrical manufacturing industry.

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<sup>x/</sup> The author of this paper was a member of CIME and Chairman of CEIME, CINPE and the working group.

(c) Recent progress

The efforts of the Commissions mentioned above have resulted in the establishment of a growing industry for electrical equipment and apparatus. Up to the present, production facilities have been extended considerably not only in the quality of equipment manufactured, but also in the increased ratings and quantity of such apparatus.

For the past five years Brazil by its favorable foreign exchange policy and its customs duties has been able to protect its infant electrical manufacturing industry by prohibiting the import of equipment, materials and apparatus which are being manufactured locally, in adequate quality and quantity. Paradoxically, sometimes, under this system it would be cheaper to import items from abroad. However, as competition sets in and development loans are paid off, the cost of electrical equipment will be lowered and this will spur the development of other related industries.

(d) Future electric power requirements

Plans, so far, have been concentrated on keeping pace with electric power requirements in order to avoid any delay in meeting the country's basic economic needs.

The table below shows the growth of installed generating capacity and per capita power production over the past 20 years and projects up to 1965.

<u>Years</u>	<u>Installed capacity kW</u>	<u>Power production kWh per capita</u>
1940	1,243,877	80
1945	1,341,633	107
1950	1,833,007	153
1955	3,148,489	232
1959	4,063,500	286
1960	4,660,000 <sup>a/</sup>	327
1965	8,000,000 <sup>a/</sup>	490

<sup>a/</sup> Estimated in accordance with the electrification programme of the Federal Government (Plano de Metas). The goal originally set at 5 million kW for 1960 could not be met due to some delays in certain individual programs. About 20 per cent of the installed power capacity is thermal and the balance is hydraulic.

(e) The increasing market

This growth in electric power has caused the expansion of many smaller industries and is resulting in an improved standard of living.

The estimated population of Brazil, 65 million in 1960, will be 80 million in 1970 and 100 million in 1980, a growth of 2.5 per cent per year. This rapid growth of the Brazilian population, coupled with the continuous improvement of its standard of living, is resulting in the tremendous development not only of a market for heavy electrical apparatus and equipment but of a consumer market for all kinds of electrical appliances and material. They will be manufactured in ever increasing quantities.

The Brazilian production of electrical equipment and apparatus as a whole is presently around 20 thousand million cruzeiros per year (in round figures, 110 million dollars at the free exchange rate).

After a short review of the present status of the manufacture of light equipment, apparatus of the consumer goods class, small and medium sizes industrial materials and apparatus, a more detailed discussion will be undertaken regarding the manufacture of heavy electrical apparatus and equipment.

2. The manufacture of electrical consumer goods and industrial equipment

(a) Wiring devices

The first step in the electrical equipment manufacturing industry was taken shortly after the end of the First World War with the production of consumer goods normally required for the electrical wiring of houses and buildings, such as: wiring devices, small switches, all sorts of molded plastic electric products, wires and cables, incandescent lamps, batteries, etc.

At present, all the country's requirements in this line of goods is entirely satisfied by the local industry.

(b) Electrical appliances

During the last 20 years the appliance industry has developed phenomenally to the point where Brazil today does not import anything except a few components. Among the appliances manufactured with the production forecast in 1960 are: refrigerators (235,000), window-type air conditioners (25,000), flat irons (90,000) vacuum cleaners (65,000), food-blenders (310,000), floor polishers (146,000), fans (100,000), water heaters (34,000), grills (9,000), radio receiving sets (390,000), television receiving sets (140,000) and radio-phonographs (40,000).

Around 1,200,000 fractional electric motors are being manufactured per year. Telephones and related switchboards are also currently fabricated in Brazil.

(c) Industrial motors and controls

The market for industrial electric motors and controls is extensive. This includes apparatus for all types of industries such as chemical, fertilizer, mining oil, paper, steel and transport.

The manufacture of industrial motors of all sizes and purposes is well established. Several plants, among them the two largest - Arno S.A. and General Electric S.A. - with factories in the State of Sao Paulo, are satisfactorily meeting the Brazilian market's requirements.

The total production of industrial electric motors is at present

/about 2

about 2 million HP per year (about 400,000 units).

The materials and equipment normally needed in industrial installations such as controls for starting and protecting electric motors, fuses, cut-outs, contactors, control boards, panels and unit substations, are currently manufactured by the national industry.

Approximately 2,000 welding sets and all types of welding electrodes are also manufactured in Brazil.

(d) Elevators and overhead travelling cranes

Elevators and escalators for all types of residential and commercial buildings are manufactured by several large organizations with all components and a large proportion of raw materials produced in Brazil. The leaders in this industry are Elevadores Atlas and Elevadores Otis.

In the same manner, the manufacture of all types of conveyors and overhead travelling cranes by several enterprises is well established.

(e) Power distribution equipment

The final stage of the electric power industry is the distribution of power and this brings it in direct contact with its customers.

The local manufacturing industry satisfies completely, both in quantity and quality, the equipment and apparatus requirements for the construction of primary and secondary distribution lines, as well as for public lighting system. Included are meters, wires and cables, insulators, hardware, transformers, etc. It may be noted that there are about a dozen companies manufacturing distribution transformers. Some of them are also producing power transformers which will be discussed later.

3. The manufacture of heavy electrical apparatus and equipment

(a) Power transmission equipment

The construction of steel towers in Brazil has shown a remarkable development during recent years.

The Sociedade Brasileira de Eletrificação, a firm specializing in the manufacture of steel transmission towers, among others, has already fabricated several thousand tons of steel towers for a 275 kV line in its

work-shop located in the vicinity of Belo Horizonte, in the State of Minas Gerais.

The Companhia Siderúrgica Nacional (Brazilian National Steel), at its Volta Redonda plant situated in the State of Rio de Janeiro, has also manufactured steel towers for up to 220 kV transmission.

The construction of transmission lines on reinforced concrete poles is very popular in Brazil. Two 220 kV transmission lines, one of 270 km and the other of 180 km, on concrete structures are presently being built. Postes Cavan S.A., with its headquarters in Rio de Janeiro and manufacturing plants in several cities in Brazil, is the leading company in this field.

All types of copper conductors and high voltage cables have for many years been manufactured in Brazil by Pirelli S.A., at its factory in the city of São Paulo.

Aluminium conductors steel reinforced (ACSR), mostly used in high and extra-high voltage transmission lines (there are 345 kV, 275 kV and 220 kV transmission lines under construction and several 220 kV lines already in operation), as well as their accessories and hardware are being manufactured for practically all sizes, by the following plants besides Pirelli already mentioned above:

Empresa de Productos de Alumínio, (EMPRAL), in Lorena, State of São Paulo

Companhia Brasileira de Alumínio, in Alumínio (Sorocaba), State of São Paulo

Alumínio de Brasil S.A., in the city of São Paulo.

Transmission line insulators and their related hardware and accessories are currently manufactured by the local industry, except for some insulators and hardware for extra-high voltage lines.

Among the porcelain transmission line insulator manufacturers, the following are listed below with the location of their factories:

Companhia Cerâmica Brasileira, in Rio de Janeiro, State of Guanabara

Indústria de Cerâmica Cerqueira Leite S.A., in the State of São Paulo

Cerâmica Santana S.A., in the State of São Paulo

Tecnocerâmica S.A., in the State of São Paulo.

Some of these manufacturers have made technical assistance arrangements with well-known foreign organizations.

A newcomer in this field, manufacturing glass insulators, is Vidraria Figueras-Oliveras S.A. (Vifosa), licensed by a French organization. The factory of VIFOSA is in the vicinity of Porto Alegre, State of Rio Grande do Sul.

(b) Power transformers

The field of power transformer manufacture has been marked by considerable progress lately. In 1956, the local subsidiary of Brown Boveri of Switzerland decided to manufacture three-phase units up to 50 mVA and 275 kV at its plant in Osasco, State of São Paulo. General Electric S.A., a subsidiary of General Electric of the United States, included in the manufacturing programme of its new factory being constructed at Campinas, State of São Paulo, the fabrication of three-phase power transformers self-cooled up to 50 mVA and 380 kV (European class).

The largest transformer units fabricated up to the present by each manufacturer are the following:

Indústria Elétrica Brown Boveri S.A.

Three-phase transformers, 30 mVA,  
220 kV and 58 mVA, 132 kV;

General Electric S.A.

Single-phase transformers, 15 mVA,  
161 kV and three-phase transformer,  
20 mVA, 132 kV;

Line Material do Brasil

Three-phase transformer, 5 mVA, 69  
kV;

Siemens do Brasil Companhia de Eletricidade

Three-phase transformer, 6 mVA,  
69 kV;

Companhia Sul Americana de Eletricidade, (AEG)

Three-phase transformer, 4 mVA,  
69 kV;

Indústria de Transformadores Elétricos (ITEL) S.A.  
Three-phase transformer, 5 mVA,  
88 kV.

Potential and current transformers for metering and relaying are being manufactured by the above companies for the same voltage as their corresponding power transformers.

The Brazilian market for power transformers will be approximately 2,500 mVA per year by 1965.

(c) Switchgear

For the large variety of components required in its fabrication and the diversity of types of equipment normally required by the market, the manufacture of switchgear, either for outdoor or indoor use, has not shown the same progress in local manufacture.

Presently various organizations are very interested in developing the production of several switchgear lines.

Just as an example it may be mentioned that General Electric S.A., with over 7,000 employees, includes among the principal products to be made in its new factory in Campinas:

Outdoor power circuit breakers

Oil-poor type, with intermediate interrupting capacities, for voltages from 34.5 kV to 161 kV,

Air-blast types, (Oilless), with high interrupting capacities, for voltages from 115 kV to 345 kV (American Standard) or 380 kV (European standard)

Outdoor disconnecting switches

Single-pole and group-operated, 3-pole types, for various voltages, up to 345 kV (American Standard) or 380 kV (European standard)

Lightning arresters

For various voltages, up to 345 kV (American Standard) or 380 kV (European standard)

Metal-clad switchgear equipment

Up to 15 kV, for indoor and outdoor installation:

Oil circuit breakers and air circuit breakers are already being made up to 25 kV. Certain types of metal-enclosed switchgear panels

/and control

and control boards are also being manufactured. Among the manufacturers of the above items of switchgear are the following:

General Electric S.A., with factories in Rio de Janeiro and São Paulo

Siemens do Brasil Companhia de Eletricidade, with factories in Rio de Janeiro and São Paulo

Sace Brasileira, with factory in São Paulo

Line Material do Brasil S.A., with factory in Rio de Janeiro

Companhia Sul Americana de Eletricidade (AEG), with factories in Rio de Janeiro and São Paulo.

The following organizations are set-up to manufacture disconnecting switches up to 220 kV/1200 A:

Line Material do Brasil S.A., with a factory in Rio de Janeiro

Fábrica Alcace de Aparelhos Elétricos Ltda., with a factory in the State of São Paulo.

Disconnecting switches up to 69 kV/600 A are being manufactured in the State of Sao Paulo by the following:

Delta Indústria de Aparelhos Eletricos Ltda.

Kerman Máquinas Elétricas S.A.

S.A. de Construções Eletromecânicas Sace Brasileira

Lightning arresters are being made by the following:

Fábrica Alcace de Aparelhos Elétricos S.A., up to 25 kV

Line Material do Brasil S.A., up to 15 kV.

(d) Power generating and large rotating equipment

The manufacture of electric power production components, including, among others, large hydraulic generating units, is the most recent approach of the Brazilian heavy electrical manufacturing industry.

Two companies are in the construction of medium size boilers up to 600 lb/sq.in. units for thermal electric plants and other industrial purposes:

Companhia Brasileira de Caldeiras, affiliated with and licensed by Combustion Engineering Inc. (USA), with its plant in Varginha, State of Minas Gerais

Babcock & Wilcox S.A., associated with Babcock & Wilcox (Great Britain), with its plant in Rezende, State of Rio de Janeiro.

The manufacture of steam turbines is being started for small industrial units, especially for sugar and paper mills. There are several companies interested in entering the field of diesel engine manufacture for marine propulsion, since the Brazilian Government is sponsoring a large ship-building programme. This will encourage the construction of diesel engines suitable for driving electric power generators, which are required in certain areas of the country where hydro power cannot be developed.

In Brazil, several mechanical and boiler shops are equipped with large machine tools suitable for the manufacture of headgates, taintergates, penstocks, valves, racks, stop-logs, and other equipment required in the installation of hydroelectric generating plants.

The manufacture of small size hydraulic turbines has long since been started by several plants located in the Southern part of the country.

More recently, two large organizations entered the field for the production not only of all types of accessories and auxiliaries for hydro power plants, but also of medium and large size hydraulic turbines:

Mecanica Pesada S.A., with their factory in Taubaté, State of São Paulo, employing 500 workers, with technical assistance agreements with Etablissements Neyrpic of Grenoble, and Schneider & Cie., also of France.

Bardella S.A. Indústrias Mecânicas, with their factory in the city of São Paulo, employing 800 workers, and with a technical agreement and a financial arrangement with the German manufacturer J.M. Voith, G.m.b.H., Heidenheim, Brenz.

The manufacture of low speed (from 100 to 200 RPM) large waterwheel generators is of special importance in Brazil. These units requiring huge machine tools for their manufacture.

The electric power market will require approximately 900 mVA additional generating capacity per year in 1965, mostly medium and large rating units.

Indústria Elétrica Brown Boveri S.A., affiliated with and licensed by Brown Boveri S.A., Braden, Switzerland, has already available, at its plant in Osasco, State of Sao Paulo, a set of large machine tools capable of producing waterwheel generators from 30 to 85 mVA and 300 to 84 rPM, which are to be driven by Kaplan hydraulic turbines, and other waterwheel generators from 50 to 160 mVA and 400 to 139 rPM, to be driven by Francis hydraulic turbines. Four 34.5 mVA waterwheel generators are presently under construction at Brown Boveri's plant.

General Electric S.A., licensed by its associates in the United States and Europe, has included in the manufacturing program of their factory which is being constructed in Campinas, State of São Paulo, the following rotating apparatus:

Synchronous waterwheel generators

up to 150 MVA, in medium and high speed units, and accordingly less for low speed units (single pieces or assemblies weighing 75 tons and 15 meters in diameter will be handled);

Direct current motors and generators for special and heavy duty

such as used for driving auxiliaries of rolling mills, heavy cranes, hoists, excavating shovels, oil well drilling machinery, winches and traction services;

Large synchronous rotating apparatus

including among others synchronous motors, slow speed special direct current motors for rolling mill main drives (up to 7,000 HP) and medium and large size frequency changers and synchronous condensers.

The construction of low-speed large waterwheel generators and high speed synchronous condensers, large direct current motors for special uses (like steel mill drives) and steam turbine generators will be undertaken by Mecanica Pesada S.A. in its expansion presently under way.

#### 4. Raw materials and components

The situation of raw materials, parts and components required by the electrical equipment manufacturing industry has also improved considerably lately. In accordance with studies made by the Development Council (Conselho de Desenvolvimento), raw materials, parts and components corresponding only to an average of 22 per cent of the cost of the heavy apparatus and equipment have to be imported. Copper represents a large portion of that percentage.

The increased production in quantity and size of structural steel and plates, heavy shafts, steel castings, magnetic sheets, aluminum shapes, plastics, porcelain and other insulating materials and resins will reduce progressively the imports of raw materials and components.

#### 5. Future prospects

The highlights brought out in this condensed report covering the present stage of the manufacture of electrical apparatus and equipment in Brazil, prove that this key industry has made remarkable progress in the last five years. Nevertheless, there are considerable opportunities for manufacturing many lines of equipment and apparatus which have still to be imported.

At the same time, as the Brazilian economy progresses, the demand for new products will force the expansion of existing plants and will invite new enterprises in the field of electrical equipment manufacture.