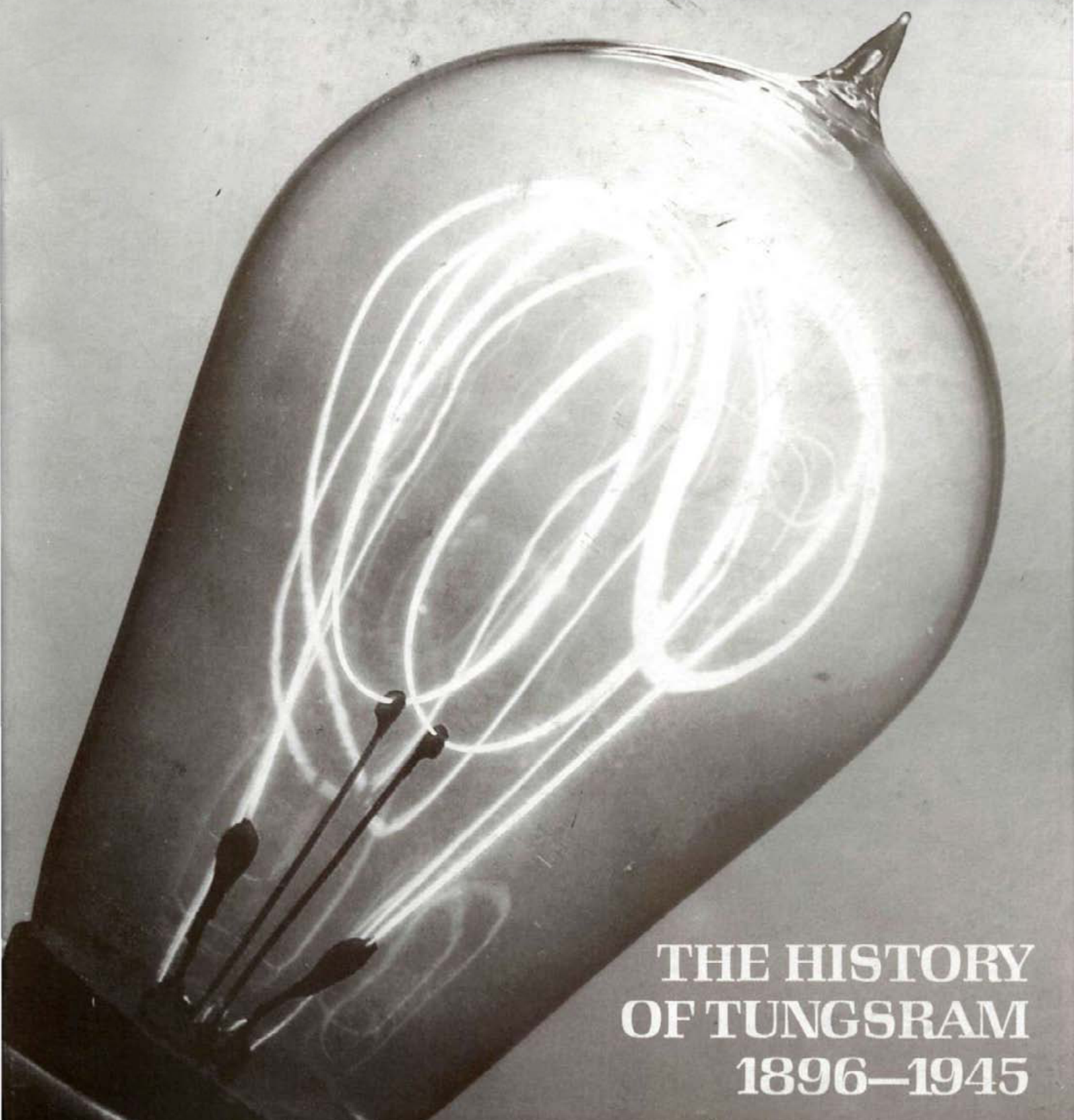




**THE HISTORY
OF TUNGSRAM
1896-1945**

OSZK

Országos Széchényi Könyvtár

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1990

BASED ON THE HUNGARIAN ISSUE WRITTEN BY

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History Committee of TUNGSRAM Co. Ltd., feeling its responsibility in exploring, conserving and fostering the Company's past traditions, decided to publish the Company's history.

The present Volume embraces events since early days until the end of World War II. Of course, no completeness can be aimed at as no comprehensive authentic social, historical and industrial background can be represented; this would go well beyond our scope.

A preliminary remark seems to be inevitable on the Company's name. For sake of simplicity, we call us TUNGSRAM, although it was in those times merely the Company's well-known main trade mark, registered in the year 1909 and assumed as style but as late as the 1st January 1989.

Our intention is to enable all those to appreciate our achievements, who have witnessed and shared the Company's efforts and successes and continue to collaborate.

Our firm conviction is, that the present is better understood and the establishment of the future is confirmed by the revelation of our past.

History Committee of TUNGSRAM Co. Ltd.

THE ROLE OF THE EGGER FAMILY IN ESTABLISHING THE ELECTRICAL INDUSTRY IN HUNGARY

On 1 August, 1896 the United Incandescent Lamps and Electrical Co. (Egyesült Izzólámpa és Villamossági Rt.) was established as a joint venture of the Hungarian Commercial Bank of Pest (Pesti Magyar Kereskedelmi Bank) and the Egger brothers. For decades the company was known home and abroad by and large by this name with some irrelevant — and temporary — modifications meaning nothing for readers. Therefore we have chosen from the variation in question the use of the present new and short name of the company, the "TUNGSRAM", this initial letter coinage, otherwise the trademark of the company since 1909. This is the excuse of the transfer of this name into the past, and also the title of this study: The History of TUNGSRAM. In effect, the United Incandescent . . . or according to the above the TUNGSRAM secured the financial backing of the bankers for the industry in which members of the Egger family had been actively involved for several decades through various enterprises aimed at founding and developing the electrical industry in Hungary.

We know very little of the Eggers' background. It seems certain that they were of Hungarian stock. There is evidence showing that Bernát Béla Egger, who was the first in the family to get involved in the electrical industry, had been born in Gyöngyös, although other sources suggest Óbuda. In any case, he must have been still very young when he founded the factory in Vienna, known as "Telegraphen-Bauanstalt", producing telegraph equipment as early as 1862. (1)

In 1872 Bernát Egger, encouraged both by the success of his Viennese firm and the spreading use of telegraphs in Hungary, decided to set up a workshop in Budapest specialized in repairing telegraph equipment. The workshop that was located at 9 Dorottya

Street, 5th District, employed eight workers at first. (2) The enterprise immediately proved prosperous, and within a few years its work-force multiplied.

On 31 December, 1874 Bernát Egger, "Viennese industrialist producing telegraph equipment", was given permission from the 5th District to set up his own business, (3) and subsequently, on 4 September, 1876, he had his branch of telegraph equipment workshop listed in the trade registry of Budapest. (4) On 1 January, 1882 Telegraphen-Bauanstalt of Vienna was transformed into a public company under the new name Austro-Hungarian Electrical Lighting and Power Transmission Factory, with the engineer János Krementzky, Bernát Egger, Jakab Egger, Henrik Egger Vienna-, and Dávid Egger Budapest residents as founding members. Within a year János Krementzky left the firm and went on to found his own electrical company. (5)

The Viennese public company gave continuous support to its Budapest branch that, beside carrying out telegraph repair work, also made pneumatic bells, telegraph equipment, electrical indicators, and had the exclusive right to produce the Berliner-type microphone. The first telephone manufactured in the Budapest workshop came out in 1884. (6)

In 1883 the company signed on József Pintér as technical director, who later proved to be a great asset when first the Egger factories and then the TUNGSRAM were on their way to become large corporations.

In 1895 the company, that was known for short as Egger B. és Társa (B. Egger & Co.), had great success in the national trade exhibition of Budapest with its pavilion showing electrical appliances.

Egger B. & Co. together with "Ganz" (another factory

in Budapest, producing electrical appliances) provided the street lights all over the exhibition area, as well as inside the buildings and along Stefánia Street and Nagykörönd. The Eggers' company delivered 18 arc lamps, each with a luminous intensity of 800 candela, and 100 electrical light bulbs, all produced in the Viennese factory. (7) The jury awarded the Budapest branch with a medal for "new invention, good quality and progress". (8)

Shortly the workshop in Dorottya Street proved to be too small and stood in the way of progress. The management of the company began to look for a new location. In 1887 they purchased the industrial estate of 7 Huszár Street, 7th District from Hungarian General Credit Bank for 56,000 Forint. At the same time, the authorities gave permission to the four Egger brothers and Dávid Egger's son, Gyula to establish an electrical company, provided that the running of the firm was left to the technical director, József Pintér. (9)

Production in the new factory began on 1 October, 1887. The total cost of the equipment amounted to 40,000 Forints. The introduction of the technology to produce incandescent lamps was an important milestone in the history of the company. In the beginning both the Mechanical and the Lamp Manufacturing Departments were located in the same building. In the front section of the L-shaped one-storey block were the offices, the drafting- and showrooms, the warehouse and the Mechanical Department, while the Lamp Manufacturing Department was in the back. The machinery was powered by an 18-20 h.p. horizontally mounted steam-engine with a Mayer-type driving wheel. The Lamp Manufacturing Department occupied a considerably larger area than the Mechanical Department did. The first phase of the incandescent lamp production was the glass-blowing.

The glass-blowers manufactured the bulbs from Thüringian glass tubes. They were also the ones who soldered on the carbon filaments. There were four blowing benches for this purpose. From here the lamps were taken to the pump chamber where 22 mercury pumps were working. The lamps were tested in a separate room. The carbon filaments were also

produced by the factory. In order to extract its salt content, the organic fibre was first soaked in water and then heated in vacuum. After the evaporation of water the residue, being rich in carbon, could conduct electricity.

The measurement room completed the Lamp Manufacturing Department. (10) The shape of the carbon filament lamps resembled a pear; their luminous efficiency did not reach 1/6th of that of today's average incandescent lamps or 1/1th of the 1m/W of the discharge lamps.

In the production of incandescent lamps the Eggers' company came before Switzerland, France and England. As far as Austria was concerned, János Kremetzky's Viennese factory started producing incandescent lamps using carbon filament in 1884.

In 1888 there were 80-100 incandescent lamps manufactured daily in the Huszár Street. In spite of the low productivity and the primitive production methods, the factory soon operated with a satisfactory profit margin, thanks to the high prices that the incandescent lamps fetched in those days, as the company faced no competition in the Austro-Hungarian Monarchy. (12)

Egger B. & Co., mechanical and electrical factory was run by the technical director József Pintér. Another director, Gyula Egger was in charge of marketing. In addition, the company employed six clerks in technical, commercial and administrative functions. The total work-force was 41 workers, including six German glass-blowers. To secure the continuous supply of skilled workers, the company also employed five apprentices.

Again, the facilities in the Huszár Street factory soon proved restrictive. For this reason, on 7 January, 1889 the company bought the neighbouring houses at 12-16 Munkás Street.

Concurrently, the owners of the company decided to widen the foundations of the incandescent lamp production by purchasing the patents of the Berlin factory Allgemeine Elektrizitätsgesellschaft. (General Electric Co. Berlin)

From similar considerations, on 1 February, 1889 the company converted its Lamp Manufacturing Depart-

ment into a separate company called Electrical Incandescent Lamps Co. Ltd. (with an initial equity of 400.000 Forint). For the time being, the separation of the Lamp Manufacturing Department was only formal. The shareholders of the new company came from the insiders of the First-Austro-Hungarian Electric Lighting and Power Transmitting Factory. Béla Egger, Gyula Egger, Antal Deutsch and Hans Roeder were on the board of directors.

The Eggers wanted to continue with the incandescent lamp production on a different location, and for this purpose they purchased a separate property to the north of the former confines of Budapest, in the vicinity of the outer Váci Road of the present district IV. of the capital. However, they had to abandon their plans to build up the factory there, because water was not available in the necessary quantity on the property. The Incandescent Lamp factory, after reaching an agreement with the Capital Waterworks in the matter of water supply, stayed in the Huszár Street, which went through important alterations and extension. (13) The Incandescent Lamp factory was housed in a one-, and a two-storey building. József Pintér and Gyula Egger continued to manage the factories. The factory employed one engineer in the position of production supervisor, one accountant, one warehouse manager, one trainee, one supervisor woman for the two unskilled female labourers and one German glass-blower foreman.

The total work-force came to 50 labourers: 12 people operating the mercury pumps, 8 glass-blowers and 30 unskilled workers. Skilled workers were well-paid in general. The glass-blowers and the foreman earned the same as the production supervisor: 1,200 Forints per annum, while an unskilled labourer took home 240 Forints a year. The working hours were between 7 and 12 a.m. and 1:30 and 6:30 p.m. (14)

The company was soon given government subsidy to help the industry settle in Hungary.

On 12 March, 1889 the Ministry of Agriculture, Industry and Commerce — while reserving its right for individual assessment, awarded The Electric Incandescent Lamp Factory Ltd. with provisional government privileges.

After much experimentation and substantial investment the company succeeded in producing carbon-filament incandescent lamps which stood up to the competition on the foreign market, and also, one that showed an appropriate luminous efficiency as well as an acceptable useful life. The home market was still very small, therefore export had a high priority on the company's marketing policy, although the high custom duties and the costs of transportation had an unfavourable effect. The Eggers worked very hard to appear on the international market. In 1889 they exported 21,420 electric incandescent lamps 70,210 lamps were exported in 1890; 190,972 lamps in 1891; 220,608 lamps in 1892 and 401,318 lamps in 1893.

The company even had business interests as far as Asia, America and Australia. It set up warehouses in Melbourne and Montreal with commissioned goods. (16) However, newer and newer competitors appeared on the international market, and the price of incandescent lamps kept falling.

While in the first year of the company's life the incandescent lamps fetched 1 Forint and 5 krajcars, in 1894 the market price already fluctuated between 36 and 38 krajcárs. In order to facilitate the home consumption, the company asked the Ministry of Commerce to instruct the commercial and industrial chambers to advertise the factory's products among the owners of factories and industrial estates. (17) The minister, however, refused to comply with the request, although he admitted that only the Eggers were producing incandescent lamps in Hungary. But he also pointed out that the firm was selling generators manufactured in Vienna, even though a Hungarian company, Ganz also produced them. The Minister notified the company that he regarded the Austrian import of generators, needed for the use of incandescent lamps, damaging — not only to Ganz, but to the whole of Hungarian industry. (18) Since the home consumption of incandescent lamps could only be boosted marginally, the company was forced to increase its export with a simultaneous increase in the volume of production, so that the falling prices could be offset with a

reduction in the production costs. This strategy on the part of the Electric Incandescent Lamp Ltd. can be illustrated with the following business figures: (19)

fiscal year	no. of lamps produced (lamps)	daily production (lamps)	production costs (krajcár)* lamp	market price (krajcár) lamp
1889/90	120,000	300	116	105
1890/91	166,000	350	75	62
1891/92	309,000	1000	60	68
1892/93	350,000	1150	44	44
1893/94	520,000	1700	36	38
1894/95	752,000	2500	28	38
1895/96	882,000	3000	26	36
1896/97	1163,000	4000	24	34.5

*100 krajcár was = 1 korona

While the annual volume of production grew almost tenfold in eight years, the work-force only tripled during the same time. The number of skilled workers hardly changed, but the female work-force increased from 30 to 140. The total work-force in 1894-1895 was 200. (20)

The First-Austo-Hungarian Electric Lighting and Power Transmitting Factory continued to produce weak-current electrical appliances parallel with the Electric Incandescent Lamp Factory Ltd. within a narrower range. The Mechanical Department employed 30—50 workers on a regular basis. Postal and Telegraph Office (P.T.O) was one of their regular customers. In 1895 the Department specialized in manufacturing multiplex relay boxes. The P.T.O had previously ordered such machinery from Antwerp.

The Mechanical Department built a multiplex relay system handling 600 customers on the occasion of the Milleneum Exhibition. (21)

THE FLOATING OF THE UNITED INCANDESCENT LAMP AND ELECTRICAL CO. LTD AND THE FINANCIAL BACKING OF THE BANKS

In 1895 the capital resources of the public company Egger B. & Co. already proved insufficient for maintaining and increasing the standard of production. When the managing director, Gyula Egger described the company's financial problems to the director of the "Hungarian Commercial Bank" of Pest he also pointed out that "they could not respond to several business proposals, exactly because they had to ensure that the absolute mobility of their capital is preserved". (22) The Egger brothers understood that the only way to remain competitive in the electrical business was to have sufficient working capital at their disposal, and to be able to further invest continuously. For this reason they drew up an agreement with The Hungarian Commercial Bank of Pest in July 1896 that they would merge the Budapest and the Viennese factories of the First Austro-Hungarian Electric Lighting and Power Transmitting Factory to form a public company. They did not choose Commercial Bank by chance; they had been using the services of the Commercial Bank in connection with every financial transaction of the public company.

It was always this bank which put up the necessary bail on behalf of Egger B. & Co. all the transport tenders towards Postal and Telegraph Office and MÁV (Hungarian National Railways). (23)

The United Incandescent Lamp and Electric Co. Ltd. held its statutory meeting in the conference chamber of The Commercial Bank on 1 August, 1896. Egger B. & Co. contributed to the funds of the public company

with their Viennese and Budapest factories, buildings, machinery, goods, raw materials, debits and claims. The Electrical Incandescent Factory Ltd. retained its independence for the time being. For the above assets, estimated to be worth 600,000 Forints, the Egger family received 6,000 shares in 100 Forint denominations.

The total equity came to 1,400,000 Forints, and the Commercial Bank bought up 33 percent of the shares. They were syndicated by the Egger brothers and by Commercial Bank. The bank was represented by three directors on the board, and the Eggers delegated five. The new company was effectually controlled by the Commercial Bank, whose representatives had the right to veto any decision. The company was obliged to have all the planned investments costing more than 10,000 Forints and all the business deals worth over 60,000 Forints countersigned by the bank, whose agreement was also needed for the employment of any new executive with an annual salary over 6,000 Forints.

On the statutory meeting Jenő Szabó, member of the Hungarian Upper House, Ferenc E. Vas, deputy director of the Commercial Bank, Péter Maishirn, retired railway superintendent, Dr. Izidor Deutsch, lawyer, Béla Egger, Dávid Egger, Gyula Egger and Jakab Egger were elected to the board of directors. (24)

In accordance with the agreement drawn up with the Commercial Bank, the new public company decided to respect the five-year contracts signed with Béla Egger,

Ernő Egger, Dávid Egger and Móric Deutsch. Béla Egger received from the Viennese factory an annual salary of 12,000 Forints, plus a company flat with electricity and heating paid for. Dávid Egger drew an annual sum of 7,000 Forints from the Budapest factory. The engineer Ernő Egger continued to be employed by the Viennese factory. (25)

Pressed by the rising shortage of capital, on 30 June, 1896 the Electric Incandescent Lamp Factory Ltd. merged into the United Electric Ltd. In connection with the fusion the equity of the company was raised to 1,650,000 Forints. The transaction was, again, conducted by Commercial Bank, whose interests this way reached 37 and a half percent. (26)

The backing of the banks made it possible for the company to upgrade all its branches, first of all, its Lamp Manufacturing Department. The demand for incandescent lamps continuously grew with the spreading use of electric light. The profitability of its production also increased, although the competition drove the prices further down every day.

The company counteracted this phenomenon by increasing the volume of production: it manufactured 5,000 lamps a day in the fiscal year 1897/98; in 1898/99 its daily output already reached 7500. (27)

Since the turnover of the Huszár Street plant went up by 30 percent on average every year, the structure of the Lamp Manufacturing Department needed thorough changes in order to facilitate the continuous upgrading of production. The spreading use of electric lighting suggested a continuously growing demand. At the same time, the prices of incandescent lamps kept falling, so that the incandescent lamp industry would only yield a profit, if mass-production was achieved. Those factories that were unable to increase their output constantly, could not keep up with their competitors. The demand was primarily met by the competitive producers, who found their market growing. In spite of all this, new incandescent lamp factories hardly emerged. The fact that the training of the workers required a lot of time, patience and money, must have contributed to this.

By the turn of the century the existing conditions in the

United Incandescent Lamp and Electrical Co. that is from here TUNGSRAM did not really allow any further increase in the volume of production. By squeezing up the work stations — in the opinion of the technical director József Pintér — daily production could have been pushed up to about 10,000 bulbs. This, however, would have probably resulted in the slackening of quality control, and in rising production costs and breakage.

The useful area of the Lamp Manufacturing Department did not exceed 3,100 m², and the daily production of 10,000 lamps would have required at least 5,300m². Every argument suggested that the upgrading of the Lamp Manufacturing Department would have to be realized on a new location. (28)

The company also faced difficulties of technological nature, since the carbon-filament bulbs did not stand up very well to transportation. The technical management was relentlessly working on improving the quality of the incandescent lamps, perfecting production technology and economization.

The lack of space affected the Mechanical Department, too. It could just about fulfil the orders of telegraph equipment and telephones, but there was not much scope for improving the Department as a whole. This caused some concern in the management, since the weak point of the Mechanical Department was precisely that it very much relied on government orders. (29)

Beside manufacturing incandescent lamps TUNGSRAM could boost with considerable success in producing telephones and installing telephone exchanges. The license agreement, which was drawn up between TUNGSRAM and Western Electric Company of Chicago in 1899, played an important part in this. On the basis of the licence agreement, the world-famous American company — a leading force in the telephone business — made its licenced products available to the Budapest public. (30)

The "common battery"-type telephone equipment found favour with the Hungarian experts, too.

In 1900, when Postal and Telegraph Office put out to tender the producing and installing of the equipment

of its telephone exchange in the Nagymező Street (Budapest), on the basis of the jury's recommendation and out of seven applicants, the job was given to the joint entry of TUNGSRAM, and Western Electric Company. That was, in fact, the first instance that Hungarian industry took an active part in the construction of the telephone exchange system in or outside Budapest. Western Electric Company vouched for the work of its Hungarian partner Central Telephone Exchange "Teréz" Budapest, one of Europe's first common-battery type telephone exchange, was built as part of this order. (31)

In 1899 a new section was added to the Mechanic Department which specialized in producing security systems for the railway. Again, this work was hindered by the lack of space, so production, for the time being, began in the near-by Óvoda Street, neighbouring the Huszár Street plant. When MÁV (Hungarian State Railway) decided to change its remote-controlled semaphores, the company was given the lion's share of the work. The new section working of the Mechanical Department first of all enhanced the company's reputation by building power-plants. At the turn of the century it delivered and installed power-stations in Szatmár, Sopron, Kapronca, Budafok and Losonc.

The power generators in Budafok and Losonc were built on behalf of Budafoki Villamossági Rt. (Budafok Electric Co. Ltd.) and Losonci Klára Villamossági Rt. (Klára Losonci Electric Co. Ltd.); in both cases, however, the majority of the shares was in the hands of TUNGSRAM.

The Budafok Power Plant was put into operation on 1 May, 1898. By then Budafok, near Budapest with its 30 large and more than 200 smaller wine producers was considered the centre of the Hungarian wine industry. The power plant first of all served to deliver electrical energy to the wine companies. The drawing of wine, previously done with manpower now was carried out using electrical energy. (32)

The Losonc power plant began to operate on 6 December, 1899. Both electrical companies were bringing considerable profit for TUNGSRAM for several years. (33)

The heavy-current goods section started to produce generators and electrical engines in 1899, as the Trade Ministry promised to grant the company with special privileges pending on this. Although electrical engine production also served to alleviate the strain on the Viennese factory, the company could only manage that with a great deal of difficulty, since the chosen location automatically excluded the possibility of a step-by-step upgrading later.

The Budapest and the Viennese factories of TUNGSRAM played a leading part in the electrical industry of the Austro-Hungarian Empire at the turn of the century.

The favourable reception of its products on the Millennium Exhibition, where the company had a separate pavilion showing telegraph and telephone equipment and incandescent lamps, further enhanced the company's reputation. (34) TUNGSRAM was represented on the World Fair of Paris in 1900, too, but here considerable business deals did not follow the professional recognition of the industry. (35)

Nevertheless, the company's exports grew significantly in this period. On his business trips, the chief executive officer of the company, Gyula Egger established sales agencies in London and Paris. He primarily managed to find market for the light-current products this way. The company increased the export of its incandescent lamps year after year, as evidenced by the dispatch notes: the gross weight of the exported incandescent lamps was 70 tons in 1897, 88.5 tons in 1898 and 117.7 tons in 1899. The growing export, by implication, also suggested the good quality of the products. The 35 tons of incandescent lamps imported annually to Hungary gave, however, less cause for rejoicing. (36)

The work-force of the Huszár Street plant grew parallel with the development of the Departments. According to the report of the District Industry Superintendent of Budapest, made on 13 April, 1899, the total work-force of 593 broke down as follows:

marketing staff	male 18	female 10
technical staff	male 12	
other staff	male 6	female 22
foremen	male 10	
errand boys	male 5	
adult workers	male 214	female 255
day-workers	male 6	
apprentices on contract	male 36	

By early 1900 the number of female staff employed in the incandescent lamp production already reached 350. (37) The workers were all members of the Health Insurance Scheme. The company insured all its workers against accidents with (Nemzeti Balesetbiztosító Társaság) National Insurance Company, nevertheless, it did not have its own doctor or surgery. The company did not provide accommodation to its workers, either; on the other hand, staff with long time of service received bonuses every year.

Not that the company couldn't afford to put some money aside for the workers' welfare, either: the Budapest factory closed the fiscal year of 1896/97 with a net profit of 155,293 Forints; that grew to 202,622 Forints in 1897/98, 198,493 Forints in 1898/99, 413,490 Koronas in 1899/1900 and dropped back to 326,379 Koronas in 1900/1901. The shareholders received 1.074,000 Koronas. The company did not even have to pay taxes after its net profits, either, since the governments special privileges exempted it from taxation for a long time. (38)

On 1 June, 1899 the Egger family, on the initiative of its Viennese members and assisted by Commercial Bank and Niederösterreichische Escompte-Gesellschaft, agreed to form the Viennese factory into a separate public company under the new name of Vereinigte Elektrizitäts-AG, (United Electricity Ltd.), with an equity of 2.000.000 Forints.

The new company, VEAG handed over shares worth 1,000,000 Forints to TUNGSRAM Rt. in return for the Viennese factory. The engineer Ernő Egger acted as chief executive officer of the Viennese factory. (39)

TUNGSRAM and VEAG continued to maintain a close association: they signed a contract mutually agreeing

to exchange new inventions and patents, to make use of each others' stocks in their material acquisitions as much as possible, and to set up joint sales agencies. They also agreed that the Viennese factory would produce heavy-current goods, heavy-power-current generators, electric engines, transformers, elevators, machine-tools, electric automobiles and railway security systems —, while the Budapest plant would concentrate on electric light bulbs, telegraph and telephone equipment, telephone exchanges, railway security systems, light-current generators and parts for electrical appliances. Both companies promised that they would advise each other on any large business deals and speculations. (40) To facilitate the smooth cooperation, top officials of the Commercial Bank were appointed to the board of directors of the Austrian company, the same way as top executives of Niederösterreichische Escompte-Gesellschaft were made directors of TUNGSRAM. The Austrian bank's interests were represented in Budapest by Móric Birkenau and Miksa Krassny, as directors. Kereskedelmi Bank received a bonus of 259,000 Koronas for restructuring the Viennese factory into a public company. (41)

THE BUILDING OF THE ÚJPEST PLANT AND THE FIRST FEW YEARS THERE

As we have already pointed out, the Huszár Street plant did not allow the expansion of the Mechanical or the Lamp Manufacturing Department. For this reason, in the spring of 1899 the company's management decided to build a new factory. They first notified the Trade Ministry in July 1899, giving their reasons in that TUNGSRAM could only complete against the unlimited resources of the German telephone and incandescent lamp industry, if the company increased the volume of its production. (42) To be able to do that they would definitely need to build a new plant with three times the capacity of the present one. Naturally, the huge investment would bring about a temporary decline in the company's performance, especially, since in the beginning production would take place on two separate locations. The management asked the Minister to continue with the special government privileges given to facilitate the production of telephones and electric incandescent lamps until the end of the term laid down in legislation, and to exempt the company from taxation for 15 years.

In answering the company's application, the Trade Ministry suggested that the new factory be built in the outskirts of Budapest, rather than inside its boundaries, and in that case the government privileges would be forthcoming for the maximum time period (43)

Before making its final decision, the management called on Richard Englander, lecturer of the Viennese Technical College, to make a careful assessment of the Huszár Street plant from the viewpoint of fire hazard, together with a feasibility study on its enlargement.

Mr. Englander completed this task and after surveying

the site he came to the conclusion that the factory could not stay in Huszár Street. "In the interest of the economy of production, the building of a new plant is advised." On 11 October, 1899 — on the basis of Englander's expert opinion — the board of directors authorized the executive committee to purchase a site of about 8—10,000 square-fathoms (1' fathom' = = 38.32 square foot). (44)

In order to purchase a site, the executive committee first looked around within the boundaries of Budapest. The liquor producer Vilmos Leipziger offered a plot of land for sale in Óbuda, right on the banks of the River Danube, which seemed suitable for the purpose. After careful consideration, however, the managing directors decided against purchasing the land, because the amount of necessary groundwork would have significantly added to the price. (45)

In the meantime, the Trade Ministry's response to the company's application arrived: TUNGSRAM would be given special government privileges for 15 years beginning on the first day of production, if it was to build a new plant for producing incandescent lamps and weak-current products in or around Budapest. The offer was made, however, on the condition that the company would abolish the old plant, invest 600,000 Forints in the new factory, provide work for 1,200 workers from the first day of production, and would make arrangements for the production of 25,000 incandescent lamps a day.

Moreover, the Ministry obliged the company to produce carbon electrodes and set the deadline for the start of production by the end of 1900. (46)

After hearing the Trade Ministry's favourable decision,

the board of directors dismissed the idea of buying a site inside Budapest, and on 28 January, 1900 they purchased a 13,500 'fathom' (that is: 13.5X13.500 square foot) property in Újpest from the land magnate Dr. Sándor Károlyi. Of the 182,250 Korona price TUNGSRAM paid out 82,250 Koronas at the time of exchanging the contract, and they were given three years to pay the remaining 100,000 Koronas. (47)

At the turn of the century Újpest, with its 41,858 inhabitants, its handicrafts prospering and its industry shaping up, was considered the most thriving suburb of Budapest.

When in early 1900 TUNGSRAM bought its present site, the property was surrounded by the Károlyi family's entailed estate of Fót, only interrupted at places by the sites of the Capital Waterworks. The first Hungarian railway line connecting Budapest and Vác had been crossing the estate since 1846. Since 1869 there had been a horse-driven omnibus service between Megyer (a part of Újpest) and Calvin Square (in the centre of Budapest). (48)

On 3 February, 1900 the management of the company notified the town officials of Újpest of the company's intention to build an electrical factory in the area with an investment of 2,000,000 Koronas, provided that adequate conditions could be guaranteed. By moving to Újpest from the country's industrial and trade centre, the company would take on considerable amount of difficulties.

In return, the management asked the civic authorities to extend the sewage system, the waterworks, the bitumen pavement and the street-lights all the way to the plant, and to deliver, free of charge, the amount of earth and sand needed to complete the groundwork. Simultaneously, the management announced that, for the time being, the company did not intend to build houses for its employees, hence giving a boost to the local house market. On the procurement of the Újpest leather manufacturer Tivadar Wolfner — who was one of the most enthusiastic supporters and initiators of the idea to build an electrical factory in Újpest — the town officials agreed to comply with the request of the management. They even topped this by waiving the

company's property taxes and other duties for the same period that the government privileges ran. (49)

When the board of directors met on 10 February 1900, they instructed the executive committee to have the plans of the factory ready by the middle of March. The chief executive officer Gyula Egger, Péter Maishirn, member of the board, and the technical director József Pintér were delegated to make the necessary arrangements for the construction work and to coordinate the whole project. As experts the chief executive officer of the Viennese factory VEAG, Ernő Egger, and Professor Richard Englander were invited. (50)

The plans were discussed by the construction committee on a meeting held in Vienna on 10 April, 1900. On this occasion the board members Ferenc E. Vas and Miksa Krassny wanted to know the reasons behind the proposed increases in capacity, aiming at 25,000 incandescent lamps a day, or, in the case of the Mechanical Department, at doubling the performance.

The technical director, József Pintér quoted past years' business figures to illustrate the reality of a production boom: the company received orders for 582,000 incandescent lamps in the fiscal year 1894/1893. This number grew to 1,224,000 lamps in 1898/1898, to 1,600,000 lamps in 1898/1899, and to 2,300,000 in 1899/1900. From the constantly growing demand it could be rightly anticipated that for the fiscal year 1902/1903 there would be orders for 6,000,000 incandescent lamps, which, in turn, would require the production of 22,000 lamps a day. Mr. Pintér also pointed out that, while in 1899/1900 the production of a single incandescent lamp cost 16 krajcárs, manufacturing 25,000 lamps a day would reduce this figure to 13,5 krajcárs. It became apparent that the drop in the price of the lamps could only be offset by the continuous increase of the volume of production. Béla Egger was against the plans that had been put forward, Professor Englander adopted them. Finally, the construction committee accepted the proposed plans. (51)

Since purchasing the land as well as completing and accepting the plans took longer than expected, the Trade Ministry extended the previously set deadline for completion of the Újpest plant until the end of 1900,

while the date set for the start of production was postponed until the spring of 1901. The Ministry, lobbied by the company's influential supporters, also agreed to modify its initial conditions, and to give time to the company until the third year of operation before reaching the originally fixed works-force. (52)

After receiving the building permitted on 30 June, 1900, the board of appointed directors signed a deal with the building contractors Sándor and Gyula Welisch. The executive committee instructed Gyula Egger, József Pintér and Richard Engländer to order the necessary machinery and sign the relevant agreements. (53)

By late September, 1900 the construction work advanced to the point that first cost analysis could be drawn.

On an extraordinary general meeting held on 5 October, 1900 the shareholders raised the company's equity from 2,000,000 to 3,000,000 Koronas to cover the building and equipment costs of the new factory. (54)

In the course of the construction work several alterations were necessitated on the plans, and even some new requirements emerged. Hence, it was decided following the request of Postal- and Telegraph Office, that there would be a post and telegraph office within the area of the new factory, and that the post master would get free accommodation in the building. (55) The Mechanical Department received an additional wing which had not been in the original plan, in order to be able to build telephone exchange systems according to schedule. By the way, the anticipated increase in the export of weak-current goods also necessitated the enlargement of the building. (56)

The construction work on the new factory was finished in the Summer of 1901. By mid-July the installation of the machinery advanced to such a stage that Láng Machine Works, which delivered the machinery for the power plant, was able to hold its first trial runs. The question of water supply was also resolved favourable: no pressure drops were registered at the wells. The gasworks were put into operation by the end of August, and the incandescent lamp production could

commence. A few weeks later the Mechanical Department moved into its new premises. (57) The building and equipment costs exceeded the planned sum by half a million Koronas and the total amount reached 2,563,719 Koronas. The building contractors received 1,006,480 Koronas. The mechanical machinery costed 141,000 Koronas, the electric equipment 97,000 the vacuum device 23,000 the boiler 60,000 the gasworks 74,000, the pavement 16,000 and the various fittings 174,000 Koronas. (58)

By the end of 1901 the new factory was working with full capacity and the board of directors, therefore, missed the deadline set by the Ministry of Trade only by one year. The start of production of the carbon electrodes necessary for the arc lamps ran into problems, and the company asked the Ministry to extend the deadline. The Ministry agreed to put off the deadline until the end of 1902. The board of directors, however, wanted to rid themselves of this obligation altogether, and finally achieved that the Trade Ministry, lobbied by the directors of Kereskedelmi Bank, changed the terms of the previous agreement. Instead of carbon electrodes, now the company was committed to produce railway security systems. (59)

The Mechanical and the Lamp Manufacturing Department were separated very definitely in the Újpest plant. Structurally the Mechanical Department consisted of a production hall, a production office, a telephone construction hall, a railway security system construction hall, a warehouse, an accounting office, a statistical office and a marketing office. The Lamp Manufacturing Department was made up of a glass blowing section, a photometric section, a vacuum section, a fitting room, a sealing section (where the stems were inserted into the bulbs), a warehouse and a marketing office. Seven engineers, six draughtsmen and nine supervisors constituted the technical staff of the Mechanical Department, while the Lamp Manufacturing Department was managed by one production manager, one chemist and ten supervisors. (60) The managerial talent of Lipót Aschner was beginning to show itself in the new factory. He was the chief clerk of the Lamp Manufacturing Department first, and deputy

director from 1 July, 1904. The annual salary of the chief executive officer, Gyula Egger was, 16,800 Koronas then; József Pintér, technical director received 15,000 Koronas and Lipót Aschner, 8,000 Koronas.

József Pintér's assessment proved correct when at the time of planning the Újpest plant he predicted that the demand for electric light bulbs would dramatically increase. It soon turned out that the Huszár Street plant could not have possibly satisfied the rapidly growing demand. On the other hand, the increased capacity of the new Lamp Manufacturing Department permitted the marketing of 3,896,538 incandescent lamps in the fiscal year of 1902/1903, and 4,519,257 lamps in the fiscal year of 1903/1904. (62)

The market price of electric light bulbs very markedly dropped as a result of the strong competition in the fiscal year of 1902/1903. This moved the factory owners to set up a cartel in order to end the further fall in the prices. One of its organizers, Philipp Westphal notified TUNGSRAM in April, 1903: "The continuous drop in the price of electric light bulbs brought about the possibility of the leading European light bulb factories coming to an agreement". (63) The incandescent lamp cartel was founded as a limited company with an equity of 1,000,000 German Marks under the name of Verkaufsstelle der Vereinigten Glühlampenfabriker (Central Sales Office of United Incandescent Lamp Factories) in Berlin on 16 September, 1903. The cartel members contributed to the equity according to the quotas allocated to them which, in turn, was determined on the basis of a turnover of 27.7 million Marks. AEG and Siemens und Halske AG. received 22.633 percent each, while TUNGSRAM was given 11.316 percent and Philips received 11.307 percent. The remaining 29.761 percent was shared between the other eight companies. The Limited Company was represented by a board of seven directors, elected by the cartel members.

According to the cartel agreement, the marketing of incandescent lamps was the responsibility of the cartel, although in the countries where no cartel members were operating TUNGSRAM had the right to sell

light bulbs up to eighty percent of its quota, either directly to users or to retailers.

The incandescent lamp cartel founded in Berlin undoubtedly eased the marketing problems of the TUNGSRAM. It took over the goods up to the amount corresponding to the company's quota for the price fixed in the cartel agreement, marked it, and then paid out the profit. Not having to worry about marketing gave a boost to the company and allowed the radical reorganization of its Lamp Manufacturing Department. This, in turn, led to considerable savings in the production costs and the establishing of new work methods. (64)

Joining the electric light bulb cartel made some of the company's sale offices redundant. Since the sales representatives had proved their excellence in the profession, the management continued to rely on their services in the interest of the other manufacturing branches. The planned expansion in the production of the weak-current goods justified to keep them on the pay-roll. (65)

While the question of the profitable marketing of the carbon-filament incandescent lamps had been resolved, the quality, the luminous efficiency and the life-time of the lamps remained to be a burning problem.

Wide-ranging research began that was aimed at raising the temperature of the filament. In the course of these researches, the lamp designed by the Nobel Prize winner chemist, Walter Nertz, generated some interest. He designed a mixture of metal-oxides to be used as filament.

While he managed to raise the temperature of the filament up to 2,350 C, the luminous intensity of the lamp exceeded that of an ordinary carbonfilament light bulb only by 50 percent. (66)

Nertz's light bulb immediately aroused the attention of TUNGSRAM's technical staff. At their suggestion the company, jointly with Ganz és Társa (Ganz and Associate), bought the license for the production of such lamps within Austria-Hungary. (67) The company, with the license in its possession, immediately ran some experiments. In the course of these experiments it

soon turned out that the Nertz-lamp would not render obsolete the carbon-filament lamps, instead, the prospects of its application seemed promising in special areas, in respect of the relation between incandescent lamps and arc-lamps. Nevertheless, the technical experts of TUNGSRAM and Ganz & Co. continued to run experiments on the license. (68) When in the spring of 1901 the Berlin factory of AEG brought out the Nertz-lamp, the license holders in Austria-Hungary decided that they would start the production of Nertz-lamps pending on the success of AEG, even though their research showed that these lamps had no commercial value. (69)

Responding to a request from AEG, the two Hungarian companies permitted the Berlin factory to sell its specially marked Nertz-lamps within the Monarchy in return of a ten percent license fee.

This, however, did not mean that TUNGSRAM or Ganz & Co. would forsake the right to produce Nertz-lamps. (70) And indeed, the two companies started producing and marketing such lamps in a limited quantity in 1903; their mass-production, however, was never realized — partly for lack of interest, and partly for successes scored in other type of experiments that gave a different direction to the future developments. (71)

The application of tungsten-filaments opened a new chapter in the evolution of incandescent lamps. The first people ever to produce incandescent lamps using tungsten filament were Dr. Sándor Just and Ferenc Hanaman, both lecturers at the Technical College of Vienna. Their lamp had a luminous efficiency of 7.85 lm/W, which hardly dropped during its useful life of 800 hours. (72) Just and Hanaman registered their invention on 13 December, 1904. The implications of the invention were unfathomable. Although in the description carbon filaments were still needed for the production of tungsten filaments, at the end the filament was tungsten entirely free of carbon. (73)

It was probably Professor Engländer, also lecturing at the Technical College of Vienna and once acting as technical expert in the construction of the Újpest plant, who drew the attention of the management of

TUNGSRAM to the new invention. The company's managing directors quickly wrapped up the deal on the priceless licence. They drew up an agreement with Dr. Sándor Just and Ferenc Hanaman on 13 December, 1904, according to which the inventors sold the sole right to TUNGSRAM to produce and sell tungsten-filament lamps within Hungary and Austria. The agreed license fee was ten percent of the billed sales. TUNGSRAM accepted a ten percent interest in the further marketing of the license and also, committed itself to the mass-production of the tungsten-filament lamps. (74)

Several-year-long experimentation preceded the massproduction of tungsten-filament lamps. The carbon-filament light bulbs preserved their hegemony during these years: the volume of production reached 25—30,000 pieces a day in the fiscal year of 1905/1906.

The capacity of the Mechanical Department was also significantly expanded in the new factory. The spacious work halls allowed the company to complete the installation work on the new telephone exchange system of Budapest by the end of 1903. The new telephone exchange system was put into operation in January, 1904. They managed to connect the more than 6,000 existing lines to the centre in Nagymező Street (:in the centre of Budapest:) by 15 April, and so the former telephone exchanges in Baross Street and Szerecsen Street could be closed down. Since by mid-August, 1904 all the cross-bar lines had been connected to this centre, the whole telephone service of Budapest was concentrated in one exchange. Between 1904 and 1906 the company received orders from a whole list of provincial telephone exchanges to expand their systems. They completed the telephone exchange of Zagreb (:today Yugoslavia:) and handed it over to Postal and Telegraph Office in 1905. (75) Beside the good business done by the telephone and telegraph section on the home front, the export of the light-current products also increased significantly.

The section manufacturing railway security systems showed an even more impressive expansion in capacity. The management bought up a whole list of patents in order to secure its prospering and to be able to stay

competitive. The patents of the Kolban-type electric railway block system, the heavy-current railway security systems and the security equipment of the Southern Railway Company of Vienna were among these licenses. The latter was especially important, since this way the company did not have to face competition from Southern Railway in doing business with MÁV (Hung. State Railway). (76)

The Hungarian factories manufacturing railway security systems set up a cartel in 1905 and divided between themselves the production quotas. Ganz and Co. received 37 percent, Roessemann and Kühne, 33 percent and United Electric Co., 30 percent. Later Telephone Factory Ltd. also joined the cartel, which necessitated the revision of the quotas. According to the new cartel agreement, Ganz and Co. was given 28.49 percent, Roessemann and Kühne, 25.41 percent TUNGSRAM, 23.1 percent and Telephone Factory Ltd. 23 percent share of the market. (77)

The company management paid great attention to every patents and inventions in the electrical industry. Their interest was especially aroused by the Pollák-Virág type of telegraph, so much so that they bought the licence already at the turn of the century. The inventors further improved the telegraph and added a perforator to it. This machine differed from the ordinary telegraphs in that it punched letters into the paper-roll and this way the message appeared on the receiving end as a written text. All that the telegraphists had to do was to put the telegraph into an envelop and mail it. (78) The company spent 8,000 Koronas on the design of the improved machine and founded a public company with an equity of 500.000 Koronas to market the licence in 1903. The first successful test of the new telegraphic equipment was between Budapest and Fiume, and also, between Berlin and Cologne. Prolonged negotiations took place about the introduction of the Pollák-Virág-type telegraph in England, France and the United States, although this machine failed, at the end, to live up to the expectations, since other, more sophisticated telegraph systems were developed in the meantime. (79) The company, engrossed in the problems of developing a new incan-

descent lamp and enlarging its circle of weak-current products, could not pay as much attention to its power-current machinery production. On 25 November, 1902 TUNGSRAM managed to draw up an agreement with its Viennese sister-company, according to which the whole power-current industry section of the Újpest plant, complete with its stocks and orders, was transferred to VEAG. The transaction, however, only meant a partial solution to the problem, since the power current industry section continued to be operated within the Újpest factory. VEAG created a branch in Budapest factory, although it was solely operated by the Viennese, for the Viennese. In effect, the power current industry section was run on behalf of the Újpest plant, but on the risk of VEAG; TUNGSRAM wanted to share neither the profits, nor the losses. (80) The Újpest factory paid out 100,000 Koronas to VEAG for the honouring of the existing deals, as well as for the commercial services done abroad in the interest of the company.

The half-measures aiming to solve the problems of the power industry section were closely linked to the question of government privileges. The factory was committed to the production of generators and electric motors by a deal made with the Trade Ministry. VEAG, however, bought the parts for these goods in Vienna. A sacked employee filed a report and the Ministry launched an inquiry in October, 1904. After the inquiry the Ministry notified the company that if the conditions were violated, they would take retaliatory measures by reconsidering both the government privileges and the government orders. On the meeting of the executive committee held on 31 October, 1904 the chief executive officer, Gyula Egger and the technical director, József Pintér strongly urged the Viennese sister company to establish a branch for the production of power-current machinery in Budapest, since neither the work space nor the work force were available in the Újpest plant. (81) Opposing the view held by the Újpest management, the chief executive officer of the Viennese factory, Ernő Egger insisted that TUNGSRAM should not change its previous practice. Since the latter view was endorsed by the Viennese board of

directors, the executive committee postponed the decision. (82)

As VEAG continued to ignore the development of the power current industry section, the executive committee put the question back on the agenda in its meeting held on 29 March, 1905. The power current industry section could not be simply closed down, since that would have meant the loss of considerable government privileges and orders. (The company was exempt from taxes until the 1st November, 1916, and in 1915 it received orders from the government worth more than 1 million Koronas which amounted to 60 percent of the total business done by the Mechanical Department in that year.) The abandoning of the power current industry market also threatened with the possibility that the company's biggest clients would go elsewhere even to buy incandescent lamps and light-current products. (83)

After taking all this into consideration, Ernő Egger informed the executive committee that VEAG would build a current industry factory within the Újpest plant by the end of 1905, and the manufacturing of generators and electrical motors should begin there by the end of June, 1906, at the latest.

The new factory had, indeed, been completed by early 1906, and by the end of April it had been put into service. (84)

The company's direct involvement in selling incandescent lamps did not come to a close with the setting up of the cartel, as it had the right, in certain countries, to market the carbon-filament lamps produced over its quota. Primarily, TUNGSRAM could build up its export market in Russia, Spain, Japan, Canada and South America. The company established sales offices in the cities of Yokohama, Kobe, St. Petersburg, Moscow, Madrid, Montreal and Buenos Aires. Lipót Aschner organized the Russian market. (85) In 1905 the company also set up permanent sales agencies in Paris and Vienna. The running of the agency in Paris was entrusted with the office manager Rudolf Lóránti, while Ignác Salzmán was put in charge of the Viennese office. (86) The British market received the lamps and the light-current goods of the TUNGSRAM through the

sales organization set up jointly with the Schwechat company Schiff & Co. (87).

Naturally, the construction of the current machine section, the relocation and the gradual realization of full production all had an unfavourable effect on the company's business figures between 1901 and 1903. In spite of the initial difficulties of the new section, the company closed the year with a net profit of 145,000 Koronas. Of course, this was not enough to pay out dividends. The profit grew to 269,000 Koronas between 1903 and 1905, and in the fiscal year of 1905/1906 it exceeded 488,000 Koronas. There was such a boom in the electrical industry that from time to time the company could only fulfil its orders by working overtime. The shareholders received a dividend of 540,000 Koronas in the three years beginning with the fiscal year of 1903/1904. The company's financial state became stable: in the fiscal year of 1905/1906 the Újpest plant and its machinery was evaluated to be worth 3.3 million Koronas, and its stocks held finished goods and raw material worth 1.6 million Koronas. Against the company's entire debt of 1.5 million Koronas its claims totalled 1.6 million Koronas. (88)

In 1901 the work-force did not exceed 700; therefore, during the previous two years it only grew with about a 100 employees. As the Trade Ministry had granted the factory's tax-free status on the condition that by 1 November, 1904 it would employ 1,200 workers, and since the management was unable to comply with this condition, it fell on Jenő Szabó, president of the board, to procure the repeal of this particular point. (89)

In order to achieve a gradual reduction in the production costs and thus increase the profits, the management primarily tried to employ cheap female labour. At the same time, and as a result of the constant widening of the production profile, it also had to increase its skilled work-force. The majority of the female workers came from the districts around Újpest. They still did not have any connections with the trade union movement for a long time to come. Most of the skilled workers, however, were already union members. The first stoppage in the Újpest plant took place in

1905. The technical director József Pintér told the executive committee on 4 March, 1905 that the carpenters had threatened with strikes in case the following of their demands were not met.

1. The company should employ a foreman, who is competent enough to run the carpentry workshop independently.

2. The piecework system should be abolished.

3. The bottom hourly wage for carpenters, machine workers and turners should be fixed in 40 fillérs, and in 24 fillérs for female workers.

4. Male and female workers should both receive a 25 percent bonus every fortnight.

5 Overtime work should be abolished. The hourly wage in case of overtime work called in exceptional circumstances should be raised by 50 percent if it is within the factory, and by 100 percent if it is outside the factory.

6. Wage penalties should be abolished.

7. It is desirable that the mutual respect between workers and foremen be observed.

8. The company should recognize the workers' elected shop steward.

9. Workers participating in a wage dispute can only be laid off in the next 6 months, if it can be proved that they did not report for work on their own accord.

10. The labour exchange should take place through employment agencies.

11. The work instructions should be given out by the foreman.

12. The work regulations should be displayed in the workshop in an accessible spot. (90)

The technical director, József Pintér told the workers' delegates that the management would discuss and remedy their complaints. The answer, however, did not placate the workers. They called a meeting that night and decided that the 65 carpentry journeymen would lay down the tools next morning, on 5 March. The strike ended on 17 April.

The management conceded to the workers on several points, and so the stoppage was not without any results:

1. Although the piecework system stayed, the piece-rate was raised.

2. The minimal hourly wage was fixed in 34 fillérs.

3. The management made a promise that it would pay 25 percent overtime bonus in case the work ends before 8 o'clock p.m. in case of overtime work after this time, the management promised to pay a 50 percent bonus both to those working in piecework and to the day-workers.

4. The management recognized the shop-steward system.

THE INTRODUCTION OF TUNGSTEN TECHNOLOGY IN THE PRODUCTION OF INCANDESCENT LAMPS TUNGSRAM'S TRANSFORMATION INTO A LARGE CORPORATION (1906-1914)

On the extraordinary general meeting held on 23 May, 1906 the official designation of the Újpest factory was modified to Egyesült Izzólámpa és Villamossági Rt. "United Incandescent Lamp and Electric Company". This is the original registered style together with its antecedents were named, "abbreviated" for simplicity, TUNGSRAM. After buying up the patent of Just and Hanaman's invention, the company spent more than a year trying to perfect the production technology of tungsten lamps. (91) The two inventors themselves participated in the experiments, in the course of which several problems arose. In essence, tungsten was extracted in glowing gas from tungsten-hexachloride onto the surface of a carbon filament. The carbon was then removed by heating the filament in moist hydrogen gas. Unfortunately, the resulting tungsten filament proved to be very fragile. The company wished to rectify this problem by employing special-purpose support wires. (92)

In March, 1906 the success of the experiments already suggested that the mass-production of tungsten lamps could soon commence. To be able to do that, however, the company would have had to invest substantial sums which it did not have. On short notice TUNGSRAM could have sold its power plants in Losonc and Budafok or its factory in the Huszár Street only at a great loss. The only course of action seemed to be the raising of the company's equity, to which the general meeting eventually gave its consent on 23 March, 1906. The shares issued in the nominal value of

1 million Koronas were bought up by the Commercial Bank and Niederösterreichische Escompte Gesellschaft at a rate of 115 percent. (93)

The hopes of an early start in the mass-production of tungsten lamps, however, proved a little too optimistic. Steady work and perseverance was needed to overcome the difficulties. Nevertheless, the company swiftly made the necessary preparations for production: in September, 1906 it put its new (second) power plant into operation and by then it has also completed the work sites. (94)

By late September the difficulties of mass-production had been largely overcome and hence the preparations for a trial run producing 600 lamps a day could commence. The company made the start of mass-production pending on the results of this test. (95)

Since at the beginning of the trial run certain disagreements emerged between the inventors and the manager of the Lamp Manufacturing Department, the executive committee decided that:

- the trial run currently being performed as well as the mass-production under preparation must, without fail, involve the participation of Dr. Sándor Just and Ferenc Hanaman;

- as soon as mass-production replaces the trial run, the inventors must be given laboratory where they can continue with their research aimed at further developing the tungsten lamp;

- the executive committee must invest the necessary amount for mass-production as soon as possible;

– the production of tungsten lamps must be evaluated every fortnight. (96)

In late November, 1906 the trial run started on four production lines, producing 700 light bulbs a day. Initially there were many faulty bulbs due to the high breakage by the inexperienced female work-force who had been recruited from the vicinity of Újpest. More worrying than was the fact that the filament of the lamps did not stand up very well to transportation. While the cargo to St. Petersburg, Madrid and Milan arrived relatively safely, the tungsten lamps exported to Vienna and Prague, despite the careful packaging, often ended up broken.

The tungsten lamps generated such a great interest that in 1907, after seeing the promising results of the trial runs, the start of mass-production could no longer be delayed. The company management invested 986,000 Koronas in this project. (98) Since the manager of the Lamp Manufacturing Department was entirely engrossed in the problems of tungsten lamp production, Simon Just, who had earlier been working for Fluorescent Light Company of Berlin and Bergmann Electrical Company, was called in to act as deputy manager. That was also the time when the chemist Dr. Ferenc Salzer signed his contract. Later he became the manager of the Lamp Manufacturing Department. (99) By early 1908 the production volume reached 2,500 pieces a day, while the capacity approached 3,500 pieces a day. In order to strengthen the technical staff of the Tungsten Lamp Unit, in April 1908 the management signed another two-year contract with Ferenc Hanaman. In this contract Hanaman committed himself to participating in the work of the Tungsten Lamp Unit as technical expert and staff member until 31 December, 1909. To secure his cooperation, TUNGSRAM doubled the salary which had been determined in his first contract signed in 1906. On top of that, he would have been given the annual sum of 1,200 Koronas to cover his accommodation expenses, had he been willing to move to Újpest. (100) In spite of all this, Hanaman did not take part in the work of the Tungsten Lamp Unit for long. Without seeking the management's approval, he left for the United States

in January 1909.

As Hanaman had failed to return by 1910, the TUNGSRAM terminated his contract as of 1 September, 1910. In any case, he had not received his salary for the previous two years. The management notified Hanaman that his cooperation would only be required in the future, if he submitted himself to the company's disciplinary procedures. Simultaneously, Dr. Just's contract of employment was also terminated, as he-allegedly-had spent all his time lately on the legal aspects of patents (101), instead of leaving it to the official in charge of the matter. Dr. Just's dismissal, however, could be traced back to his insistence on certain licence fees. The departure of two such eminent scientists meant serious losses to the tungsten lamp manufacturing of TUNGSRAM.

The mass-production of tungsten lamps required further and further investments. As the factory's Gas Supply Unit could not meet the ever-increasing demands of the Tungsten Lamp Unit, and since the problem of storage could not be resolved, either, in 1908 the Gas Supply Unit was expanded. (102) In the following year the work area and the storage space of the Tungsten Lamp Unit was enlarged and a new building was added. The Gas Supply Unit, where the necessary hydrogen was produced, also received further installations. (103)

Beside the latest investments and the developing of new support wires for the tungsten filament, the managing directors were concerned with other problems of light bulb manufacturing. In this respect several of their projects were crowned with success. For example, from AEG of Berlin they bought the licence for producing vitrit glass and from 1907 onwards vitrit glass replaced the porcelain insert of the lamp base. (104) In 1908 the company produced a metal lead-in wire which was a great deal less expensive than the platinum wire used earlier in incandescent lamps. (105) At the same time, the company bought the license for producing a kind of chromium-plated metal wire suitable for supporting the tungsten filament. (106)

After overcoming the numerous obstacles, the daily

output of the Tungsten Lamp Unit grew to 5,000 pieces in 1909. On the initiative of the technical manager, József Pintér, the company introduced the production of paste in the manufacturing of tungsten filaments still in the same year. For this purpose Pintér also asked permission to enlarge the building; however, the executive committee did not agree to any additional construction work, as the investment in tungsten lamp production had already totalled over 1.4 million Koronas. As a temporary solution, the executive committee suggested the introduction of night shift. (107)

The company, the inventors and two Viennese investors founded the International Tungsten Co. Ltd. for marketing the patent of Dr. Just and Hanaman on 19 November, 1906. (108) The company, which hence became the sole proprietor of the patent, licensed it in thirteen different countries. Gyula Egger was named as the chairman of the public company, Ferenc Hanaman was his deputy and Dr. Sándor Just became the chief executive. The board of directors of the International Tungsten Co. Ltd. unanimously endorsed the contracts which TUNGSRAM had signed with Dr. Sándor Just and Ferenc Hanaman in Újpest on 15 February, 1905 in the matter of the two inventors' employment. (109) TUNGSRAM had sold the licence to produce tungsten lamps in Germany for 800,000 German Marks even before International Tungsten Co. Ltd. was formed; in England the license was marketed in 1907. The deal concluded with General Electric Co. was worth \$75,000. (110)

The intense competition in the export market and the recurring drops in the price of tungsten lamps urged the company to further investments and greater production. In order to remain competitive, the executive committee issued the directive to make arrangements for the production of 10,000 lamps a day. Immediately after the resolution preparations were made to enlarge the factory. Three wings were given second floors and the construction and fitting of the new work halls began. In the spring of 1910 further two wings received second floors. The useful area of the Tungsten Lamp Unit grew to 8,250 m² from 4,100 m² within one year.

The cost of investment totalled 1,845,000 Koronas. (111)

In spite of all this, the company was only able to meet 60 percent of the existing demands in the countries where it held the license, which amounted to 5 million tungsten lamps. There was a real danger of new competitors' emerging. The continuing reduction in the price of the light bulbs further pressed the company in the direction of greater production. In 1910 AEG of Berlin reduced the price of tungsten lamps by 33 percent and, of course, TUNGSRAM had to follow suit. The forecast further fall in the prices could only partially be balanced by the reduction of production costs, hence leaving no alternative for the company but to increase the volume of production intensely in order to eliminate the competition and prevent the further shrinking of its profit margin. (112)

By the end of 1910 the technical manager, József Pintér already recommended to make preparations for the production of 22,000 lamps a day.

Without the slightest hesitation, the executive committee authorized the managing directors to expand the Tungsten Lamp Unit, investing further 1.5 million Koronas. The construction work and establishing was completed by the end of 1911. The work halls of the Lamp Manufacturing Department were not yet available for the Tungsten Lamp Unit, as the former department, with its business waning, could still bring in an annual profit of over 200,000 Koronas. (113)

With the expansion of the Tungsten Lamp Unit an increase could be anticipated in the factory's hydrogen consumption. This caused serious problems, since the Gas Supply Unit was, in many respects, objectionable: first of all, it was not safe from explosion and, secondly, the customers buying the oxygen (the by-product sold to reduce production costs) often complained about the purity of the gas. For this reason, in the spring of 1911, Linde Company founded a factory producing hydrogen on the premises in accordance with an agreement drawn up between the parties. The Munich company paid 8 Koronas for every square-fathom of the land its business took up. The hydrogen produced here was led into the main container of

TUNGSRAM through a pipe system. TUNGSRAM even handed its own Gas Supply Unit over to Linde Company. The transaction did not require any investment and guaranteed the factory's hydrogen demand at a favourable price. (114)

While the management of TUNGSRAM was constantly occupied with the upgrading of its Tungsten Lamp Unit, a revolutionary invention was developed in the research laboratories of General Electric Co. in the United States. In 1908 William D. Coolidge discovered that tungsten powder sintered and pressed into rods at a temperature of 1,500 C became so ductile that the rods were suitable for wire-drawing. The Coolidge procedure became the basis of economical tungsten lamp production very soon and, after Siemens and Halske of Berlin had bought the patent in 1911, the procedure also became widely used in Europe.

In the autumn of 1911 TUNGSRAM suffered a setback in the competition against the German tungsten lamp manufacturers. In six months it was only able to sell one and a quarter million tungsten lamps on the foreign market, because the Coolidge technology enabled its competitors to flood the market with cheaper and better-quality tungsten lamps. For this reason, the board of directors of TUNGSRAM ordered the management to employ experts for developing the wire-drawing procedure immediately. (116) Beside the technical problems, however, difficulties concerning the patent rights also emerged. Hence, in May, 1912, TUNGSRAM decided to contact Auer Company, the German licence holder of the American patent, and proposed to set up a body representing joint interests. The Berlin company wanted the Lamp Manufacturing Department of TUNGSRAM to form a separate public company and hand the majority of the shares over to Auer Company. Although this was the company which manufactured and distributed the Osram lamp, the best coil lamp at the time, the transaction did not take place, because handing over the majority of the shares would have meant the foregoing of the company's independence. (117)

After this unsuccessful attempt the management renewed its efforts to lay hands on the production

license. In autumn, 1912 it began negotiations with the German license holders of General Electric Co.'s patent, Siemens und Halske and Auer A.G. Initially the Berlin manufacturers asked for 8 percent of the selling price of the lamps as the license fee. Basing the calculations on the marketing of 5 million lamps in one year, this would have meant for TUNGSRAM an expenditure of 400,000 Koronas. (118) After prolonged negotiations the licence agreement was finally concluded on 1 December, 1912. According to this TUNGSRAM had the right to manufacture tungsten lamps with the Coolidge technology; in return it was to pay 3 percent license fee after the first 6 million lamps, and 15 percent after the lamps produced on top of this. In addition, TUNGSRAM undertook not to sell lamps produced with the Coolidge procedure in England and France. The agreement prohibited the Austrian license holders of the Coolidge technology from setting up tungsten lamp factories in Hungary. This, however, did not stop the Viennese lamp manufacturer János Kremenetzky from founding a factory producing tungsten lamps in Budapest in 1913, even though the Hungarian market was inundated with tungsten lamps. This action prompted the management of TUNGSRAM to call upon the Berlin lamp manufacturers and ask them to start patent law proceedings against János Kremenetzky for breaching the agreement. (119)

By 1913 the Tungsten Lamp Unit was entirely converted to the application of the modern Coolidge technology in its production of tungsten lamps. These were already marketed with the Tungsram trade-mark mentioned before registered in 1909. (120) In the Lamp Manufacturing Department, the company continuously invested in the up-to-date technology after 1908, this way securing the profitability of production on the long run. The machine lines would have allowed the manufacturing of 22,000 lamps a day, even though production was increased only by 45 percent, as all the efforts to boost the production volume were frustrated by the extremely large fluctuations in the labour force. Every spring and autumn twenty-five percent of the workers left the company and undertook agricultural work. At the same time, the training of new workers

took very long, greatly adding to the production. The fact that the old filament workshop was far from being adequate also hindered the efforts to increase production.

The wire-drawing technology changed the manufacturing of filaments beyond belief. Three hundred and fifty workers lost their jobs as a consequence of the new technology, allowing the company to save 300,000 Koronas in labour costs.

With the introduction of the new technology the company once again became competitive on the world market, both in price and in quality. (121)

The daily output of the Tungsten Lamp Unit reached 27,000 lamps in October, 1913. The executive committee of the company, influenced by the successes scored both on the foreign and the home market, ordered the management to raise the annual production volume of the GSL-s (:General Service Lamp:) to 7 million pieces; to begin the manufacturing of torch- and battery-operated miniature lamps; and to make preparations for the production of the so-called 'half-Watt' lamps: the gas-filled lamps, but using half the power. In addition, the company decided to set up a research laboratory. (122)

Just as TUNGSRAM once again reached the world standard, Irwing Langmuir developed the gas-filled incandescent lamp in the research laboratory of General Electric Co. and submitted the patent on 19 April, 1913.

The invention opened up a new phase in the manufacture of incandescent lamps. The inventor discovered that by filling the bulbs with gas he could greatly enhance the light efficiency of incandescent lamps, and this applied especially to lamps using coiled filament. Nitrogen gas, when filled into the bulb, reduced the evaporation of tungsten, allowing the glowing of the filament at a higher temperature without affecting the length of its useful life. (123)

The management of TUNGSRAM immediately realized the potentials of gas-filled lamps and began the experiments under the direction of Aladár Perczel already in 1913. With this a new phase began in the production of incandescent lamps which brought

several new technical problems into focus, including questions concerning the purification of the filling gas and the manufacture of coiled filaments.

At the end of 1913 TUNGSRAM closed an eventful period in the production of incandescent lamps. The Újpest factory became a large enterprise. The executive committee duly acknowledged the results of the technical staff shown in the field of tungsten lamp production on the eve of the Great War. Seeing these results the Viennese board director Miksa Krasny expressed his joy which was all the more notable since earlier he had held a pessimistic view of the company's future prospects. The acknowledgement was first of all due to the technical manager József Pintér and his colleagues who had done their utmost to raise the standard of lamp production. (124)

The Hungarian government also appreciated the successful work done by the company. The Trade Ministry awarded the Tungsten Lamp Unit with fifteen years of tax-free status beginning on 17 May, 1907 on the condition that it would employ at least 450 workers and invest a minimum of 1.1 million Koronas. TUNGSRAM improved on both counts, as the Tungsten Lamp Unit employed over one thousand workers and the company invested more than 1.4 million Koronas. (125) As of 1 December, 1912 the Coolidge type lamps were enjoying tax-free status for fifteen years. (126)

The relationship between Sándor Just and TUNGSRAM further deteriorated after 1910. In 1911 the management repeatedly informed the executive committee that the chief executive officer of International Tungsten Co. Ltd. was posing difficulties to TUNGSRAM in an "offensive manner". Hence the executive committee authorized the management to buy up the majority of the International Tungsten Co. Ltd. shares. Once Commercial Bank, acting on behalf of TUNGSRAM, had bought the 6.500 shares owned by Sándor Just for 65 Koronas each, and this way had acquired 97 percent of the International Tungsten Co. Ltd. shares, all forms of cooperation were ended between the inventor of tungsten lamps and TUNGSRAM. (127)

The incandescent lamps using carbon filament continued to feature on the market for quite some time yet, even though the demands for them were rapidly dropping. In the fiscal year of 1909/1910 TUNGSRAM quota totalled 3,540,000 lamps. (128) Business, however, was so limited after the triumph of the tungsten lamps that the cartel formed to market the carbon-filament lamps broke up on 31 March, 1914 and the cartel members regained their independence. TUNGSRAM was given its 35,000 Mark capital and its share of the reserve fund, further 10,000 German Marks, back by the cartel (129)

At the time of the triumph of tungsten lamps the company's Mechanical Department also went through substantial changes. The Department was doing more and more business each year. Government orders were worth an annual 4-6 million Koronas. The available work space and machinery of the Department grew accordingly.

The professional reputation of TUNGSRAM was also significantly enhanced by the successes of the units producing telegraphs and telephones. After completing the telephone exchange in Terézváros Postal and Telegraph Office decided to build another telephone exchange at the address of 17 Maria Terézia Square in order to provide service for thousands of new subscribers. As the completion of the telephone exchange handling 15,000 lines was delayed, TUNGSRAM assembled a temporary exchange capable of handling 4,000 lines, which was put into operation in November, 1912. When in 1909 the modernizing of the provincial telephone exchanges became warranted, the Postal- and Telegraph Office, with the consent of TUNGSRAM invited the competition — the Deckert-Homolka Company and the Telephone Factory — to participate in the project. According to the resulting agreement, half of all the orders in connection with the new Budapest telephone exchange and the modernizing of the provincial exchanges would go to TUNGSRAM, and the rest, to the competition. The license fees were shared equally between Western Electric Co. and TUNGSRAM. (130)

After receiving the second large order to build a

telephone exchange in Budapest, TUNGSRAM felt the need to establish closer links with the American company. The president of Western Electric Co. himself wished to widen the cooperation. By 1912, when the idea of closer cooperation emerged, TUNGSRAM had already been in business contact with Western Electric Co. for 12 years in connection with various license agreements. The telephones and the exchange systems assembled by the Újpest plant in Hungary had all been patented by Western Electric Co. of Chicago. As there were two other companies in Hungary which produced telephones and exchange systems, TUNGSRAM wanted to modify the license agreements with Western Electric Co. — the leading force in the weak-current goods market at the time — in such a way that the license fees of 10 and 12.5 percent would not reduce its competitiveness.

As a result of the negotiations that had lasted a whole year, an agreement was signed by the two companies in the autumn of 1912, according to which TUNGSRAM was not to pay license fees after the orders coming in on or beyond 1 May, 1912. On the other hand, Western Electric Co. took over shares in the face value of 1 million Koronas and hence assumed an active interest in the Újpest factory. Western Electric Co. purchased the shares in cash at 150 percent. The American company was committed to give technical and economical support to TUNGSRAM. (131) The presence of Western Electric Co. in TUNGSRAM as well as its readiness to cooperate with TUNGSRAM, significantly strengthened TUNGSRAM position in the telephone industry. In 1913, when the installation of automatic telephone exchange systems was considered, the system designed by Western Electric Co. was chosen by the expert body of Postal- and Telegraph Office, as the most advanced. On the basis of this opinion, the Trade Ministry ordered Postal- and Telegraph Office to start negotiations with TUNGSRAM about replacing the two Budapest telephone exchanges with semi-automatic systems. The price offer of 5 million Koronas submitted by the TUNGSRAM management was accepted and work began right away, even if World War One temporarily halted it.

The company's Mechanical Department first of all relied on government orders between 1906 and 1914 and, as a result, neglected the weak-current goods end of the market. Lipót Aschner, who had been appointed to the post of marketing manager on Gyula Egger's recommendation in 1908, laid the responsibility for this on the Mechanical Department. The relations between Pintér and Aschner rapidly deteriorated following the accusations. Aschner questioned the technical competence of the Weak-Current Goods Department, claiming that without the patents of Western Electric Co. the Department would never have survived in the market. Aschner ultimately wanted TUNGSRAM to stop producing weak-current goods. (133) In response to Aschner's accusations, Pintér prepared a memorandum. In early 1908 the executive committee asked the board member Ernő Egger, who was also the chief executive of the Viennese branch, to settle the dispute by giving his expert opinion.

Ernő Egger placed the production and the marketing of weak-current goods in the Újpest factory under close scrutiny. He concluded that the activities had brought the company 12-15 percent net profit (134) and hence recommended to continue with them. He pointed out that by eliminating the Weak-Current Goods Department, the Mechanical Department would have had to rely solely on government orders. In the interest of rationalizing the production he recommended that:

- only first class goods should be produced in large quantities
- the less marketable goods should be purchased rather than produced
- a production and marketing strategy adjusting to the realities should be developed
- through the training of the marketing staff, production and marketing should be brought into harmony. (135)

On the basis of Ernő Egger's expert opinion the executive committee decided to continue with the production and development of weak-current goods. The problems concerning the production of power-current machinery were also resolved permanently in this period. The Viennese company "Vereinigte Elek-

trizitäts-AG" built up its plant manufacturing power-current machinery on the 856 square-fathom land within the Újpest factory and, on 26 November, 1907, turned it into a separate company under the name of Egyesült Villamossági és Gépgyár (United Electrical and Machine Factory). (136) TUNGSRAM completely dissociated itself from the power machinery industry in 1910 when it sold the shares of its power plants in Budafok and Losonc for 692,000 Koronas to a company called "Részvénytársaság Villamos és Közlekedési Vállalatok Számára" (Share Company for Electric and Transport Businesses). In the same year TUNGSRAM also sold its Huszár Street plant for 546,000 Koronas to Haggenmacher Sörgyár (Haggenmacher Bier Factory). (137) These deals allowed the company to settle its long-standing debts, as well as to buy further land around the Újpest factory. After prolonged negotiations, the management purchased 14,510 square-fathom's from Count László Károlyi on 10 June, 1911. This was done more as a precaution, since there were still undeveloped areas within the Újpest factory. (138) The company thoroughly restructured its export policy between 1906 and 1914. It kept the old sales agencies, while also establishing several new trade organizations. The company appointed Gyula Egger and Lipót Aschner as founding members of the Viennese firm, Tungstram Incandescent Lamp and Electrical Company Limited. TUNGSRAM being a member of the cartel established to market the carbon filament lamps, wanted to avoid to appear as the owner of the limited company. (139)

TUNGSRAM founded a company called Tungstram Fabbrica di Lampade ad Incandescenza ed Impresa Elettrica in Milan, and another one called Obschestvo Electrosviet in St. Petersburg. As the Tungstram companies both in Vienna and in Milan proved extremely successful, similar sales agencies were also established in Madrid and Prague in 1913. By organizing the export market, TUNGSRAM managed to dispose five-sixth of its increased production volume in the foreign market without any difficulties. (140)

In spite of the problems of production and the large

investments, the company paid out 6,5 million Koronas in dividends between 1906 and 1914. In the same period it raised its equity to 6.5 million Koronas, while its capital reserves reached 5.8 million Koronas. The Újpest plant, complete with machinery, was valued at 8.7 million Koronas in the fiscal year of 1913/1914. The company's liquidity is best shown by the fact that it had 5.1 million Koronas in outstanding debts as opposed to its 4.3 million Koronas liability, while also being in possession of supplies and goods worth 4 million Koronas.

The following figures can also demonstrate the triumph of tungsten lamps:

Fiscal year	Profit (Koronas) Carbon-filament lamps	Profit Tungsten lamps
1908/1909	373,372	17,599
1909/1910	346,088	320,093
1910/1911	194,715	630,820
1911/1912	100,304	376,784
1913/1914	15,000	641,000

Chief executive officer, Gyula Egger, technical manager József Pintér and marketing manager Lipót Aschner were all instrumental in turning TUNGSRAM into a large corporation. Gyula Egger acted as administrator délégué after 1 May, 1906. His duties consisted of checking the business management and representing the company abroad. With the passing of the years he became gradually less active and the running of the company was left with the managerial and business wizard, Lipót Aschner, who held the complete confidence of the two major share-holders, the two banks. (141) József Pintér continued to act as the technical manager of both departments, although he was getting more and more tied up with the running of the Mechanical Department. The two distinguished managers were elected to the board of directors on the general meetings held in 1912 and 1913.

The heads of departments running the Lamp Manufac-

turing Department were Dr. Ferenc Salzer, Simon Just and Ármin Helfgott. (142) The chemical engineer, Aladár Peczel joined TUNGSRAM on 1 March, 1912. Earlier he had worked for Westinghouse, the Viennese incandescent lamp manufacturer. His services to the company proved invaluable when the company's tungsten lamp production went through a critical phase. (143) Developing the production technology of the tungsten-coil lamps in the TUNGSRAM was associated with Perczel's name.

The company's work-force was 2,300 in 1910, which grew to 3,600 by 1913. At the same time, the TUNGSRAM Hungarian Wagon and Machine Factory employed 2,500 workers, while Mannfred Weiss Steel and Metal Works had 6,000 employees. (144)

TUNGSRAM introduced certain regulations in 1913, which uniformly applied to the work-force as a whole, requiring "every worker to show, both in his conduct and work, loyalty, honesty, diligence, as well as obedience and respect towards his superiors". No one was allowed to leave the factory during working hours, unless one had permission in the form of an exit ticket signed by one's superior. People could only have medical examination in the factory's surgery with an appointment card issued in the workshop office. "The workers were allowed to consume food brought from home on the premises only when that did not interfere with the continuous work". (145)

The adverse housing situation in the locality greatly hindered the company's efforts to expand the work-force, and did that especially in the case of the skilled workers. This problem affected the Lamp Manufacturing Department more than it did the rest of the factory. The management of the company first wanted to improve the situation by building roughly 200 flats for its workers in 1907. Several suggestion had been submitted in connection with the Tungsram Housing Estate. The executive committee finally instructed the technical manager, József Pintér to work out the details of the proposal. (146)

The workers' cultural advancement was not helped by the slowly progressing construction work. Minor in-

initiatives in the cultural field already emerged in the first years of the century.

A club fighting against alcoholism was formed, headed by the chief mechanic, Ferenc Horváth. The club held lectures in order to get its message through to the members.

The club also had a football team for years. The choir, which numbered forty members, was, again, organized by Ferenc Horváth in 1903. They enjoyed great popularity around 1910, and from time to time gave concerts to the workers. In the cultural field the workers had no more organized activities within the framework of the factory. Otherwise it was the growing trade union movement, and the Újpesti Munkásotthon (*Workers' Home of Újpest*) within this, which was primarily involved in the cultural advancement of the working class. (147)

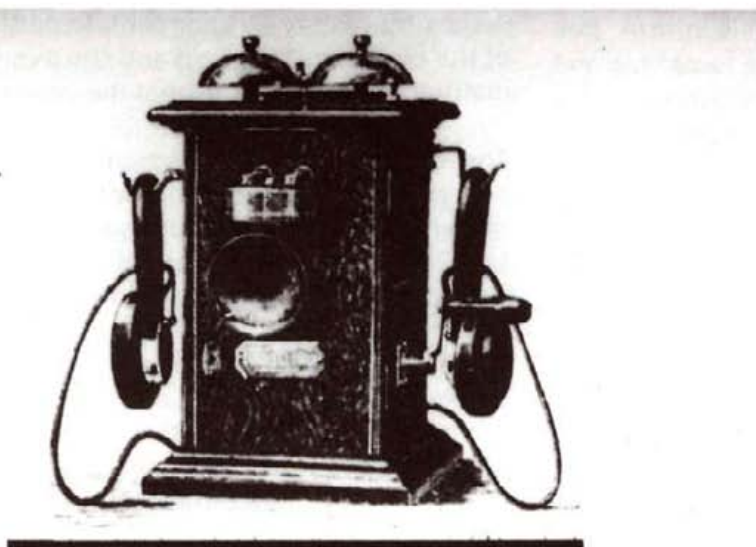
The technical, marketing and administrative employees of the company concentrated first of all on founding and developing the factory's sport activities. The Ampère Sport Club was established in 1911. It had sections specializing in gymnastics, fencing, hiking, tennis, ice-skating and rowing. The club built tennis courts and an ice-ring from its own resources. The gymnasts worked out in a school-gym quite a distance from the factory, therefore very few people could attend the training regularly. For this reason the executive committee, on the initiative of the management, lent 14,000 Koronas to the sport club to build its own gym in the place where today the surgery (:reception room:) is found. The construction work came to 17,000 Koronas, of which the members of the sport club put up 3,000 Koronas. (148)

With the overall work-force rising, the number of organized labourers also went up. This stood in the way of all efforts to reduce production costs through cutting the workers' wages right from the start. When in 1905, following the carpenters' strikes, attempts were made to cut the wages, the workers resorted to stoppages of work. On 13 August, 1907 seventy-two blacksmiths and locksmiths laid down the tools, demanding that the minimal hourly wage of blacksmiths and mechanics starting out should be fixed in 36 fillérs.

In addition, they called on the management to raise the wages by twenty-five percent, to settle the questions of the piece-work system and the overtime pay and to instruct the foremen to treat the workers with humanity.

The strike ended on 31 August, after the management had complied with the majority of the demands: the minimal wage was determined in 36 fillérs, there was a 10–20 percent pay-rise and the company promised to see to the complaints in connection with the piece-work system. (149)

On 3 July, 1908 sixty male and thirty-five female workers of the Tungsten Lamp Unit went on strike after the management had withheld 25 and 8 percent of the wages of the men and women respectively, for the extremely high percentage of rejects. The strike was called off on 8 July without achieving anything, and 27 workers left the company as a result, while the rest of the work-force had to accept the decision of the management. (150) Forty-five workers in the press-works laid down the tools on 20 January, 1912 to force the management to take back a union representative called János Varga who had been dismissed for alleged incompetence, and to fire the foreman Róbert Vajda for being rude to the workers. As the management very firmly rejected the demands, the Hungarian Trade Union of Steel and Metal Workers boycotted the Újpest factory. Finally the management and the workers settled the dispute through negotiations: the mechanic János Varga was taken back and the workers dropped their demand concerning Róbert Vajda's dismissal in return. The Trade Union of Steel and Metal Workers promptly called off the boycott and the strike was ended on 10 February. (151)



Desk telephone set with magneto inductor



Desk telephone set with calling dial stand

THE COMPANY DURING WORLD WAR I.

The outbreak of the First World War greatly hurt the company: its export market shrunk and the future of its outstanding debts in the Entente countries, totalling about 1.5 million Koronas, became uncertain.

The management, however, soon overcame the difficulties: it succeeded in maintaining the high standard of production, introduced new products, and balanced the lost revenues by restructuring its export market.

In the fiscal year of 1915 TUNGSRAM marketed 5.7 million lamps. Forty-two percent of this was sold in Austria-Hungary, twenty-five percent was exported to Italy, eleven percent to Rumania and four percent to Spain. The company exported to the Entente powers through neutral countries. A new Tungsram firm was established in Switzerland in order to increase the company's share in the Italian market. Surprisingly, the demand for carbon filament lamps reached 2.5 times the annual sales of the previous years. (152)

The invention of the so-called 'half-Watt lamps' forecasted the possibility of a new boom in the production of the Lamp Manufacturing Department. However, the mass-production of lamps required a cheap filling gas. As the nitrogen-extracting process developed by the departmental head Armin Helfgott was complicated, unmanageable and highly explosive, in late 1914 the technical manager instructed the engineer, Gyula Hevesi to construct a device which was both safe and productive. Hevesi solved the problem in a comparatively short time: he developed a completely operational, safe and nearly automatic machine. (153)

The production of the 'half-Watt lamps' could start in 1915. Initially production was limited to a thousand lamps a day, but the demand for these lamps was so

great that in the summer of 1915 the executive committee ordered the management to increase the volume of production to 3,500 lamps a day. The committee allocated 65,700 Koronas to the project. (154) The planned increase in the production could only be realized in January, 1916, due to problems in purchasing the necessary equipment. (155)

With the introduction of gas-filled lamps it became increasingly obvious that termination of the agreement signed with Linde Company in 1911 was in the company's interest, as the subsidiary of the firm, Hydroxigen Co., was unable to deliver hydrogen to TUNGSRAM in the desired quality. After long and tedious negotiations TUNGSRAM cancelled the agreement and bought back from Hydroxigen Rt. the land handed over to it, together with the accompanying buildings. (156)

Although the company had basic materials and lamp bases in large quantities at the outbreak of the war, its supplies soon required a fill-up. As by 1915 copper was not available, the company purchased bases made of iron, which were plated with zinc and copper in order to protect them from staining. As the purchasing of these iron lamp bases also became impossible very soon, the board of directors decided to buy the modern machinery which had been acquired by Ganz Electric Co. just before the war and TUNGSRAM started to produce its own lamp bases. (157)

The Tungsten Lamp Unit alone showed a net profit of 1.5 million Koronas in the fiscal year of 1915/1916. Such a respectable performance was made possible by the company's marketing of 2,864,000 lamps more than in the previous year. The profit margin was especially high on the 'half-Watt lamps', of which 669,000 were sold in that year. The Austrian-Hungarian-German cartel founded on 1 August, 1915 for the

marketing of light bulbs greatly contributed to achieving such a high profit margin. In repeatedly raised the prices during its short existence. (158) According to the cartel agreement, TUNGSRAM was allowed to sell 7,986,000 lamps. The sale of carbon-filament lamps slightly rose again to 500,000 pieces in 1916. (159)

The great demand for tungsten lamps, both the half-Watt (gas-filled) and the one-Watt (vacuum) versions, encouraged the management to increase the production capacity of its Lamp Manufacturing Department further. The executive committee accepted the management's proposal and instructed it to run up the capacity of the Tungsten Lamp Unit with a 2 million Korona investment to the production of 15,000 'half-Watt lamps' a day. To secure the necessary capital, the extraordinary general meeting held on 26 October, 1916 raised the equity by 1.5 million Koronas. (160)

The full capacity of the Lamp Manufacturing Department was utilized even in the last years of the war. As the running of the Mechanical Department's war production required József Pintér's full attention, in late 1917 the management temporarily entrusted Lipót Aschner with the technical management of the Lamp Manufacturing Department. Aschner was allowed to make technical and structural changes only after consulting with Pintér.

The management's decision turned out to be a successful one. In a short time Aschner was able to increase the production volume considerably. The Lamp Manufacturing Department was always provided with the necessary basic materials and tools well in advance. Although production was continuously increasing, finished goods hardly ever piled up in stock. (161)

In the third year of the war important experimental work began in the Újpest factory of TUNGSRAM. It so happened that the military command ordered the company to produce electronic vacuum tubes for the army's telephone amplifiers. The somewhat rudimentary tubes were promptly taken to the front. (162)

A piece of tungsten wire made up the cathode of the thermionic valve, which was encompassed in a cylindrical grid made of a piece of perforated nickel foil and

was surrounded by the anode which was also cylindrical. (163) The quality of the thermionic valves rapidly improved. This was partly due to the fact that a successful theoretical explanation was found for the phenomenon, and partly to considerable advances in production technology, first of all in vacuum technology. (164) The thermionic valves used by Telephone Factory Corp. for the army field radios code-named KLERÁ had been produced by the Újpest factory. The Tungsram electronic vacuum tube, which was for years the irreplaceable part of the wireless technology in Hungary, originated in research aimed at developing incandescent lamps. (164)

While the Lamp Manufacturing Department was allowed to keep and develop its original production profile during the war, three-quarter of the Mechanical Department's production was taken up by the war industry. The military command ordered grenade-cases, ignition devices and, later, even hand-grenades from the Újpest factory. The war production demanded heavy investment and a lot of new machinery; their amortization, however, was also very fast. (166)

In any case, the manufacturing of railway security systems and telephone exchanges had to be cut down quite substantially due to shortages of supply materials. The production of telephones barely reached one-third of the peace-time production. The company was able to install the József Telephone Exchange in Mária Terézia square on 15 July, 1917 only after making concerted efforts. As the manufacturing and the laying of the cables proceeded very slowly, all the lines in the area could not be opened immediately: even so, the temporarily installed system which had been handling 4,000 lines became redundant.

The financial status of TUNGSRAM was extremely good, partly due to the success of tungsten lamps, and partly, as a consequence of the very profitable war industry. In the four years of war the company made a net profit of 6.1 million Koronas, of which the shareholders received 4 million Koronas in dividends. The company's equity was raised from 6.5 million Koronas to 10 million Koronas to meet the cost of the continu-

ous investments and to preserve the company's liquidity. In just four years the assets of the company grew in value from 15 million Koronas to 30 million Koronas. The good business figures made it possible, for example, that the company was able to stash away fund of 2.6 million Koronas in the fiscal year of 1917/1918. In contrast with the officially stated figure of 1.8 million Koronas, the profit reached 3.83 million Koronas in that year, of which the two major shareholders — the two banks — received a bonus of 400,000 Koronas.

In the form of internal tantieme 330,000 Koronas were paid out. In the last fiscal year of the war business increased from the previous year's figure of 15,5 million Koronas to 27 million Koronas, while labour costs only grew from 6 million Koronas to 9.3 million Koronas. (167)

The substantial internal savings allowed TUNGSRAM to buy up considerable businesses and holdings. From the viewpoint of the incandescent lamp industry the purchase of the majority of the shares in Hungarian Glass Factory József Inwald Company Ltd. was the most outstanding, as this was the company which had supplied TUNGSRAM with glass for years. The entire glass factory went into the possession of TUNGSRAM in 1917. (168)

TUNGSRAM bought the paper-mill of the Neményi brothers in Erzsébet (a satellite town of Budapest) in 1917 to secure the paper supply necessary for the packaging of incandescent lamps. The company had been purchasing its paper supply from the Neményi brothers since 1907. When in 1917 the cartel formed to represent the Austrian corrugated cardboard industry tried to persuade the owner of the Erzsébetfalva factory, József Neményi to sell his business, he offered it for sale to TUNGSRAM instead, out of respect for the long-standing business relations. As the proposal seemed promising from TUNGSRAM's point of view, the board of directors decided to buy the factory in Erzsébetfalva for 300,000 Koronas and, together with József Neményi, established a public company to continue the work. The management allowed an investment of 400,000 Koronas for modernizing the factory's equipment, but in the last years of the war

they were already unable to get hold of the machinery. (169)

A four-year-long dispute and animosity ended on 16 May, 1917, when the Viennese lamp manufacturer, János Kremenetzky and TUNGSRAM agreed to turn Kremenetzky's Budapest light bulb factory into a public company under the name of Hungarian Tungsten Lamp Factory János Kremenetzky Co. Ltd. Fifty percent of the total shares, Worth 700,000 Koronas, were taken over by TUNGSRAM. At the same time, the two parties signed an agreement on marketing and production quotas, in which the Újpest factory also secured for itself the option of taking over all the shares of the new company. (170)

TUNGSRAM assigned an even greater importance to the acquiring of Elektrische Glühlampenfabrik Watt A.G. The company paid out 700,000 Koronas to the Austrian Landerbank for the shares of the Viennese lamp factory, in addition to taking over its bank debts of 2 million Korona. (171). From 1 January, 1918 Watt was controlled by TUNGSRAM. It produced 7,000 lamps a day and its quota in the Austrian-Hungarian-German incandescent lamp cartel was 4.5 million lamps. Within a short time TUNGSRAM completely restructured the factory. Its wiredrawing unit was closed down, as tungsten wire was provided by the Újpest factory. The newly available work space was used to increase production. Since only Watt had manufactured X-ray tubes in the Monarchy, TUNGSRAM did not abolish this branch. (172)

Now the management decided to establish a research laboratory for developing new products. The board of directors offered the job of running the laboratory to Ferenc Hanaman, who signed the contract in Vienna on 19 April, 1918. Hanaman willingly accepted the job, as he had already worked for the company at the time of developing the tungsten lamp. The board of directors put the breaking off of relations down to the "harmful influence" of Dr. Sándor Just. Beside developing new basic materials and improving the final products, Hanaman also made a commitment to explore the possible ways of perfecting existing production methods and machinery. As the board as-

signed high priority to the setting up of the laboratory, it took steps towards exempting Hanaman from military service. (173)

By establishing a research laboratory the management of TUNGSRAM hoped to create an advanced research centre, rather than simply give assistance to the production of incandescent lamps. TUNGSRAM's long-term goal was to be listed (once the hostilities were over) among the companies which exchanged inventions and licenses with General Electric Co. free of charge.

As Hanaman could not be exempted from doing military service, the setting up of the research laboratory had to wait until after 1918.

The war took a great toll in the work-force of TUNGSRAM: 286 of its workers did military service in 1914/1915, and their number grew to 349 in 1915/1916. The work-force needed to maintain and improve production could only be increased by taking on female staff. Still, the permanent fluctuation continued to pose severe problems in the factory's running: more and more female workers chose to work in ammunition factories, where the work was easier to master and the employees were able to quit for the spring and the summer to do agricultural work. As their training in TUNGSRAM took weeks — or even months in some cases —, it was very difficult to replace them. In certain departments ninety percent of the female workers taken on during the Summer of 1917 left the factory before completing their training. The company wanted to make up for the shortage of workers by raising the production norms, but in fact achieved just the opposite: even the experienced female workers slacked off. In the question of labour shortage the board of directors could see only one solution: they proposed the management full automatization, as well as the modernization of the existing machinery, to the management in order to switch from manual labour to machine power in as many work phases as possible. (175)

The huge labour turnover, however, could be assigned not in the least to the fact that during the first years of the war the company did not care much to raise the

workers' pay. With their pay frozen, the workers were unable to keep up with the rapidly growing prices, in spite of putting in longer and longer hours. At the same time, the profitability of the company, as we have already pointed out earlier, rocketed to new heights every day.

Beside low pay, the working conditions were also deplorable. The female staff working next to the vacuum stoves operated at 400 °C often had to put up with an almost unbearable heat. The position and the circumstances of the skilled workers also rapidly deteriorated as a result of the war effort. (176)

In 1917 a number of engineers and shift leaders, headed by Gyula Hevesi and Ármin Helfgott, joined the National Trade Union of Private and Commercial Employees. On the initiative of the organized technical and administrative staff the organized technical and administrative staff the Trade Union Council called together the female workers to discuss the situation and the future. On the meeting the women decided to join the Trade Union with great enthusiasm. The management looked suspiciously on the spreading of the union movement, even though they were unable to stop it. The marketing manager, Lipót Aschner was the only one who, in the case of the staff working in the administration, attempted to put an end to the organizing: he called the staff in his office and informed them that all those joining the Union would be immediately sacked.

The administrators could not be scared off: they notified Aschner in a letter that the entire workforce and the administration, supported by the Union, would go on strike, unless he withdrew his threat. At the end there was no need for industrial action, as the management, seeing the united front put up by the workers, withheld from making further steps. (177)

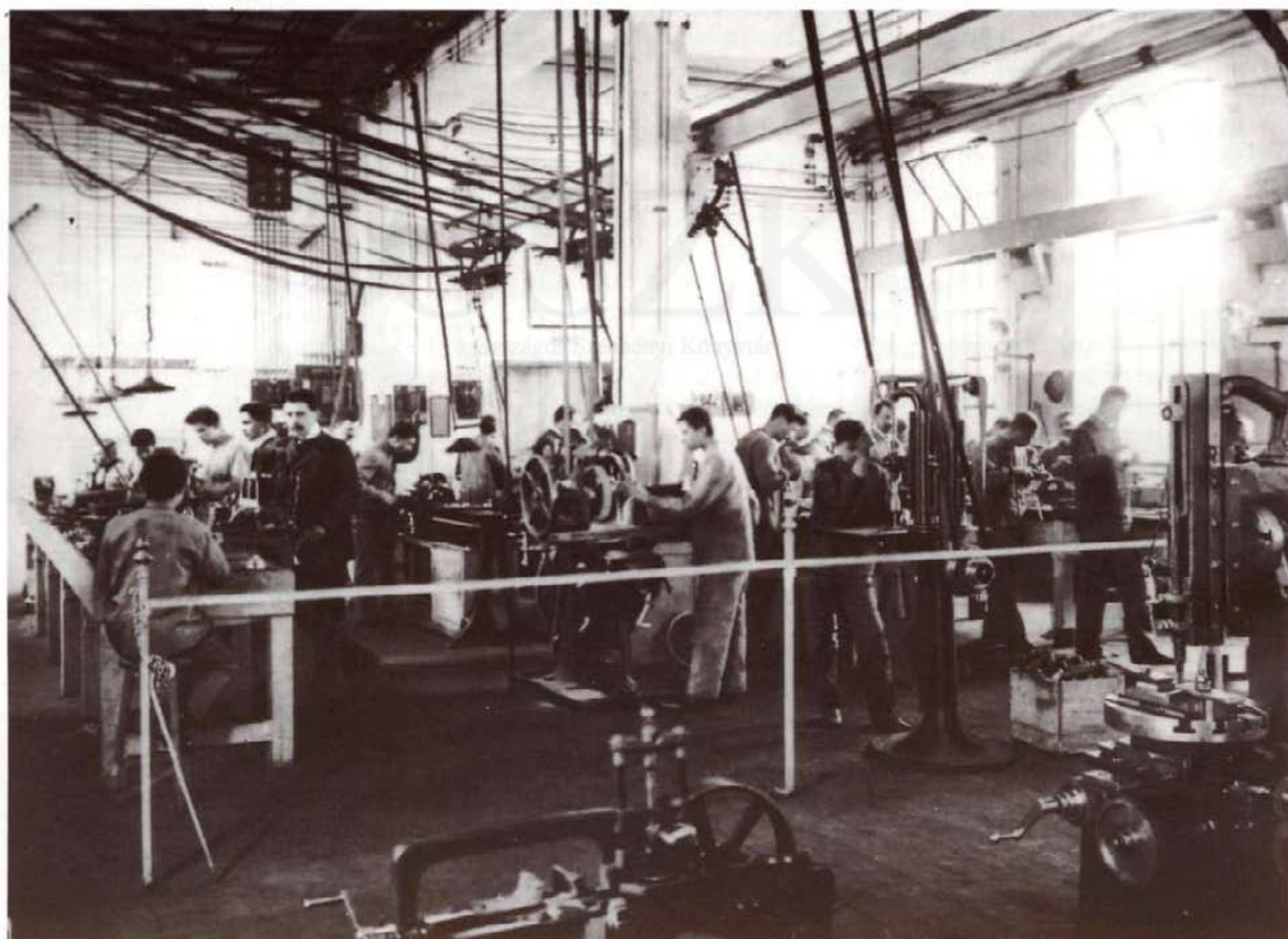
The organized movement of the workers and employees was not without effect. On the Trade Union's initiative the workers were given pay rises twice in 1917, and three times in 1918. The gradual increase in the hourly wages did not burden the company, as it could easily pass the extra costs on to the customers. (178) At the same time, rising wages and salaries

hardly eased the problems of the workers and the employees, as the food prices, with the exception of that of flour, bread and beans, cost five times more in the last year of the war. The situation was further aggravated as the industry mainly catered for the military, while goods meeting the public's needs were produced in less and quantities and in inferior quality.



Watt Wien trade mark

TUNGSRAM tool shop in the 20s



THE COMPANY DURING THE TWO HUNGARIAN REVOLUTIONS IN 1918 AND 1919

After the obvious loss of the World War I and the total collapse of the former Habsburg Monarchy a bourgeois democratic revolution known as Aster-Revolution was aroused in Hungary by the general despair. Hungary became a republic with the president count Michael Károlyi, a democratic politician known abroad too.

The atmosphere in the Újpest factory was very tense during the weeks prior to the bourgeois democratic revolution of October. The workers' latest demand for a new wage settlement was turned down by the management who gave their grounds in that only a brief spell had passed since the last pay-rise. The workers went to a committee specially set up by the government to examine public grievances. After prolonged negotiations the company finally agreed to a 25 percent pay-rise. Consequently, the administrators also managed to procure a substantial raise for themselves. (179)

After the triumphant October revolution, in early November, war production in the Újpest factory was production in the Újpest factory was cancelled with immediate effect by a government order. The Ministry of Defense was owing 3.8 million Koronas to the company. (180)

The shortage of raw materials — due to the long war — posed grave difficulties for TUNGSRAM in running its various departments. While the management succeeded in piling up enough coal for the production of gas for its Lamp Manufacturing Department to last until the end of January, 1919, the coal to be burnt in boilers was only enough for a few weeks. As the Újpest

power plant of PHOEBUS was able to supply electrical power to the factory for the time being, the coal reserves for boilers were stashed away for leaner years. In order to save coal the Trade Ministry limited the working hours in the Lamp Manufacturing Department to the interval between 7.30 a.m. and 2.30 p.m. as of 1 December, 1918. The workers were allowed compensation for the lost two hours, which was paid by the Trade Ministry. Special departments, such as the Gas and Hydrogen Unit, continued to operate round the clock.

During the bourgeois democratic revolution of October TUNGSRAM did not export goods in order to be able to meet the demands of the completely exhausted home market. The company had considerable stocks of raw materials necessary for incandescent lamp production. (181)

In early December, 1918 the executive committee thoroughly restructured its business management. Lipót Aschner was entrusted with the position of managing director, so Gyula Egger's term was ended. After acting for 24 years as chief executive officer and managing director, Egger retired from active management, only retaining his seat on the board of directors. József Pintér remained the technical director and became vicepresident of the board. Dr. Ferenc Salzer, head of the Lamp Manufacturing Department was transferred to Watt as director, while Frigyes Baumann moved from Vienna to Újpest as head of the department. Béla Friedmann was appointed to the post of technical director, the manager, Dávid Aschner became deputy director, and the chief engineer, Béla

Balázs, the head of the Mechanical Department. (182) The board meeting held on 28 December, 1918 gave permission for another pay-rise, inflation adjustment and clothing allowance. The board ordered the transfer of 30,000 Koronas to the Mayor as a contribution to the expenses of the expenses of the Újpest "militia". (183)

The shortage of coal in the first few months of 1919 began to give cause for concern. In the Lamp Manufacturing Department, where 1683 employees were working, only 30 percent of the production capacity was utilized. Only 81,000 lamps were produced weekly, which meant that the overhead costs of 235,000 Koronas had to be compared with the total sales value of 110,000 Koronas. The Lamp Manufacturing Department paid out a weekly 15,600 Koronas in benefits to 179 unemployed workers. (184) The situation was even worse in the Mechanical Department. The utilized production capacity did not exceed 25 percent, so the 960 employees of the Department only produced goods worth 90,000 Koronas. This figure had to be compared with production costs of 139,000 Koronas. The Mechanical Department handed out benefits to 125 unemployed people. (185) Because of the political intolerable international conditions, the government Károlyi was no more able to hold themselves after a time and left the odium of wielding power to a socialist-communist political group. These proclaimed the Hungarian Soviet Republic modeled on Soviet pattern as a propetarian dictatorship. Until afterword it came out, that only for a period of some month.

The proclamation of the Soviet Republic brought about a major turn in the life of TUNGSRAM too: the company was nationalized. The Commissariat of Nationalized Industry put János Molnár in charge of the whole company as production commissar, Marcell Ambrus became the head of the telephone and telegraph production, and László Havas, the head of the Lamp Manufacturing Department. (186) At the same time, the Controlling Work Council was formed. The duty of the production commissars, as the agents of the Nationalized Industry Commissariat, was to keep up the work moral, guarantee the continuous prod-

uction and the best possible technical management of the factory. The Controlling Work Council supervised the activities of the production commissars. The Soviet Republic assigned great significance to the incandescent lamp industry Department of the Nationalized Industry Commissariat held talks with the leaders of the Újpest factory on several occasions and worked out a plan to improve the running of the Lamp Manufacturing Department, as well as to survey the company's demand for raw materials and the public's demand for the finished products. (187)

In spite of these TUNGSRAM soon made a recovery: the Lamp Manufacturing Department was working with 40 percent of its capacity, the telephone and telegraph equipment production reached 60 percent of its capacity. Unemployment was ended, the Lamp Manufacturing Department had 1540 workers, the Mechanical Department, 1506 employees. Later there was another great drop in production as approximately 900 men were called up to do service in the Hungarian Red Army. (188)

During this Council Republic the nationalized company's expenses were covered by the nationalized Commercial Bank. Financing posed no problems, since TUNGSRAM's shares worth 3.7 million Koronas, 10,000 Italian Liras and 9.9 million German Marks were sufficient to serve as a guarantee. (189)

During the brief existence of the Council Republic the administration was unable to carry out the restructuring of the Újpest factory. In spite of the difficulties however, it could still maintain the standard of production.

TUNGSRAM IN THE FIRST DECADE OF THE HORTHY REGIME

Modifications in the company's structure during the Early 1920's Admiral Horthy, the later Governor taking up the place of the former kingdom and his supporters including certain quarters of the Entente Powers and local allies defeated the improvised fighting forces of the Hungarian Soviet Government and subverted the so called proletarian dictatorship. These few months were not sufficient for this system to establish radical and steady economic changes.

On 1 August the Rumanian Royal Army marched into Újpest, arresting the local leaders of the Commune in Hungary and the members of the workers' councils. The Rumanian interventionists, together with the Horthy militia, destroyed the revolutionary organizations of the Council Republic one by one. In the wake of the interventionists and the militia came the landowners and the industrialists to restore the old order.

The capitalists' rule was swiftly reinstated in the Újpest plant of TUNGSRAM. As a retaliatory measure, 778 workers and 138 office employees were sacked, as of 1 August, 1919, for "improper conduct towards the company".

Those who were able to keep their job did not have an enviable position, either. The Horthy regime halved the wages fixed by the Council Republic and raised the working hours from 48 to 52 hours a week after 1 August. In spite of the lower pay and the longer working hours the workers, who had become impoverished after the war, were forced to take the jobs in order to support themselves and their families. From the surviving — fragmented — sources it is clear that TUNGSRAM was not an exception to the rule in this respect: by 1921 the work-force of the Újpest factory exceeded that of the pre-war years. (1914:

2,795 employees — 1921: 2,834 employees)

Continuous production was temporarily hindered by the invading Rumanian Royal Army, who took along 1.5 million Koronas worth of equipment and supplies, when they finally withdrew from Újpest. TUNGSRAM however, was soon able to recover its losses through its foreign branches, and could supply the Újpest factory with the essential basic materials, as well as the coal, glass and metal necessary for the production of incandescent lamps.

As a consequence of the Trianon Peace Treaty, Hungary's internal market was substantially reduced, which adversely affected a great number of Hungarian companies. The loss of territory did not hurt TUNGSRAM as much as it hurt others, since the company had been disposing much of its products abroad already before the war, and it could continue with its export activities after the war. In 1921 roughly 22 percent of its incandescent lamp production was sold at home and the rest was realized on the foreign markets.

The industry based on vacuum technology was going through rapid development in the early 20th century. The tungsten coil and the use of the various filling gases substantially improved the luminous intensity and the useful life of incandescent lamps. As a result of this development, electric light replaced gas light nearly everywhere and by the 1920s incandescent lamps had become exclusively used in a very large part of the world. The expanding market was accompanied by a sudden development in the electronic and the telecommunication industry, to which — especially in the latter case — the war provided a great boost. The technical and the technological develop-

ments guaranteed that only those companies could survive on the market which had been thoroughly prepared: companies that could not keep up with the international competition were doomed to failure.

The management of TUNGSRAM — which had been headed by Lipót Aschner since December, 1918 — assessed its position realistically in the given situation. It responded to the challenge partly by selecting a narrower production profile and, partly, by carrying out a substantial modernization program in the branches which survived the selection. It took almost a decade to carry out these two — basically simultaneously implemented — strategic goals. The successful attainment of these goals largely contributed to the fact by the second half of the period TUNGSRAM had achieved international recognition as one of the leading companies in the industry. To give an idea of the company's standing in Hungary's economy, we only have to point out that the 'hard' currency resulting from TUNGSRAM's export sales at the end of 1930 exceeded that of Hungary's total agricultural export in that year.

In the first few decades of TUNGSRAM's history — as it has already been mentioned — the company was actively involved in the various branches of the electrical industry. By the early 1920s, however, the Újpest factory only consisted of two units: the Lamp Manufacturing Department and the Mechanical Department, otherwise known as Telephone and Telegraph Department.

Next to the Mechanical Department, but not subordinated to it, was the Railway Security Systems Department, which designed such systems in close co-operation with Hungarian State Railways. The equipment was partly — manufactured by the Mechanical Department. In 1922 the production profile was widened with the new Radio Tubes Department which was called the "Audion Department". Later it became rapidly developing unit and stayed in importance not far behind the Lamp Manufacturing Department.

During the early 1920s the Telephone Department was the company's healthy, prosperous and fully exploited branch. It was from here that the — since then much

expanded — branch of the telecommunication industry was launched in Hungary, which later was going to be associated with the name of today's Belioanisz Telecommunications Factory and its predecessor, Standard Electrical Co. Ltd. The government was the principal customer of the Telephone Department. The complete modernization and automatization of the telephone exchange system in Budapest had already been decided before the First World War. The war, the revolutions and the change in the government all caused delays in the installation of the automatic telephone exchanges.

In the very beginning of the 1920s the Trade Ministry, on the recommendation of the Executive Board of Hungarian Mail, found Western Electric Company's rotary system to be the most suitable. In 1922 the Post-Office-Administration was instructed to give the earlier mentioned modernization programme to TUNGSRAM, the owner of the rotary system's production license in Hungary. (TUNGSRAM had signed an agreement with the American company about cooperating in the field of telephone manufacturing already in 1912, at the time of building the József Telephone Exchange. The company renewed this agreement in 1922.)

There was a fierce competition going on for the Hungarian postal contracts between the three interested companies: TUNGSRAM, Telephone Factory and Ericson Hungarian Electrical Co. Ltd. The latter was the Hungarian branch of the indentially named world-famous Swedish company. In the agreement signed on 9 January, 1923 the three companies divided between themselves the postal contracts. As a matter of fact, the chief executive of Telephone Factory, Kornél Neuhold was the driving force behind the agreement. He wanted TUNGSRAM to hand over to the other two companies some of its contracts to build automatic telephone exchange systems in Budapest. According to the preliminary agreement of 1922, the contracts to build exchange systems in or around Budapest would go to TUNGSRAM, while the other two companies were to share the contracts in the rest of the country, together with certain telephone ex-

changes around Budapest. But the fierce battle between the three companies continued. It was Ericson which was the most dissatisfied with its quota, although Telephone Factory also complained: so much so that it even considered to fight a price war.

The Telephone Factory went through a very difficult phase at the time: it did not have enough orders and, as a consequence, faced financial problems. TUNGSRAM, as the strongest of the three, responded with a bold maneuver. After long preliminary talks, in early March, 1925 Lipót Aschner bought the majority of the Telephone Factory shares for TUNGSRAM. At the same time, TUNGSRAM handed over its orders to produce railway security systems to Telephone Factory. Then in April, 1925 TUNGSRAM bought from Wiener Bankverein more Telephone Factory shares, this way eliminating one of its competitors. Lipót Aschner also negotiated about buying Ericson, but a deal did not follow. The Trade Ministry compensated Ericson with orders to build smaller provincial telephone exchanges.

In 1923 the Trade Minister gave the preliminary order of building the Krisztina Telephone Exchange (16,000 customers) to TUNGSRAM, together with its ancillary exchanges and the Central District Telephone Exchange (10,000 customers). The contracts were finalized and extended in 1925. That was also the time, when TUNGSRAM won the contract to automatize the Teréz Telephone Exchange (10,000 customers). According to the contract, written in several parts, TUNGSRAM was to build a network consisting of 70,000 lines. This number would have been sufficient to accommodate the villages in the vicinity of Pest (Rákospalota, Pestújhely, Kispest, Albertfalva, Budafok). The capital telephone exchanges had to be automatized in a way which would allow the manual exchanges to operate continuously and would result in no holdups whatsoever in the telephone service.

The building of the telephone exchanges posed new engineering and technological problems to TUNGSRAM. The construction and the technology of the telephone exchanges had to be adapted to the local circumstances and the whole work had to be designed

from the technological and structural documentation provided by the Antwerp (Hoboken) factory of Bell Electric Company on the basis of an agreement with Western Electric Company. The management of TUNGSRAM put the chief engineer, Mr. Décsi in charge of manufacturing the automatic telephone exchanges, while the production and the technical documentation was left with the manager, Miklós Hegedűs.

Miklós Hegedűs began his career in the Mechanical Department as an office worker. He gained very wide-ranging experiences in the administration. Next he closely studied the organizational structure of the partner companies. He was an autodidact, in the best possible sense. He spoke German fluently, and later also mastered English and French. He realized that the building of automatic telephone exchanges required the employment of young mechanical engineers, technicians, machine-tool makers, skilled mechanics and engine fitters with the appropriate qualifications and at least a minimal proficiency in foreign languages. There were plenty of engineers and technicians available, as it was then that Technical University and Higher Technical College released their first graduates after the war, and the Hungarian industry was hard put to employ these trained people. Miklós Hegedűs recognized the paramount importance of the introduction of the compatibility of the parts in machine-tool making. He organized the machine-tool makers' workshop of the Mechanical Department, which was at that time among the first in the country, both as far as size and quality were concerned.

Despite the difficulties caused by the new technical challenges, the Mechanical Department vigorously embarked on fulfilling the postal order which was worth nearly 20 million gold Koronas. To have an idea of the growth of the Mechanical Department, it is worth noting that (in contrast with its work-force of 1,023 in 1914) by 1923 — the year of launching the telephone project — the Mechanical Department already employed 1,242 workers and by 1926 it had 2,625 workers. (In the same year there were only 1,066 employees working in the Lamp Manufacturing Department!)

The staff of TUNGSRAM successfully introduced the mass-production of precision instruments and completed the on-site assembling of the telephone exchanges within four years. The automatic telephone exchanges were swiftly put into operation one after the other:

Krisztina	28 April, 1928	2,440 lines
Krisztina	12 May, 1928	2,550 lines
Central District	9 June, 1928	1,090 lines
Central District	21 July, 1928	4,980 lines
Teréz	21 July, 1928	9,400

In fact, the construction of the first exchanges took five years and altogether resulted 20,460 lines. The Mechanical Department also participated in the construction of the Hungarian cable network. The required Pupin cables were also manufactured by TUNGSRAM. Between 1926 and 1928 the company, together with other firms, helped laying the long-distance cable between Vienna and Budapest and also received large orders from the army. These army orders, however, had a price: in 1927 TUNGSRAM agreed to buy Elektromos és Finommechanikai Gyár Rt. (Electrical and Precision Instrument Factory Co. Ltd. — EFIME) or, more precisely, its Reiter Ferenc Street plant. After the war EFIME was the cover business of the Hungarian army people, who carried out secret rearmament there and — hidden from the eyes of the Entente powers — hoped to produce aircraft and parts. As a result of incompetent management, however, the factory went bankrupt. There were plans to restructure the factory for incandescent lamp production using foreign capital, which prompted TUNGSRAM (who was afraid of the competition) to buy the factory. TUNGSRAM did not make a bad deal after all, considering that the Ministry of Defense, in connection with the deal, committed itself to buying equipment worth 10 million Pengős within the next six years in order to meet the Army's needs of telecommunication gear: telephones, telegraphs, wireless radios and the rest.

In 1927 the Mechanical Department received orders

worth 25 million Pengős to build telephone exchanges in Budapest. (The conversion from Korona to Pengő took place between 1924 and 1926.) On top of this, TUNGSRAM won another, approximately 1.5 million Pengő contract to build a telephone exchange in Bucharest.

Therefore, the Mechanical Department was doing satisfactory business and the manufacture of automatic telephone exchanges also had a favourable influence on the production of luminous sources and electronic vacuum tubes. The high mechanical and technological standard resulting from the production of automatic telephone exchanges greatly contributed to the development of TUNGSRAM's own mass-production of parts, machine-tool production and vacuum technology.

While the construction of automatic telephone exchanges continued at a remarkable pace and newer and newer orders came in from the telephone industry, the management of TUNGSRAM decided to change its profile.

The telephone licence agreement which had been signed in 1921 expired in 1926. In October 1926 Lipót Aschner started negotiations with the representatives of International Electric Company (ISTEC) in Paris. In the course of these talks Lipót Aschner asked for the American company's help in purchasing the rival firm, Ericson. The representatives of ISTEC turned down this request. In their counter-proposal they suggested that the Mechanical Department be separated from TUNGSRAM and form a public company. They were willing to take over half of the shares of the new public company, to transfer the right of the telephone licences to the new company and promised to extend its area of operation to the neighbouring countries. The negotiations which had lasted nearly two years ended with success: on 1 January, 1928 Standard Electrical Co. Ltd. was established with an equity of 15 million Pengős and with Lipót Aschner as president.

The position of the new company was regulated by a separate agreement between the two parent companies. According to this, the new company would stay within TUNGSRAM's plant, and continue to build

telephone exchanges using equipment, basic materials and personnel taken over from TUNGSRAM. In return, TUNGSRAM would get fifty percent of the profits originating from the postal orders not yet completed, while in the long run, Standard SC. would prepare for the production of radio equipment and commit itself to purchasing the necessary electronic vacuum tubes from TUNGSRAM. In addition to the telephone licenses, ISTEK were to pay 3 million Pengő to TUNGSRAM for the assets handed over to Standard SC., and to provide other benefits to TUNGSRAM. (Later the relations between the two companies deteriorated and Standard completely parted with TUNGSRAM in 1938, even moving to a separate location.)

Following the complicated business transactions, TUNGSRAM's production profile was modified. It seems that, after considering the rapidly growing demand for electric light sources all over the world, TUNGSRAM's management saw in the production of incandescent lamps a more reliable business than in the manufacturing of equipment necessary for the occasional postal orders. They also saw greater business in the radio industry which was getting very popular at the time, and preferred to establish the production of radio valves in Újpest as a new branch. Beside everything else, the company's difficult financial situation must also have contributed to TUNGSRAM's decision. As part of the Standard deal, the American company bought TUNGSRAM's Telefon-gyár (:Telephone Factory:) shares and the resulting money allowed TUNGSRAM to reduce its bank debts and to realize its planned investments, most of which were connected with modernizing the production of incandescent lamps.

The Incandescent Lamp Industry Home and Abroad

In the previous chapter we saw that after the First World War the management of TUNGSRAM had committed itself to produce incandescent lamps. They

should have also realized that the company had to employ the latest technology, if it wanted to remain competitive on the international market. During the war, and even in the years that immediately followed, the Hungarian companies had been cut off from the Western, and above all, the American technologic advances.

Already in 1920, in order to end the technologic isolation forced on the company by the war, Lipót Aschner started negotiations with certain representatives of International General Electric Co. (IGEC) of New York about the exchange of licenses, as well as technologies, in connection with the production of incandescent lamps. An agreement was reached only after an extremely tedious series of discussions which had taken one and a half years long, as Lipót Aschner's report to the company management revealed it on 31 October, 1921. The agreement allowed TUNGSRAM to use the IGEC licenses in return for a license fee. At the same time, the American company took an active interest in TUNGSRAM, and had representatives on TUNGSRAM's board of directors.

As part of the deal with IGEC, two people from TUNGSRAM's management, the director, Dr. Frigyes Baumann and the chief engineer, Dr. Ferenc Salzer were sent to America to study the incandescent lamp factories of IGEC in the autumn of 1922. The two executives made an account of their experiences on a two-day conference held in the factory in early February. The factory's modernization programme was outlined on the basis of their reports and the ensuing debate.

From the reports of the two executives it became apparent that the American incandescent lamp production made considerable progress in the field of automatization. Before automatization the separate work phases were executed in different departments, the system of component acquisition was complicated, etc. All this required much manual labour and a complicated production planning. With the introduction of automatization the amount of manual labour was considerably reduced and productivity went up very markedly.

The acquisition of the automatic machine lines would have required a large investment from TUNGSRAM. The projected cost of automatization reached \$120,000. At that time the company did not have so much money available, so, instead of buying the equipment from the U.S.A., the management decided that TUNGSRAM itself would manufacture the automatic machine lines according to the documentation provided by IGEC.

This decision caused serious problems for the management of TUNGSRAM, since its own machine tool making was still at an early stage. Also, the documentation provided by IGEC had to be converted to the metric system and had to be adapted to the European standards, as the American lamps often differed from their European counterparts both in size and in construction. The fact that the production of automatic telephone exchanges — an even greater engineering and technological task was under development in TUNGSRAM concurrently, only added to the management's difficulties.

With the odd exception, TUNGSRAM bought its machinery from abroad before the 1920s. The mechanics' workshop simply serviced the existing machinery most of the time, and it still had no modern machine tools, whatsoever. It had no suitable gear milling machine, measuring instruments, not even a tool-making workshop. Only the Lamp Manufacturing Department had a modest tool-making workshop, the job of which was limited almost exclusively to servicing punching-, blanking-, drawing- and thread rolling tools as well as machines.

There was the added difficulty that up till then chemists and physicists had made up the technical management: Dr. Frigyes Bauman, Dr. Ferenc Salzer, Dr. Salpeter. (The same could be said initially about the department manufacturing electronic vacuum tubes, and the research laboratory also had a similar makeup.) The relatively small number of engineers indicated that their role in the technical management was also less substantial.

The eminent engineers and technicians, who were working in the Lamp Manufacturing Department —

Ferenc Berényi, who organized the programming and the dispatching service, Miklós Hrabcsák and Árpád Telegdy, who were the managers of the large-size and the special — lamp production — were completely tied up with developing new products and overcoming technical problems.

At that time the management of TUNGSRAM did not encourage the technical documentation of the parts production and the assembling; in fact, it looked upon any such proposal with some degree of distrust. The management was concerned that the technical documents, if passed into unauthorized hands, could easily give away information about the company's production technology (they were first of all worried about the 'outsiders'). Their concern was not entirely unfounded, since at that time the companies, in general, had no legal protection against industrial espionage, except in cases explicitly connected to military technology. As a result, the production processes and the work phases were, most of the time, based on the notes of departmental heads and managers (or on words of mouth even, in some cases!), and the alteration of these procedures had not been formally regulated at all.

The technical manager of TUNGSRAM, Frigyes Baumann realized the contrast between the objective — automatization, application of modern technology — and the available capacity. In the matter of building American-type machinery for producing incandescent lamps he approached the Mechanical Department. Miklós Hegedüs and Jenő Pintér, the manager and the constructor of the mechanics workshop of the so-called 'K' department readily responded. Jenő Pintér was the other 'great' autodidact of TUNGSRAM. Overcoming a physical handicap — the legacy of the First World War — Pintér educated himself with great enthusiasm and determination. He learned to speak German and English and, for an extended period, he was the sole expert of TUNGSRAM on the documentation of IGEC machines. In 1927, in the interest of further developing the production technology, the rapid expansion of the so-called 'K' department was launched, when its management was strengthened with Jenő Pintér and Já-

nos Lévai. (Jenő Pintér, together with Miklós Hegedűs, fell victim to the fascist destruction.

The augmented Machine Works of the 'K' department started to produce machine tools. Here, almost in a spontaneous fashion, a group of engineers and technicians was formed, whose work greatly contributed to boosting the capacity and to improving certain designs. They paid special attention to the automatization of work phases which posed a health hazard. László Bánki, Béla Reisz and Zoltán Kövér developed press machine safety systems which were unique in the whole country. Béla Király and Béla Kertész produced a semi-automatic bulb-inside-frosting machine; Ernő Shiffer, the shift leader József Rajna and the engine fitter András Druszil achieved, in a commendable cooperation, full automatization in the production of the insulating glass insets, essentially following the basic ideas of János Lévai's patent. They were also the ones who found a way to replace the chemical procedure with a mechanical method — grinding — in turning the colour of the lamp caps yellow. This procedure meant considerable savings in cost and work area, made the heat-treatment of the lamp caps unnecessary, and resulted in the increased strength of the products. And again, they were the ones, together with shift leader Köbl, who modernized the production of lamp bases by replacing the individual press machines with automatic multi-stage-drawing machines, and developed the necessary tools.

The modernization of the production of incandescent lamps necessitated the modernization of the utility system (electricity, water, hydrogen, compressed air, etc.), not even documented accurately on a map previously. Very often only the staff of the utility services knew namely from memory where to find a power line or a gas pipe. The decade-long work of surveying and mapping these — mostly underground — pipes and power lines was initiated and supervised by the engineer Gyula Viola. At the end, the production of automatic machines was achieved within the framework of the company. At the same time TUNGSRAM's — since then internationally recognized — vacuum-technological machine manufacturing was established.

In the course of modernizing the production of incandescent lamps — during the mid-1920s — approximately 170 different machines were put into service. The introduction of automatization simplified the work phases as compared to the earlier methods, and split the whole production sequence into three parts. By the end of the modernization period the daily capacity of TUNGSRAM reached 120 thousands lamps — without an accompanying increase in the work-force. It must also be pointed out that TUNGSRAM carried out the whole project during the worst years of inflation, with cheap labour and inflated prices.

While the modernization of the production of incandescent lamps continued with great energy within the factory, the expected growth in the company's output urged TUNGSRAM to be as independent from its suppliers as possible. The acquisition and the production of glass bulbs necessary for incandescent lamps was a recurring problem of the company. In the aftermath of the Trianon Peace Treaty the glass factory of Ujantálvölgy bought by TUNGSRAM during the First World War went over to the Czechs and, as a result, there were daily transport difficulties. To end these difficulties, on 5 April, 1921 TUNGSRAM bought the shares of Glass Factory of Tokod and gradually changed the factory's profile from the earlier, mostly industrial glass ware to the production of glass bulbs. Glass Factory of Tokod, which had to rely on imported sand, started to produce glass bulbs in 1922. TUNGSRAM made substantial investments in Glass Factory of Tokod. The company decided to build a new blast furnace tub and pot, pottery and warehouse. As the workers earlier had commuted to Tokod from Felvidék, the annexed Northern part of Hungary, annexed by Czechoslovakia in the interest of maintaining a regular work-force the company now decided to establish a housing estate for its workers in this provincial town. Already in 1923 one hundred and thirteen flats were handed over to the factory workers. The glass factory had four to five hundred workers after the investment and was able to produce 20—25,000 bulbs a day. It formally retained its independence, although actually it was controlled by TUNGSRAM.

The necessary, quite large amount of packaging material meant an equally severe problem for TUNGSRAM. For this reason the talks that had earlier been initiated about buying the shares of the Neményi Paper Mill of Csepel were renewed in 1920. TUNGSRAM secured an option to buy these shares, although it never purchased them. Business considerations moved the company to choose another solution. The shares of the paper mill nominally went into the possession of TUNGSRAM, and the Újpest factory's interests were represented in the Neményi Paper Mill's board of directors by Lipót Aschner and one of his sons, Pál Aschner. In return, members of the Neményi family also had a say in the running of TUNGSRAM; for example, Dr. Béla Neményi ran the Law Department as company director.

As we have already pointed out, the domestic market only had a secondary importance to TUNGSRAM, at least as far as quantity was concerned. Nevertheless, the company management could not ignore what was taking place on the home front of incandescent lamp production. Understandably, they were concerned to hear the news in 1922 that a new incandescent lamp factory was in the making in Budapest. The fact that one of the inventors of the tungsten lamp, Sándor Just was among the founders of the new factory, made the emergence of the competitor all the more alarming to the management of TUNGSRAM.

The Just factory held its statutory meeting on 9 January, 1921, and the construction of the new incandescent lamp factory in Újpest, on the site of an old liquor factory was immediately decided. The factory was designed to produce 30,000 lamps a day. The first lamps were produced still in the same year and were marketed in 1922. Since the factory was able to produce most of its basic materials — for example, glass bulbs which were produced in blast furnace pots within the factory — it was a potential threat to TUNGSRAM's supremacy on the domestic market. Also, the name 'Just' must have had a good ring, because the new company was soon given substantial domestic and foreign orders.

The first period in the history of the Just factory proved to be a success. For a while the share-buying fever, brought about by the high inflation rate, even guaranteed the capital necessary for the factory to purchase equipments. The majority of the shares were in the hands of six private investors, who had increasing difficulties in raising the money for the newer and newer investments. The main share-holders already offered the shares of the Just factory for sale to TUNGSRAM in 1922, but Izzó declined the offer at that time. In 1924, when the setting up of the international incandescent lamp cartel was already under way, the syndicate of the four leading companies (IGEC, Osram, Philips and TUNGSRAM) decided that the time was ripe for getting rid of their competitor: they did not want to give to Just factory its quota, or rather, they wanted to lay their hands on that quota. In the Summer of 1924 the syndicate, through various agents including one of the directors of the Just factory, quietly bought the shares from the previously mentioned six inventors and one large bank, MOKTAR, as well as from other share-holders. On 16 October, 1924 the leaders of TUNGSRAM suddenly appeared on the board meeting of Just factory and announced that they held the majority of the shares and they were unwilling to put any more money into the company which was already operating with a loss. The board of directors had no choice but to close down the factory and lay off the employees and the workers. Some stormy scenes took place in the general meeting of the Just factory, held in December, 1924, when the small share-holders, together with the sacked employees and workers, voiced their grievances. But every show of temper was wasted. The Just company went into liquidation, the factory was dismantled, the machines were moved to the Újpest plant of TUNGSRAM and the old factory building was used as a storage space, carpentry workshop, etc. Since the factory's liquidation was prolonged by the small share-holders' resistance (until 1948, in fact), the syndicate tried to profit from the formal existence of the Just factory even during the years of the liquidation procedure. Sándor Just's silence was bought for the yearly sum of a thousand

dollars, the ex-director of the factory was formally employed by TUNGSRAM, while the quota allocated to the Just factory within the international cartel was divided between the four large companies.

The campaign launched against the Just company coincided with a major event in the incandescent lamp industry: the forming of the international incandescent lamp cartel.

The intense industrial developments following the First World War, together with the growing competition on the markets and the dynamic channelling of capital towards the incandescent lamp production and other branches of the electrical industry, moved the leading factories of the world to establish an international cartel. The idea of a cartel was brought up by the Dutch company, Philips, and the German Osram Group. With the exception of the French, Belgian and the Spanish companies, almost every European factory joined the cartel. After holding long preliminary talks, the signing of the agreement, known as the 'General Patent and Business Development Agreement', took place on 14 December, 1924. The cartel's legal body was incorporated under the name of PHOEBUS S. A. PHOEBUS, which resided in Geneva, managed the cartel's affairs as an independent body. The cartel agreement very strictly regulated the operation of the member companies. It worked almost as a separate international company with elected boards, appointed executives, independent inspectors. At the end, 90—95 percent of the world's incandescent lamp producers joined the cartel. At the same time, the cartel consisted of several groups, the most significant being IGEC (which, however, only joined the cartel with its European branches on account of the American antitrust laws), the German Osram group, the Philips concern, English Electric Company and TUNGSRAM's concerns. These five groups made up the core of the cartel, as evidenced in the fact that they held ten of the sixteen seats — and therefore, the majority — on the board of directors. Since TUNGSRAM was a founding member, it, too, had a place on the board of directors, allocated to Lipót Aschner, who was at one point the vice-chairman of the board. In addition, he

was actively involved in other organizations and committees of the cartel. TUNGSRAM's participation and its leading position hence secured had the added advantage that its employees — primarily researchers — had a chance to study the work of other cartel companies.

Beside and on top of the already listed groups, there were the so-called 'pools' formed in order to secure stronger positions within the cartel. These 'pools' developed closer, direct cooperation between each other. An example of such 'pools' was the one constituted by Philips, the Osram Group and TUNGSRAM. These associations, however, failed to eliminate the constant disputes — and in some cases litigation, even-between the members.

PHOEBUS S. A. was formed with the high-minded objective of improving the standard and the economy of electrical light sources all over the world. In fact, the real aim behind this slogan was to drive the non-member companies out of the market. There is some written evidence in the PHOEBUS documents showing that in the most important areas PHOEBUS was only prepared to give 5 percent of the market to the non-member companies.

Improving the quality of the lamps was only one way of getting rid of the competition, rather than being its ultimate goal. At the same time and as a by-product, this ruthless competition between the companies, and the attempt to destroy the weaker contestants and take over their shares of the market, resulted some very significant technological advances.

It was PHOEBUS, for example, which for the first time carried out a complete rentability study concerning lighting. The cost of electrical energy, the initial investment, the cost of replacing the light bulbs and servicing the light system featured in this calculation. The calculation aimed to show that, even when the higher electricity rates of the 1930s were considered, it was worth trading off the increased luminous efficiency of the lamps with a shorter useful life. This was how the 1,000 hour useful life of the general service lamps arose and became standard. This is still an accepted figure in Europe today. The companies not joining the

cartel made a big show of the fact that their lamps lasted longer than 1,000 hours. Only they forgot to mention that the luminous efficiency of their lamps was inferior.

PHOEBUS, too, had to propound the scientific foundation of its stance in the question of the useful life of the lamps. The general benefits of this research were felt throughout the entire industry for decades to come. The joint scientific capacity of the cartel members was needed to come up with a mathematical relationship between luminous efficiency, energy consumption and useful life for the various types of lamps.

The cartel agreement specified compulsory standards for incandescent lamps. It formulated the concept of SCE (Standard Corporation Efficiency) for checking whether the products of the member companies met the specification. SCE expressed all the qualitative parameters of an incandescent lamp in a single parameter, making the comparison between various products possible. PHOEBUS established its own research laboratory, where the products of all the cartel members — as well as those of the non-member companies — were regularly tested. This way PHOEBUS became the pioneer of the practice of statistical quality control, which has been widely used in several branches of the industry ever since.

One of the major functions of PHOEBUS was the division of the market between the members by way of defining their quotas. The quotas were determined on the basis of the member companies' sales figures in 1921 or 1922. The quotas were expressed in 'units', this way dealing with lamps of various types and outputs. Prices were calculated in the currency of 'Phoebus S' which was linked to the value of the gold dollar. At the time of founding the cartel, TUNGSRAM's quota amounted to 5.655 percent of the world's total production: 22,199,121 units or 17 million lamps annually. With this figure TUNGSRAM came third in the cartel after Philips and Osram.

By the way, at the time of founding the cartel a certain 'reserve fund' was set aside for TUNGSRAM with reference to the fact that it still could not recover from the damages of the First World War.

The cartel agreement permitted each member company to 'trade' with each other in their quotas according to the members' special business interests or any other considerations. Naturally, these transactions were rigorously checked and this option was only allowed if strict financial conditions were met.

In the first three years TUNGSRAM's share in the cartel's sales was as follows:

Fiscal period	The cartel's total sales	TUNGSRAM's sales	Over or under achievement
in thousand units			
First period, 01/01/1925 – 31/05/1926	592,000	30,710	—2,288
Second period, 01/06/1926 – 30/06/1927	448,000	26,593	+1,187
Third period, 01/07/1927 –	493,000	29,460	—3,841

The figures show that in the first period TUNGSRAM was unable to meet its quota as defined by the cartel and received a refund of 490,000 Pengős in return. In the second period it overshot the target and hence was obliged to pay compensation to its partners in the sum of 230,000 Pengős. In the third period its sales, again, fell short of its quota, and the sales figures of the following years showed similar variations. The quotas were subject to changes, as the companies which paid compensation after their excess production in one year, asked for the raising of their quotas next year. For example, at the end of the 1920s TUNGSRAM agreed to hand over its quotas in China and Brazil to IGEC on account of the high cost of transportation.

We must point out that in cases where larger quotas changed hands, the companies actually delivering the goods were obliged to use the trademarks of the companies which originally owned the quotas, and their products had to meet very strict specifications.

There were ceaseless manipulations around the quotas by the member companies, often resulting in acrimonious disputes about the way of rendering the accounts. In such disputes — or, in fact, in any disagreement between the member companies — a separate jury, elected by the cartel's general meeting, was to mediate. In disputes between cartel members and outsider companies or government bodies the cartel's interests were represented by PHOEBUS S. A. or its attorneys.

Perhaps the most important part of the cartel agreement was the section laying down the extremely harsh regulations in dealing with the non-member companies. Cartel members were forbidden to sell basic materials and parts to the outsider companies so that they would not become more competitive. In order to remain competitive at all, the outsider companies responded to this by lowering their prices below that of the cartel members.

The cartel launched a ruthless price war against the outsider companies. They produced second-line lamps — "Nebenmarke Kampf-Lampe", in German — and sold them considerably below the price of the outsider companies' products. (The second-line lamps were produced using reject tungsten filaments of uneven thickness.)

The purpose of the price war was to subdue the outsider companies. These could only choose between two possibilities: either they joined the cartel or withdrew from the incandescent lamp business.

The cartel quite often bought a company and either ran it under the name of one of its member companies, or closed it down. The latter happened to the Just factory. In fact, the interests of the strongly centralized international incandescent lamp cartel ran counter to the interests of the consumers. With its strict business policy and monopolistic prices and quality, the cartel was able to fill the shops and the customers' homes and factories with lamps which suited the interests of its own membership. At the same time, the cartel secured a market for its members, who pocketed an extra profit from the monopolistic prices. The cartel

also provided a certain technical advantage to its members, since — according to the cartel agreement — the members were free to use each others' patents, and were only obliged to settle the finances later. The guaranteed market and the technological advantages, therefore, had great advantages for the cartel members, who — especially in the first period — made quite a profit. They were able to finance their research and development and the initially loss-making electronic vacuum tube production from this money.

When the Germans occupied The Netherlands first and then France, the Dutch Philips and the French incandescent lamp factories went into their possession. This would have meant the German control of the cartel. The war gradually rendered the operation of PHOEBUS impossible. The international incandescent lamp cartel practically ended its operation after the outbreak of the Second World War. In January, 1941 TUNGSRAM notified L.J. Van der Valk, the chief executive officer of PHOEBUS of its intention to leave the cartel as of 1 March, 1941, and with that its membership was formally terminated.

The First Years of Electron Tube Production

After the First World War an important new section was added to the electrical industry: electronics. The traditional products of the electrical business were generators, electric motors, transformers, indicating device etc.

The widespread use of incandescent lamps served the development of electronic vacuum tubes. Then the radios became popular, and with that the production of radio valves took off in a big way. The broadcasting business launched in America gave a great boost to the radio industry. Following the example, the standardized and closely interconnected development of radio transmitters and receivers began all over the world.

The constant drive to perfect the existing tubes was the major task of the electronic vacuum tube industry. This

was aimed at two major objectives: on the one side, there was the economy, the safety and the durability of the tubes, as well as the cheaper and better production technology. The technical development aiming to serve these two goals brought about changes, first of all, in the basic material and the structure of the cathodes, beginning with the tungsten cathodes right to the modern oxide cathodes.

The other main objective was to increase the number of applications of electronic vacuum tubes, as well as their wattage. The satisfactory technical solution of the problem meant by heating the thermionic valves from the mains posed a great deal of difficulties.

By the end of the 1920s the electronic vacuum tubes powered by batteries had been more or less phased out. The development of electronic vacuum tubes designed to run on the mains had greater prospective and helped to increase the wattage and the sensitivity of the tubes. At the same time, solutions had to be found to the special technical problems accompanying operation from the mains, such as the occasional power surges, for example, which could damage the extremely sensitive tubes.

The boom in the production of electronic vacuum tubes in Hungary took place between the two world wars. The work-force was there, and the Hungarian experts acquired a good reputation in the electrical industry. The necessary basic materials were available in Hungary, and the industry only had to rely on foreign export for smaller quantities. There was an almost unlimited market for the products. The country was still in a backward state as far as electrification was concerned and this way the further growth of the market with the advance of electrification could rightly be expected. The relatively low cost of production and the renowned reputation of the Hungarian technical staff had a favourable influence on the export. For the above reasons, the introduction of electronic vacuum tube production in Hungary seemed attractive to the investors. Between the two world wars we can distinguish two periods in the Hungarian electron tube production. The first period lasted until the early 1930s, when broadcasting started in Hungary, which

resulted in a growing number of radio sets in the country. In 1927 there were only 82,000 people who owned radio licenses in the whole country, as opposed to the 300,000 licence owners in 1930. This period saw the founding of the radio valve industry.

TUNGSRAM produced electronic vacuum tubes for the field radios of the Austro-Hungarian army already in 1917, but those were, more or less, custom-built. The real mass production began in 1922. That was the time when the Audion Department was established within the factory. Beside producing electronic vacuum tubes, some research and development was also part of the work of the department. (The Research Laboratory was also involved in producing radio valves.) Only a limited number of documents have survived to tell about the first years of operation in the life of the Audion Department. Jenő Pintér was most likely to be in charge of the technological development and the start of production in the early days, while Károly Czukor and his group handled the construction of the tubes as well as the electronic problems in general.

The cathodes of the first electronic vacuum tubes of TUNGSRAM were still made of tungsten and were marketed with the designation H2 and H3. The MR series—MR2 and MR3—came out in 1925; they had tungsten cathodes, containing a small amount of thorium. This type helped spreading the radios' popularity, since it operated at a lower temperature—1600 C—which, in turn, allowed the extended use of batteries as power supplies. Therefore, it is hardly surprising that the first TUNGSRAM electronic vacuum tubes were advertised in the newspapers in early 1925. The construction of the surviving H2, H3, MR2 and MR3 tubes shows that these tubes followed the American and the French design, rather than that of the Germans.

During the mid-1920s the production technology went through changes, too. At that time the machinery, was the same as in the production of incandescent lamps. To achieve the appropriate vacuum level, diffusion pumps replaced the earlier used rotational oil pumps. Later on magnesium getter was used to maintain a good vacuum throughout the useful life of the tubes.



The extremely rapid development of radio technology started a fierce competition in the international market all over the world, which resulted in newer and newer tube designs. In the mid-1920s the barium tubes appeared on the European markets and, since the older Tungsram tube designs could not compete against these valves, the Audion Department was facing the prospects of the closure.

Then TUNGSRAM's two experts, Dr. Károly Czukor and Ernő Winter developed Tungsram's own barium tube in about four months of intensive work and, in 1927, these tubes appeared on the market. The barium tube was further developed and, following Pál Tury's research, the expensive and fragile platinum used in the cathode was replaced with the cathode core of metallic tungsten. This research produced tubes, such as the G409, which already reached the world standard. There were several other changes in the construction of the tubes; for example, tubes were produced with two or more grids, which allowed the use of smaller batteries as power supplies in radios . . . (During the 1920s electrification in Hungary — especially in the rural areas — was far from complete, therefore, each radio set required its own power supply.) As a result of the triumph of broadcasting, the structural development of the tubes went through its most dynamic phase. The competition between the factories made the development even faster. There was still no cartel agreement between the factories which produced radio valves, so TUNGSRAM faced fierce competition trying to find export market for its goods produced in excess of the domestic consumption. By the end of the 1920s TUNGSRAM was making progress in this respect and the Tungsram tubes were sold all over the world in ever growing numbers.

The surviving documentation of the production and export of radio valves is relatively scarce, and the various figures often contradict each other. The volume of production between the years of 1925 and 1930 went (approximately) as follows:

Year	Number of tubes
1925	252,000
1926	291,000
1927	262,000
1928	291,000
1929	642,000
1930	1,123,000

According to other sources, 379,000 radio tubes were produced in the fiscal year of 1926–1927. This figure fell to 170,000 in the fiscal year of 1927–1928.

The number of tubes sold fell short of the number of tubes produced. The sales figures in the same two fiscal years went as follows:

1926–1927	288,000
1927–1928	150,000

The next table shows the geographical breakdown of the sales figures:

	1926–1927	1927–1928
	fiscal year	/ pieces
Hungary	56,000	53,000
Europe	190,000	74,000
America	39,000	22,000
Elsewhere	3,000	1,000

As the tables indicate, only 20–25 percent of the total number of tubes were sold on the domestic market; more than half was built into the radios of other European countries and the rest was realized on other markets. Austria provided the greatest market, while the Argentine sales more or less accounted for the American market. Tungsram tubes were sold in almost every European country, but India and South Africa was also among its clients. The sales were conducted mostly through the various foreign sales offices of Tungsram which had been set up all over the world.

Radio valve production was still largely a matter of manual work in this period; it was not a profitable business and only its perspectives could justify the investment. The total costs of the 170,000 tubes produced in 1927—1928 added up to 248,20 percent of the total sales price. In this, 71,7 percent was the cost of material, 28,88 percent was the labour cost and the so-called factory overhead costs made up 147.62 percent. The above cost analysis in itself can show the financial drawbacks resulting both from the large structural investments of the introduction of mass-production after rapid development and from the expensive basic materials. These years really were the heroic times of radio valve production.

The bad business figures of the 1920s, however, did not discourage the management of TUNGSRAM. The fact that the entire ground floor and first floor of Building No. 36, which was built in 1930, was given to the radio valve production or, using its contemporary name, the Audion Factory, can testify to that. Engineer Holzer was put in charge of the factory. István Elek, an accounting expert of great organizational talent was given the task of reducing the production costs of the factory and turning the previously loss-making business into a profitable one. The second period, when the structural investments were reaped and the rational organization of the work began, took place in the 1930s.

The First Decade of the Research Laboratory

No large company can do without research and development. Perhaps more than the invention of new products, the perfecting of existing products and technologies, as well as the adapting of other companies' inventions to the conditions of one's own factory necessitate the intensive work in this field.

Hungary has several scientists and engineers whose discoveries and inventions considerably contributed

to the prosperity of the country's industry. These pioneers mostly worked on a single project, quite often had no connections with the industry, while others became investors or at least top managers in various factories. Of all the large Hungarian companies only TUNGSRAM had its own research and development centre, the Research Laboratory set up in 1921.

Research Laboratory — which continued to operate throughout periods up to the present day — had varying success. Almost a decade had past before its two major inventions — the large-crystal tungsten coil and the incandescent lamp filled with krypton — were born. These two results had — and still have — wide-ranging implications in the industry all over the world.

The successes of the technical and industrial development, which had been born in our defensive war efforts in the First World War and which continued to shape the industry and the structure of the whole technical sphere of postwar era, while also intensifying the competition on the international markets, greatly contributed to the founding of the Tungsram Research Laboratory. The survival in the competition was the external stimulus which prompted the management of TUNGSRAM to establish the laboratory. Lipót Aschner, the chief executive officer of TUNGSRAM did not have a technical aptitude; instead, he had a feel for hitting on the right ideas to create the appropriate technical background for a solid, competitive and profitable company.

There had been research and development in TUNGSRAM before the Research Laboratory was founded. We only need to refer to Sándor Just's and Ferenc Hanaman's tungsten lamp invented in 1903, or the successful development of radio valves in 1917. These results, however, were not the products of carefully planned and coordinated research.

Choosing the head of the Research Laboratory caused considerable headache for the company management. People having the right academic qualifications could only be found in universities, and they were not willing to give up their position for an undoubtedly different line of work, more closely connected to the

industry. Lipót Aschner announced on TUNGSRAM's board meeting held on 11 December, 1920 that Ignác Pfeifer had accepted the job of running the laboratory. (On the same meeting the sum of 1.6 million Koronas was allocated for the equipment of the lab.) Ignác Pfeifer (1867—1941) had been a lecturer in the Chemistry Department of the Budapest Technical University since 1912. He joined the movement of the socialist engineers in 1918, and during the Hungarian Council Republic he was the head of the Social Production Commissariat, beside participating in the work of several committees of the Science and Technology Council. In the purge following the fall of the Council Republic a number of prominent scientists of the Technical University, as well as other institutions, were made redundant. A great many of them fled Hungary, seeking fame in other countries for themselves as well as the land which expelled them. Ignác Pfeifer stayed. He even resigned from his university chair voluntarily in order "to protest against the measures (numerus clausus) irreconcilable with the idea of human rights". Ignác Pfeifer accepted the job of running TUNGSRAM's research laboratory.

Although Pfeifer's original research had been somewhat different, as an excellent organizer and a scientist of good practical sense, he became more than simply the head of an institute which was unique in the industry at the time: he grew to be its inspiration and spiritual father. Pfeifer continued to be loyal to his progressive ideas: in the 1920s he became a member of liberal bourgeois parties and also had a leading role in the free-masonic movement.

Ignác Pfeifer was not the only one who gave up (or, was forced to give up) the — at the time, more respectable — university post to do industrial research. Ignác Pfeifer selected his first colleagues mostly from the most talented — and similarly inclined — people of the young academic generation. That was how Dr. Imre Bródy, Dr. Pál Selényi, Pál Vidor, etc. got to work in the Research Laboratory.

Industrial research is different from the kind of research taking place in universities. Acclimatization to the new circumstances naturally caused some prob-

lems to the new colleagues in switching from academic work to industrial research. In an interview given later Dr. Pál Selényi said: "...the tendency of transforming (its results) into technical use, i.e. inventions, is inherent in science, and an industrial researcher does nothing more than trying to speed this process up a little."

The management of TUNGSRAM gave lots of freedom to its researchers. Perhaps that was how the management tried to make up for their sacrificing the greater freedom of academic research for the sake of the industry. Nevertheless, the management demanded results which helped the production and could be converted into money. The contract of the engineers and physicians employed by the Research Laboratory included a condition, whereby they had to conduct their projects so that they end in inventions. The patents had to be registered under the name of TUNGSRAM, and it was TUNGSRAM who would first of all benefit from the resulting profits, although the inventors, too, shared in the fame and fortune. But patents did not follow immediately; it took time before the work of the research laboratory produced significant results. The management of TUNGSRAM — and Lipót Aschner, more than anyone else — supported the work of the laboratory with the necessary patience and finances. Once Imre Bródy remarked about the money spent on research: "...they did not give all that money to the research laboratory from humanitarian reasons; instead, they invested so that one day a successful invention would return the investment with ample profit". The same thing was expected from the Research Laboratory, and its staff had to live up to this expectation. Initially the Research Laboratory had very modest means. Its first home was a one-storey building consisting of a few rooms, and it was annually extended. The new building was handed over in 1930. It was regarded a modern laboratory at the time, providing a comfortable work environment for the staff.

The research carried out during the first phase of the laboratory's history was aimed at perfecting the production of incandescent lamps. This work had two

major areas. One was improving the production of incandescent lamps in order to enhance their luminous efficiency and the quality of the light. The other area was the constant checking of the basic materials necessary for incandescent lamps (metals, glass, gases, etc.) and the developing of new materials.

Parallel with the automatization of incandescent lamp production, the possible improvements in the production technology and the assistance in solving the problems of automatization came to the fore of the researchers attention.

There were projects which continued to feature on the Research Laboratory's agenda throughout its history — for example, the work aimed at perfecting the tungsten filament. Tungsten filaments had to face extremely rigorous requirements. It had been known for long that the mechanical properties of tungsten depended on its crystal structure. All over the world researchers tried to produce tungsten structured from large crystals. The task was all the more challenging since the desired technology should have been suitable for mass-production, not simply for laboratory conditions. This problem occupied the staff of the Research Laboratory for quite some time, until their research was finally crowned with considerable success.

Wide-ranging experiments were carried out concerning the other important element of vacuum technology, molybdenum. There was continuous work in glass technology and, after long and steady efforts, the researchers succeeded in producing glass which was suitably manageable and transparent. Appropriate processes for etching, painting and coating glass were also developed. The work of the Research Laboratory was not separated rigorously from the activities of other technical staff working within the factory. Developing automatic telephone exchanges, incandescent lamps and radio valves in the same location had the added advantage of allowing the healthy "migration" of the professional staff and the well-qualified workers. This opportunity left the door open for everyone to find the place most suited to their talents within the factory. For example, that was how György

Szigeti moved first to the Research Laboratory in 1928, after working in the Mechanical Department, and eventually ended up in the Audion Department where he studied the areas of application of radio valves, as well as their calibration. Moving the talents around continued to be a company policy. TUNGSRAM's Patent Office belonged to the Research Laboratory. Its task was to register the patents used by the company, but also, to keep the researchers informed about the patents and monitor the status of research projects from the viewpoint of registering them as patents. The reputation of Tungsram's researchers very soon spread outside the factory. Ignác Pfeifer became the president of the Hungarian Chemistry Society, Dezső Pillitz, and later, Pál Vidor, its first secretary. The staff of the research laboratory held several lectures in various societies and published articles in technical journals.

The Emergence of the TUNGSRAM Corporation and its Business Achievements

Earlier we have already noted what steps TUNGSRAM took in order to be self-sufficient both in basic and in secondary materials. To this effect they bought the glass factory of Tokod and the shares in the paper mill of the Neményi brothers. Then, in the interest of defining a production profile, they bought shares in the Telephone Factory and took part in founding Standard Electric Corp. All this took place within Hungary. During the early 1920s, however, TUNGSRAM started to increase the number of its foreign investments. 1922 TUNGSRAM bought from Elektro-bank of Warsaw the shares of the Warsaw incandescent lamp factory called Cyrkon. Cyrkon was capable of producing 1 million lamps annually. TUNGSRAM continued to use the Cyrkon trademark as a secondary trademark even after the Second World War. TUNGSRAM continuously acquired new foreign sales agencies, the most significant of which operated

as independent public companies. In 1927 the TUNGSRAM corporation consisted of the following factories and commercial enterprises:

Factories (100 percent interest)

Elektrische Glühlampenfabrik "Watt" A.G., Vienna
Zjednoczone Fabryka Zarowek Spolke Akcyjna (Cyrkon), Warsaw

Tokod Glass Works Corp., Budapest

"Klara" Glashüttenwerke A.G., Utekac (Glass Factory of Ujantálvölgy)

Factories (Joint ownership)

Telephone Factory Corp., Budapest

Standard Electric Co., Budapest

Dial Telefon SC., Budapest

Sales Agencies Abroad

Tungsrám Elektrizitász A.G., Bratislava

Tungsrám Glühlampen und Elektrizitász GmbH, Prague

Tungsrám Sahko O.Y., Helsinki

Tungsrám Electricitász Aktielskab, Copenhagen

Minora Société á Responsabilité Limitée, Paris

Sociedad Tungsrám Fabrice de Lamparas

Incandescencia, Madrid

Tungsrám Elektrizitász A.G., Zürich and its branches:

Tungsrám, Brussels

Tungsrám, Bucharest

Tungsrám, Milan

Tungsrám, Temesvár

Tungsrám, Zagreb

Tungsrám, Kolozsvár

Tungsrám, Belgrade

Tungsrám, Alexandria

In addition to the independent sales agencies working under the name Tungsrám there were nearly fifty ventures selling Tungsrám products all over the world as sales representatives and commissioned agents.

The profitability of a certain company is best shown by the financial reports filed at the end of each fiscal year.

Public companies were obliged by law to produce and publish such reports in the period between the two world wars. These reports were presented formally on the general meeting of the shareholders, but they also helped to inform the public about the profitability (or the lack of it!) of a company. The published reports also served as the basis of taxation to the authorities.

And they also informed the Stock Exchange where the share prices of a company were basically determined by the dividends paid out to the share-holders. As a result, these public reports ought to be treated with a good deal of reservation, since the above considerations, and not the actual accuracy, played a large part in preparing them.

The most important entry in the TUNGSRAM reports is the profit. After the fiscal year of 1925—1926 this went as follows (1925—1926 was the first time that the accounts were made using a stable currency, Pengő):

Fiscal year	Profits in Pengős
1925—1926	1,447,686
1926—1927	1,943,341
1927—1928	2,738,826
1928—1929	3,168,148
1929—1930	3,897,760

The above figures unequivocally show that, according to the key indicator, the company's finances looked extremely healthy during the five years: the profit was doubled. With the rising profits the dividends paid out to the shareholders also grew. The dividends paid after a share, having the nominal value of 40 Pengő went as follows:

Fiscal year	Divided	
	in Pengős	in %
1926—1927	4.00	10
1927—1928	5.00	12
1928—1929	5.60	14
1929—1930	6.40	16

Actually, the dividend paid in 1929—1930 was the highest between the two world wars.

One of the main sources of increasing the profit — always and everywhere — is the numerical growth in

the volume of production. The truth of this statement would be hard to prove in the case of TUNGSRAM since it was in these years that the company changed its production profile and gave up producing railway security systems, telephone exchanges and telegraph-equipment. For this reason we only consider the production figures of the surviving units, the Lamp Manufacturing Department and the Audion Department:

Fiscal year	Incandescent lamp production	Radio tube production
1925	15,088,000 pcs	252,000 pcs
1930	23,429,000 pcs	1,123,000 pcs

Regarding the first and the last year's figures of the above specified period it is clear that the volume of production of the two major products increased considerably. In the same time, the value of the company's assets decreased as a result of the already mentioned changes in the production profile.

Fiscal year	The value of factory site, buildings, equipment in Pengő
1925-1926	18,733,672
1926-1927	18,733,672
1927-1928	14,276,056
1928-1929	14,276,056
1929-1930	14,675,465

The cost of automatization carried out during the worst years of inflation was included in the high figure of the first year, and was quoted in the balance sheet already in stable Pengő. The fact that the previously described growth of production was achieved without enlarging the factory shows the success of the modernization programme in the case of incandescent lamp production. But automatization did not yet bring the anticipat-

ed results in every field. For example, there was no significant drop in the cost of production, which would otherwise be expected in cases of such marked increases in the volume of production.

The profitability of incandescent lamp production went as follows (per lamps, in fillérs):

	1926/27	1927/28
proceeds (less the costs of marketing)	89	89
Production costs	49.3	47.6
Other costs (opening costs, interests, depreciation charges, etc.)	22.9	25.5
Total costs	72.2	73.1
Total profit	16.8	15.9

As a result of the automatization, the production costs of incandescent lamp manufacturing decreased, but this was offset by an even greater increase in the operating costs. This way the profitability of incandescent lamp manufacturing suffered an — admittedly marginal — setback. Nevertheless, it still stayed over 15 percent and, as such, remained a profitable business.

(This analysis did not feature in the financial reports.) The rentability of electrical vacuum tube manufacturing showed some improvements in 1928—1930, but this branch was still at an early stage of development. There were further profits from the payments owing to the installation of the automatic telephone exchanges of Budapest by Standard Rt. — although this, again, was not included in the reports. From all this we can infer that TUNGSRAM's actual profits considerably exceeded those admitted in the reports. There were a number of ways to conceal the actual profit. From the next table it is clear that the stocks very heavily featured in the balance sheets.

Fiscal year	Value in Pengős
1925–1926	10,587,325
1926–1927	9,978,397
1927–1928	6,442,193
1928–1929	6,833,512
1929–1930	8,390,266

In general, the stocks held the company's sixmonth requirements, and in the case of the finished lamps, its eight-month projected sales. The relatively high level of stocks concealed some real difficulties; for example, the basic materials mostly included metals which were extremely difficult to come by. The size of the stocks of finished lamps is explained by certain stock systems and the lagging transportation. With the exception of 1928–1930, there were always about 10 million lamps stocked up. But the large stocks also permitted to conceal some internal reserves.

Certain reserves were openly declared in the reports. A very important entry in the balance sheets was the depreciation deductions which reached extremely high percentage in the case of TUNGSRAM. Just to give an idea, let's take the fiscal year of 1929–1930, when the factory building and equipments were estimated to be worth of 14,675,465 Pengős. This has to be compared with the same year's depreciation figure of 12,715,465 Pengős.

The section dealing with debits and claims in the reports gives an opportunity to draw some interesting conclusions.

Fiscal year	Claims (debtors)	Debits (creditors)
1925–1926	8,792,619	7,198,679
1926–1927	12,235,132	8,889,125
1927–1928	10,463,495	2,985,171
1928–1929	11,403,495	3,586,071
1929–1930	10,654,230	2,690,485

From the entries listed under Debits it is clear that TUNGSRAM hardly ever had to rely on creditors during the second half of the 1920s, since it had sufficient working capital at that time.

During the same years the company's total claims grew significantly and exceeded its debits many times over. A number of realistic factors contributed to the high figures in its outstanding claims; for example, it took a couple of years to settle the PHOEBUS accounts or to sort out the finances with the commissioned sales agents which were often working in remote areas. The situation was similar in the case of the subsidiary firms. Actually, it would be very difficult to find out about the real financial state of the subsidiaries, since the reports did not have the appropriate statistics. We do have some information on the subsidiaries from other sources, although not about each year. The Viennese Watt factory showed a profit of 286,000 Pengős in 1928, Cyrkon of Warsaw closed the same year with roughly similar profits, the profits of Tokod Glass Factory SC. reached 280,000 Pengős, and the profits of Klára Glass Factory of Ujantálvölgy, 340,000 Pengős. A large part of the subsidiaries' profits were swallowed up by TUNGSRAM either through overcharging them for the basic materials and the intermediate products supplied to them, or — exactly the other way around — through paying less for the basic materials bought from them.

For the lack of internal financial reports, the real profitability of TUNGSRAM is best revealed from the reports of the accountants of the bank, itself financially interested in the company, Pesti Hungarian Commercial Bank.

An examination of TUNGSRAM's books in 1929 sums up the company's actual financial status in the following table (in Pengős):

(i)	the plan (a subjective estimate)	7,000,000
(ii)	bonds (based on actual Stock Exchanges figures)	18,235,000
(iii)	stocks (without remainders)	6,596,000
(iv)	debtors (less the creditors setting up a pension fund)	12,209,000
A grand total of		44,040,000

The final figure shows that the actual value of the 412,500 TUNGSRAM shares was 44 million Pengős in 1929. This implied that the shares having a nominal value of 40 Pengős were worth 106.5 Pengős each, or to put it in other way, they feched 250 percent of their nominal value!

Just before the worldwide depression of 1929—1933 TUNGSRAM was in a very strong financial position. This fact greatly helped the company to survive the years of Depression without serious shocks. In fact, the company made use of the slump in the housing industry and heavily invested in construction works.

Building No. 34 was designed in 1928 and the construction of several buildings took place in 1930—1931. These developments have determined the factory's image right until the latest times.

Building No. 36, the Research Laboratory and the Recreation Centre were all built in this period. The company even had reserves to exploit the grave financial situation of its old adversary, the Kremenetzky factory, and by pressing the Viennese company into a deal, TUNGSRAM was able to improve its positions both in the incandescent lamp cartel and on the domestic market.

TUNGSRAM FROM THE YEARS OF DEPRESSION UNTIL THE END OF WORLD WAR II

The Company's Strategy in the 1930's

Like any other company, TUNGSRAM, too, faced the hardest — and often crucial — decision: to find realistic objectives for investing its resources available for development. Not only did the company have to compete on the international market against several non-member firms outside the cartel, but also, it was forced to keep the pace dictated by the greatest cartel members — IGEC, Osram and Philips — irrespective of the various cartel agreements. Later on the American RCA and the German Telefunken also joined the three 'greats'. Although the Phoebus cartel agreement divided between the cartel members the incandescent lamp market, but it also facilitated a competition of quality between the member companies, instead of eliminating it. The exchange of information between the cartel members brought many advantages in the technological sphere, but the adaptation of these technologies required a lot of work and money.

The agreement on the free flow of information was not much help in the case of new products, special purpose light sources or the entirely new type of light sources such as electric discharge lamps and fluorescent lamps. The agreement did not include a large part of these, or if it did, then the leading cartel members found a way to delay giving out the documentation until they secured a sufficient lead in the market. TUNGSRAM's sales agencies all over the world rightfully demanded that in the interest of meeting their quotas they should be allowed to lay hands on all the new products brought out by the cartel members. The company could only embark on developing wholly independent and innovative products

on a number of rare occasions. Everywhere else it was forced to follow the lead on the market. Even so, the copying of all the new developments would have been enough to exhaust the company's resources. The company's decision to narrow the production profile, to hand over the manufacturing of railway security systems and telephone exchanges, and to concentrate only on two areas, on the production of incandescent lamps and vacuum tubes, seemed more and more justified each day.

Beside appearing with newer and newer products on the market, the companies were pressed by the international competition to raise the quality of the products, too, while the growing demand and the falling prices required, both in the production of incandescent lamps and radio tubes, the introduction of new machinery, automatization and significant increases in production capacity.

In the early 1930s all the leading producers of incandescent lamps were preparing for the mass-production of low- and high-pressure discharge lamps. The 'all-conquering triumph' of incandescent lamps, for the time being, was able to hold out against the development of the new products. McFarlan Moore had just come up with the nitrogen- and the carbon dioxide-filled discharge tubes, but discharge tubes filled either with pure neon or neon mixed with other inert gases were already being manufactured, using inert gases gained from air by the process invented — quite independently from each other — by George Claude and Karl von Linde. General Electric Company's intensive development of its normal fluorescent lamp series resulted in a version suitable for mass-production, as presented to the fellow cartel members in 1938. Philips brought out its first high-

pressure mercury vapour discharge lamps in 1936. In the field of radio valves, beside the earlier mentioned developments, the research and development laboratories of the leading companies were all intensely working on television receiving tubes.

In defining its business policy, TUNGSRAM relied on the experience of the previous years. This showed that — irrespective of the cartel agreement regulating the sale of incandescent lamps — if the price and the quality was right, a great deal more lamps could be sold than specified in the quotas.

In every ten years the world's electric energy consumption roughly doubled and the demand for incandescent lamps increased at a similar rate. Large areas awaited electrification all over the world. The consumption of incandescent lamps per capita — as published by PHOEBUS — could well indicate the progress. In 1936 this number was equal to 1.0 (annually and per capita) in the advanced industrialized countries and 0.5 in Hungary.

Experience showed that the discharge lamps and tubes, in spite of their improved luminous efficiency, were no substitutes for incandescent lamps; rather, they conquered new areas for electric lighting or challenged the larger traditional light sources. The operation of discharge light sources required considerably greater initial investment than their incandescent counter-parts of equal luminous power; moreover, the better luminous efficiency was partly wasted, since for a discharge lamp to give out the same amount of light resembling the frequency spectrum of day-light, more luminous power was needed than in the case of incandescent lamps which had a frequency spectrum shifted more towards the red. Discharge light fixtures generally had larger dimensions than did the incandescent light fixtures, and their installation also required more skill. They were less suitable to achieve spot light or intimate effects and, therefore, they were of little use in people's homes. When subjected to it for a longer period, many people get a headache from the light of discharge sources and develop headache.

Considering the above problems, as well as other

aspects, TUNGSRAM formulated its business strategy of the period. (This strategy was never summed up in writing, nor vocally.)

1. Normal incandescent lamps provide the daily bread and butter. The quality of these normal lamps must be improved, keeping abreast of the other leading companies. Productivity and production capacity must be increased by the further automation of production. At the same time, the development of discharge light sources, as well as their advertisement, is recommended, but not at the expense of incandescent lamps. The production of miniature, vehicle and large-size special-service lamps must be facilitated with the introduction of modern machinery.

2. The production of radio valves must be perfected and increased by employing new, modern machinery. At the same time, the management must bear in mind that the leading companies of the industry will constantly market new versions and following the new developments would tie up a lot of financial and intellectual resources. Powerful vacuum pumps — both the rotary and the mercury diffusion types — must be designed and produced, primarily in the interest of raising the standard of radio receiving and transmitting tube production. Research and development teams must be set up in preparation for a television project.

3. The production of parts must be modernized, increased in capacity and improved in quality, because it determines the standard of production, as well as of quality, of all the products. For the above reason, the capacity of the design and production of machines and tools must be continuously improved and modernized.

4. The subsidiaries' demands for investment must be met in order to be able to sell machinery and parts for incandescent lamps and radio receiving tubes, this way substituting for markets previously supplied with finished goods but now lost in consequence of these countries' efforts to achieve a self-sufficient and independent industry.

5. The utility service units, i.e. the plants providing or distributing gas, steam, hydrogen, electric energy,

etc., must be developed according to qualitative, quantitative and economic considerations parallel with other tasks.

6. Beside setting down the major guidelines, the management must possess the appropriate flexibility which will allow the company to follow the changes in the international market, both as far as technology and quality are concerned. Production must follow the results of research and development more closely. The gap between research and industry must narrow down and a development department suitable for designing and introducing production technologies must be created. The independence of all the managerial and production units must be increased without limiting the chief executive officer's sole responsibility in making the final decision. (Lipót Aschner would not agree to giving that up anyway.)

7. Social institutions must be established to bind to the factory the work-force necessary to maintain the high standard of production. (Recreation centre, canteen, swimming pool, sport clubs, etc.)

The Work and the Results of the Research Laboratory

In the late 1920s — as we have already pointed out — there was a worldwide attempt to improve the quality of incandescent lamps and to produce new types of light sources. The fact that the most important licenses in the light source industry were about to expire inspired the research and development teams and helped the emergence of new companies outside the cartel. "The history of the incandescent lamp industry clearly indicates that the best protection against these (new companies) are the patents which improve the quality of the lamps to such an extent that a lamp of poorer quality could not compete against these in spite of the lower price. Therefore, we must help the technical progress of incandescent lamps with real, revolutionary inventions, rather than simply rely on the methods of step-wise refinement" — Imre Bródy

wrote these words in a report prepared for Lipót Aschner on 14th June, 1932, in which he appealed for more support to his ongoing experiments.

In 1930 the Research Laboratory was moved to its new, two-storey building which then met the requirements of the times. The library of the research centre was situated in the building, as were the labs and the workshops necessary to the research work. According to a report in 1933, the sections of the Laboratory which dealt with incandescent lamps employed approximately 40 people. Five of them were engineers, but there were another three engineers working on the improvement of incandescent lamps in the factory. Three engineers were employed in the patent department and two worked in quality control. Our readers might be amused to learn that Imre Bródy at one time also looked after the library of the Laboratory. In 1936 certain changes took place in the management of the Research Laboratory. That was the time when Ignác Pfeifer, at the age of 69, retired and TUNGSRAM's choice of replacement fell on Zoltán Bay, the 36 years old physicist of the University of Szeged. Not only did TUNGSRAM offer him the top position in the Laboratory with higher income and better research conditions, but also, it donated 300,000 Koronas to Technical University of Budapest in order to set up a department for him, hence founding Central-East Europe's first Nuclear Physics Department. In 1944, following Lipót Aschner's deportation, Zoltán Bay became TUNGSRAM's technical manager. While in Szeged, Zoltán Bay belonged to the circle of Albert Szent-Györgyi. A staunch anti-fascist with progressive views, he did much for the persecuted people, hiding them in the final days of the war, until he was forced to go underground himself. Zoltán Bay immigrated to the United States in 1948. The Research Laboratory's staff was enlarged in the 1930s: that was when Tibor Szász, Pál Tury, György Tarján, Imre Patai, Tivadar Millner and others joined the institution.

a) The GK-tungsten

As we have pointed out earlier, the gas-filled (nitrogen-filled) coiled filament lamps invented by Langmuir

caused important changes in the light source industry after the First World War. The coiling process imposed new requirements on the tungsten filament. In TUNGSRAM, like in all the other incandescent lamp factories of the world, the race to develop the non-sagging tungsten filament was on. TUNGSRAM's own non-sagging filament was based on the so-called 'GK-tungsten' (Great-Crystal) which is still produced today under the same designation. Before TUNGSRAM's GK-tungsten, similar research already took place elsewhere in the world. For example, it was the Hungarian-born Aladár Pácz who introduced a process in the United States which enabled tungsten filaments to maintain non-sagging properties at high temperatures. In TUNGSRAM experiments aimed at producing large-crystal non-sagging tungsten filaments began around 1920, roughly at the time when Pácz's patent was registered. The first time these attempts bore fruits in the form of actual patents was in 1924 and the success was linked to the names of Pál Tury and György Tarján. The further development of GK-tungsten — the basic principles of which had already been laid down in the patent of 1924 — was the work of Pál Tury and Tivadar Millner, the two chemical engineers and metallurgists who, while maintaining contacts with the Laboratory, worked in the Lamp Manufacturing Department.

Through the production of GK-tungsten, Hungary became the leading tungsten producer of the world. The technology and the additive developed by Millner and Tury resulted a filament which had the desired non-sagging, large-crystal structure. The novelty of the technology lied in the use of aluminium additives which gave better properties than did the Americans' additives or those of the Viennese Watt company. (The Hungarian patent of 1935.) Lipót Aschner proudly reported to the board to directors on a meeting held on 25th November, 1935: "Due to the excellent quality of our tungsten filament, the quality of our incandescent lamps came out on top, according to the results of the compulsory tests performed by PHOEBUS on all the PHOEBUS products. The American General Electric Company is seriously interested in our filaments and

placed quite a large order for starting materials. It appears that IGEC is thinking about switching to our type of filament in its production."

This is how Tivadar Millner remembered the developing of GK-tungsten in his inaugural speech on the Academy of Sciences in 1956: "The rods made from pure tungsten powder consisted of crystals having diameters of roughly 0.1 mm or less. The GK rods — or sometimes their surfaces only — consisted of large crystals with diameters between 5 and 10 mm. The temperature at which pure tungsten filament of 0.1 mm crystals goes through rapid re-crystallization is between 1000 and 1200 °C, while the corresponding temperature in the case of GK filaments is between 2200 and 2400 °C. In the re-crystallized pure tungsten filament of 0.1 mm long crystals the crystallites are no longer than the diameter of the filament, while in the case of GK filaments they can reach a length 20 or even 100 times longer than the diameter. The filaments coiled from pure tungsten of roughly 15 microns (for example, the double-coiled filaments soon expand under their own weight at a temperature of 2400—2500 °C, while the GK filaments maintain their original length for up to a 1000 hours. The re-crystallized tungsten filaments are extremely fragile at ordinary temperatures, as opposed to the GK filament which stays solid. The internationally acclaimed reputation of our incandescent lamps and radio valves is based on the above good properties of GK tungsten." The appearance of the krypton lamps only added to the requirements to which tungsten filaments had to stand up. The first krypton lamps marketed by the French Compagnie des Lampes had single-coiled filaments. TUNGSRAM began its experiments with similar filaments. GK tungsten, however, enabled TUNGSRAM to produce krypton lamps with double-coiled filaments, further exploiting the advantages of krypton-filled lamps.

b) The History of Krypton Lamps from the Patent to the Mass-Production.

The greatest achievement of the Research Laboratory was the invention of the krypton lamp. The patent was

actually registered under the title "Gas-filled electrical incandescent lamp with metal filament" on 1th August, 1930. But the patent bearing the number 103.551 in fact described the krypton-filled lamp.

This is how the inventor, Imre Bródy, summed up the story of the krypton lamp's birth in a subsequent piece of writing: "The first man ever to mention krypton as a filling gas for incandescent lamps was Jacoby. He only referred to krypton there as a substitute for argon. It was Claude who first stated that krypton was more suitable than argon. He recognized that, as the result of the lower heat conductance of krypton, the heat losses must be also smaller in krypton than in argon. This was not, however, followed up by actual experiments. We discovered in February, 1929 that, quite apart from the lower heat losses, the adverse effects of another phenomenon (thermic diffusion) can also be reduced by the application of krypton. This especially had important consequences in the case of double-coiled filaments, because the heat losses here were already so minute that their further reduction was quite negligible, while the adverse effects of thermal diffusion remained the same. This way the problem branched out in two. Naturally, one cannot produce a good lamp simply by replacing argon with krypton, so there is a structural problem. The other problem concerns the production of krypton.

"Air Liquide" registered several patents for producing krypton in the 1920s. All these patents were based on gaining krypton from air as a by-product of oxygen or nitrogen production. This method, however, did not seem suitable for the purposes of incandescent lamp manufacturing, so next we speculated over the possibility of producing krypton as the primary product, without having to separate the other components of air, first of all the oxygen and the nitrogen. We consulted in this matter with Linde and Air Liquide. Few months later — and almost at the same time — all three companies turned in patents showing that this method was viable. Our krypton factory in Ajka was founded on this principle and, after some initial difficulties, it has now been working smoothly for two years.

We set out to solve the structural problem concurrently with the problem of how to produce krypton.

First we had to make a lamp to check the correctness of our assumptions. This was not easy since krypton had never been produced in large enough quantity to fill a normal lamp. After long negotiations we managed to get half a litre krypton from Linde Company. The experiments carried out with this krypton provided the validity of our theory. But we still had to solve several structural problems. The poor electrical solidity of krypton caused a lot of difficulties, especially in the case of double coiled filaments. We overcame this problem by getting right the mixture of the gases (USA Pat. No. 2060657).

Naturally, some problems still exist, as the commercial production of krypton lamps had only been going on for 4 years, but we are confident that these problems will be solved and we shall be able to make further improvements on the krypton lamp.

Újpest, 1st August, 1939

Bródy"

This writing described the story of the krypton lamp very briefly and concisely, showing both the modesty and the confidence of a successful inventor. Let us recapitulate the major points of the story again.

As Bródy's writing revealed, the large foreign research centres had been studying the possibility of increasing the luminous efficiency of incandescent lamps for quite some time. The better luminous efficiency of the lamps filled with a mixture of argon and nitrogen — instead of pure nitrogen — was, at that time, put down to the poorer heat conductance of argon. Imre Bródy measured the energy balance of a 110 V/65 Dlm lamp and the results (in his own words indicated that "the importance of the heat conductance of the filling gas must not be overestimated, because the energy of the ultraviolet radiation covers the greatest part of the loss . . .

Experience showed that the replacement of 1 percent of the nitrogen with argon already resulted in noticeable improvement of the lamp. According to the energy figures, this improvement cannot be explained solely by the difference in the heat conductance and other sources must also be found."

Next Bródy went back to the relevant physics books to find a new starting point. Again, we quote his own words: "After long research I found the correct explanation for the superiority of argon in the following postulate of Chapmann's: If there is a spatial temperature difference in a mixture of gases, chiefly consisting of a light gas mixed with a small amount of heavy gas, then the heavy gas will shift towards the cooler place. This phenomenon is called thermo-diffusion. This basically differs from ordinary diffusion in that ordinary diffusion tends to cancel out the differences in density, while thermo-diffusion often causes differences in density. We can convince ourselves of the correctness of this theory by experiments. The gas-filled incandescent lamp provides a perfect environment for thermodiffusion. In a Langmuir-type film there is a temperature difference of approximately 2100 °C within a distance of 1 mm (the temperature of the filament is 2700 °C, and of the gas chamber, 600 °C). The small amount of heavy gas in this case is the tungsten evaporated from the surface of the filament. Its molecular weight is substantially larger (186) than that of the argon (40) or the nitrogen (28). The evaporated tungsten atoms are driven to the outside surface of the Langmuir film by thermo-diffusion. From here they are swept away by convection and subsequently form condensation on the glass surface. The process, therefore, blacks and burns out the lamps by destroying their filament just as it does in the case of ordinary diffusion. Now we can understand why the replacing of nitrogen with argon improves the performance of the lamps. Nitrogen has a molecular weight of 28, argon has a molecular weight of 40. As far as weight is concerned, argon is a lot nearer to tungsten than nitrogen is. That means that the harmful effects or thermo-diffusion are less substantial in argon than in nitrogen. The realization of the fact that the useful life of gas-filled incandescent lamps are largely determined by thermo-diffusion gave me the idea to use a filling gas of large molecular weight. In that case the useful life of lamps can be extended at any given filament temperature. On the other hand, by choosing the filament with the appropriate length and dia-

meter we are able to raise the temperature of the filament without reducing the useful life of the lamp." Krypton, with its still larger molecular weight, was an obvious candidate for the next series of experiments. Unfortunately, krypton was not available in suitable quantities at that time. Bródy had the following to say about this: "To check the correctness of our theory, first we moved in the opposite direction: in February, 1931 we built a lamp filled with the lightest of all the inert gases, helium. Helium has a molecular weight of 4, therefore, in this case we expected very strong thermo-diffusion. The lamp filled with helium . . . had to be a very poor one. As the results of the experiments entirely bore out our assumptions, we continued the experiments using krypton."

Imre Bródy mentions in the announcement that the chemical engineer Emil Theisz also participated in the experiments.

After such preliminaries the first krypton lamp was about to be made. However, since krypton was very expensive and extremely hard to come by, grave difficulties stood in the way of the further experiments. At the end a lot of money and some good connections were needed to buy the necessary amount of krypton. The first six lamps were completed on 2nd July, 1931, following the registering of the patent. The lamps were tested by Physikalisch-Technische Reichsanstalt of Berlin in 1932 and the results showed that the average useful life of krypton lamps was 1124 hours, while the useful life of an Osram lamp of similar wattage was a mere 299 hours. Krypton- and argon-filled lamps with the same type of coils were used to determine the gain in the luminous efficiency of the krypton lamps. The first experimental krypton lamps had the E-series (Einheits-form) bulbs of the argon lamps, only one size smaller, in order to reduce the volume that had to be filled. TUNGSRAM's technical staff was forced to design new shape and size for the krypton lamps in order to economize on the expensive filling gas. That was how the original mushroom shaped bulbs were born by administering modifications on the E-series. This form is already depicted in the Hungarian patent No. 113.488, dealing with the volume of the krypton

lamp. The first mushroom-shaped bulbs were hand-made in the Research Laboratory. In 1934, when TUNGSRAM informed its PHOEBUS partners of its plans to go ahead with the production of krypton-filled lamps, the more extensive experiments necessitated the application of machines in the production of bulbs. In the Summer of 1934 TUNGSRAM informed its fellow cartel members on a meeting held in Újpest about the success of the experiments and the company's intention to produce krypton lamps. The two directors representing Philips, Dr. Geiss and Lokker, made a counter-announcement. They told that Philips was about to market the argon-filled lamp fitted with double-coiled filament. Since the experiments to develop double-coiled filaments based on the Millner-Tury type GK-tungsten proceeded satisfactorily in Újpest, TUNGSRAM announced its plans to produce krypton lamps fitted with double-coiled filament as a novelty. (The first experimental krypton lamps still had single-coiled filaments.) No gas-filled candle and spherical shaped lamps had previously been produced for industrial decoration. Therefore, great success could be expected from the candle shaped and decorative lamps filled with gas (krypton) and fitted with double-coiled filament. The experiments showed a fifty percent improvement on the earlier lamps of the same size. The candle and spherical shaped lamps with opaque glass were brought out bearing this in mind. These lamps with their white light and minimal loss of luminous power later proved very popular with the public.

The experiments, again, showed that the candle-shaped krypton lamps had a few (1—2—3) percent higher luminous efficiency than the mushroom-shaped krypton lamps of the same coiled filament, when calculated over their 1000 hour useful life. This gave the idea for replacing the mushroom-shaped lamps with ellipsoid ('plum') shaped ones which approximated the candle shape more. Such bulbs were better cooled by the air flowing upwards along the glass, so it was possible to design even smaller lamps. This, in turn, promised further savings on krypton.

But the mass-production of krypton lamps was still a

long way off from the first experimental products, although their better luminous efficiency, as well as their other advantages, were all justified in the tests. By far the greatest obstacle on this road was the high price of krypton. For the production of the first experimental lamps the company finally managed to buy the necessary krypton for 800 German Marks a litre — and even that only after Osram had intervened on TUNGSRAM's behalf! According to TUNGSRAM's own estimates the price of krypton used in lamps which could be sold on the market for a realistic price could not exceed 6 German Marks per litre! (The exchange rate of German Marks and Pengő in commercial transactions fluctuated between 1.36 and 1.63) The scientific experiments aiming to solve the problems of the industrial production of krypton were associated with equally complicated business negotiations. As Imre Bródy himself wrote in a note to the chief executive on 14th July, 1932: "In the matter of the krypton lamps we have reached the point where the most important questions are not the technical but the commercial ones."

The work of competent scientific researchers in itself would not have been sufficient to achieve the mass-production of krypton lamps in Hungary; the kind of far-sighted and bold company management was also needed which TUNGSRAM was lucky to have at the time.

In the matter of purchasing krypton, TUNGSRAM contacted the companies of Linde, Air Liquide and I.G. Farbenindustrie. I.G. Farbenindustrie turned down TUNGSRAM's offer, but the other two companies thought it possible that their existing oxygen plants could deliver 10—20 m³ krypton gas, although they regarded the price offer of 20 German Marks too low.

The purchase of krypton became increasingly important for TUNGSRAM, to the company was exploring the possibilities of setting up its own krypton producing plant. One of the most essential licenses of the process, which concerned the heat exchange components used in the regenerating phase, was owned by Linde Company. When TUNGSRAM showed interest in the licenses, Linde gave a very poor opinion on the

prospects of krypton production. (The fact that Air Liquide's own efforts to produce krypton collapsed round about the same time was also incorporated in this assessment.)

Although the two foreign companies tried to discourage TUNGSRAM in the matter of krypton production, both of them quickly registered patents concerning the production of krypton in order to own the license, regardless of the initial difficulties. Concurrently with the negotiations, Imre Bródy, together with Mihály Polányi (the Hungarian-born lecturer of Manchester University who also worked as an advisor for TUNGSRAM), Egon Orovan and others, worked out a procedure for the industrial production of krypton as the primary product. Egon Orovan, being an associate of the Kaiser Wilhelm Institut (Berlin-Dahlem), had already had a chance to participate in the study of primary krypton production. Lipót Aschner, the chief executive officer of TUNGSRAM, earlier had asked Orovan to act as the company's outside expert in negotiations with foreign clients on several occasions. Imre Bródy, in collaboration with Ferenc Kőrössi, precisely determined the krypton content of air. "... we worked out a spectrographic method. First we removed from air everything which was not an inert gas through a chemical process using metallic barium; in the residue — which largely consisted of argon — we determined the relative magnitude of a number of suitable spectral lines, as compared to the spectral line of argon. Next we artificially produced a similar mixture of pure argon and krypton and this way constructed a formula correlating the relative magnitude of the spectral lines to the density of krypton ... The experiments — which roughly lasted a year — bore the result of determining the krypton content of air in 1.5×10 parts."

The first paragraph of page 11 in the same Bródy lecture contains the brief description of the Bródy-Polányi primary krypton-xenon production process using small amount of liquid air.

On 16 October, 1934 Imre Bródy reported to the chief executive officer, Lipót Aschner, that they had produced 1437 krypton lamps up till that time. Disputing

the objections of Philips, he claimed that "We have no technical obstacles which could justify the further delaying of the establishment of a krypton producing plant."

The results of Bródy and his colleagues strengthened TUNGSRAM's position in the negotiations with the so-called 'gas group'. This group was formed by the companies of Linde, I.G. Farbenindustrie and Air Liquide. The 'gas group' already showed some interest in TUNGSRAM's inventions during its meetings held in January and February of 1933, but the various parties all had dissimilar interests.

Lipót Aschner described TUNGSRAM's point of view in a letter written to Ignác Pfeifer on 25th July, 1933. On the one hand, the company hoped to form a separate group from the PHOEBUS members for running the krypton factory, while on the other hand it tried to persuade the 'gas group' to undertake the installation of the krypton factory and guarantee the continuous production of krypton at about 6 Marks per liter. Aschner also wanted the 'gas group' to agree not to sell krypton to other factories without PHOEBUS's permission, promising a 10 percent licence fee to the 'gas group' after the krypton factory's production in return. The two leading European incandescent lamp factories, Osram and Philips, did not want to join the agreement on the production of krypton lamps. Especially Osram's withdrawal was potentially dangerous, since TUNGSRAM was worried that the German company, being a leading force in the German economy, might be able to procure the government's help in preventing Linde from supplying the machinery necessary for the krypton factory. Later Osram modified its stance and itself introduced the production of normal and decorative krypton lamps with double-coiled filament. Philips also studied the advantages of krypton lamps. Although their own research verified these advantages — they recorded a 3.6 percent improvement in the luminous efficiency of ten different types of lamps, while also registering a colour difference not perceptible to the naked eye —, finally decided against the manufacturing of krypton lamps. Philips — being in possession of the double-coated

opaque glass bulbs with the smallest light absorption figure in the whole world (6 percent) — responded to the challenge of TUNGSRAM's krypton lamps with their own decorative argon-filled lamps with spherical and candle-shaped bulbs and double-coiled filament. The American IGEC also declined the offer to participate in the krypton campaign. The negotiations between János Lévai, a top executive of TUNGSRAM's Lamp Manufacturing Department, and Mr. Sloan, then the head of IGEC, took place in 1937 about the possibility of jointly setting up a factory producing enough krypton and xenon to meet the demands of the entire incandescent lamp cartel.

In the course of the negotiations it became apparent that the American company worked with an extremely high profit margin — 85—88 percent depending on the actual type —, while the same figure would have only reached 62 percent in the case of krypton lamps. In addition, they found the idea of increasing the useful life of the lamps through krypton and xenon filling imprudent from business considerations. In giving their major reason for not participating in the joint enterprise they pointed to the closure of a French factory which had exploded at the start of production. They were, again, informed of the fact that smaller explosions also occurred in the already operating krypton plant of Ajka, interrupting continuous production from time to time. (The American company had a point, since it was impossible to prevent the forming of copper acetate from acetylene during the process of fractional distillation in krypton production, and this compound in crystallized state could easily react to the smallest impact, or friction even, by explosion.)

Here, again, time was on the side of research. Linde and the engineers of TUNGSRAM (Dr. Mach, Tibor Mihalovits) managed to control the forming and the explosion of copper acetate without causing danger to health or damage to property. Moreover, by 1939 a continuous, safe and reliable method of krypton production was achieved. Although it was the French company Compagnie des Lampes which brought out the krypton lamps with the single-coiled filament first, later TUNGSRAM remained the sole producer, the

others being discouraged by the hazard of arc burn.

The krypton-filled incandescent lamps was the main attraction in TUNGSRAM's pavilion on the International Fair of Budapest in 1936. The krypton lamp also appeared on the French market in the same year. Of the 49,000 krypton lamps produced until July, 1936, 3,500 were delivered to France where they were marketed by the local Tungsram sales agency: they included both the decorative and the normal types, as well as the Dekalumen series. At last, the 'gas group', which in the meantime heavily invested in krypton production, was willing to deliver the machinery necessary to equip a krypton factory in Hungary; in addition, they started the monthly delivery of two cubic meter of krypton. This quantity was sufficient to launch the test production of krypton lamps in TUNGSRAM.

In July, 1936 Lipót Aschner announced that the final deal had been concluded with the 'gas group'. The building of the krypton factory in Ajka began in still the same year, as an independent TUNGSRAM venture.

The krypton factory of Ajka, which was in fact owned by TUNGSRAM, actually became dependent on the 'gas group' on account of using foreign licenses.

Imre Bródy was right in that it was possible to detect a certain amount of the air's xenon content (both in the purchased and the home-produced version), although at that time he was still of the opinion that the separation of the two gases was unnecessary. In one of his notes dated 31st July, 1939 he already toyed with the possibility of isolating xenon and using it to fill vehicle and mine lamps. It was only after 1945 that this idea eventually materialized.

In its early days krypton lamp was a powerful weapon in TUNGSRAM's hand in the fight against the competitors within the cartel. In the war waged on the outsider companies the cartel members considered even as small an increase in luminous efficiency as 1 lm/Watt a serious argument in favour of marketing. Compared with the argon-filled normal lamps krypton lamps showed an improvement of approximately 1 lm/Watt. Such a figure already deserved the attention of the Hungarian economists, since in those days a

considerably larger percentage of the electrical energy was used for lighting than it is the case today.

The krypton lamp's success laid not so much in its increased luminous efficiency, as in its small size and attractive appearance. Its pleasant white light and its inherent decorative effects (spherical and candle shape) have remained valid marketing arguments till this day. We make a note here that the increased luminous efficiency of the krypton lamps and the double-coiled filaments failed to make an impact on the American market, since the electrical energy was so much cheaper there, and the average earnings so much higher, that the introduction of krypton lamps was not justified. On the other hand, the fluorescent lamps and the high-pressure mercury vapour lamps, which showed a dramatic increase in luminous efficiency, were introduced in the U.S. long before anywhere else. The efforts to cut the production costs of krypton gas and lamps did not stop at the building of the krypton factory.

A report signed on 31st July, 1939 by Dr. Imre Bródy, Dr. György Bródy and Tibor Mihalovits was sent to the chief executive to enumerate the problems of krypton production. "The production of krypton lamps, and also, of krypton gas, has reached a turning point. The possibility of improving the present design of the lamps, as well as that of developing new designs, depend on the purity of krypton. Our influence on the production of krypton is minimal and indirect at the moment. We have no ways of implementing our own ideas and suggestions; instead, we are reduced to looking on helplessly whether Linde is willing to conclude the lessons of the Ajka plant for the future and implement the necessary changes or continues with the processes, invented either by itself or by us, at our expense." The report contains suggestions for new methods of krypton production, for some of which patents had already been registered.

By 1941 Dr. Imre Bródy and Tibor Mihalovits had completed the work on a new method of krypton production, which incorporated the lessons of the previous experiments. This differed from Linde's process on two major points. Between 1939 and 1941

TUNGSRAM considered the possibility of establishing one or more new krypton factories, but it was afraid of the patent law procedures that might follow the introduction of the new process, and was also worried that the PHOEBUS members might not buy the surplus krypton. For this reason, and with regard to the war-time circumstances, no new plants were established in the end.

Dr. Imre Bródy and his associates also stated in their letter that the krypton problem had been divided into two branches: one was the construction of the lamp, the other was the production of krypton. But there was also a third 'branch': the price of the produced krypton! This problem did not have a satisfactory solution immediately after the first krypton plant had started producing. The production of krypton required a lot of electrical energy. TUNGSRAM, therefore, assigned great importance to the price of electrical energy necessary for the production of krypton, which would, of course, also be reflected in the price of krypton. In spite of all the advantages of krypton-filled lamps, the high price of krypton alone would make them unprofitable and unmarketable. This argument led TUNGSRAM's management in putting forward the ambitious plan to establish its own power plant — possibly in the vicinity of the krypton factory — complete with its own mine delivering the necessary coal. The purchase of Ajkai Coal Mine of Ajka and Power Plant of Ajka was decided accordingly.

With the production and marketing of the first krypton lamps the experiments on the lamp's design did not come to a halt, either. Several changes were executed in order to increase their efficiency. Emil Theisz's research was aimed at minimizing the danger of arc burn-off in the lamps. Dr. Imre Bródy's experiments were aimed at the development of high-pressure incandescent lamps of a 100 Watt, encased in quartz bulbs. Emil Theisz, Dezső Pillitz and Tibor Krassó worked out a process to recover krypton from the reject lamps and the dead spaces of the vacuum pumps.

Beside developing the krypton-filled lamps—which had already been discussed separately — there were various other experiments going on in the Research

Laboratory. It was decided on a conference held in the Research Laboratory on 18 February, 1930 that the Laboratory would study the possibility of producing fluorescent discharge tubes. György Szigeti became the specialist in this field. The Research Laboratory produced a number of fluorescent lamps using incandescent cathodes. Next the researchers experimented with high-pressure discharge light sources. The Laboratory produced high-pressure mercury and cadmium vapour lamps as early as 1936. In 1937, following up Zoltán Bay's original idea, György Szigeti produced a discharge light source filled with high-pressure krypton which had a luminous efficiency figure of 30 lm/Watt. The experiments on these types of lamps were discontinued after the end of the work war II.

The Research Laboratory also paid attention to such radioactive light sources in which electrons produced by decaying soft beta radiation (such as tritium), impinging to certain phosphorus excite it to light. Such light sources today are used in certain countries in signalling devices (for example, in the railways). In 1940 the production of discharge tubes and cathode ray tubes raised a few questions in connection with the theory of luminescence. Several people — among others Elemér Nagy, Zoltán Bodó and György Gergely — joined in the research. This work was primarily theoretical.

Ferenc Körössi and Dezső Pillitz also did some research on the prevention of arc burn-off. They experimented with high- and extra-high-pressure (2—3 atmosphere, and over 10 atmosphere) krypton lamps, in order to reduce the evaporation of the tungsten filament. The lamps produced in these experiments show resemblance to the pencil-shaped halogen lamps used today for photographic purposes. Initially the researchers were very much interested in the role of the traces of vapour found inside the bulbs. It was Tivadar Millner who worked out a procedure to absorb the vapour by the application of an appropriate getter. In this chapter, which began with the description of the Research Laboratory's initial conditions, we have come a long way from the newly built two-storey

building of the modestly manned and equipped institute which nevertheless was unique in Hungary, both in importance and in achievements.

We have traced the story of a new product from the moment of its conception down to the realization of its mass-production. If this story became confusing at places and was, perhaps, hard to follow sometimes, then life is to blame which cannot, under any circumstances, be shown in its entire complexity.

The Development and the Production of Radio Receiving Tubes from the 1930's

Radios really became popular only from the 1930s onwards. That was the time when the network of radio broadcasting was extended worldwide. Radio receivers powered by dry anode batteries and separate heating batteries were gradually replaced with radio sets running from the mains. This was the time when radio sets became popular in Hungary, too. While in 1930 the radio broadcasting services had 300,000 subscribers, by 1937 this number grew to 383,000, and by the outbreak of the Second World War the number of subscribers reached half-a-million. TUNGSRAM was also forced by its competitors on both the international and the domestic markets to intensify its efforts to develop and produce radio valves.

Only part of the development work took place in the Research Laboratory. In the early 1930s the Radio Valve (Audion) Department was set up which administratively was only loosely connected to the Research Laboratory. Károly Czukor was in charge of the Radio Valve Department first, to be replaced by Ernő Winter who was a prominent figure in the radio valve research. (Ernő Winter, together with Károly Czukor, developed the world-renowned cathode tube using metallic barium. When his appeal for a small pay-rise in reward of his achievements was turned down, he left TUNGSRAM and found a job in the Netherlands. Later he returned to Újpest, responding to Lipót As-

chner's invitation, but this time he insisted on a considerably higher salary.)

The Radio Valve Laboratory's staff numbered approximately 30 people. There were two engineers, Ernő Winter and Mátyás Marton, and a physicist, Imre Glazner working on development projects in the Laboratory, while György Szigeti and Mihály Neumann were involved in the production. Next to the Laboratory there was a separate Test Production Department which was headed by Károly Czukor. He summed up the tasks of the Radio Valve Laboratory and the Test Production Department (which, in fact, was another laboratory): "...perfecting the production technologies, improving the quality and the useful life of the new tube designs, developing new designs and documenting the technologies which serve the production."

The Radio Valve Laboratory and the Test Production Department was situated on the second floor of the new Research Laboratory. In 1929 Károly Czukor submitted a proposal in the matter of equipping the new units and suggested that an elevator be built for the staff. Lipót Aschner marked the proposal with the following comment: "A staff elevator for the second floor? Isn't that a luxury?" (This was how his old colleagues described this trait in Lipót Aschner's personality: In the essential issues he is generous, but in the tiny matters he is as stingy as a Scotsman!)

The early 1930s were also called the age of the oxide cathodes in the radio business. The low operating temperature and the high specific emissivity of the oxide cathodes permitted the development of a directly heated tube series for radio sets operated from the mains. In this field Ernő Winter and Károly Czukor were doing fundamental work in the laboratories of TUNGSRAM. The directly heated tubes bearing the Tungstram trademark came out in 1939. These were already also suitable for radio sets operated from the mains. The construction of the tubes incorporating two or more grids and the development of Tungstram tube designs suitable for the application of pentodes took place in these years. Following the work of Ernő Winter, the antimicrophonic radio valves were de-

veloped and the cause of the grid emission was felt about. The patents of the noble metal coating applied in order to reduce the grid emission effects were soon used all over the world. The invention of Imre Zakariás and Ferenc Perisch — the dual cathode outlet used in high-frequency valves — and Ernő Lukács's discovery concerning the space-charge limited currents also date back to these days.

In the late 1920s the successful mechanization of the vacuum technology reached the production of electronic vacuum tubes. The mechanization was first accomplished in the United States and, as a result, the marketability of the American radio valves suddenly went up everywhere. The new tube designs of TUNGSRAM might have been comparable to the most advanced American tubes, but since their mass-production had not been accomplished, their quality and price was not acceptable on the international markets. The main reason behind the unsatisfactory state of affairs in this area was the fact that in TUNGSRAM the production of radio valves followed the techniques used in incandescent lamp production, i.e. much of the technology required manual labour. The quality of the radios depended on the electrical properties of the tubes, as well as the other components, and the varying quality of the tubes, which resulted from the rudimentary technology, did not help the reliability of the radio sets.

The technology of radio valve production was closely studied in 1932, and so were the methods used in research and development, as well as the relation of research and production. József Gábor, who was later put in charge of the radio valve production, called this production the "standardized amateurism" in the course of the often passionate debates which took place in TUNGSRAM. In 1931 the electronic vacuum tube production was moved to a new location, to the recently completed Building No. 36. Here the conditions permitted to prepare for mass-production. The production of parts (cathodes, grids) took place on the ground floor, while the first floor accommodated the assembly lines and the calibrating units. The machinery was manufactured by the already ac-

complished Machine Works of TUNGSRAM. In the production of radio valves the old organizational structure lived on, whereby the work was divided into separate phases (assembly, sealing and pumping, electrical treatment and measuring), even though in the production of incandescent lamps the complete construction had been done by groups of machines (units) for years.

The studies carried out in 1932 showed that the existing problems had their roots in the unsatisfactory cooperation between the research and development teams and the production sphere. The Radio Valve Laboratory in fact ran the whole production, instead of simply developing new designs. The mechanical construction and the production technology of the new designs, the first provisional tools — which were still ordered from outsider tool makers — and the necessary drawings were all designed in the laboratory. Frequently even the purchase orders were placed by the laboratory, quite independently of the production sphere. All these meant a huge burden for the laboratory staff, who were left with not enough time to work out the production technology for all the new designs. Production was the area where the greatest problems existed and, from time to time, came to the surface. József Gábor's report of 17 July, 1932 revealed that the thickness of the glass used for manufacturing tubes was 1.6 mm, 25 percent thicker than the 1.1 mm thick glass used by the American and other companies. At the same time, the breakage reached 9 percent in Újpest. József Gábor noted: "It is possible that the higher breakage is linked to the thicker glass; the phenomenon is repeated year after year and no one has paid attention." He found the application of molybdenum too high: while the cost of material for a complete grid was 1.6 fillérs in a foreign company, the same cost 4.3 fillérs for TUNGSRAM. Also, the labour costs of the grid production were 31 times higher in TUNGSRAM than in the American companies.

More than 40 percent of the breakage of the finished lamps resulted from inaccurate assembling. "In our competitors' factories one tiny machine turns out

finished, identical grids by the thousands; in TUNGSRAM the same task engages 37 female labourers and 2 supervisors." The combined time of parts production and assembling was 191 minutes in TUNGSRAM the same task engages 37 female labourers and 2 supervisors." The combined time of parts production and assembling was 191 minutes in TUNGSRAM, compares to the 6.2 minutes which was needed to do the same work in the American company RCA. "...which meant that in the United States only one-third of the 63,000 work-hours would have been needed in July, saving 20,000 Pengős in labour costs." He found the proportion of the producing and the non-producing sphere unacceptable: the 240 strong productive work-force employed in assembling and in parts production was backed by a service team of 46 who were paid by the hour. According to a document, in December, 1934 the unit costs of a high-frequency pentode and rectifier was 1.62 Pengős in the United States; the same cost 3.15 Pengős to TUNGSRAM. The greatest discrepancy concerning the production costs was shown in the overheads per tube: this amounted to 25 percent of the total unit cost in the United States and 55.9 percent in TUNGSRAM. Expressed in money, this in itself was more than the unit cost of a complete American tube! (1.76—1.62)

Another critical report, compiled by the Sales Office of the Radio Valve Department, stated that the quality of the tubes showed large variations. Only the first series were good and the following ones already provoked embarrassing criticism. This was the situation even with such excellent designs as the anti-microphonic valve series. The assembling of the tubes was very often not up to the standard, but the resulting faults would only be discovered by the customers.

In late 1934 József Gábor took over the management of the Audion Department. Earlier he had been responsible for TUNGSRAM's entire electrical power system and other electrical equipment. He was also in charge of a workshop producing electrical measuring, ageing, etc. devices for the factory. The company's radio valve production first of all benefitted from his organizational talent, which was desperately needed in the given situation.

It had already been decided on a factory meeting held on 3 September, 1932 that the person in charge of the Audion Department would have to be given control over the complete production. From the above consideration the Test Production was transferred to the Audion Department and the head of the Department also had a greater say in the work of the Radio Valve Laboratory. The Test Production Department, being the intermediate unit between the Radio Valve Laboratory and the mass-producing department, took over the job of making the first few thousand tubes of the new designs, hence easing the mass-producing department of the problems of test production. The Technological Laboratory set up next to the Test Production Department was first headed by Mihály Neumann, to be followed by Jenő Porubszky, its task was to work out and mechanize the glass technology of radio valve production, to organize the quality control of the glassware and to coordinate the work of the glass factory and the Audion Department.

Following the example of the Lamp Manufacturing Department, a chemical plant was established with János Horváth as its first manager. That was the first time that chemical compounds were produced which met the requirements of radio valve production. József Gábor urged for the setting up of the Audion Department's own machine tool production and press-work, as well as for providing all the conditions necessary for the mass-production of parts for valves.

On top of all these, the rationalization of radio valve production was very effectively helped by the patent and license agreement drawn up in 1933 between TUNGSRAM and the world-renowned American company, Radio Corporation America (RCA).

The modernization of the machinery was based on the above mentioned agreement. TUNGSRAM's experts had to adapt to the Hungarian environment the American machinery which, beside being more productive, also allowed less variations in quality. TUNGSRAM's technical staff had to make adjustments on the machines in order to produce tubes which corresponded to the European standards. That was the time

when the American machines manufacturing grids were put into service, which also had to be adapted to the Hungarian requirements. As it had already been noted by TUNGSRAM's staff, the American tubes "significantly differed from the ones used in Europe, both in construction and in technical parameters". The results of rationalization already showed in 1934—1935. It was observed in a report dated 4 July, 1935 that the factory breakage (rejects) had been brought down to 19 percent in those years, compared to the previously recorded figure of 25 percent. The further reduction of factory breakage continued in the following years: in 1936 it was a mere 9 percent. This reduction favourably affected the production costs of radio valves. In order to reduce the production costs still further, the piece-work system was extended: while only 5 to 10 percent of the total tube production had been organized on a piece-work basis earlier, in the first half of 1935 production norms were set up in 9 percent of all the work phases which could be done on a piece-work basis.

In 1934 the Audion "D" Department was established and became "the centre the orderly work and the smooth and efficient running of production originate, and which provides the link between the various units of production, as well as that between the production and the marketing departments".

Those problems of production did not strictly concern the research laboratories, although also affected the work of the researchers. On the one side, the disputes between the factory and the Research Laboratory became permanent, on the other had the unparalleled competition on the international market drove the researchers to even greater efforts. It was the Dutch company, Philips, more than anyone else, which kept bringing out new designs in order to keep abreast of the large American companies. TUNGSRAM, which had to compete against Philips on the Hungarian market, was also forced into this race.

On the Summer of 1928 Philips bought Vatea Radio Technical and Electrical Co. Ltd. of Budapest, then moved it to a new, more spacious location in 1933 and continuously enlarged its production capacity — first

of all in the field of radio receiving tubes. TUNGSRAM responded to this challenge by starting up a subsidiary in The Netherlands, in Tillburg.

The contention between the two giant corporations became very fierce: they constantly fought legal actions in the courts. The patent and license agreement drawn up between TUNGSRAM and RCA in 1933 improved the Hungarian company's position in the contest against its two European partners and competitors, Philips and the German Telefunken. According to the agreement, the American company agreed to making available its 'Standardized notices' (a complete set of information concerning the American radio valve designs) to TUNGSRAM. RCA regularly sent the updates of the set right until the outbreak of World War Two.

Beside the agreement with RCA, TUNGSRAM resorted to other measures in order to force its competitors into making a deal. In 1933—1934 the company called on those members of the Hungarian Trade Ministry who represented Hungary in the next German-Hungarian trade negotiations to object strongly to the campaign continued against the Tungsram tubes in German. "We have repeatedly held talks, directly and indirectly, with the companies of Philips and Telefunken, who have a detailed agreement in the radio business covering every international market, to reach an agreement... if the Hungarian government were to put adequate pressure on the German government to restrain the lobbying groups (Wirufa, Funkverband) from campaigning against the Tungsram tubes... then our prospects of selling tubes on the German market could be very good, which indirectly would also improve the chances of a deal with Telefunken and Philips to secure the growth of our radio valve exports for years." — Lipót Aschner, the chief executive, wrote these words to the deputy undersecretary of state of the Trade Ministry on 20 February, 1934.

As a result of the intervention, the company's prospect of selling radio valves in German improved considerably, which moved Telefunken to force Philips to cooperate with TUNGSRAM. (Between the two European companies had already existed some sort of a

cartel agreement called 'Wewag', which TUNGSRAM also wished to join.)

The representatives of the three companies laid down the basic concepts of the radio valve agreement in Chateau d'Ardenne on 14 July, 1934. It took another two years before the cartel agreement known as 'INRACO' (International Radio Valve Cooperation) was finally signed in Vienna on 5 July, 1936. To some extent the agreement favoured the two large cooperations, since they signed it as joint parties on the one side, while the Hungarian company formed the sole party on the other side. The IVRACO agreement of PHOEBUS. Not all valve designs were covered, neither were photocells, mercury cathode tubes, cathode ray tubes, gas filled controlled tubes, sound tubes synchronized with image etc. The agreement was signed to run retrospectively from 1 May, 1934 until 30 June, 1945. Quotas for selling radio valves were determined, just as in the case of the Phoebus agreement. They were based on the sales figures of the parties between 1 March, 1934 and 28 February, 1934. TUNGSRAM was clearly at a disadvantage, as indicated by its quota being fixed at 12 percent, as opposed to the 88 percent joint market share of the other two parties. However, the agreement enabled TUNGSRAM to increase its sales by 200,000 valves. The agreement did not cover France, England, Northern Ireland, the United States, Canada, Newfoundland, Cuba, Japan and the colonies of these countries.

The IVRACO agreement also brought about a certain amount of cooperation in the matter of patents and allowed the large-scale standardization of the valves, so the majority of the valves produced by the three companies could be used in all kinds of radio sets. In addition in the countries covered by the agreement TUNGSRAM was free from the pressure of having to develop new radio valve designs. This freedom, however, had a price: the Újpest factory agreed to pay to the other two companies 5 percent license fee after its products sold in the major European countries, and 2.5 percent after the products sold elsewhere.

The IVRACO deal and the agreement signed with RCA enabled TUNGSRAM to learn about the American

patents in the electronic vacuum tube industry and to obtain the necessary documentation. TUNGSRAM was given no information about the European radio valve designs and their production technology, since it had no such agreement with Philips and Telefunken. This way the above mentioned companies were given a head start on the markets. TUNGSRAM only found out about the new designs when the other two companies had already developed the new constructions. Since radios were seasonal products and the European partners came up with new valves for the new radio sets nearly every year, TUNGSRAM was only able to start working on the development and production of these new designs once these valves had already been out on the markets.

The IVRACO agreement failed to eliminate the competition in other aspects, too. The radio valve cartel very much respected the interests of the American companies which first of all wanted to protect their domestic markets. Therefore, they exported considerably less of their products than did Philips or TUNGSRAM, for whom export was absolutely crucial. (Not even the German Telefunken — which enjoyed monopoly in the domestic market — was forced to fight over the foreign markets the way its other two partners had to, who could only exploit their existing high production capacities by selling abroad what they could not sell on their small domestic markets.)

Nearly simultaneously with the international cartel agreement the Hungarian factories, too, wanted to come to a cartel type agreement. Orion (as an TUNGSRAM subsidiary), Standard, Telephone Factory, Engel Károly (EKA) and Siemens first signed an agreement in 1933. Later Telefunken and Philips also joined this group with their Hungarian branches — probably influenced by the IVRACO deal. The Hungarian branches marketed their own designs — which had been developed with the help of the parent companies, naturally. (When Philips founded a research laboratory for its new Budapest plant in 1935, the parent company immediately intervened and had it closed down.)

The Hungarian cartel was formed to safeguard the factories' interests: it regulated the retail price of radio

sets, the conditions of sale, the retailers' trade allowance (rebate), the conditions of the hire-purchase system and the terms of the guarantee. In 1936 Orion, Philips, Standard and Telefunken also signed a cartel agreement regulating the production of goods. The cartel agreement indirectly helped to raise the technical standard on the domestic front, because the cartel members annually informed each other of the major technical parameters of their new designs. In 1939, based on the agreement between the producers of radio sets, a new radio design was launched which used Tungfram valves and which, following the success of the German 'Volksfänger', catered for the average households. Its cheap price greatly contributed to the rapid growth of the radio subscribers, and even if its production was not profitable, it helped advancing the production technology of both the valves and the radios. The Hungarian radio cartel also offered other advantages to TUNGSRAM; for example, Philips was obliged to buy valves from TUNGSRAM for its radios marketed in Hungary.

During the mid-1930s the intense research and development work continued in the radio valve industry. Since TUNGSRAM was only provided with the physical dimensions and the electrical operating parameters of the new standardized valve series (in keeping with the letter of the international cartel agreement) and the documentation of their production technology usually arrived too late (if it arrived at all), naturally, the experiments to develop valves which better suited these specifications continued in TUNGSRAM's laboratories.

The so-called 'Allstroom' tubes, the heated universal radio valves arranged in series, running both on batteries and mains, were completed in 1934 and were also used in Orion radios. Then in 1938 TUNGSRAM announced the E-series valve heated from 6.4 Volts, this time still marketed with a flattened shape.

The efforts towards standardization and universal compatibility already dominated the further constructions. In 1935 the valves of the A, C and K-series came out. The cathodes of these designs could all be heated from both batteries and the mains, D.C. or A.C.

Between 1932 and 1935, following the research of Dr. Ernő Winter, the company developed its anti-microphonic valves and demonstrated the physics of the phenomenon known as grid emission. The patents concerning the reduction of grid emission by the noble metal coating of the grid were soon applied all over the world.

In 1936 the tuning in of a radio set to a particular station was still an elaborate procedure: those sets had 2—4 knobs to fiddle with in order to achieve perfect reception. The so-called 'magic eyes' served to ease the problem of tuning in to a frequency. The improved version of these 'magic eyes' were still world-famous in the 1950s. The quality of the Tungsram 'magic eyes' placed them well ahead of the similar tubes produced by its European competitors.

In the second half of the 1930s VHF radios became very popular. Tube designs providing better VHF reception were studied all over the world. Beside the electrical improvements, efforts were aimed at developing better tube constructions and production technologies. The American and the European metal valve technology, the pure glass valves and, finally, the miniature valves were developed accordingly. "In the Radio Valve Laboratory and the Test Production Department of TUNGSRAM we developed entire miniature valve series already in 1937—1938 which were more advanced than those coming out later" — Ernő Winter remarked in 1954. — "These valves, however, were not marketed", he added. The so-called pure glass valves (series 21) were brought out in 1939. Their small dimensions and the novelty of their entirely glass construction allowed to make further advances in the design of receivers, this way tracing out the valve industry's future direction, so to speak. The pure glass series took over the electrical parameters of the flat-shaped E and U series, together with the advantage that now it was possible to meet all the existing circuit requirements using no more than four valves (ECH 21, EBL 21, ADZ 21 and EF 22).

This series revolutionized the production technology. Thanks to this series, the so-called flat-shaped glass technology taken over from the incandescent lamp

industry became totally obsolete. The new technology basically affected the internal construction of the valves, allowing greater accuracy in assembling, as well as the increased durability of the components.

The introduction of the pure glass series took place during József Gábor's management. The new glass technology was developed by Mihály Neumann, Béla Reiss, Jenő Porubszky and Elemér Martinek. TUNGSRAM brought out its world-renowned battery-powered radio receiving tubes as part of the pure glass series. The tungsten cathode filament with the appropriate diameter, used for heating the valve, was developed by Pál Tury and Dr. Tivadar Millner, while the oxide cathode coating was designed by Ernő Winter.

The relations between research and production were never without strains during the 1930s. The setting up of the Test Production Department and the improvements in the factory organization brought some results, but the valve production between the two world wars was always a tempestuous and more dynamic affair than the incandescent lamp production. Following the increasing demands and the pace dictated by the competition, the number of designs were always going up.

In a report written jointly by József Gábor and Ernő Winter in January, 1937 the authors observed that "...the designs are not allowed to become standard; it is Philips, more than any other company, which tries to reply to the challenge of the American tubes. TUNGSRAM has been dragged into this race by Philips. We completed the development of all the designs, the E series included, only we did that at a much reduced standard, compared to the one achieved by Philips." (The report also argued for the need to develop transmitting tubes.)

In a later report, dated from 1941, Ernő Winter himself observed that the Test Production Department was "unable to live up to the expectations". Philips and Telefunken brings out 10—15 designs annually, for the production of all of which the Test Production Department must make preparations. "On top of this, the Test Production Department would also have to establish up-to-date mass-production technology for each of the

new designs developed by the Radio Valve Laboratory."

According to another report, also dated from 1941, József Gábor saw the root of all the problems in the fact that the number of the various tube designs reached the point where "it frustrates the rational production".

According to Gábor, there were less types of caps, bulbs and electrodes in the incandescent lamp manufacturing, while the volume of production was far greater. Others thought that the situation was not much better in the incandescent lamp industry, either: the number of different types of lamps was put at 50 to 60 thousand in 1940. Before the Second World War the overwhelming majority of the electronic vacuum tubes were used in commercial radio sets, serving entertainment purposes. In the 1930s new areas of application were discovered for the electronic vacuum tubes. The news about a new telecommunication device called television reached Újpest already in 1932. In a memorandum written in September, 1932 Ignác Pfeifer called Lipót Aschner's attention to Dezső Lendvai was TUNGSRAM's engiener delegated to the U.S. According to the report "...the first phase of television experiments has been completed, as a result of which it is now possible the receive quite primitive pictures by television sets developed right down to commercial marketing."

In the next few years there were frequent reports on the growing popularity of televisions. The report of the Audion Export Department, dated 16 February, 1935, gave a detailed account of the television's development in Great Britain and the United States. Among others the report states: "The triumph of television has a paramount bearing on our electronic vacuum tube industry... From the above mentioned facts it is evident that we must prepare, well in advance, for the business potentials meant by television." The report suggests the setting up of a separate laboratory dealing with televisions. This was, indeed, put into service in March, 1937 with Károly Czukor as its first manager, and Dr. István Barta, Pál Terebesi, Kálmán Magó and Kálmán Kincse as staff members. The laboratory was

located on the second floor of the water-tower. It was agreed that TUNGSRAM would be producing television sets. The first experimental television transmission took place on 21 June, 1937. The first transmitted picture was a drawing of Mickey Mouse, the second showed the well-know Tungsram trademark, the letter T. The next experimental television transmission followed on 22 October of the same year, showing the portrait of Maxwell, the famous English physicist. At that time TUNGSRAM was very nearly up to the world class standard in the field of television technology. In Europe it was only Great Britain which had a daily three-hour programme; in France the work continued to install a TV station on top of the Eiffel tower, and Germany planned the start of the regular television broadcasting in the autumn of 1938. The American RCA proposed to sign an agreement with TUNGSRAM on television technology which would have covered the exchange of information on transmitting stations and receiving sets. RCA also planned to send their representative to Hungary. It was the war preparation which interrupted the development of television technology and caused a serious setback.

Immediately before, as well as during the war the areas of application were widened for radio valves: telecommunication set up for non-entertainment purposes, army equipment, etc.

TUNGSRAM wanted to follow the development in these areas, too. The company carried out extensive work in the field of microwave technology. György Dallos, the engineer who some years later suffered martyrdom, was the first to do experiments in this direction, to be joined by others later. The valves for the first microwave two-way radio were built Winter, Szepesi and Budincsevsics. Then a transmitter operating on a wavelength of 58 cm was completed in 1941. Its output power of a few milliwatt was sufficient to establish communications first with the Tungsram holiday camp and later, between Mount Naszály and the Research Laboratory.

During the Second World War the military interests dominated the development work. The Army ordered

from the Laboratory — and from Zoltán Bay, personally — the development of a locator for artillery. Almost the entire Research Laboratory took part in the development which had to be kept in secret. The theoretical design work was done by Simonyi, Papp and Antal Solyi; Istvánffy from Standard helped designing the aerial, the transmitter was built by Zoltán Szepesi, and György Dallos constructed the receiver. The first echoes of land targets were registered on 13 April, 1943, but the device measuring the horizontal angle, the distance and the height of the targets was still to be designed and manufactured. The distance measuring device was built by Kálmán Magó and Papp, based on the original idea of Zoltán Bay. The artillery locator called *Barbara* was completed in 1944, although the army could already not make much use of it.

Those members of the Research Laboratory's staff with an anti-German feeling — Zoltán Bay included — did not rush to complete the army orders. All of them were more concerned with the scientific aspects of the arising problems. After the war they sent microwave signals to the Moon from a radar working on 2.5 m wavelength which was constructed from the surviving bits of these locators. On 6 February, 1946, only a few days after the announcement of the experiments carried out in the United States the same radar was able to register the echoes of the signals.

There were other types of experiments beside the ones mentioned already; for example, Pál Selényi worked on the interesting subject of electrography. His results, however, were never put to any practical use. In the second half of the 1930s the methods of electrography were also used in oscillographs, video-telephones and the transmission of televised images, still and motion pictures alike. Meanwhile, however, other, more efficient methods were developed for the same purposes and hence electrography remained a curiosity of the history of sciences. Scientific progress is not possible without mistakes and deadends.

The production of transmitting tubes began in the Újpest plant in 1933—1934. Beside the growing popularity of the radio amateur movement, there was

another potential customer: Hungarian Postal Services considered to buy the valves for its relay stations from Hungarian companies. Although in this case the isolationist tendencies seemed to favour TUNGSRAM, at the end the deal went to Philips, with the provision that the tubes had to be produced in Hungary. Despite missing the order from the Hungarian Postal Service, the production of transmitting tubes continued in Újpest. Tubes worth 7—800 thousand Pengős were manufactured in 1936—1937, some of them for export. By the end of the 1930s TUNGSRAM produced 10—12 thousand transmitter tubes annually, coming in 30—35 designs. The annual production reached 33,200 tubes in 1942, worth more than 2 million Pengős. The number of designs fell dramatically in this year and the business was dominated by the Army orders. The export, primarily to neutral countries such as Switzerland, Sweden, Portugal, Finland and Spain, continued. TUNGSRAM's experts saw great future in the production of transmitting tubes. In 1943 they calculated that after the war there would be some 10 thousand civil airports in Europe, all of which would require transmitting tubes in the millions. TUNGSRAM was also involved in the production of tubes used in microwave medical equipment.

The Further Advance of the TUNGSRAM Corporation

The worldwide economic recession between 1929 and 1933 did not effect TUNGSRAM as much as it did the companies in to other sectors of the economy. This is underlined by such facts as the purchase of Coal Mines of Ajka, the building of the Krypton Factory of Ajka, the establishment of the mechanized glass factory in Újpest and the further expansion and development of the foreign sales agencies and factories.

a) The Founding of the Krypton Factory and the Power Plant of Ajka

In the previous chapter we have already pointed out on

more than one occasion that at the time of inventing the krypton lamp TUNGSRAM was still a long way away from the mass-production of the new lamps. Imre Bródy already knew — and we have pointed this out also — that the key to the problem lied in the industrial production of adequately priced krypton. One precondition of the industrial krypton production was the founding of TUNGSRAM's own krypton factory. We also discussed that the so-called 'gas group' was willing to equip a factory in Hungary producing krypton as the primary output. The production of krypton required a great deal of electrical energy, because for the separation of just one liter of krypton from air through a procedure called 'washing' one million liters of air had to be pushed through the cycle. In order to be able to secure cheap electrical energy needed for the production — and, partially, also to speed up the negotiations with the 'gas group' — TUNGSRAM bought Coal Mines of Ajka, for 3,268,786 Pengős. This vertical expansion also ended the long battle which was waged between TUNGSRAM and the coal mines for years on account of the high price of coal, its poor quality making it unsuitable for gasification and the high cost of transportation caused by delivering the coal from distant mines.

The coal mines of Ajka had been producing good quality coal (3600 calories on average) since 1868. Their daily output at the time of the purchase was 130 wagons, but there was capacity for more. The pit in Padrag was opened in 1943, and with that the daily production already reached 200 wagons. Another fact also featured in the decision to buy Coal Mines of Ajka Corp., namely the additional power plant which had two-third of its capacity immediately available for providing electrical energy to TUNGSRAM's planned krypton factory. The purchase also solved the problem of finding location for the krypton factory, since the 1000 kW power consumption of the factory could be met locally.

The German Linde company undertook the design of the factory, delivered and installed the machinery and provided the technical documentation necessary for the operation of the machines. On behalf of

TUNGSRAM János Lévai, Tibor Mihalovits, Egon Orówan (outside expert), Imre Bródy and the architect Dezső Antal took part in the work.

The factory had the following major economical parameters: 36.7 kWh/1 krypton-xenon, daily production of 560—580 liters at a unit cost of 1.26 P/1 krypton-xenon. The factory started the production in 1937. This was the world's first operational krypton factory. (Although Air Liquide's factory had been built earlier, it was closed down for the regular occurrence of explosions.) The total investment of setting up the factory was 1,847,000 Pengős; from this the factory buildings cost 441,000 Pengős, and the equipment, 1,252,000 Pengős. TUNGSRAM had seven blocks of flats built for its workers next to the factory. TUNGSRAM invested a total of more than factory. TUNGSRAM invested a total of more than four and a half million Pengős in the two enterprises connected with the production of krypton (the krypton factory and the coal mine), not counting the costs of the experiments and other relevant expenses, such as the high-pressure krypton purification, the development of the machinery producing bulbs and lamp, etc.

The performance of the krypton plant of Ajka did not live up to the expectations in the first few years. There were constant disputes with Linde, the company delivering the equipments, about the quality of the krypton and other problems. The major source of these arguments lay in the fact that the German company, referring to patent agreements, did not give access to TUNGSRAM's experts to study the workings of the most important equipment. They had their permanent representative in Ajka who called out Linde's own mechanics from Germany for the occasional breakdowns.

Continuous production started in the krypton factory in the spring of 1938. Its output in May totalled 12 m³ of krypton. They were only able to get 0.85 l krypton from 1000 m³ air, which was less than expected. The energy needed to produce one liter of krypton was 44.6 kWh. By the autumn of 1938 the plant was running smoothly. The monthly production reached 17.5 m³, corresponding to the planned annual performance.

The resulting krypton was filled in bottles in Ajka and sent to Újpest. The engineer Tibor Mihalkovits, who was appointed by TUNGSRAM to act as technical supervisor, greatly contributed to the smooth operation of the plant. In close cooperation with the company management he succeeded in forcing Linde to amend the faults and, working together with Imre Bródy, he came up with a new method of producing krypton. The old power plant of the mine could only meet the energy needs of the krypton factory temporarily, an additional factory which was on the cards at the time. Therefore, TUNGSRAM embarked on the building of a modern power plant with an annual capacity of 250 kWh energy already in 1938. The krypton factory of Ajka would not have needed this much energy, so it was suggested that those units of the factory which required a lot of electrical energy (for example, the planned electrical glass furnaces of the glass factory) should be moved to Ajka, also. (There was even an experimental electrical glass furnace operated with direct current in the Újpest glass factory.) But the plan was discarded and other electricity consumers were found to utilize the surplus energy capacity.

TUNGSRAM started talks first with Aluminium Ore Mining and Industry Co. Ltd. and later, with Hungarian Bauxite Mining Co. Ltd. in order to find buyers for its surplus electrical energy. Both these companies had sizeable bauxite mines in the counties of Fejér and Veszprém and now wanted to establish alumina factories and aluminum furnaces which also needed a lot of electrical energy, possibly at a low price. In 1940 — almost three years after that the krypton factory had started producing — a deal was made by TUNGSRAM and Hungarian Bauxite Mining Co. Ltd. about the sale of an annual 210 kWh of electrical energy. After signing the deal the building of the power plant began on a site of 96,000 hectares (1 hectare = 2,471 acres). A sum of 28 million Pengős was budgeted for the building of the power plant and the related pit of Padrag. According to the plans, the first block of the power plant would have been running in November, 1942. The government also helped financing the project with 18 million Pengős, bearing in mind the strategic importance of

the industry. The boilers were designed by the Swiss company Sulzer and some of the accessories were also delivered by the same company. The boilers used powdered coal for fuel; their heat-exchange was based on radiation. The boilers were made from a single molybdenum steel rod, and had their maximum pressure set at 80 atmosphere and maximum temperature at 530 °C. This was the first high-pressure boiler plant in Hungary. Sulzer was represented in Hungary by the engineer László Heller. Nevertheless, Lipót Aschner invited Heller to direct the design and the construction of the power plant as an outside expert. Representing the company, István Gyárfás, Tibor Mihalovits and Gyula Viola took part in the work.

The coal-dust mills and the high-pressure turbo supply pumps were also purchased from abroad. Because of the war, the majority of the goods already arrived late, but the captiousness of the Hungarian officials made things even worse: the appointed (and incompetent) government representative, always surrounded with gendarmes, was himself the cause of a number of technical blunders. So, it is only understandable that the construction work dragged on and the expenses were constantly going up. As a result of concerted efforts, the first boiler was at last operating in February, 1943, three months after the original deadline. The second boiler, however, was not working until March, 1944, and neither was the turbo generator. The power generator started working in 1943, although barely half of the planned power was produced: 100 kWh. The construction costs had reached 34 million Pengős by early 1943, even though the inflation brought on by the war also contributed to that.

The power plant was only completed after the Second World War.

b) The Building of the Mechanized Glass Factory in Újpest

The increased incandescent lamp and radio valve production required an increase in the production of the necessary glassware.

Before 1932 TUNGSRAM brought the necessary glassware parts from its glass factories in Tokod and

Ujantálvölgy (Utekac), and partly from the factories of Inwald in Mossbrunn, Austria, and Osram in Weisswasser, Germany. The glass factories of Tokod and Ujantálvölgy primarily produced blown, pressed and ornamental glassware under the direction of such distinguished experts as Jenő Eggenhoffer, Vilmos Frommel, Jenő Schlisz, to name but a few. Both factories had very good furnace staff and glass-blowers. The lead-glass tubes and rods, the back insulating glass rods and grits and the various special and hard glass components were bought from outside the concern, from the already mentioned Austrian and German companies. The company, therefore, was always exposed to the danger of its competitors' exploiting the situation, either through price policy or design strategy. It did not come as a surprise then that TUNGSRAM's management decided in 1930 to widen its glass manufacturing. They expected this way to free the capacity of the existing manual glass furnaces for the production of the special bulb designs which could not be produced on machines. By setting up a mechanized glass factory in Újpest the quite substantial transportation costs could also be reduced. Still in the summer of 1930 TUNGSRAM bought from Osram an American-built machine capable of producing 70,000 glass balloons a day. This machine was called 'Ivanhoe' and it had been working in Osram's plant in Siemestadt. TUNGSRAM also bought Osram's automatic glass tube drawing machine of a type called Danner. Lipót Aschner made a deal whereby Osram would be providing professional assistance throughout the design of the Újpest glass factory and would also help in the training of the Hungarian staff. The design of the furnaces would be done by the German factory's team specialized in building furnaces, under the guidance of Professor Gelhof, Osram's glass physics, chemistry and technology expert.

In 1930, after signing the agreement, work on the design of the glass factory's building began, while the construction work started in September of still the same year, using bauxite cement in the fashion of the age. (This construction method led to the ripping out of a railing and the death of a young worker.)

Simultaneously with the construction work, a delegation was sent to Germany to study the production technology on the spot. János Lévai was appointed to coordinate and direct the whole project.

The glass factory was built up in one year, costing 4,200,000 Pengős, but the start of production was delayed until 1932. Although the Hungarian staff of the Újpest glass factory immediately manufactured glass bulbs with the required precision, the glass material of the bulbs became so full of bubbles after a few days of operation that it was not suitable for light bulbs. The problem of setting things right was further frustrated by the fact that the German professor had died in the meantime, leaving TUNGSRAM's staff on their own to face the difficulties. Even the American experts of IGEC were unable to add anything to the analysis of the home staff, even enlisting the expertise of the chemical engineer Dr. Oszkár Knapp. They came to the conclusion that the problems arose from the separate heating of the melting area and the work area of the furnace, as well as from the arrangement of the connecting channel below the bottom surface of the two areas. This arrangement slowed down the flow of glass between the two tubs and, as a result, the air bubbles of the glass in the work tub were created by the automatic suction heads of the glass blower, staining the glass bulbs. After rectifying the faults, the production of the mechanized glass factory became stabilized, so much so that TUNGSRAM was unable to run it to full capacity. But since the production was only possible with fully utilized furnaces, and since the work force also had to be engaged continuously, the company prepared for the manufacturing of new products. The company first started producing water-glass for the paper- and the textile-industry, then it attempted to manufacture chemo-resistant glass tubes for medical purposes. These were later turned into ampules by Hungarian Tungsten Incandescent Lamp Factory — the company which in the meantime had gone into the possession of TUNGSRAM.

c) Further Stages in the Growth of the Corporation

Beside strengthening its position vertically, TUNGSRAM also worked continuously to improve its standing both within the increasingly prosperous incandescent lamp cartel and in the domestic markets. The famous Viennese incandescent lamp and radio factory Joh. Kremeneczky A.G. nearly went bankrupt during the economic depression of 1929—1933. The executives of TUNGSRAM were of the opinion that by acquiring the Viennese factory they could take over its quota in PHOEBUS, while also ridding themselves of an annoying competitor in the domestic incandescent lamp and radio market.

It was TUNGSRAM's Viennese subsidiary, Watt A.G., which formally bought the Kremenetzky factory in 1930. (The Kremenetzky name and trademark had such a good ring on the international markets that even Watt A.G. switched to using the Kremenetzky name until 1942.)

The Hungarian Tungsten Factory Ltd., which manufactured and marketed the Orion radios in Hungary, formally retained its independence in spite of the change in its ownership; nevertheless, there were considerable changes in the structure of its product profile. The manufacturing of incandescent lamps continued, although at a much reduced intensity. While in 1931 the production of incandescent lamps still reached 2.4 million pieces, only 1.5 million were produced in the next year. The production of incandescent lamps then stayed roughly at this level right until the end of World War Two. The Orion, the Watt and the Ferrowatt designs were not stopped, either; such trademarks were retained by the Tungstrom corporation. By taking over TUNGSTEN Factory Ltd. cartel quota TUNGSRAM was entitled to use these trademarks.

The increased production of radios meant the greatest change in the life of Magyar Wolframgyár Rt. Egyesült Izzó — that is now TUNGSRAM — delivered the radio valves for these radios. It also delivered parts to the Hungarian Tungsten Factory started producing the already mentioned ampules to make up for production

lost elsewhere; then in 1937 it began to produce thermos flasks. The machinery for both new products were delivered by TUNGSRAM's Machine Works, and the necessary glass material, by its glass factory.

Hungarian Tungsten Factory Ltd., despite being a subsidiary itself, began to expand in the 1940s. It bought Remix Electrical Ltd. for 400,000 Pengős in 1941. This factory produced electrical components (resistors, capacitors, etc.) for radios in its Tűzoltó Street plant, exporting about 60 percent of its production. It employed approximately 260 people in the year of the purchase. The organizing talents of Miklós Fodor, one of the one-time owners of Remix, proved very valuable to TUNGSRAM in other projects of the corporation (for example, the building of the Power Plant of Ajka). Remix also retained its formal independence after 1941.

Hungarian Tungsten Factory Ltd. — again, with the help of TUNGSRAM — bought the Francia Street plant of Enamel-, Metal-ware and Electrical Factory of Budafok and also, the shares of an electrical company called Agrolux Ltd. (previously known as Hajós and Szántó Electrical Company).

In 1941 TUNGSRAM acquired the majority of the shares of the glass factory of Feketeerdő, in the county of Bihar (now in Rumania). Then in 1943, by acquiring interests in the Glass Factory of Zagyvápálfalva, TUNGSRAM secured the leadership of the entire Hungarian glass industry.

In the years that followed the economic depression the isolationist tendencies dominated the economy of Europe, but one might even add, of the whole world, also. International trading was, of course, at a low ebb. The isolationist tendencies also meant that a significant number of the countries moved in the direction of self-sufficient economy, making the import of complete products more difficult and, at the same time, agreeing to the import of parts more readily. The isolationist tendencies in the incandescent lamp industry resulted in the proliferation of companies outside the cartel. Even PHOEBUS's efforts were insufficient to reserve this process and the cartel members,

case of radio valve factories, radio valves, whose import was not permitted or was not rentable on account of the high custom duties.

Such a divergence in the company's profile brought about the development of the machine works in Újpest, specializing in the manufacturing of machines used in incandescent lamp manufacturing. What once had been an in-house workshop, now became one of TUNGSRAM's fundamental branches.

To give an idea of the size of the TUNGSRAM Corporation, we present a table showing the break-down of its work-force (30 April, 1929):

Factory	office workers	workers	total
Újpest	808	4264	5072
Joh. Kremenetzky, Vienna	232	1225	1457
Hungarian Tungsten Factory Ltd.	127	703	830
Milan	39	56	95
Warsaw	72	198	270
Tillburg	27	81	108
London	35	129	164
Bucharest	60	65	125
Paris	128	122	250
Glass factory, Klára Utekac	7	631	638
Glass Factory Tokod	14	860	874
Total work-force	1,572	8,356	9,928
Coal Mines of Ajka	30	970	1,000
Tungsrám sales agencies	250	73	323
A grand total of	1,852	9,399	11,251

As a result of the new acquisitions, the total number of workers employed by the corporation had reached 13,846 by January, 1943, giving a further increase of 20 percent.

The subsidiaries and branches constituted a complex organization. Every company retained its share company structure enjoyed prior to joining the corporation, and even the foreign agencies were reorganized

into formal independent companies. This striving for independence was explained by the rising nationalist mood exhibited in the various countries. To tackle the nationalist tendencies, such organizational structures were formed which made the foreign branches financially interested in one another; for example, the Yugoslavian sales agencies and assembly plants were run as if they had been the subsidiaries of the Tungsram factory in Zurich.

In the growing isolationist mood the transfer of profit from the subsidiaries to the parent company became increasingly more difficult. This difficulty was bridged by license agreements concerning various patents owned by the Újpest factory, as well as other agreements about certain consultation fees due to TUNGSRAM, drawn up first between the assembly plants and TUNGSRAM and later between the assembly plants and Swiss holding company set up just for this purpose. Then the Swiss company used the proceeds to buy basic materials on the international markets. This source of acquisition enabled TUNGSRAM to continue with its production through- therefore, other ways of securing their markets had to be found.

To adapt to the new circumstances, TUNGSRAM, like the rest of the large international companies, set up factories (assembly units, more precisely) working beside its existing, registered and legally independent, foreign branches which, in fact, were sales agencies. In certain cases these moves were connected to the ruthless competition against the great opponents on the market. When the Dutch company Philips bought shares in Hungarian businesses, TUNGSRAM responded by acquiring a small Dutch company, Radium Tillburg, and turned it into a radio valve and incandescent lamp assembly unit. Later this company even moved into radio manufacturing. An incandescent lamp factory (assembly plant) was established in Milan in 1930, a radio valve factory in London in 1934, another incandescent lamp factory in Bucharest in 1936, an incandescent lamp factory in Bratislava and a radio valve factory in Paris in 1937, and an incandescent lamp assembly unit, again, in Paris in 1939. The

Warsaw branch added the assembling of radio valves to its list of products in 1938; two factories went into the possession of TUNGSRAM in Yugoslavia, in Zagreb and Panchova, specializing in the assembly of incandescent lamps, and then came the setting up of the factory in Belgrade. The establishing of assembly units were on the cards in Argentina, Switzerland, Sweden, Egypt and Turkey. A large part of the machinery for the Argentine factory had already been completed, when the war came and ruined the plans. The listed factories all had production capacities in the neighbourhood of 2 million incandescent lamps or, in the case of the radio valve factories, between 300,000 and 700,000 tubes.

All the foreign branches were fitted with machinery built in Újpest and — wherever the law of that country permitted — were provided with parts and technology imported from Újpest, working under the guidance of the technical staff, again, delegated from Újpest. Their production, both in volume and structure, entirely followed the directions issued in Újpest. Most of the times these factories produced normal lamps or, in the out the war. In 1941 TUNGSRAM's Újpest plant had enough copper to last three years, its tungsten supply was enough for five years, nickel and molybdenum enough for two years, tin for four years, etc.

The Production and Trade Figures of the Company from the First Year of the Depression until the End of World War Two

The famous Wall Street Crash broke out in New York on 24 October, 1929. It marked the beginning of a worldwide economic depression. The crisis did not acknowledge geographical barriers or national borders: it soon spread to Europe. As a result of the Depression, masses of goods became unmarketable, prices rapidly fell, industrial production took a nose dive and mass-unemployment followed. The Depression was very acutely felt in Hungary, too. The situa-

tion was especially bad in the agriculture and the industry, first of all in the heavy industry, where production fell by more than half. At the same time, the food industry and some other companies, mostly producing consumer's goods, were slightly less hurt by the Depression.

TUNGSRAM also belonged to those companies which produced consumer's goods and, therefore, were less susceptible to the effects of the Depression of 1929—1933. The opening phrases of the report prepared for a board meeting assessing the company's performance in the fiscal year of 1930—1931 described the company's grave situation throughout these difficult years: "The economic crisis has been felt in almost every country, where we are present on the market with our products, unfavourably affecting our trade. We have been only able to achieve sales figures approaching last year's performance, because we could further develop some of our recently introduced business projects."

The second sentence in this report refers to the fact that, while the volume of production significantly fell in the incandescent lamps business, the production of radio valves rose.

Year	incandescent lamps production in pieces	radio valves
1929	22,157,000	642,000
1930	23,429,000	1,123,000
1931	12,970,000	1,936,000
1932	10,194,000	1,834,000
1933	11,084,000	1,611,000
1934	15,670,000	2,345,000

It is evident from the table that the two charts show quite a different story. While incandescent lamp production fell by 60 percent in 1932, as compared to the record figures of 1930, the volume of radio valve production grew year after year until 1931 — it trebled in two years! — and, following a two-year long slight setback, rose to a new record in 1934, crossing the two-million valve barrier.

Behind the drastic drop of incandescent lamp production there was also a certain amount of speculation on the part of TUNGSRAM's management. While the stocks were piling up in almost every branch of industry during the Depression, in the same period TUNGSRAM significantly reduced its stocks, both home and abroad, by holding back production. In 1930 TUNGSRAM had 16,383,000 incandescent lamps in TUNGSRAM stock; by 1934 it had only 7,043,000. It is typical of TUNGSRAM's business performance that its published figure showed a profit even in the years of the Depression. The profits went as follows:

Fiscal year	Profit (in Pengős)
1929-1930	3,897,760
1930-1931	3,991,098
1931-1932	3,527,293
1932-1933	2,719,981
1933-1934	1,380,684
1934-1935	1,486,034

Analyzing the profits we must bear in mind that, as a consequence of TUNGSRAM's peculiar position, its business performance was only reflected in the books with a one- or two-year delay. It was the final clearing-up of the PHOEBUS accounts, which took longer than usual, although the accounts of the foreign branches could not be completed until after the end of the given fiscal year, either. This was how the company could show the largest profit in the worst year of the Depression in 1930—1931, and the smallest — barely 40 percent of the previous profits — in the years of the economic recovery!

In drawing the balance of the company's actual performance during the Depression we must also take into consideration the new investments TUNGSRAM realized in the corporation in these years. It bought the Viennese company, Joh. Kremenetzky in 1930—1931, and significantly expanded the Újpest plant. The company began the construction work on the new headquarters of the Research Laboratory in 1929, a three-storey building was completed (No. 37.) for Standard,

and another one, the new mass-production block (No. 36) which accommodated the extended radio valve production, as well as the new Machine Glass Works and the Recreational Centre. In order to provide central location for its warehouses and offices, TUNGSRAM bought the Eötvös Street plant in the 6th District, and also established a swimming pool and a rowing club by the banks of river Danube, straight across the Újpest plant. These new developments significantly added to the value of the company's fixed assets. In the records the value of the factory sites, buildings and equipment went as follows:

Fiscal year	Profit sum in Pengős
1920-1930	14,675,000
1930-1931	16,320,000
1931-1932	20,076,000
1932-1933	23,226,428

The increase in the company's wealth invested in fixed assets was nearly 9 million Pengős within these few years, giving an almost 58 percent growth.

The company presumably financed these significant additions from its reserves stashed away in the previous years and cleverly concealed from the records. This business policy — and the generally improving economic environment — brought about, from the mid-1930s on, another boom in the company's performance, which lasted right until World War Two. The general economic boom which resulted from the preparation for war from the mid-1930s onward did not help TUNGSRAM much, since it was hardly at all involved in the production of war materials. On the other hand, the isolationist tendencies, also looming large at the time, had an unfavourable influence on TUNGSRAM's trade. Nevertheless, the company was able to maintain its position both on the domestic and the foreign markets.

The profits of the next few years are shown in the following table:

Fiscal year	(Profits in Pengős)
1934–1935	1,486,034
1935–1936	1,777,319
1936–1937	2,262,880
1937–1938	2,248,091
1938–1939	2,392,771
1939–1940	2,539,885
1940–1941	2,534,529
1941–1942	3,514,995
1942–1943	4,338,038
1943–1944	4,721,562

Tungsrám's profits continued going up every year in this decade, too. This was so in spite of the fact that the company also continued to invest in this period at the same rate as it had done previously. This was the time when the krypton factory was built, the coal mines of Ajka went into the company's possession, the power plant of Ajka was established and several foreign branches were set up, beside the permanent construction work in the Újpest plant. The cost of all these investments was about one million Pengős each year. In the 1930s the company also bought large pieces of land. In 1937–1938 it bought from the Károlyi family an approximately 43,000 square fathom (1 sf = 38.32 square foot estate complete with buildings including the inn of Megyer. Certain chemicals — fluoride acid, colloidal cotton, etc. — were stored here. TUNGSRAM also bought nearly 6,000 "square fathom" of land from the Franciscan Order in 1940. Before the said purchases TUNGSRAM and its subsidiaries owned nearly 360.6 cadastral yokes (1 cadastral yoke = 1.42 acres) of land home and abroad.

The next table shows the company's wealth invested in fixed assets (factory sites, buildings and equipment):

Fiscal year	Total in Pengős
1933–1934	23,450,793
1934–1935	23,860,000
1935–1936	24,475,637
1936–1937	24,528,693
1937–1938	28,275,133
1938–1939	28,473,427
1939–1940	29,144,890
1940–1941	34,562,409
1941–1942	45,871,671
1942–1943	53,674,791
1943–1944	68,885,892

The value of the company's fixed assets very nearly trebled within ten years. The fact that TUNGSRAM had managed to finance all its investments from its own resources right until 1941 (when it had to borrow to cover the cost of building the power plant of Ajka) tells a lot about the company's monetary position. It was TUNGSRAM's improving production and sales figures from the 1930s onward, which enabled the company to finance its own project.

The incandescent lamp and radio valve production of TUNGSRAM in this period is outlined in the following table:

Year	Incandescent lamps	Radio valves
1934	15,670,000	2,345,000
1935	14,986,000	2,219,000
1936	19,807,000	2,599,000
1937	24,600,000	3,165,000
1938	24,685,000	2,421,000
1939	25,296,000	2,587,000
1940	23,201,000	2,385,000
1941	20,369,000	2,309,000
1942	26,465,000	2,613,000
1943	23,681,000	2,055,000

(No information is available on the year 1944.)

In 1937, for the first time since the Depression, the incandescent lamp production reached the twenty million barrier, never to fall below that mark again.

In the late 1930s the incandescent lamp production had the following breakdown:

Lamp designs	Fiscal year	
	1937-1938	1938-1939
Normal vacuum lamps	6,132,168	4,906,934
Normal gas-filled lamps up to 100 W	7,789,564	7,620,097
lamps from 150 W	958,258	1,008,830
Festoon lamps	162,522	162,823
Special lamps	4,327,226	3,394,791
Pearl sealed lamps	3,091,339	1,874,802
Glow lamps	13,128	44,897
Krypton lamps	2,675,694	4,718,943
A total of	25,149,899	23,732,117

Looking at the table the sudden growth of the krypton lamp production, going up by nearly 80 percent within one year, becomes evident.

According to the schedule, in 1937 the production of 9.2 million incandescent lamps were targeted in the first 4 months of that year; further 6.5 million lamps were to be manufactured in the summer months — between May and August —, and in the remaining 4 months another 9.3 million lamps would complete the round figure of that year's total of 25 million lamps.

The variety of designs shown in TUNGSRAM's production was matched by the fluctuating intensity of their manufacturing throughout the year. Generally, three periods were distinguished within each year.

The reason for this was that the quality of the lamps produced during the summer heat was inferior to that of the lamps manufactured in the cooler months. For this reason, and also to protect the health of the workers, in that period the factory only ran for seven hours a day, or 35 hours a week, since only maintenance work was done on Saturdays. The production peaked in December and in the following couple of months. Experience showed that the "cheapest and the best quality lamps were produced" in those months. The cooling air had a lower temperature in the winter months, allowing to fill the lamps to a higher pressure. The workers' productivity was lower during the summer months, in the inefficiently cooled and of too low clearance work halls.

The incandescent lamps were being marketed primarily within the framework of PHOEBUS in this period, too. The cartel's trading was also hurt by the Depression, as it can be seen from the trade figures of TUNGSRAM:

Year	Number of lamps sold
1930	19,616,000
1931	13,045,000
1934	16,430,000
1935	18,223,000
1936	21,600,000
1937	27,361,000

The table clearly indicates that the trading did not reach the level of business done in the first year of the Depression until 1937. The trade figures could have even been better, had the company always been able to meet its inflated quotas during the mid-1930s. (For example, in 1935 TUNGSRAM missed its quota by 2.5 million lamps TUNGSRAM's quota came to 10.13 percent of the cartel's total business in 1939. The company's export had the following break-down one the international market in 1936:

Country	Lamps	Country	Lamps
Austria	291,657	China	36,912
Belgium	1,047,500	Germany	6,962,013
Brazil	2,692	France	1,128,202
The Netherlands	247,589	Sweden	39,790
Italy	595,490	Switzerland	501,709
Spain	26,221	Turkey	269,090
India	409,352	Portugal	16,151
Ceylon	1,216	Madeira Isl.	1,692
South Africa	211,591	Argentine	323,283
Other Africans	11,214	Congo	1,112
Guayana	911	Bolivia	9,100
Malta	1,014	Columbia	81,568
Cyprus	3,213	Ecuador	20,508
Mauritius	12,234	Iran	43,970
Aden	3,871	Peru	84,470
Albania	6,517	Thailand	33,942
Bulgaria	112,833	Uruguay	177,289
Bohemia	1,250,603	Venezuela	19,510
Syria	3,689	Danzig	16,852
Angola	771	Estonia	9,272
Iraq	6	Denmark	171,033
Mozambique	6	Finland	700
Tanguanyika	6,036	Greece	232,206
Egypt	239,869	Lithuania	148
Palestine	114,621	Norway	594,557
Rumania	2,006,006	Poland	411,449
Hungary	3,000,965	Philippines	37,447
		Yugoslavia	682,653

A total 21,514,665

Approximately 79 percent of the above was the share of the TUNGSRAM companies, roughly 11 percent originated from the Kremenetzky factories and the remaining 10 percent was bought from other companies. Osram, for example, contributed to the German sales with 1,621,000 lamps. On the other hand, TUNGSRAM also helped out other cartel members with deliveries to meet their allocated quotas. These arrangements were to the advantage of both parties. The holder of the quota saved money on the cost of

transportation and the lamps were still sold with its trademark. From the published list it is evident that the lamps bearing the Tungsram trademark reached nearly every country in the world — not in equal volume, of course. By the end of the 1930s the cartel's trading, and TUNGSRAM's quota in it, had grown significantly. Concurrently with the expansion of the corporation, TUNGSRAM's foreign subsidiaries increasingly shared in the growing sales.

The complete incandescent lamp trade of the corporation is shown in the next table, showing the contribution of the various members of the corporation.

Corporation member	1939-1940	1940-1941
TUNGSRAM, Budapest	27,909,920	23,011,560
J. Kremenetzky, Vienna	6,359,576	5,456,220
Radium, Tillburg	515,765	129,797
Hungarian Tungsten Factory	1,456,010	1,166,760
Other subsidiaries	5,437,158	4,533,426
A total of	41,678,429	34,297,763
The total export	36,385,947	27,632,505
Sales in Hungary	5,292,482	6,665,258

Corporation member	1941-1942	1942-1943
TUNGSRAM, Budapest	26,600,139	25,643,686
J. Kremenetzky, Vienna	6,079,311	5,176,664
Radium, Tillburg	192,292	191,055
Hungarian Tungsten Factory	1,585,173	1,641,858
Other subsidiaries	6,701,162	6,229,014
A total of	41,159,077	39,422,277
The total export	33,433,914	31,688,188
Sales in Hungary	7,725,163	7,734,089

The table clearly shows that in the years just before and during the war basically there was no change in the production of the corporation, neither in the volume of its export; it was only the destination of the

export which changed. The export sales to neutral countries went up — to Switzerland, Sweden, Portugal and Turkey. As a consequence of Hungary's provisional territorial gains, the domestic trade of incandescent lamps increased significantly (by two million lamps, roughly). The fact that the import of incandescent lamps to Hungary was practically non-existing also helped to bring about such an increase. In 1941 TUNGSRAM managed to come to an agreement with its domestic competition outside the cartel, which had emerged in the meantime, on how the domestic market should be divided up. The agreement guaranteed the following quotas to the other four companies:

Factories	Units
I. Zwack and Associate	379,000
Mrs. S. Stommer,	
Merkur Incandescent	
Lamp Factory	375,000
László Prerovszky	365,000
Eterna Rt., Kolozsvár	241,000
A total of	1,360,000

It was also agreed that TUNGSRAM would deliver the necessary parts to these four companies; moreover, it was decided that "... the much reduced prices which resulted from the several-year-long price war should be brought to a uniform level".

In fact, the agreement signed in 1941 meant the setting up of a domestic incandescent lamp cartel which reaffirmed TUNGSRAM's position in the domestic market.

From the above table it is apparent that the number of radio valves produced by TUNGSRAM stabilized at over two million after the mid-1930s, only exceeding 3 million in 1936. We do not have a complete breakdown by designs of the company's radio valve production. In 1941, for example, approximately 250 designs were produced on eight machine lines, or ten, if we include

those produced in the Test Production Department. To avoid the frequent switch-overs, one machine line generally produced no more than four designs in a months. This method, however, required that the stocks of each design be kept at a high level. The radio valve stock fluctuated at about one million pieces each year.

The radio valve cartel founded in 1934, which guaranteed a market for each of its members, undoubtedly helped to stabilize the sale and the production of radio valves. The cartel only covered a smaller portion of the world, but TUNGSRAM made a separate agreement with the IRAVCO members, concerning the British, French and Spanish markets. Otherwise, TUNGSRAM's share of the cartel's total sales came to 12.28 percent, and the Tungsram valves reached every corner of the world.

In the first ten month of the fiscal year of 1937—1938 the sale of electronic vacuum tubes in the various countries went as follows:

Country	Valves
Argentina	112,783
Australia	2,193
Bulgaria	17,400
Belgium	163,523
Norway	50,207
Austria	111,067
Poland	171,538
Portugal	1,571
Brazil	2,149
Denmark	129,258
Germany	194,633
Finland	27,206
The Netherlands	59,463
Ireland	2,429
Italy	68,884
Yugoslavia	49,435
African countries	229
Rumania	98,476
The Soviet Union	19
Sweden	110,561

Country	Valves
Switzerland	54,748
Bohemia	166,966
Hungary	144,538
Number of valves sold within IVRACO's territory: a total of	1,741,276
Number of valves sold outside IVRACO's territory:	
France	961,436
Spain	22,280
England	751,991
A total of	3,475,393

By the end of the fiscal year of 1937—1938 TUNGSRAM had fulfilled its quota and sold 2,932,000 valves within the IVRACO territories.

From the next table we can see that the total production of the corporation exceeded three million valves in each but one year. At the same time, the overall trend pointed downward, and it was especially apparent in the case of the parent company's production. The import restrictions which followed from the war times, greatly contributed to this fall-off. At the same time, the domestic trade of radio valves nearly doubled. This could be traced back to the effects of both the territorial gains mentioned earlier and the import restrictions operated by Hungary.

Corporation member	1939—1940	1940—1941
TUNGSRAM, Budapest	3,172,154	2,223,258
J. Kremenetzky, Vienna	303,610	246,508
Radium, Tillburg	76,056	96,129
Hungarian Tungsten Factory	207,931	242,025
Other subsidiaries	42,221	4,140
A total of	3,800,972	2,803,060
Sales in Hungary	328,672	353,439

Corporation member	1941—1942	1942—1943
TUNGSRAM, Budapest	2,128,834	1,888,695
J. Kremenetzky, Vienna	443,956	539,715
Radium, Tillburg	203,977	164,489
Hungarian Tungsten Factory	232,760	251,782
Other subsidiaries	581,731	561,305
A total of	3,591,259	3,405,986
Sales in Hungary	863,449	775,203

In 1943 the domestic sales of radio valves continued to go up, reaching nearly one million (954,300, to be exact). Two major factors had contributed to this growth.

More than 200,000 valves were sold to the army, of which Standard, alone, bought 174,000. The number of tubes sold to operate the imported radio sets also went up: 100,000 valves were bought for Philips radios and 36,000 for Telefunken radios. The Orion radios of Hungarian Tungsten Factory required 270,000 valves.

The business figures and achievements we have outlined so far almost completely conceal the hardships imposed by World War Two. The corporation suffered very serious losses during the war. The Warsaw branch was nearly completely obliterated, when Germany overran Poland in 1939. The Yugoslavian factories suffered very heavy damages in 1941. The companies in Great Britain were declared enemy property and were taken over by the government. It was getting increasingly difficult to continue with the export; on several occasions the deliveries got lost or were bombed on the way. There were problems with the supply of materials, although the stocks which had been filled up in the previous years assured the factory a smooth production for still some time to come. TUNGSRAM's results between the two world wars reflected the success of a company which could adapt to the Hungarian circumstances well and could keep abreast with the foreign competition, both in quality and in technical development. TUNGSRAM occupied a

prominent place among the factories of the west, home and abroad.

Of the European companies only Philips could have been considered to have essentially the same profile. The German Telefunken — just like the American RCA or Siemens, another German company — only produced electronic equipment and parts, while Osram limited itself to manufacturing incandescent lamps. The two American companies, IGEC and Westinghouse, mainly produced high-powered equipment and machinery beside their incandescent lamp businesses, making all comparisons with TUNGSRAM impossible. Anyhow, TUNGSRAM's exports between the fiscal years of 1932—1933 and 1938—1939 slightly exceeded that of its famous Dutch competitor — that is, if the article about Philips published in a Dutch paper on 11 May, 1939 is anything to go by.

On the home front — as far as the total capital investment of the individual Hungarian companies were concerned — TUNGSRAM, with its equity of 25 million Pengős, came first among the electrical companies and was third in the entire industry, according to the Compass of 1938—1939.

The fundamental source of these achievements, beside the flexible and courageous business policy, was the creativity of the excellent Hungarian physicists, engineers and technicians and the assiduous and competent work of several thousands of employees, all working for Tungsram.

The Social Structure of the Factory. The Workers' Material and Cultural Circumstances in Újpest

Like any other company, TUNGSRAM, too, was more than just a multitude of buildings and equipment; it was also a given social formation, a community of very specific internal structure. A factory's community is never as stable as are, for example, the walls of its

buildings: it is in perpetual motion, changing with the social-economic-political relations of the given country. It does not follow from the above, however, that every factory in Hungary had the same structure, wage policy, social and cultural conditions. TUNGSRAM's community was, in many respects, unique; its overall social structure digressed from the general pattern in Hungary in many ways. These differences were partly linked to the financial status of the company, its production profile — see, for example, the relatively high proportion of female employees —, and partly derived from the specific qualities of the factory's leading elite, from their general attitude.

Throughout the period between the two world wars TUNGSRAM was run in an organizational form which corresponded to the Hungarian laws regulating the operation of share companies. Formally, its highest executive body was the annual general meeting of the shareholders. The board of directors submitted their report about the passed fiscal year for approval on these general meetings, the company's a financial balance and the report of the supervisory committee were presented here, and the shareholders elected the next board of directors, who would conduct the company's affairs in the interval between the two general meetings.

Only the major shareholders were present on the general meetings: they were the representatives of the big banks and corporations holding large blocks of shares. TUNGSRAM's general meetings were formal affairs almost without exception. In the important issues the major shareholders had come to an agreement well in advance on meetings from which the public was excluded and the decisions of which did not have to be reported to the official state bodies. (The material of the general meetings had to be submitted to the registry court.) The officially elected board of directors usually consisted of 9—12 persons, representing the major shareholders. Its chairmen were all long provided by Pesti Hungarian Commercial Bank, ("Pesti" is an abbreviation = "of Budapest") in the persons of Henrik Fellner, Fülöp Weiss and Lajos Valkó. TUNGSRAM's standing was reflected in the fact

that the afore-mentioned chairmen had all come from the top management of the bank. Until the end of the 1920s the members of the founding family, the Eggers, who by then had been living in Vienna, were also represented on the board. Certain members of the Hungarian aristocracy, together with a few expoliticians, appeared on the board in the 1930s. The board membership was not at all a bad deal: every member received an annual sum of about 10,000 Pengős. A board meeting was called usually three or four times a year; also, there used to be an executive committee until 1940 which was selected from the board members and had quite an operative function in the management of the company, especially during the 1920s. Until his abduction by the Germans on 19 March, 1944, Lipót Aschner (Asakürt, 1872—1952) was entrusted with the position of chief executive officer on the major shareholders' recommendation. Lipót Aschner was a born manager. He started out as a minor administrator and rapidly rose to the top of the management. At one point he was even elected vice-president of the industry's international organization. According to the surviving sources and his contemporaries, he was a hard-working man who gave his whole life over to the company. The public life — with the exception of sport — did not interest him. Inside the 'house' he had the last word; he presented the reports to both the board meetings and the executive committees and represented TUNGSRAM in the most important international negotiations. His characteristic signature, an angular letter 'A', features on masses of documents, making one wonder how he could possibly have time to read them all. His memory was legendary; not only did he read and sign the documents put in front of him, but also, he remembered their major points. Lipót Aschner did not have large quantities of TUNGSRAM shares; still, all the major stock exchange transactions of the company are associated with his name — he represented TUNGSRAM everywhere. The salary of the chief executive was determined by either the board of directors of the executive committee. According to a document dated from 1938 — when the three-year contracts of the top managers were signed — Lipót

Aschner's annual salary was fixed at 118,000 Pengős, which was almost as much as the Prime Minister's salary. In addition, he also filled top jobs in the other branches of the corporation; for example, he was chairman of the board in Telephone Factory Ltd., and later, in Standard Ltd. These positions brought in further income for him. We cannot determine his total annual earnings exactly, but he must have been one of the highest-paid managers in the Hungarian industry. He rightly deserved it.

It must be added that, according to a memo by the managers heading the company in 1947, between 1940 and his abduction by the Germans Lipót Aschner "...in response to the anti-Jewish legislation, gave up the salary due to him, this way making it possible for the company to keep the ordinary employees on the pay-roll, without reducing their salaries."

Lipót Aschner survived the war in the most extraordinary way: the major shareholders of the company secured his release from the concentration camp of Mauthausen by paying 100,000 Swiss Francs to the Germans. He was taken to Switzerland by some SS officers in December, 1944, just before the end of the war. He returned to Hungary from there in 1947 and acted as vice-chairman of the board of TUNGSRAM right until his death in 1952.

József Pintér was also on TUNGSRAM's board of directors until his death in 1928. He had been the technical director of the company since 1887, the time when the company's Huszár Street plant was established; later he became the deputy of the chief executive officer. The memory of this widely respected figure is preserved in the memorial plaque in a street named after him near the factory. Ignác Pfeifer, the founder and the first head of the Research Laboratory was also a board member. In addition to the work he did for TUNGSRAM, Ignác Pfeifer played an active role in the bourgeois liberal opposition throughout the Horthy era. He became a member of the Capital Municipal Authority and was also involved in the struggle to stop the spreading of fascism. He did much to protect and help the ordinary people.

Beside Lipót Aschner, there were five or six executives

looking after the affairs of the TUNGSRAM corporation. Leó Fischmann followed József Pintér in the position of deputy chief executive; the foreign marketing was directed by Vilmos Rosenfeld, and Dávid Aschner was in charge of the domestic sales. The chief accountant was Jenő Hirschbein.

The managing directors of the factory were, in that actual order, Frigyes Baumann, Miklós Hegedűs, János Lévai and Árpád Telegdy. (The latter rather committed suicide in the final days of the war, than participate in the evacuation of the factory.) Bertalan Neményi, who was heading the legal department, was also a company director. Following the mid-1930s several changes were made in the line-up the company management. Zoltán Bay became the head of the Research Laboratory and Hugó Zala was appointed to the post of chief accountant.

Dénes Jankovich and Zoltán Bay took over the running of the company. Zoltán Bay got in contact with the Hungarian resistance movement in 1944; he helped to hide the left-wing workers' leaders of the factory and he did everything in this power to keep the Jewish engineers in their jobs. As a result, he, too, was forced to hide out when Szálasi the Hungarian nazi leader took over the government.

In the factory hierarchy the managers and the chief engineers came right next to the directors. In 1938 the directors' salaries were fixed between 20,000 and 60,000 Pengős annually.

Leó Fischer's salary was 56,000 Pengős at that time. Zoltán Bay, who had just joined the company, 'only' received 34,000 Pengős. The managers were paid 20,000 Pengős, the same as János Lévai was. Ernő Winter received 14,300 Pengős then, which was more than the salary of József Gábor, who headed the Audion Department. We only have information concerning the salaries of the people working in the lower administration from earlier times. According to a document from December, 1928 the chief engineers (two persons) working in the production were getting 717 Pengős a month, the engineers heading the workshops (18 persons) received 525 Pengős a month, the salary of the engineers working in production (35

persons) was 344 Pengős, the engineers working in the offices (23 persons) were given 275 Pengős, while the paid 305 Pengős a month. In the same period the hourly wage of skilled labourer was 91 fillérs on average, and the most they could get was 1.25 Pengős. (Assuming 200 working hours a month, this would roughly come to 200 Pengős a month in the years preceding the Depression!)

The administrators, even the typists, were given 13 months' wages a year, because the company handed out from its profits an extra month's wages to them almost every year.

In return for the comparatively high wages, TUNGSRAM demanded through professionalism and hard work from its management and administration. The requirements included, for example, the proficiency in a foreign language, and that was not only expected from those, whose work had something to do with the export. In the 1920s German language was extensively used in the company's administration; several important documents were written out in German. However, the international character of the concern often necessitated the knowledge of the English and French languages.

From 1929 the company operated its own pension scheme for its administrators. In 1938 —after 40 years of active service — Lipót Aschner's pension was fixed in 36,000 Pengős a year.

The total number of office workers was progressively increasing from the second half of the 1930s onwards. In 1935 there were still only 540 administrative workers; by 1939 this number went up to 855, reaching 1006 by 1942. The upward trend continued during the war. While there had been 15 administrators for every 100 workers in 1935, this number went up to 18.5 by 1939 and to more than 20 by 1942. A defensive tactics to sabotage the anti-Jewish legislation was partially responsible for this increase. Rather than laying off Jewish administrators, the company took on more and more non-Jewish staff in order to reach the required 'Christian-Jew' ratio. But the over-regulated war time economics also demanded more and more administrators, hence also contributing to the swelling up of

the administration. The company also set very high professional standards for its technical staff. Their tasks included the translation and adaptation of the technical-technological documentation which resulted from the various agreements with the large international companies on the exchange of technical information. Together with the departmental heads, they had to direct the different test productions and to solve any technical problem that might have emerged in connection with the new ventures and the construction work carried out within the factory. They had to analyze and evaluate the data concerning the performance, the quality and the efficiency of production of the subsidiaries and to see to the training of the staff working there. Sometimes they were working abroad for years, starting up a new factory or an assembly plant. The rapidly expanding corporation and the wide-scale international cooperation, however, also gave them numerous opportunities to advance their knowledge and skills.

The company's Research Laboratory was more than just the heart and soul of TUNGSRAM's technical development: it proved to be the Alma Mater of the entire telecommunication and light source industry. Several members of its staff — György Szigeti, Ernő Winter, Pál Selényi and others — became the leading authorities in their field after the end of the World War II.; many people, Zoltán Bay included, brought fame to the name of their old laboratory through their work done outside the country. A number of TUNGSRAM managers and employees fell victim to Fascism, to the devastation of World War Two. The company management did much to rescue its endangered employees from the most severe consequences. They managed to find shelter for Imre Bródy in the camp set up inside the factory until September 1944. However, when Imre Bródy discovered that his wife and daughter had been carried off to the labour camp in the brickwork of Óbuda, he left his relatively safe hide-out, declining all words of caution by saying: "... if they are slain, I don't want to live, either." So he, too, became a victim of the Holocaust.

The community of the Újpest factory largely consisted of workers. The factory's working-class society itself was split into several strata. The skilled workers were the elite on the top. They were not only able to manufacture the company's special-purpose machinery, but could also turn out a rapidly growing number of machines for export. It seemed only natural for them to learn how to operate and maintain those machines, too. The shift leaders and the group leaders of TUNGSRAM's numerous assembly plants and other subsidiaries producing parts for incandescent lamps and radio valves mostly came from the ranks of these skilled workers. This group was even able to supply experts for the foreign branches to pass on the know-how at crucial times, such as the starting up of a factory was, for example. In manning the factories of Tillburg, London, Bucharest, Pozsony and Paris the crucial problem — beside the appointment of the chief engineer of the new plant — was to find at least one Hungarian foreman to do the fine adjusting of the machinery. In fact these Hungarian skilled workers were the ones who fitted the equipment, put the factory into operation, trained the foreign personnel working on the machinery and they were also the ones who ran the production in the first few years. Back in the parent plant this middle and lower management was burdened with the increasing volume of development problems and test productions which were implemented in the production units, possibly without disturbing normal production, even after the various laboratories had been established. As an example, we ought to mention the name of the tool-maker József Hegedűs whose book titled 'The Handbook of Tool-Making' was published by the tool-makers' section of the Hungarian iron- and metal-workers' union in 1936 and was considered a basic book in its category at the time.

The following tables will be helpful to give a picture of the company's work-force. The published data mostly refers to the Újpest plant, but it is necessary to clarify a few points in advance.

The office workers of the Újpest factory managed the affairs of the whole corporation, not simply that of the

Újpest plant, and, therefore, the presented ratio of workers versus officials is slightly misleading. The total work-force showed large variations even within just one year, often reaching 300—500 workers, while the published data refers to that year's average. There is no reliable information to decide whether shift leaders and group leaders were counted as workers or officials.

From the above considerations it follows that the presented data is purely informative, although it gives an accurate enough picture of the major trends.

Year	Work-force	Total number employees
1930	2,338	2,547
1931	2,224	2,443
1932	2,148	2,373
1933	1,905	2,127
1934	—	3,184
1935	3,169	3,709
1936	3,281	3,770
1937	4,088	4,628
1938	4,153	4,883
1939	4,635	5,490
1940	4,230	5,066
1941	4,395	5,286
1942	4,975	5,981

The table clearly shows that between the first year and the last the increase was more than a 100 percent. During the years of the Depression, between 1929 and 1933, the total work-force went down, but the decrease did not even reach 20 percent. The number of employees already showed a substantial increase in 1934 and the trend from there onwards is continuously — although not linearly — going up.

The female workers were in majority in TUNGSRAM work-force. Sampling a ten-year interval, the next table shows the ratio of the female and the male workers:

Year	Male	%	Female	%
1933	709	37	1,196	63
1938	1,732	41	2,421	59
1942	2,252	45	2,723	55

Interestingly, the percentage of female workers went down in these ten years and, unlike in the statistics of the Hungarian industry as a whole, this tendency continued during the war. While the female employees were in majority all along — their percentage always exceeded 50 percent —, there was not a single woman in the company management, starting from departmental heads upwards, in the period between the two wars.

A document dated 30 March, 1937 gives information on the composition of the work-force with reference to age and length of employment:

Length of service	No. of workers	Percentage
0–10 years	3695	90
over 10 years	413	10
A total of	4108	100

Age	No. of workers	Percentage
less than 30	2616	64
30 to 40	1042	25
40 to 50	295	25
more than 50	155	4
A total of	4108	100

According to the table, in 1937 less than 10 percent of the employees worked in TUNGSRAM for more than 10 years. Interpreting the figures one must bear in mind that the total work-force showed a significant increase precisely in the years of 1936 and 1937,

adding up to a more than 100 percent increase since 1933. At that time TUNGSRAM took into consideration in its wage policy the years already spent in employment with the company. Each year special gifts were presented to those who had completed their 25th year with the company.

According to the table, 89 percent of the workers in TUNGSRAM were less than 40 years old. This phenomenon could not be regarded as positive altogether. The relative youth of the work-force partly originated in the general practice whereby the female employees would only remain with the company until they got married or had their first child. On the other hand a considerable part of these women assembled tiny electrical components straining their eye-sight, consequently very few of them over 40 years could do this job.

Having seen the composition of the work-force according to sex and age, let us consider its breakdown by the level of training and wages.

In the Újpest plant on 31 December, 1933, this was as follows:

Male workers

The worker's level of training	Lamp and Audion departments		'E' Department		Glass factory	
	No of workers	Hourly wages (fillers)	No of workers	Hourly wages (fillers)	No of workers	Hourly wages (fillers)
Skilled worker	94	95	177	92	60	78
Trained worker	179	63	41	64	40	61
Day-worker	82	50	88	48	8	48
apprentice	11	27	14	22	—	21
Total	366	—	320	—	108	—

Female workers

The worker's status	Lamp and Audion departments		'E' Department		Glass factory	
	No of workers	Hourly wages (fillers)	No of workers	Hourly wages (fillers)	No of workers	Hourly wages (fillers)
Skilled worker	—	—	—	—	—	—
Trained worker	1,500	47	—	—	—	—
Day-worker	16	38	21	37	1	38
Total	1,516	—	21	—	1	—

As the table reveals, the workers of the Újpest plant could basically be divided into four groups. The skilled workers made up the first group: locksmiths, mechanics, turners, tool-makers, etc. They were mostly working in the 'E' Department, the unit which manufactured and serviced the machinery. They were the best-paid workers in the whole factory — and there was not a single woman among them!

The most numerous group was that of the trained workers, the so-called machine-workers. Women had an overwhelming majority in this category: there were 1500 female workers, opposed to the 260 male employees. They were all working in the Lamp Manufacturing Department and the Radio Valve Department. There were only 94 male skilled workers helping the 1500 female trained workers in these two fundamental departments.

The third group consisted of the untrained labourers where, again, men had the outright majority: the ratio here was 38 women against 178 men. There were no women in the last group, either, where the journeymen and the apprentices were lumped together.

TUNGSRAM is still remembered by many people as a factory which used to pay its workers above the average. And indeed, this was so in the final year of the Depression, in 1933. According to a report dated 1

December, 1933, the hourly wage of a skilled worker was 7 fillers more in TUNGSRAM than elsewhere, while a trained worker received 5 fillers less and a trained female worker, 2 fillers more in TUNGSRAM than their counterparts would get in the factories belonging to the Association of Iron and Machine Works.

That is to say, the skilled male workers were paid 3 Pengős more, the trained female workers 1 Pengő more in a week, than they would get working in the factories of the afore-said association. In the same period one kilo of sugar cost 1.30 Pengős, one kilo of fat was 2.10 Pengős, brown bread cost 40 fillers and the price of 1 kilo of beef was 2.40 Pengős. By paying that little extra, TUNGSRAM had the edge over the other employers in the eyes of the workers, when it came to doing their weekly shopping.

Between 1933 and 1938 the labour costs hardly changed at all in the entire Hungarian industry.

The hourly wages were only raised significantly during the war, but in real terms these raises were worth nothing because of the simultaneous price rises. High inflation in the second half of the war had the effect that the wages could not keep up with the rising prices.

Hourly wages in the various ranks of the workers during the war went as follows:

Status	1938— 1939	1939— 1940	1940— 1941	1941— 1942	1943— April
average hourly wages in Pengő					
Skilled worker	0.83	0.84	0.98	1.22	1.35
Trained male	0.58	0.60	0.71	0.86	0.93
Trained female	0.48	0.49	0.56	0.64	0.66
Untrained labourer	0.46	0.47	0.55	0.68	0.80

If we compare these figures with the ones showing the situation on 1 December, 1933, we will find that the hourly wage of a skilled worker in 1938—1939 was less than it had been in 1933; the same applied to the trained male workers, while the hourly wage of trained female workers remained unchanged. Nevertheless, the substantial difference between the hourly wages of men and women did not disappear; on the contrary, it grew wider as the war went on: the hourly wage of the men went up by 35 fillér, as opposed to the 18 fillér pay rise which women received in the same period. Skilled workers were getting the most: a 52 fillér pay-rise. Since TUNGSRAM did not contribute much to the war industry, its wages began to fall behind the national average. Male skilled workers, for example, were paid only 94 percent of what workers earned in the factories belonging to the Steel Works, while the trained male workers of TUNGSRAM took home even less: 77 percent of what their counterparts were getting in the steel industry.

The general pay rises issued by the government played a major role in the growing wages. A seven percent wage rise was ordered on 7 October, 1940, followed by a further 8 percent wage rise on 1 May, 1941, and then came the national inflationary compensation of 30 percent in the summer of 1943. However, even these repeated wage rises could not counter the price rises which accompanied the war. The real

wages per capita only increased until 1940; in 1943 these already fell behind the 1939 figures by 20 percent.

The wages are not the sole indicators of the position and the current circumstances of the working class. Workers were not indifferent towards the environment in which they had to do their job, either.

In the early 1920s the sight which greeted the visitors entering the workshops (the tinting, the staining or the spiral corroding workshops, for example) was shocking. The strenuous physical work was done by sickly coloured and wasted figures in rooms filled with poisonous gases, with minimal or no ventilation at all.

The manual pressing of the glass inserts of the incandescent lamps required an immense bodily effort. One could often witness female workers and mechanics with mutilated hands, working on the newly fitted press machines which still completely lacked all kinds of protective gear. The technology of incandescent lamp and radio valve manufacturing presented a whole list of potential dangers: explosion, fire hazard, pollution of the work halls and the environment by poisonous gases and vapours which were either left to float inside the factory halls until escaping through the airing passages or were artificially ventilated into the atmosphere without any neutralization and polluted the air of the immediate neighbourhood. The work halls were over-crowded and far too low built in general, making the ventilation of poisonous gases difficult; the majority of the machinery were operated without protective equipment; electric hazard was caused by the complete lack of earthed circuits; the various high-voltage equipments were fitted without the minimum of safety precautions. It was only in the late 1920s that a campaign against the various health hazards was launched by the staff of the Machine Works Department in an almost spontaneous fashion. It was also the time when the complete automation of the production of vitrit-glass took place followed by the semi-automatization of the inside frosting process. In the production of incandescent lamps the individual press machines were replaced by machine-lines which eliminated the extremely hazardous manual feeding.

The surveyance and the documentation of the utility systems — gas, electricity, hydrogen, compressed air, electrical power lines, etc. — and the earthing of the circuitry was carried out in the mid-1930s. Most of the safety problems arising from the designing and the introduction of the electrical measuring devices and equipments were solved simultaneously with the modernizing of the radio valve production. The heads of the various departments (Lamp Manufacturing Department, Radio Valve Manufacturing Department) all supported the idea of mechanizing the hazardous work phases and raising the level of health protection. János Lévai, head of the Lamp Manufacturing Department wrote the following in his memoirs: "...the implementors of the efforts were given effective support by the trade unions and the workers' shop-stewards, which was very much needed since the workers directly affected by the measures very often resisted to the introduction of the new work methods and the application of protective attachments, partly, because they feared for their jobs and partly, because they were only be able to attain their previous level of earnings in the new routine after another learning period."

Beside the improvements in health protection and work safety, there were other national measures to advance the position TUNGSRAM's workforce. In 1937 the Hungarian government introduced the legislation fixing the length of a working day in 8 hours. The fact that during the preparation of the legislation the management of TUNGSRAM was strongly against the bill by declaring that "...we find the introduction of the 48-hour long working week impossible to implement in our factory" brings them no credit. A list of other social legislations followed the introduction of the 8-hour working day. Minimum wages were determined and the workers were entitled to a paid holiday (six days a year), as well as family supplement after their children. Family supplement was fixed at 5 percent after one child. At the time of introducing the law — in the late 1930s — family supplements were paid after some 2,000 children in TUNGSRAM.

These late measures of social legislation were, indeed, late, considering that a number of them — the 8-hour

working day and the paid holiday included — were suspended in autumn, 1939, following the outbreak of the war.

The other emergency measures introduced in the aftermath of the war affected the workers equally severely. Sugar was rationed in 1940, promptly followed by the rationing of fat, flour and bread; in 1943 meat and milk coupons were issued, and very soon nearly every commodity became rationed: clothing, footwear, etc. Next to the centrally regulated market with restricted prices a black market economy flourished, where everything was available at a considerably higher price than the one set by the government. This was when the prices in general continued to go up, with the wages lagging further and further behind.

The severe problems in the food supply and the growing anxiety of the public which followed moved the government to alleviate the workers' hardships by mobilizing the companies. From 1941 onwards various relief programmes were organized in TUNGSRAM, too. The workers were allowed to plant beans, green peas and potatoes on the empty land of about 58,000 square meters owned by the company. They were even provided with the necessary seeds and plants for their agricultural projects. In addition, a separate food-store was set up to supplement the employees' food supply. This served to ease the problems of shopping, since it was the working women burdened with the hopeless job of shopping for their family in the empty stores, who were the worst affected by the war. More and more of them were forced to stay away from work. In the Food Store flour, fat and soap were sold for government coupons, but once there was also a campaign to raise pigs, for example, which aimed to give a boost to the supply of fat. Large quantities of legumes, potatoes, onions, etc. were brought up from the provinces, often directly bartered for goods produced by the company. In 1942 500 wagons of wood, 250 wagons of coal and 70 wagons of coke were distributed among the employees. There was another campaign to collect footwear and clothing for the workers. A payment-in-parts scheme further eased the problems of the employees of the factory. On top of the

government allowance, TUNGSRAM paid a monthly 35 Pengős to the families of servicemen. In 1942 cheap meal was served in the Recreation Centre: a meal with meat cost 62 fillérs, and one without meat was 40 fillérs. Seven hundred meals were served to the employees daily in 1942.

It was part of TUNGSRAM's company policy to attract and keep the work-force by providing social, cultural and sport facilities to them. Prior to the afore-mentioned government acts TUNGSRAM had already provided its workers—mostly its office workers — with facilities not generally afforded by other companies in the Hungarian industry in order to meet the social and the cultural demands of the employees. In the Recreation Centre which was built in the early 1930s a spacious and nicely furnished canteen and a modern kitchen was set up for the convenience of the employees. This kitchen was, at that time, a remarkable accomplishment and nothing like it could be found in any of the other factories of Újpest.

On the first floor of the Recreation Centre there was an indoor tennis court which was unique in those time not only in Budapest, but perhaps in the whole country. The outdoor courts were lined up in front of the Audion building. The changing rooms used to be, where the surgeries are today. Tennis was definitely considered a gentleman's sport at that time and the manual workers did not frequent the TUNGSRAM courts.

Actually, chief executive officer Lipót Aschner was a generous supporter of sport. He was elected president of the Újpest Gymnastic Club, predecessor of the famous football club, "Újpesti Dózsa" in 1925. The club received regular and wide-ranging support both from Lipót Aschner and TUNGSRAM, and several sportsmen were given jobs in the Újpest plant.

The river Danube, being near to the factory, offered an excellent opportunity for water sports. A boat-house called 'Ampère', near to the Glue Factory Leiner, had already existed in the early 1920, and was available to the office workers of TUNGSRAM. After the silting up of the channel between Palota Island and the Újpest banks, however, the boat-house suddenly became surrounded with dry-land. The company later establish-

ed a new, much larger boat-house complete with swimming pool and beaches on the land bought from the Károlyi family near the Inn of Megyer.

TUNGSRAM 'crossed' the Danube in 1942. It built a — by the contemporary standards — enormous holiday centre and boat house on the other side of the Danube, providing weekend recreation simultaneously to nearly 10,000 people. Regular ferry service linked the recreation complex situated on both sides of the river. (It is still in service today.)

Cultural life in TUNGSRAM only began after World War One. The 'Tungsram Male Choir and Theatrical Group' was formed in 1921 which, according to the entry form, offered its members an amateur theatre, a chess club and a library.

First the old choir was revived: the 55-member male choir was later converted into a mixed one. Beside the home concerts they also took part in national competitions and received invitations to perform in various programmes organized outside the factory. In the late 1930s Béla András was the chorus master. Thanks to his and the choir members' endeavors, the compositions of Bartók and Kodály were already performed by workers' choirs at a time when it was not at all customary to sing such 'new wave' music.

The amateur theatre could only be formed after the Recreation Centre had been completed. By contemporary standards it had a well equipped permanent stage, rehearsal room and an adequate concert hall. The actors of the theatre company worked as a team for many years and understood each other well. They regularly performed classical and popular plays, operettas, etc. which corresponded to the fashion of the contemporary audience.

It was, again, only after the Recreation Centre had been completed that the Library found a worthy surrounding. In the early 1920s it had no more than one or two thousand books, but by the 1930s the figure reached 10,000. There is no information concerning the number of its regular readers, but its voluntary staff, who were devoted to the cause of culture, looked after the library enthusiastically.

The management of TUNGSRAM was not nearly as generous towards culture as they were towards sport. The running of the Recreation Centre cost nearly 100,000 Pengős, the choir received an annual grant of 3,000 Pengős. In the same year the company spent nearly 1 million Pengős on maintaining the sports fields and supporting Újpest Gymnastic Club.

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- 5) Official extract from the list of joint ventures compiled by the Viennese Commercial Court, issued by Fővárosi Cégbírószág (Trade Registry of the Capital).
- 6) OL K 231-2-42775/1899
- 7) A budapesti 1885-ös országos kiállítás főjelentése (Report on the National Exhibition Held in Budapest in 1885), Vol. 1, Budapest, 1886, pp. 53, 55
- 8) Az 1885. évi budapesti országos kiállításon kitüntetett közreműködők jegyzéke. (List of the Award Winning Participants at the National Exhibition Held in Budapest in 1885), Budapest, 1885, p. 176.
- 9) József, Szekeres — Árpád, Tóth: A Klement Gottwald (Ganz) Villamossági Gyár története (The History of the Klement Gottwald [Ganz] Electrical Company), Budapest, 1962, p. 84: Ganz had produced arc lamps since 1885; its annual production of arc lamps exceeded 9,000 after 1898.
- 10) Fővárosi Cégbírószág (Trade Registry of the Capital), No. 313/1887, Trade licenses issued by the Prefecture of the 7th District.
- 11) Dr. Ferenc, Kardos: A Tungstram gyártmány- és tudománytörténete (The History of Tungstram's Production and Development), Manuscript, p. 13.
- 12) OL z 40-462 and K 232-2-1548/1894: The production of incandescent lamps closed the fiscal year of 1889/1890 with a loss of 27,387 Forints, which was reduced to 14,472 Forints by the fiscal year of 1892/1893.
- 13) OL K 232-2-1548/1890
- 14) OL K 232-2-1548-37400/1889
- 15) OL K 232-9-3541/1889
- 16) OL K 232-1548-9641/1894
- 17) OL K 231-2-5528/1893
- 18) OL K 231-2-5528/1893: Egger B. and Co. imported the generators from its Viennese factory, and thus created an unwelcome competition for Ganz.
- 19) OL Z 40-462
- 20) OL K 232-2-1548-96041/1894
- 21) OL K 232-2-11528
- 22) OL Z 40-462
- 23) Vilmos, Sándor: Nagyipari fejlődés Magyarországon 1867-1900 (Industrial Development in Hungary, 1867-1900) Budapest, 1954, p. 475
- 24) OL 41-1123: the company had a sales agency in the Kossuth Lajos Street in Budapest.
- 25) OL Z 41-1123/B-1: of the Egger brothers only Dávid Egger was living in Budapest. Bernát-Béla Egger stayed in Hungary only from time to time.
- 26) OL Z 41-1123: Jakab Egger and Associates put up as security the shares received for the merger of Villanyos Izzólámpagyár Rt. (:Electrical Incandescent S.C. :) for Commercial Bank.
- 27) OL 40-462
- 28) OL 40-462-9: the Huszár Street Plant suffered from the shortage of storage space: instead of the 2,200 m² needed, it only had 930 m² available for storage.
- 29) OL Z 40-462
- 30) OL Z 41-1123/kk-III: The Viennese Niederösterreichische Escompte-Gesellschaft bought shares in Egyesült Villamossági Rt. (Electrical Incandescent S.C.)
- 31) "Magyar Posta" (Hungarian Mail, periodical), No. 1931/5 Ötvenéves a magyar távbeszélés (Fifty Years of Hungarian Telecommunication), pp. 278-280.

32) OL Z 40-462: report of the Board of Directors, 15 September 1898.

33) OL Z 600-5: Minutes of the meeting of the executive committee held on 29 November, 1899.

34) Sándor, Matlekovics: Magyarország közgazdasági és közművelődési állapota ezer éves fennálláskor (The Economic and Cultural Conditions in Hungary at the Millenium), Vol. 8, Budapest, 1898, pp. 923-924.

35) OL Z 40-462: participation at the Paris Universal Exhibition cost 10,000 Koronas.

36) Kereskedelmünk és iparunk az 1899. évben (Our Trade and Industry in 1899 Budapest, 1900, p. 171: the company gave the volume of exported lamps in hundred kilos in a report to the Hungarian Chamber of Commerce and Industry.

37) OL K 231-2-1548/1899

38) OL Z 195-15227/1899: 94.41 percent of the profit was tax free in the first fiscal year; the company had to pay taxes only after 5.59 percent of its profits originated from repair works.

39) Compass Finanzielles Jahrbuch, Vol. 2, Vienna, 1916

40) OL Z 601-681: the contract concerning the cooperation between the Budapest and Vienna companies, 1 July, 1900.

41) Sándor, Vilmos: Nagyipari fejlődés Magyarországon 1867-1900 (Industrial Development in Hungary, 1867-1900) Budapest, 1954, p. 476

42) OL K 2321-42775/1899: in an application addressed to the Ministry of Trade, Egyesült Villamossági Rt. (United Electrical S.C.) mentioned that the first telephone set had been produced in the Budapest factory of Egger B. és Társa in 1884.

43) OL K 2321-42775/1899: it was decided on the general meeting of the company, held in the autumn of 1899, that the new factory would be built in Újpest.

44) OL Z 611-1: the minutes of the directorial board meeting on 11 October, 1899.

45) OL Z 600-5: the minutes of the executive committee's meeting on 9 December, 1899.

46) OL Z 195-23115/1899

47) OL Z 601-51: the company had to pay 5 percent interest after the arrears of the sales price at the manorial accounting office of Fot.

48) Dr. István, Harkay: A 75 éves Izzó kultúrtörténete (The Cultural History of the 75 Years Old Izzó), manuscript, p. 2.

49) OL Z 601-50: the company's application to the prefecture of Újpest.

50) OL Z 600-1: the minutes of the directorial board meeting on 10 February, 1900.

51) OL Z 41-1123 n-IV: the minutes of the Construction Committee on 10 April, 1900: Béla Egger was against the building of a new factory, because in his opinion it was possible to increase the production volume of incandescent lamps in the Huszár Street plant, too.

52) OL Z 195-8687/1900

53) OL Z 600-5: the minutes of the executive committee's meeting on 4 July, 1900.

54) OL Z 599-2: the minutes of the general meeting held on 5 October, 1900

55) OL Z 600-1: the minutes of the directorial board meeting on 19 January, 1901.

56) OL Z 600-5: the minutes of the executive committee's meeting on 22 March, 1901

57) OL Z 41-1123-14/XXIII: the minutes of the executive committee's meeting on 17 July, 1901.

58) OL Z 41-1123 k/XII: memorandum of commercial Bank on 30 September, 1901.

60) OL Z 600-5: the minutes of the executive committee's meeting on 26 June, 1904

61) OL Z 600-5: the minutes of the executive committee's meeting on 26 June, 1904

62) OL Z 600-4/1912-1913

63) T. Iván, Berend — György, Ránki: Magyarország gyáripara az imperializmus első világháború előtti időszakában (Hungarian Industry during the Imperialist Period before the First World War), Budapest, 1955. p. 101.

64) OL Z 41-1123 kk/III

65) OL Z 41-1123 m/XVIII: the minutes of the executive committee's meeting on 29 February, 1904

66) Tibor, Balázs: A tudományos kutatástól az ipari gyártásig az izzólámpa története nyomán (The History of Incandescent Lamp From Scientific Research to Industrial Production), Budapest, 1965. p. 62

67) József, Szekeres — Árpád, Tóth: A Klement Gottwald (Ganz) Villamossági Gyár története (The History of the Klement Gottwald [Ganz] Electrical Company), Budapest, 1962. p. 96: TUNGSRAM is not mentioned as the owner of

the license, although Ganz and TUNGSRAM jointly bought the production license of the Nertz lamp. Later they carried out the experiments jointly, too.

68) OL Z 600-5: the minutes of the executive committee's meeting on 21 September, 1900.

69) OL Z 600-6: the minutes of the executive committee's meeting on 13 June, 1901.

70) OL Z 41-1123 m/V: the agreement with Ganz és Társa (Ganz & Co.) on 3 December, 1902.

71) OL Z 599-3: the minutes of the directorial board meeting on the fiscal year of 1902/1903.

72) Tibor, Balázs: A tudományos kutatástól az ipari gyártásig az izzólámpa története nyomán (The History of Incandescent Lamp from Scientific Research to Industrial Production), Budapest, p. 63.

73) Dr. Pál, Gadó: Az Egyesült Izzó kutatólaboratóriumának története (The History of TUNGSRAM's Research Laboratory), manuscript, p. 49.

74) OL Z 600-3: the minutes of the executive committee's meeting on 13 December, 1904

75) OL Z 599-3: directorial report on the fiscal year of 1903/1904.

76) OL Z 600-5: the minutes of the executive committee's meeting on 7 January, 1905.

77) OL Z 41-1123 kk/III

78) Magyar Ipar (Hungarian Industry, periodical) Vol. 1901, p. 258: Ipari Újdonságok. A betűíró gyorstávíró: József, Virág a Magyar Mérnök és Építész Egyletben bemutatta a Virág-Pollák-féle betűíró gyorstelegráf-rendszert (Industrial Novelities. The printing Telegraph: József, Virág Introduced the Virág-Pollák Type Printing Telegraph System in the Hungarian Engineer and Architect Club).

79) OL Z 40-462: minutes of the managerial meeting of TUNGSRAM held in Vienna.

80) OL Z 601-681: contract between the Viennese and Budapest companies concerning the transfer of the branch producing high powered electrical equipments.

81) OL Z 600-5: the minutes of the executive committee's meeting on 31 October, 1904: Gyula Egger's report on the problems of producing high powered machinery.

82) OL Z 600-5: the minutes of the executive committee's meeting on 13 December, 1904: debate on the future of the production of high powered machinery.

83) OL Z 600-5: the minutes of the executive committee's meeting on 29 May, 1905.

84) OL Z 600-5: the minutes of the executive committee's meeting on 23 April, 1906: the plant producing power current electrical goods was built on the site of TUNGSRAM.

85) OL Z 600-5: the minutes of the executive committee's meeting on 19 November, 1902: the sales agency in Madrid was set up by the director, Emil Mezey.

86) OL Z 600-5: the minutes of the executive committee's meeting on 7 January, 1905.

87) OL Z 600-5: the minutes of the executive committee's meeting on 9 September, 1904.

88) OL Z 599-3: the report of the directorial board meeting on the fiscal year of 1905-1906

89) OL Z 41-1123 m/XVII: the minutes of the executive committee's meeting on 23 December, 1903.

90) OL Z 600-5: the minutes of the executive committee's meeting on 4 March, 1905: A magyarországi szocialisztikus munkásmozgalmak az 1905. évben (The Socialist Type Working Class Movements in Hungary in 1905), Budapest, 1906, p. 690

91) OL Z 599-3: the report of the directorial board meeting on the fiscal year of 1905-1906.

92) Technikai fejlődésünk története (The History of Our Technical Development), Budapest, 1929, p. 925

93) OL Z 41-1123 k/XIV: the minutes of the directorial board meeting on 10 March, 1906.

95) OL Z 600-1: the minutes of the directorial board meeting on 20 September, 1906.

96) OL Z 600-5: the minutes of the executive committee's meeting on 16 October, 1906: Dr. Just and Mr. Hanaman were also present at the meeting.

97) OL Z 600-5: the minutes of the executive committee's meeting held in Vienna on 26 November, 1906

98) OL Z 600-6: the minutes of the executive committee's meeting on 15 January, 1908: investment costs of the tungsten lamp factory amounted to 986,000 Koronas until early 1908 instead of the 730,000 Koronas.

99) OL Z 600-5: the minutes of the executive committee's meeting on 11 January, 1907.

100) OL Z 600-1: Ferenc Hanaman's contract of employment, 18 April, 1908.

101) OL Z 600-5: the minutes of the executive committee's

meeting on 9 January, 1909: Ferenc Hanaman, who was sent to the United States to market the license of Nemzetközi Wolframlámpa Rt. (International Tungsten Lamp S.C.), informed the company management that he had been offered a job by General Electric Company.

102) OL Z 600-5: the minutes of the executive committee's meeting on 17 June, 1908.

103) OL Z 600-5: the minutes of the executive committee's meeting on 9 January, 1909.

104) OL Z 600-5: the minutes of the executive committee's meeting on 25 February, 1907.

105) OL Z 600-5: using another metal instead of platinum meant a saving of 15,000 Koronas in the case of every 500,000 lamps.

106) OL Z 600-5: the minutes of the executive committee's meeting on 26 November, 1910.

107) OL Z 600-5: the minutes of the executive committee's meeting on 7 February, 1909.

108) OL Z 601-292: the transfer of Dr. Just and Hanaman's patents to Nemzetközi Wolfram Lámpa Rt. (international Tungsten Lamp S.C.)

109) OL Z 40-462: the regulation of the business management of Nemzetközi Wolfram Lámpa Rt. (I.T.L.S.C)

110) OL Z 600-5: the minutes of the executive committee's meeting on 12 September, 1910.

111) OL Z 40-462/5: József Pintér's briefing on the expansion of the tungsten lamp factory.

112) OL Z 600-5: the minutes of the executive committee's meeting on 26 November, 1910.

113) OL Z 600-5: the minutes of the executive committee's meeting in November, 1910: József Pintér's calculation on the projected costs of the new investments.

114) OL Z 600-5: the report of the directorial board on the agreements signed with Linde Company of Munich and on the handing over of the hydrogen plant.

115) Balázs, Tibor: *ibid.* pp. 64-65

116) OL Z 600-5: the report of the directorial board on the operation of the Lamp Manufacturing Department on 4 November, 1911.

117) OL Z 41-1123 n/VIII-1: the memorandum of Commercial Bank underlining the need of securing the license to produce incandescent lamps with drawn filament.

118) OL Z 41-1603/m: the memorandum of Fülöp Weiss, chief

executive officer of Commercial Bank, on the negotiations with the incandescent lamp factories of Berlin.

119) OL Z 600-1: the minutes of the directorial board meeting on 19 April, 1913.

120) The 'Tungsrám' trademark which was born from combining the words 'tungsten' and 'wolfram' (English and German for tungsten), was registered on 28 April, 1909. Its first successful application, however, only took place in 1912.

121) OL Z 600-5: the minutes of the executive committee's meeting on 9 January, 1913: the reduction in the cost of production was 6 fillérs per lamp in the case of 5,000,000 lamps.

122) OL Z 41-1123 m/XV-5: the minutes of the executive committee's meeting on 30 October, 1913.

123) Dr. Gadó: *ibid.* p. 53.

124) The executive committee raised Aschner's *tantième*, who was going to get 2 percent of the net profits.

125) OL Z 600-5: the report of the directorial board on the 15-year tax free status of the tungsten lamp factory.

126) OL Z 41-1123 m-XV-9: the Ministry of Trade's letter on the tax free status of the tungsten lamps with drawn filament, 14 April, 1904.

127) OL Z 41-1123 X/1: the Commercial Bank's instruction to buy Hungarian Tungsten Lamp S.C. shares owned by Sándor Just.

128) OL Z 600-5: the minutes of the executive committee's meeting on 17 June, 1909: the sales of incandescent lamps using carbon filament dropped by 8 percent in the fiscal year of 1908-1909.

129) OL Z 600-5: the minutes of the executive committee's meeting on 4 November, 1911: the trading of the companies represented by the incandescent lamp cartel fell by 15 percent in 1911.

130) OL Z 600-5: the minutes of the executive committee's meeting on 9 January, 1909.

131) OL Z 600-5: after Western Electric Company's taking interest in the company, TUNGSRAM elected the Berlin industrialist, Otto Zwietusch, Western Electric Company's European representative, to its board of directors.

132) OL Z 600-5: the minutes of the executive committee's meeting on 14 April, 1914.

133) OL Z 40-462/5: József Pintér's memorandum urging for the keeping of the weak current branch.

- 134) OL Z 600-5: the minutes of the executive committee's meeting on 7 February, 1909.
- 135) OL Z 40-462/5: Ernő Egger's report on the production of weak current merchandise.
- 136) OL Z 601-49: contract between TUNGSRAM and Unites Electric and Machine Works S.C., 21 October, 1910
- 137) The Huszár Street building was mortgaged at Commercial Bank of 288,000 Koronas.
- 138) OL Z 601-51: purchase agreement with Count László Károlyi.
- 139) OL Z 41-1123 kk/III: notes on the company's foreign sales agencies.
- 140) Kereskedelmünk és iparunk az 1913. évben (Our Trade and Industry in 1913), Budapest, 1914, p. 134.
- 141) OL Z 606-1: Gyula Egger's contract of employment, 16 March, 1906
- 142) The chemist, Ármin Helfgott was the brother of Dávid Aschner's wife, therefore, was also related to Lipót Aschner.
- 143) OL Z 606-2: Aladár Perczel's contract of employment was already signed in Vienna on 1 December, 1909.
- 144) The annals of Magyar Vasművek és Gépgyárak Országos Egyesülete (National Union of Hungarian Iron and Machine Works), 1913, p. 234.
- 145) The uniform industrial work regulations were prepared by Magyar Vasművek és Gépgyárak Országos Egyesülete (National Union of Hungarian Iron and Machine Works).
- 146) OL Z 600-5: the minutes of the executive committee's meeting on 8 June, 1907.
- 147) Dr. István, Harkay: Az Egyesült Izzó Kultúrtörténete (The Cultural History of the 75 Years Old Izzó), manuscript, p. 85
- 148) A magyarországi szocialisztikus munkásmozgalmak az 1907. évben (The Socialist Type Working Class Movements in Hungary in 1907), Budapest, 1908, pp. 1100-1101.
- 150) A magyarországi szocialisztikus munkásmozgalmak az 1908. évben (The Socialist Type Working Class Movements in Hungary in 1908), Budapest, 1909, p. 1215.
- 151) A magyarországi szocialisztikus munkásmozgalmak az 1912. évben (The Socialist Type Working Class Movements in Hungary in 1912), Budapest, 1913, pp. 536—537
- 152) OL Z 599-3: report of the directorial board on the fiscal year of 1914/1915
- 153) Hevesi, Gyula: Mérnök a forradalomban (An Engineer in the Revolution), Budapest, 1965, p. 77.
- 154) OL Z 41-1123 m/XV-14: the minutes of the executive committee's meeting on 6 April, 1915.
- 155) OL Z 600-5: the minutes of the directorial board meeting on the production of half-Watt lamps, 24 January, 1916.
- 156) OL Z 600-5: József Pintér's report on the problems with *lampafej* (lamp-base).
- 158) OL Z 600-5: the board of directors' report on the operation of the tungsten lamp department in the fiscal year of 1915/1916
- 159) OL Z 600-5: the contract with the Berlin lamp factories.
- 160) OL Z 600-1: the minutes of the directorial board meeting on 11 October, 1916
- 161) OL Z 41-1123 n/VIII-5: the memorandum of Commercial Bank on the production of Izzólampagyár (:Lamp Factory:) between 1 May, 1917 and 31 December 1917.
- 162) Dr. Ferenc, Kardos: A Tungstram gyártmány- és tudománytörténete (The History of Tungstram's Production and Development), manuscript, p. 77.
- 163) József, Árvay: A magyar ipar (Hungarian Industry), Budapest, 1941, pp. 267-271; Bay, Zoltán: Az elektroncsőipar fejlődése Magyarországon (The Development of Electronic Vacuum Tubes in Hungary).
- 164) OL Z 606-68: the report of the telephone and telegraph department on the radio valve, 2 October, 1919.
- 165) Dr. Ferenc, Kardos: ibid, p. 75.
- 166) OL Z 600-5: the minutes of the executive committee's meeting on 11 December, 1916.
- 167) OL Z 40-1123 n/VIII-6: the notes of Commercial Bank on the financial state of TUNGSRAM in the fiscal year of 1917-1918.
- 168) OL Z 601-437: contract with the Viennese company Glas-Fabriken und Raffinerien Josef Inwald A.G., 8 Ma, 1917
- 169) OL Z 41-1123 n/VIII-5: report of the Commercial Bank's auditor, 14 February, 1918.
- 170) OL Z 600-5: the minutes of the executive committee's meeting on 16 May, 1917
- 171) OL Z 600-5: the report of the directorial board on the purchase of the Viennese incandescent lamp factory, Watt.
- 172) OL Z 600-5: report on the restructuring of the Viennese Watt.

173) OL Z 600-1: contract of Ferenc Hanaman's employment signed in Vienna on 19 April, 1918.

174) OL Z 600-1: the minutes of the executive committee's meeting on 7 March, 1918: the license agreement drawn up between TUNGSRAM and the lamp factories of Berlin would have expired in 1922. It was the ambition of the management to reach, by then, a technical level which would have permitted the signing of an agreement with General Electric Company on the free exchange of patents.

175) OL Z 600-4: memorandum concerning the importance of new investments, 4 June, 1918.

176) Hevesi, Gyula: *ibid*, pp. 85-88.

177) Hevesi, Gyula: *ibid*, pp. 97-98.

178) OL Z 600-5: the minutes of the executive committee's meeting on 14 June, 1918.

179) OL Z 600-5: the minutes of the executive committee's meeting on 4 December, 1918.

180) The documents describing the company during the bourgeois revolution of 1918 are extremely fragmented.

181) OL Z 600-5: the minutes of the executive committee's meeting on 4 December, 1918.

182) Only Gyula Egger, József Pintér, Lipót Aschner and Henrik Fellner participated at the 4 December, 1918 meeting of the executive committee, the members of the Viennese directorial board were absent.

183) OL Z 600-1: the minutes of the directorial board meeting on 28 December, 1918.

184) OL Z 601-84: the accounts of the incandescent lamp factory concerning the number of employees and the production between 15 February and 15 March, 1919.

185) OL Z 601-84: the accounts of the telephone and telegraph factory on the work-force and production between 15 February and 15 March, 1919.

186) Szociális Termelés (Social Production, magazine) 1919/1, p. 15.

187) Szociális Termelés (Social Production, magazine) 1919/1, p. 15.

188) OL Z 601-84: the accounts of TUNGSRAM on its work-force and production during the Council Republic.

189) OL Z 601-681: the letter of Commercial Bank's Business Commissar to TUNGSRAM's Production Commissar, 16 April, 1919.

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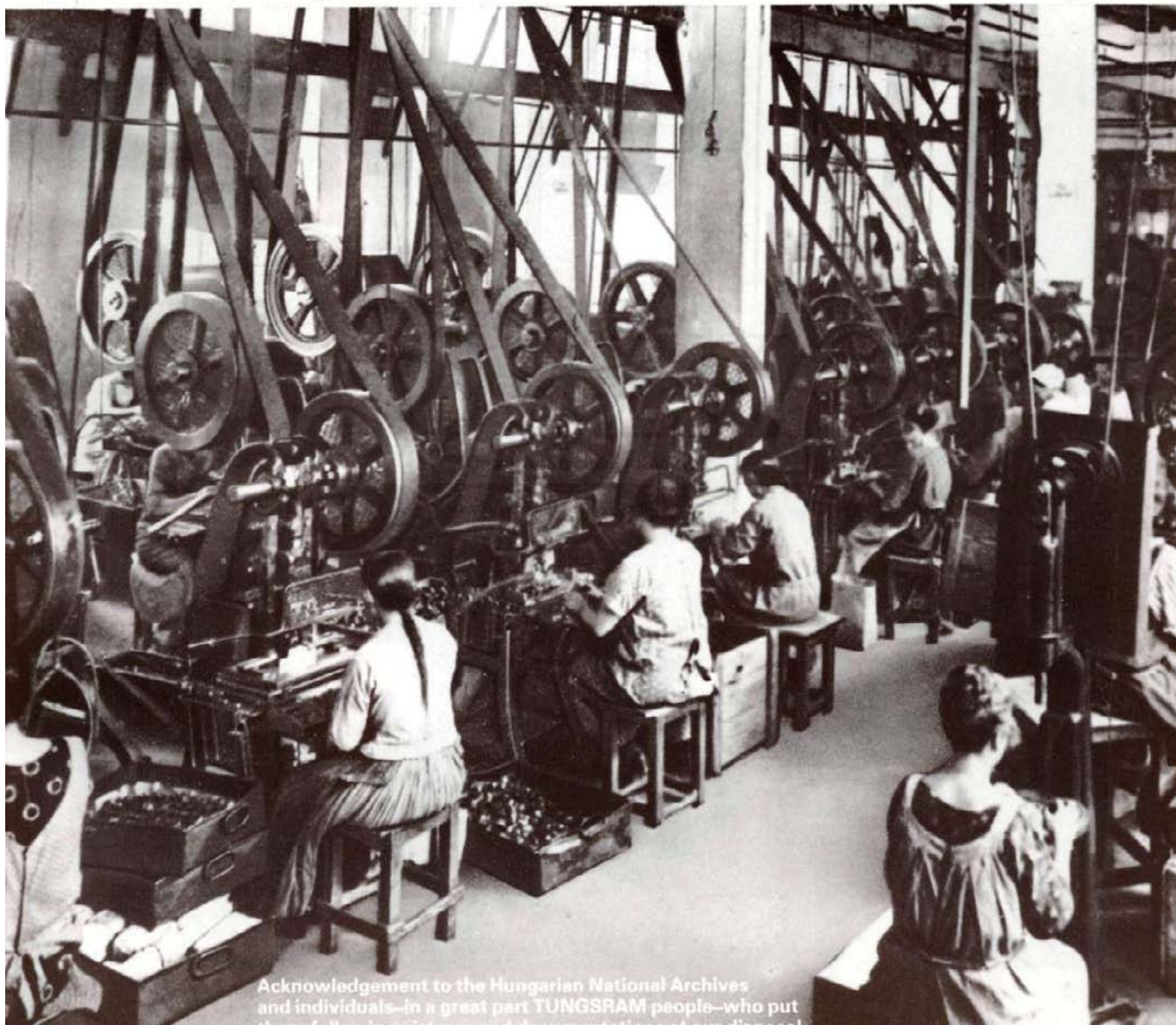
Egyesült Izzó Rt. (United Incandescent and Electrical S.C.) documents of Magyar Országos Levéltár (Hungarian National Archives)

Pesti Magyar Kereskedelmi Bank (Pesti Hungarian Commercial Bank) documents of Magyar Országos Levéltár (Hungarian National Archives).

OSZK

Országos Széchényi Könyvtár

And now pictures and figures: 1896–1945

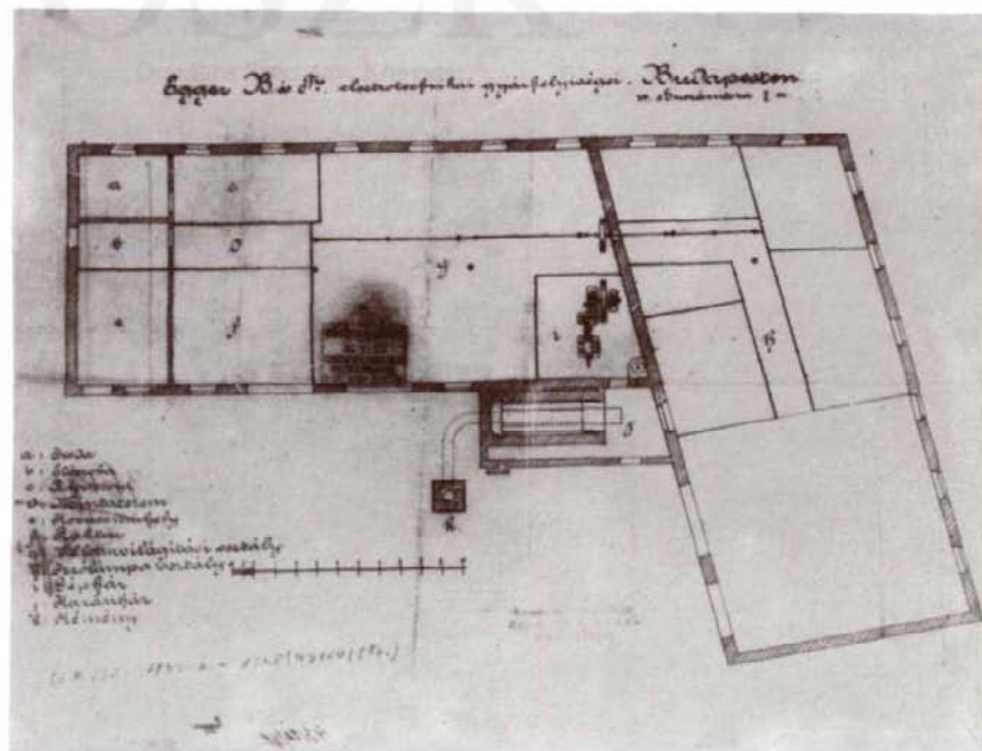


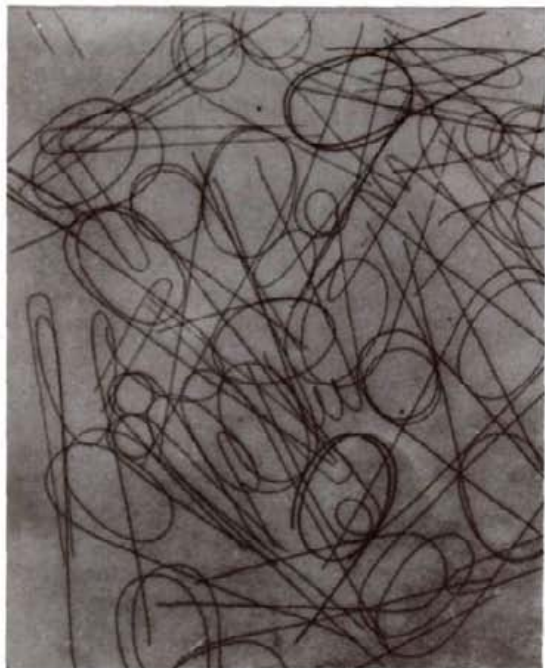
Acknowledgement to the Hungarian National Archives
and individuals—in a great part TUNGSRAM people—who put
these following pictures and documentations at our disposal

This print of the Danube Embankment was made in the last century. It was somewhere here, in Dorottya Street, where the Egger company, which was established in Vienna in 1872, set up a sales agency and repair shop to market their telephone and telegraph equipment.

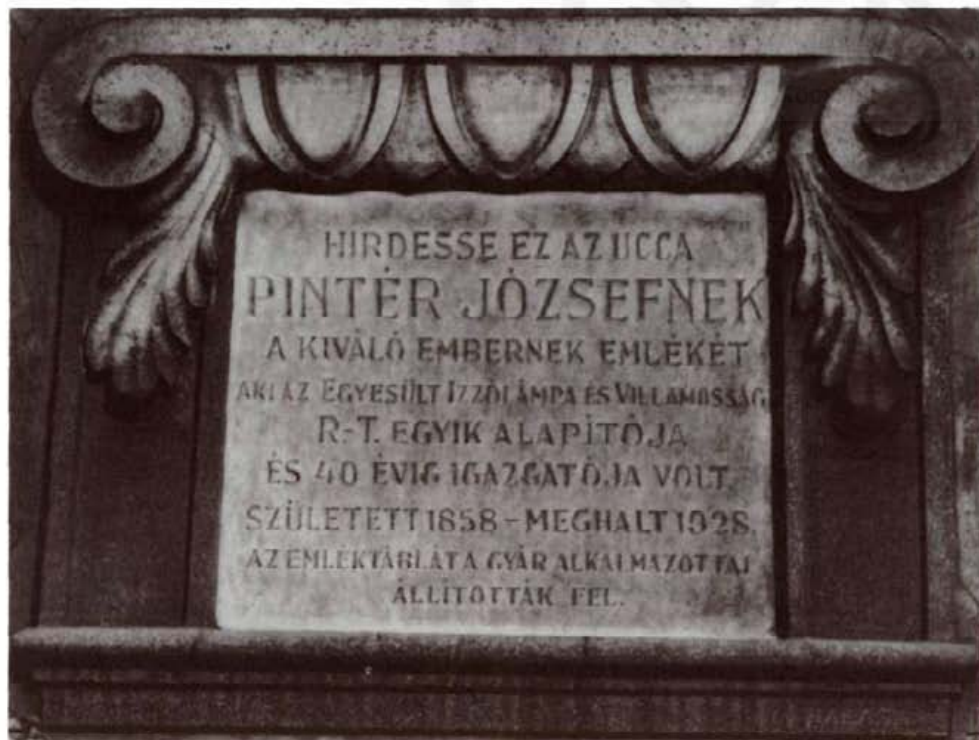


After the humble beginning, the small family business was quickly transformed into a prosperous company, which necessitated to move the factory to a new location. This sketch from 1887 shows the ground plan of the new site. Today there is a pub here.





Carbon filaments used in the first incandescent lamps.



This is a plaque commemorating József Pintér who had been one of the founders and, for decades, the technical director of the United Incandescent Lamp and Electrical Company Limited that is "TUNGSRAM" (and further here always TUNGSRAM). The plaque is placed near the present headquarters in the street named after him.

Kereskedelmiügyi

MINISTER.

68106.

II.

*A kereskedelmi és ipar kamarának
Budapestnek*

*Felhívom a kamarát, hogy Egger B. és társai, a legutóbbi igazolt képviselője Dr. Deutsch Friederich-
vid (F. Sz. u. 24) alapján, értesítve, hogy meggyőződés-
aról, miszerint a fentiekben említett Keres-
kedelmi és ipar kamara a létező elektrotechnikai gyár-
jelen berendezéséről is kéri az államnak kedvezmény-
nyek elvonatkozását keltett felhívásokról, a fentiekben a volt
földművelési és ipar- és kereskedelmiügyi miniszter úrnak
1888. évi augusztus hó 2-án 39623. sz. a kelt rende-
letével engedélyezett államnak kedvezményeket a fent-
i gyárminőségű juttatás egyetértéssel továbbra is juttatás-
mal fenntartani.*

Budapest 1890 november hó 27-én.

W. M. J.

42 185-4735/1890

109. C.

Calling attention to the fact that the company provided work opportunities to an increasing number of workers, it applied to the Ministry of Trade for special tax allowances. This document shows that the special tax status, again, was granted.

Pester Ungarische Commercial-Bank

Budapest.

Wir haben mit Ihnen Folgendes vereinbart:

I. Wir werden bis spätestens 1. August n. S. eine Actiengesellschaft gründen, der wir die Etablissements in Budapest und Wien der unser Eigentum bildenden Firma B. Egger & Co. mit Geltung vom 1. Januar 1896 übergeben werden. Die Modalitäten dieser Übergabe sind die Nachstehenden:

II. Wir werden Prospect, Statuten und Firma dieser Gesellschaft im Einvernehmen mit Ihnen festsetzen, und die Constituirung in der Weise vornehmen, dass die Genehmigung und Protokollirung der Gesellschaft durch das k. ung. Handels- und Wechselgericht erfolge. Die erste Bilanz der neuen Gesellschaft wird pr 30. Juni 1897 aufzustellen sein.

III. Der Sitz der zu gründenden Gesellschaft ist Budapest.

IV. Die Direction der Gesellschaft wird aus acht Mitgliedern und der Aufsichtsrath aus fünf Mitgliedern bestehen. Sie werden drei, resp. zwei von diesen Mitgliedern und wir die restlichen Mitglieder zu delegiren haben. Falls im Laufe der Geltung dieses Übereinkommens einzelne Mitglieder ausscheiden, wird derjenige Theil das neu zuwählende Mitglied zu delegiren haben, der das ausgeschiedene Mitglied delegirt hat. Die Direction der Gesellschaft wird ihre Beschlüsse statutenmaessig mit Stimmenmehrheit fassen. Es wird jedoch ausdrücklich vereinbart, dass die durch Sie delegirten Mitglieder in allen wichtigen Fragen ein Vetorecht haben sollen in der Weise, dass etwaige Beschlüsse, gegen die diese Mitglieder oder eines derselben protestiren nicht zur Ausführung gelangen dürfen. Sollten solche Beschlüsse gegen den Widerspruch der durch Sie nominirten Mitglieder dennoch erbracht und ausgeführt werden, so steht Ihnen das Recht zu, solche Beschlüsse

The Egger family's proposal to the Hungarian Commercial Bank (Budapest) about establishing a public company. The date is 8 July, 1896.

A

MAGYAR ASZFALT

RÉSZVÉNY-TÁRSASÁG

BUDAPEST, ANDRÁSSY-ÚT 30. SZÁM

elvérell minden néven megrendelő

ASZFALTBURKOLÓ

valamint

FALSZÁRÍTÓ MUNKÁK

teljesítését

jótállás mellett, legelőcsébban.

♦

Elismert legjobb minőségű aszfalt - anyag

(biharmegyei bányák terméke) vialókra is szál.

kittatik.

18-20-19

TELEFON.

Nagyobb gépgyár Budapesten,
mialóbbi belépésre keres

fiatal technikust,

ki több évi műhelygyakorlattal
bir és szerkezeti munkákat ön-
állóan végezni képes.

Próbaidő 4 hét. Bizonyítvány-
másolatokkal ellátott, részletes
ajánlatok «Gépgyár 100» jel
alatt e lap szerkesztőjéhez cím-
zendők.

118-1-1



EGGER B. és J^{SE}

BUDAPEST

VII. ker., Huszár-utca 7. szám.

TELEFONOK

hangosan beszélő mikrofonnal

Villamos világítás és erőátvitel

VASUTI ÉS HÁZI TELEGRÁF

CSILLÁROK (LUSZTEREK) 149-24-25

VILLÁMHÁRÍTÓK stb. stb.

Költségvetések ingyen és bérmentve.

An advertisement of Egger B. & Co. (TUNGSRAM's predecessor) from 1895. The company's earlier product profile is still dominant, although the electric lighting, the future star product is already mentioned.

Gründung der Gesellschaft bestehenden Actienbesitzes theilhaftig.
Nichtsdestoweniger haften wir für alle Ihnen gegenüber eingegangenen
Verpflichtungen solidarisch und zwar jeder von uns mit seinem ganzen
zu immer befindlichen Vermögen.

Saemtliche Mittheilungen, die Sie mit Beziehung auf die vorliegende Vereinbarung an uns zu richten haben, sind Sie berechtigt, an Herrn Dr. Isidor Deutsch in Budapest, V.Sas-utca, 24. zu richten, und wird sie an diesen Herrn gerichtete Mittheilung Ihrerseits so zu betrachten sein, als ob sie an uns alle gerichtet und uns allen zugestellt worden waere.

XI. Alle Kosten dieser Vereinbarung haben wir zu tragen.

XII. In Streitfällen unterwerfen wir uns der ausschließlichen Gerichtsbarkeit des Schiedsgerichtes der Budapester Waaren- und Effektenbörse.

Budapest, 6. Juli 1896.

in billiger
preis
Wela
Mineral
Julius
 beste techn. Aug. Fabrik
 für elektr. Beleuchtung
 und Maschinenbau
 P. Eggen & Co.
 Wien & Budapest
 1899

The final page of the preliminary agreement, preparing the statutory meeting of TUNGSRAM. It was signed in July, 1897.

J E G Y Z Ö K Ö N Y V .

Felvétellett Budapesten 1896 évi Augusztus hó 1-én délelőtt 10 órakor az
"Egyesült villanyossági részvénytársaság" alakuló közgyűléséről.

Az "egyesült villanyossági részvénytársaság" egybegyűlt
részvényaláírói egyhangúlag Vas E. Ferencz urat bízván meg a tár-
gyalás vezetésével ki ezen megbízást elfogadva konstatálja, hogy a
jelen jegyzőkönyvhöz 1/. a. csatolt nyilatkozat tanúsága szerint a
mai alakuló közgyűlésre valamennyi részvényaláíró kellő időben meg-
hívatott és hogy a következő tőzsvényjegyzők vannak jelen:

1. Előő ő. magyar villamvilágítási és erőátviteli gyár Egger B. és társa "bpesti és bécsi bej. cég nea kész- pénzben álló betétele.....	8000
és ezen cég készpénz jegyzése	800
2. Egger Gyula.....	800
3. Egger Dávid	800
4. Dr. Deutch Isidor	20
5. Vas E. Ferencz	20
6. Dr. Mezei Mór	20
7. Maishirn Péter	20
8. Deutch Mór	500
9. Fehér Miksa	20

aláírt részvénytárral, minél fogva 9 az-as kilenc részvényes kik

összesen..... .. 9000

dárral részvénytárral az alapítóval együtt az egész részvénytőkét képvisel-
lik, van jelen. Elnök tehát a közgyűlést az 1876 évi XXXVII. tcz. 154.
§-ának 1. bekezdése és 155. §-a értelmében megalakultnak és határozatké-
pesnek jelenti ki, a közgyűlési jegyzőkönyv vezetésére Dr. Deutch Isi-
dor urat, annak hitelesítésére Maishirn Péter és Deutch Mór urakat kéti
fel és az alakuló közgyűlést megnyitottnak deklarálja.

Elnök felhívja a közgyűlést, hogy az 1876 évi XXXVII. tcz.
154 §.-ának 1. pontja értelmében az alaptőkének kellő aláírás és befí-
zetés által történt biztosításáról meggyőződést szerezzen és a tárggyban

The first page of the minutes re-
cording the proceedings of the
statutory meeting, held on 1 Au-
gust, 1896. Here, and for decades
to come, the company is men-
tioned under its original name,
United Incandescent Lamp and
Electrical Company Limited.
TUNGSRAM has been the trade-
mark of the company since 1905; it
was only in the past few years that
the company became to be known
by the name TUNGSRAM.

EGYESÜLT VILLAMOSSÁGI RÉSZVÉNY-TÁRSASÁG
 UJPEST 4.



Bizonyítvány

személy igazoljuk, hogy budapesti
 születési Hódoltság
 1899. szeptember 1-ét
 1904. szeptember 15-ig
 gyártott és szerelt villamos berendezéseket és alkatrészeket
 és is jelen ideig alatt, így magánjelleggel szert
 szerzett és teljes magánjelleggel szert
 Szerzett és teljes magánjelleggel szert
 igazoljuk, hogy a gyártott és szerelt villamos berendezéseket
 magánjelleggel szert és teljes magánjelleggel szert
 a budapesti Hódoltság
 a fennsorolt telefon központ
 a budapesti új központ
 a fennsorolt központ
 szerzett és teljes magánjelleggel szert
 szerzett és teljes magánjelleggel szert
 Szerzett és teljes magánjelleggel szert
 szerzett és teljes magánjelleggel szert
 Szerzett és teljes magánjelleggel szert

Ujpest, 1904. szeptember 15-én

EGYESÜLT VILLAMOSSÁGI RÉSZV. TÁRS.
 ÜZEMVEZETŐSÉG
 ELNÖK: HODOLTSÁG

Letter of recommendation issued
 by TUNGSRAM on 15 September,
 1904 on request from one of its
 technicians who wanted to leave
 the company.

Handwritten note:
Kereskedelmiügyi
m. kir.
elminiszter.

1898. évi.

Kereskedelmi és iparkamrájának
Budapestre.

Ut. Gyorsított villamosműgyi
részvénykibocsátásig Budapestre, mely azon
kérdéssel foglalkozik, hogy Budapestre
vagy annak közelében iparkamra
és gyors áramú egyéb gyárműveket
előállítására szolgáló nyomvonat kiépítési
gyáripari területre, melyre az 1890. évi
Kereskedelmi és iparkamrai törvény
meghatározott állami kezesség
mellétek engedélyezése, és keltetve a ka-
marát, hogy a gazdaságminiszter és a
Kajmánlászlóval a területet állami kezesség
mellétek foglalkoztatásig létesítendő
iparkamrai részre az iparkamrai terület
jólétét károsító 15-éves időre
azonnal engedélyezése az feltétel alatt,
melynek foglalkoztatásig az új gyors áramú
alább 600.000 forintig, melynek befizetése
a régi gyors áramú megépítésére és az új
gyárművekre az első két évben legalább
1200.000 forintot állandóan foglalkoztat.
mi tartozik, létesítendő tovább, mely az a
feltétel, hogy foglalkoztatásig a régi
áramú részre 25.000 forintot

The Trade Minister's letter to the Chamber of Commerce and Industry, dated from 1899, informing the latter about the conditions on which the continuation of TUNGSRAM's special government privileges were made pendant after the company's moving to the new location.



This group photography, which was taken still back in the Huszár Street plant, radiates the aura of the Franz Josephian period—and also, that of the heroic early days in TUNGSRAM's history. The man with blond hair sitting in the middle of the front row is József Pintér, the technical director. Second to his right is Lipót Aschner whose name has been associated with an entire period in the history of the company.

Ördösveteli György



Én, György Ördösveteli, mint eladó, —
márta 20-án az alábbiakban megírtak szerint Budapest-
ra mint régi ház a következő feltételek mellett keltettem.

1. György Ördösveteli eladja, az alábbiakban megírtak szerint megvásárolja a fentebb leírt ház
melynek helye a 3427, 3428 és 3429 ház a fentebb leírt ingat-
lanok az 13500 négyzet méter területű földterület, a mely a
jelen szerződéshez fűggetett feltétel szerint 3427/1, 3428/1 és
3429/1 ha. számokkal jelöltek.

2. Az előző pontban keltetett terület vételára
Kétszáz negyvenöt 11 denariát 13 korona 50 fillérben azaz 13500
korona 50 fillérben azaz 13500 korona
azaz 13500 forintnak megfelelően azaz 13500 forint
pénzt meg, a mely összegből 13500 korona azaz 13500 forint
kifizetésére keltetett a jelen szerződés aláírásánál
egyidejűleg a pesti magyar Kereskedelmi Bank által a magyar

2601-5111

ÖRDÖSVETELI GYÖRGY
1. sz. oldal

By signing this purchase agreement TUNGSRAM took possession of its new site in Újpest. The central offices and factory buildings of the company have been here ever since. Újpest, which is a district of Budapest today, at that time was a separate town. This way the move to the new location fell in the category of rural industrialization and, as such, was accompanied with further tax benefits.

Deb
Budapesti Kereskedelmi és Gyarmata
Budapest



Fizetkedjék nekünk a következők
delományokból melyek Kezden at a Lloyd társaság. Agya
neve gőzhajóval Japánba szállítottak csomagtáskái egy-
zolványokat kiállítani is lehetik:

Yokohama (Japán) hajószáma jennu 3 an

1 korda	66	pl	226	minu	226	kg	226	kg
1	"	"	229	"	"	20	"	2120
1	"	"	230	"	"	20	"	2120
1	"	"	231	"	"	20	"	2120
1	"	"	232	"	"	20	"	2120

Kobe (Japán) hajószáma jennu 3 an

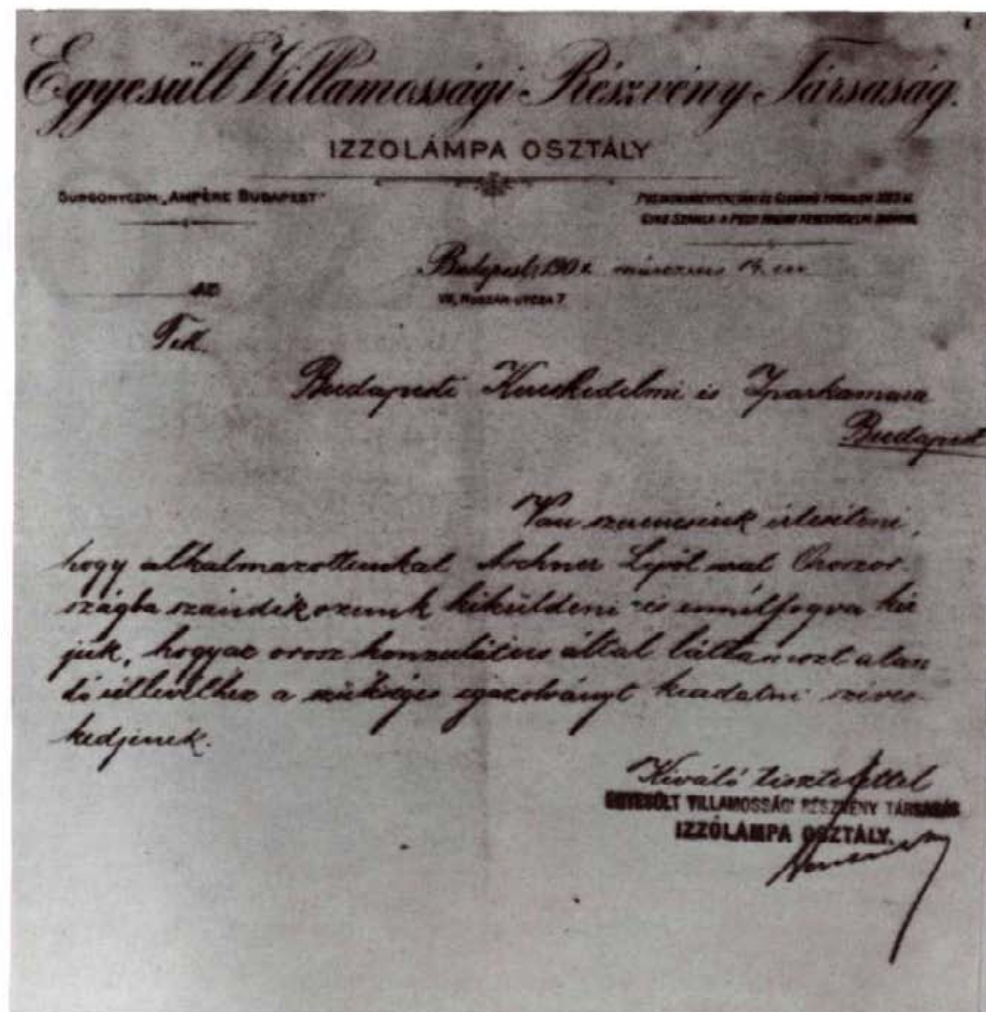
1 korda	66	pl	224	minu	224	kg	224	kg
1	"	"	225	"	"	20	"	2120
1	"	"	226	"	"	20	"	2120
1	"	"	227	"	"	20	"	2120

1 korda kifizetése kifizetése kifizetése
kifizetése kifizetése kifizetése

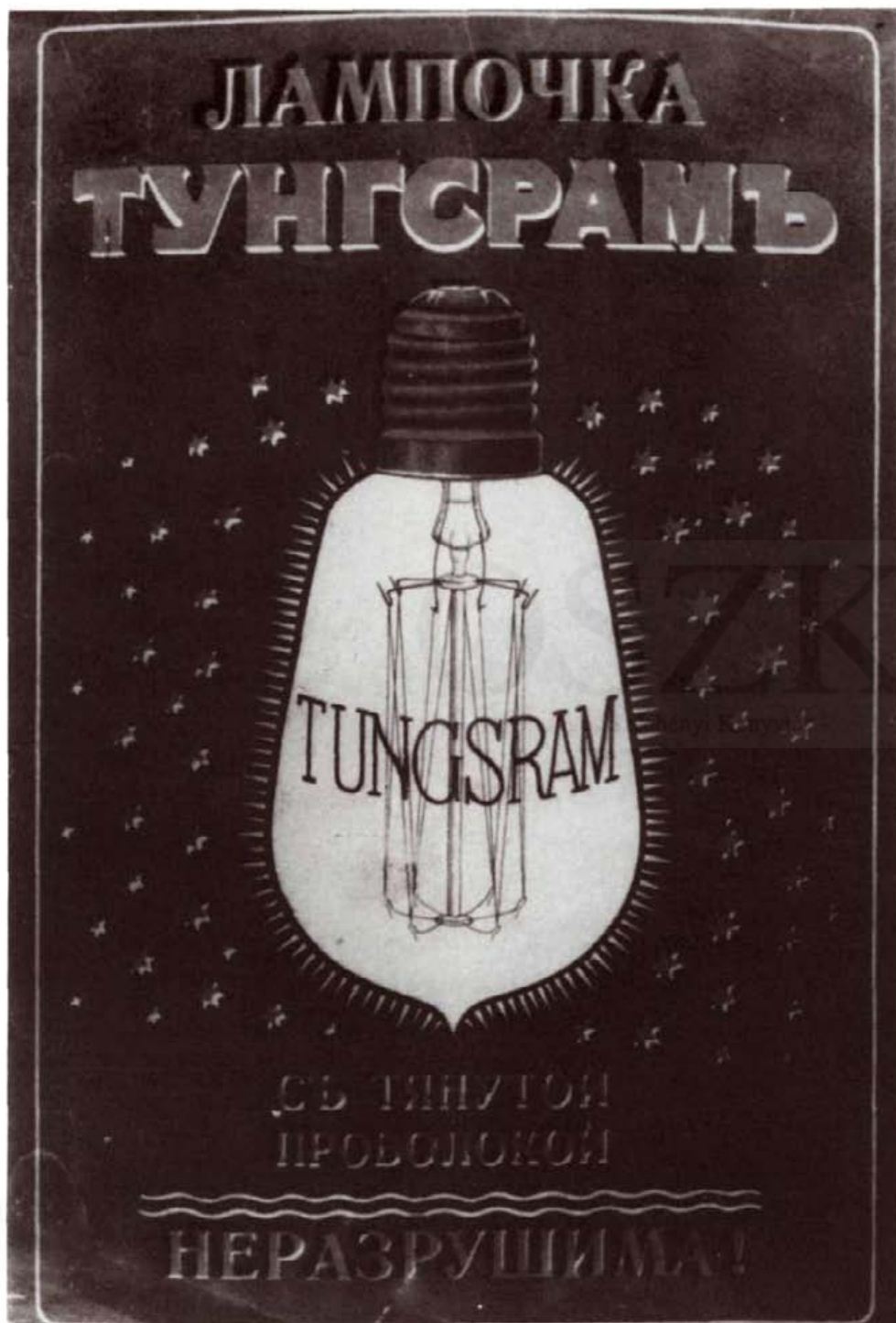
Kiváló kifizetése
KIVÁLÓ KIVÁLÓ KIVÁLÓ
KIVÁLÓ KIVÁLÓ KIVÁLÓ

KIVÁLÓ KIVÁLÓ

The young company had very good trade connections abroad from the outset. According to this letter, TUNGSRAM exported lamps—packed in barrels—to Japan as early as 1900.



This letter, dated from 1901, holds the Lamp Manufacturing Department's application to the Chamber of Commerce and Industry for a certificate enabling one of its employees to have his passport endorsed by the Russian consulate, as he was about to go on a business trip to the Tsarist Russia. The low-ranking administrator in question was called Lipót Aschner, the company's future chief executive officer.



This old Russian TUNGSRAM poster bears out what has just been claimed in connection with the company's good eastern trade connections. The letter which comes last in the Cyrillic transcription of the word TUNGSRAM only serves to harden the sound of the previous letter, the letter "M". This letter was judged as superfluous and was abolished under Lenin. The inclusion of this letter suggests that the poster dates back to the 1910's, the same way as the drawn filament incandescent lamps do.

EGYESÜLT VILLAMOSSÁGI

RÉSZVÉNY-TÁRSASÁG
 KEZELŐTT EGGEN 11. KÖR TÁRSASÁG
 BUDAPEST.



Nagyméltóságú MINISZTER UR

Kedves URUNK!

Nagyméltóságod eddig a honi ipar megerősödése és további fejlődése érdekében inaugurált lelkes tevékenysége bátorít fel bennünket arra, hogy jelen alázatos kérelmünket előterjesztjük.

Körülbelül tizenöt éve lehet, hogy gyárunkban az első telefon-készüléket előállítottuk s ez által hazánkban új iparágat honosítottunk meg, mely az üzleti és technikai fejlődésnek igen kielégítő haladását mutatja. Ily módon sikerült gyártásunkat jelentékenyen fokozni és az általunk gyártott szerkeszetek tekintetében oly haladást elérni, mely készülékeinket méltán sorossa a külföldön előállított legkitűnőbb hason gyártmányok közé. Világosan igazolja ezt az is, hogy a hazai telefon-hálózatokon kívül Románia, Bulgária és Görögország ismételtén bízta meg bennünket telefon- és központi kapcsoló készülékek szállításával.

A telefongyártással egyidejűleg kezdtük meg a villamos izzólámpák előállítását is és izzólámpa-gyárunk évi produkciója a lefolyt idő alatt 30.000 darabról 2.800.000 darabra emelkedett. E gyártmányunknak csak jelentéktelen része kerül belföldön eladásra, elismert kitűnősége azonban lehetővé teszi a gyártmány legnagyobb részének külföldön, különösen Európa minden államban,

Here is another application requesting the continuation of earlier granted government benefits. The language is Hungarian, the type-writer is German, which explains the hand-written accent marks absent from German language. By the way, the response to the application was, once again, a favourable one.

<u>Újpesti szénbányászati vállalat</u>	
Telekvizsgálati költségek	4455.22
Gyári teltek	190065.—
Telepeltetés	19130.30
Építkezés	1000430.62
Építési vezetőség költségei	55262.17
Építési költség számla	34905.02
Közműbér	69723.24
Kövezési munkák	16830.94
Mechanikai osztály berendezése	34502.24
Iskolalupa berendezés	28166.32
Villamos berendezés	97776.32
Installatio	174806.75
Fuvar	6193.38
Kutaköltségek	11472.24
Iparvágány	15916.52
Vas szállítmányok	139631.32
Ventilatio	3802.80
Felvonó	6932.34
Kerítés	4955.43
Gázórák	40164.32
Száritó kályha	643.80
Pontai előállítás	2732.50
Transmissio	13938.88
Üzem költség	1001.31
Körleg	2317.97
Kiseb. berendezések	7735.04
Telefon	8619.12
	K 2326260.46
Kamatok 1901 - 1903 április 30.	237458.83
	K 2563719.29

Details of the bills in relation with the construction work of the Újpest plant.

Egyesült Villamossági Részvény-Társaság

IZZÓLÁMPA-OSZTÁLY.

Sürgönyezim: „Ampère Ujpest.”
Távbeszélő száma 10—01.

UJPEST, 1903. szeptember hó 15.
Postahivatal 4.

T. CZ

Van szerencsénk szives tudomására hozni, hogy az izzólámpa-ipar kedvezőtlen helyzete következtében a szakmáltató cégek oly csúfól egyetértettek, hogy az eladói árakat szabályozzák. Az összes érdekelt izzólámpagyárosok között a következő eladói árakat állapították meg:

Normális izzólámpa 5, 10, 16, 25, 32 gyf. 45—135 volt 60 fillér.

•	•	10, 16, 25, 32	•	136—175	•	75
•	•	10, 16, 25, 32	•	176—240	•	75

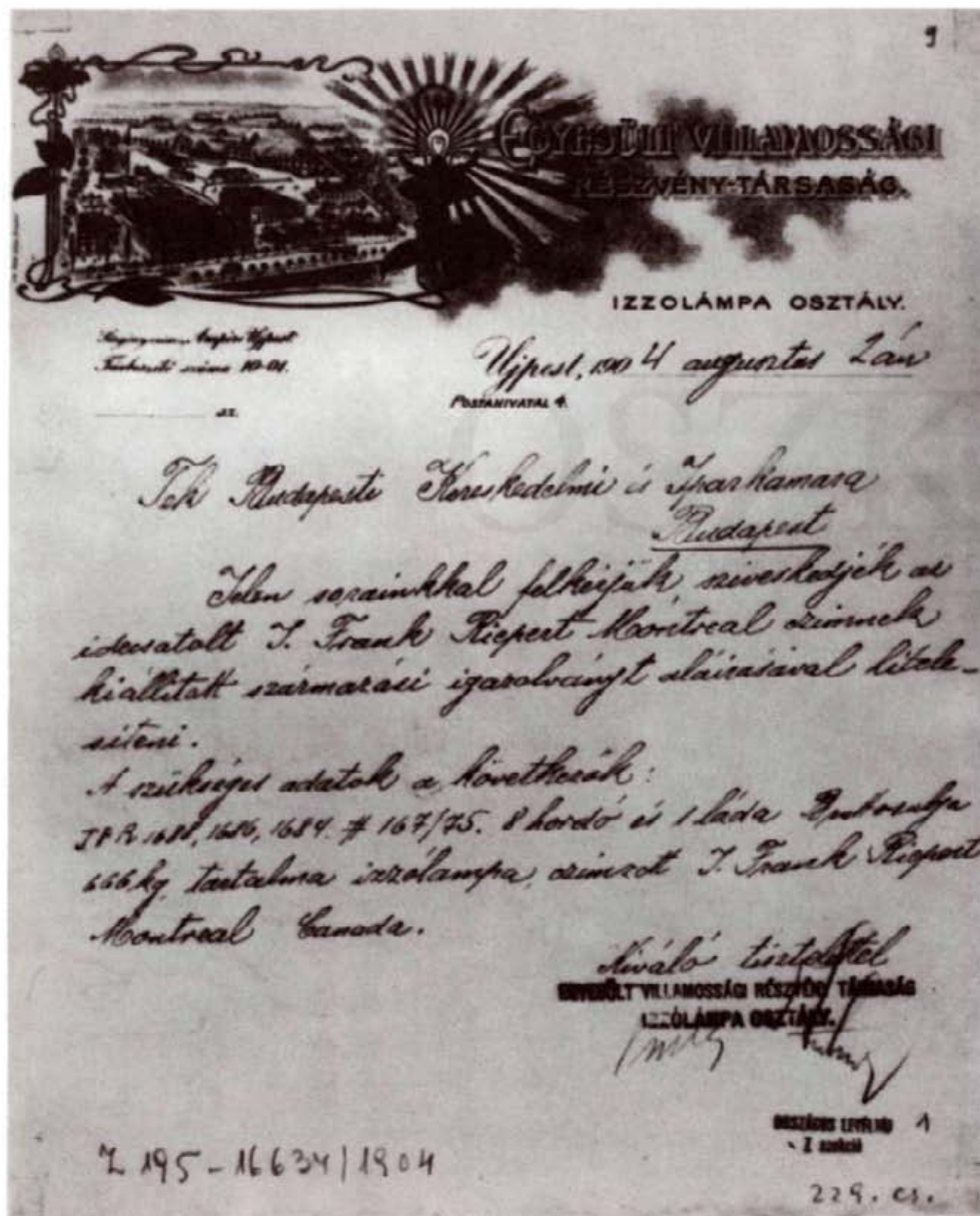
darabonként bérmentve odaszállítva, levonás nélkül.

Magunkat ajánljuk,

kiváló tisztelettel

Egyesült Villamossági Részvény-Társaság
Izzólámpa-Osztály.

Here is a letter from 1903, confirming the prices of incandescent lamps, as agreed by the cartel.



Another proof of TUNGSRAM's good foreign trade connections is this letter in which TUNGSRAM's Lamp Manufacturing Department asks the Chamber of Commerce and Industry to certify an export delivery to Canada.

**EGYESULT IZZOLAMPA ES VILLAMOSSÁGI
RÉSZVÉNY-TÁRSASÁG**

SZÜGONYCZAI
"AMPERE" UJPEST.
TELEFON: 10-01.
16-12.

Ujpest, 4. 1903. július 2.
Budapest mellett.

K Ö R Ö Z V É N Y .

Köretnek a tisztelt osztályfőnök urak, hogy ezen körözwényt
osztályuk nőtlen tisztviselőivel tudomásulvétel végett közölni
sziveskedjenek :

Társaságunk f.é. június hó 17.-én megtartott igazgatósá-
gi ülésén az igazgatóság a következő határozatot hozta :

A társaság nőtlen tisztviselői értesítendőek, hogy ugy a
számt anyagi érdeklükben, valamint a társaság érdeke szempont-
ból nem engedhető meg azoknak a nőtülés, illetve olyan tiszt-
viselők a társaság szolgálataira alkalmazottnak tekintendőek,
ahlyk meg nőtülnek annálkül, hogy akár a társaságnál éltetett
törvényekben, akár más egyéb mellékjövödelemben nem tudják
a következő megállapított évi összjövedelmet kizutatni :

1./ Kereskedelmi és műszaki tisztviselők K 3.600.-- évi jö-
vedelem

2./ Egyéb tisztviselők K 3.000.-- " jö-
vedelem.

Az ügyvezető igazgatóság :

In this memorandum addressed to all the unmarried administrative employees, the company—in order to protect its reputation—announces that in future it would only permit its staff to marry once their income reaches a certain level. (The regulations of the Habsburg Monarchy's imperial army laid down similar conditions for its officers.) This level of income was fixed at 3,600 Koronas in the case of those working in commercial or technical positions and 3,000 Koronas in the case of all the other staff members.



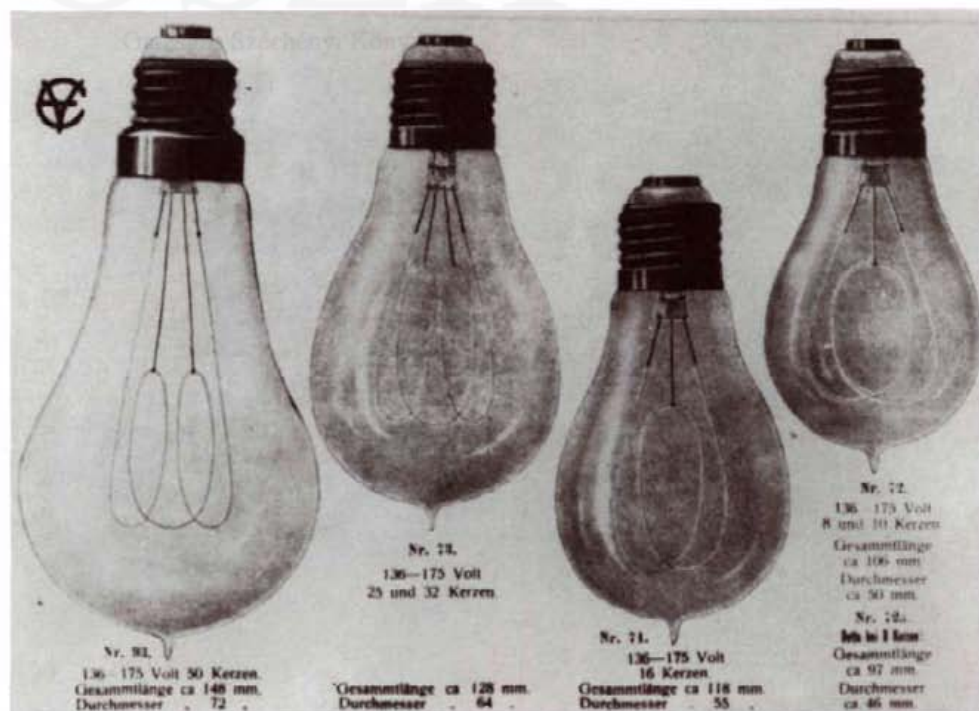
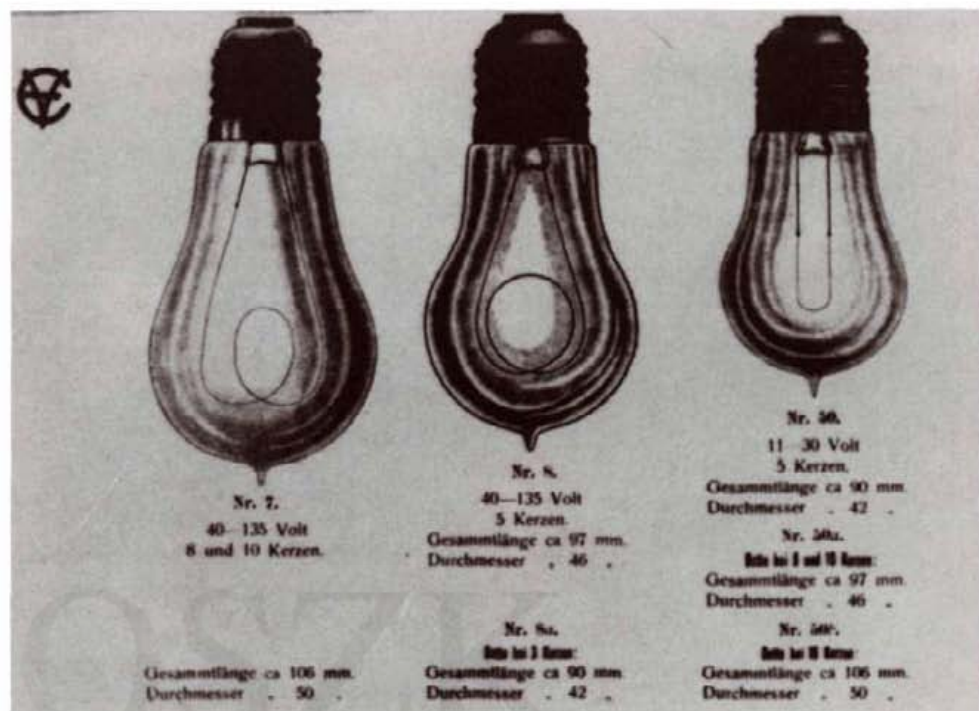
The company's first catalogue advertising its incandescent lamps was written in German and it described 74 different designs. As the old form of the company's name was used, the catalogue must have been published sometime before 1905.

Inhalt:

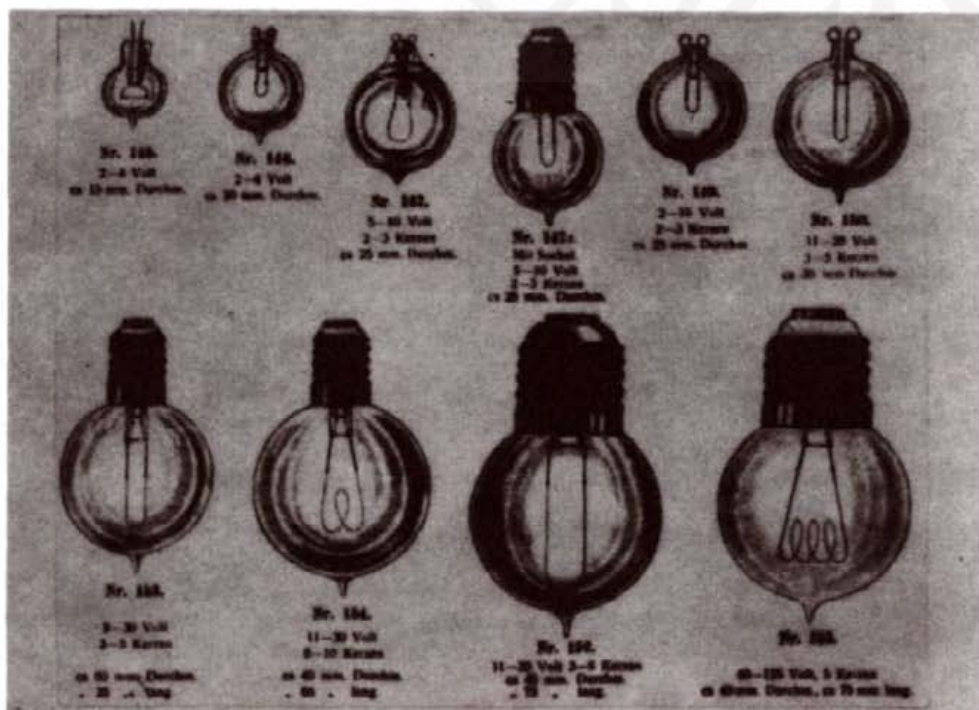
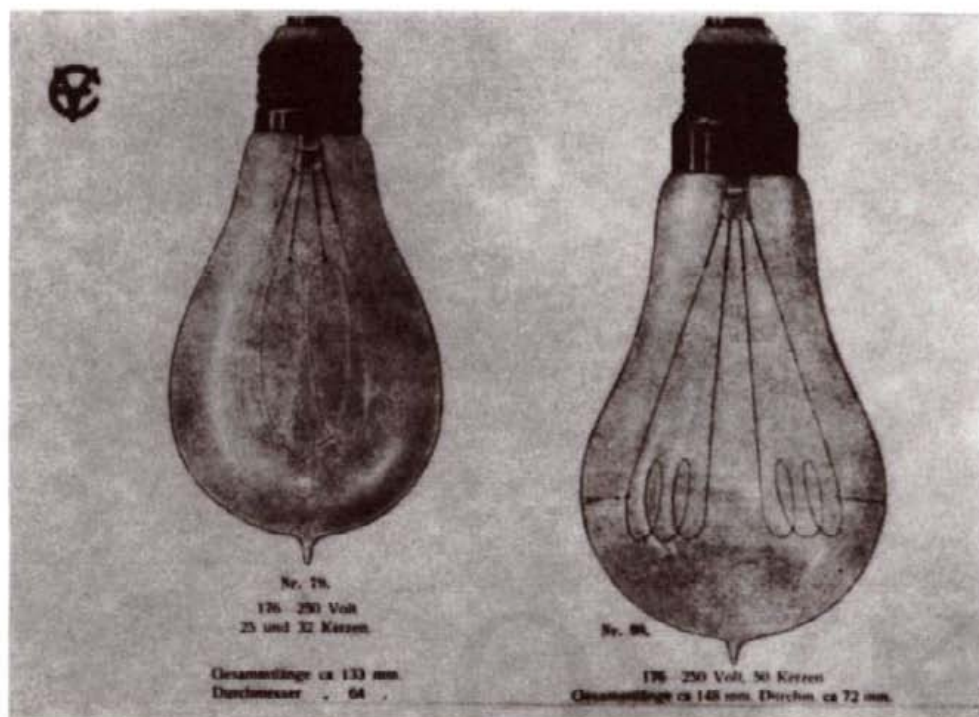
Birnenförmige Lampen bis 125 Volt	Seite 4-6	Röhrenlampen	Seite 17-19
Birnenförmige Lampen bis 175 Volt	7	Fadlampen	20-21
Birnenförmige Lampen bis 250 Volt	8-9	Luxus- und Phantasielampen	22-24
Kugel-Lampen	10-14	Lampensockel	25-26
Kerzenlampen (glatte und gedrehte)	14-18		

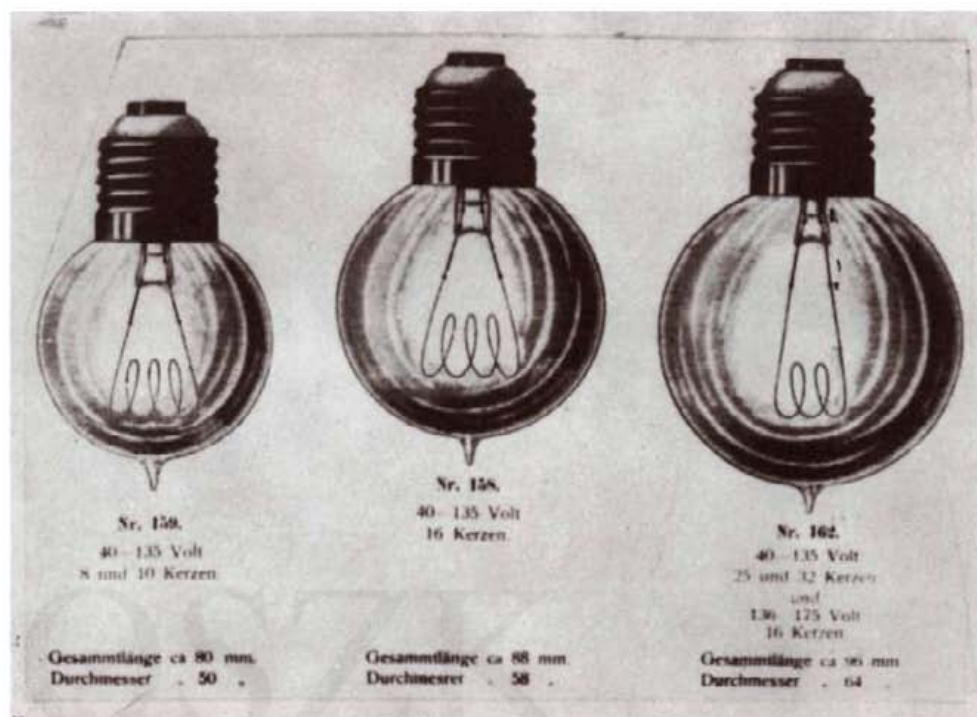
Numerisch geordnetes Inhaltsverzeichnis:

Nr.	Seite	Nr.	Seite	Nr.	Seite	Nr.	Seite	Nr.	Seite	Nr.	Seite	Nr.	Seite
1	4	12	17	24	16	72	7	88	20	145	10	158	11
2	4	12a	17	25	16	75	8	88a	20	146	10	159	11
3	4	13	17	26	16	76	8	98	7	147	10	160	13
4	5	13a	17	45	22	78a	8	98a	9	147a	10	161	13
5	5	13b	17	45a	22	77	14	110	15	149	10	162	11
6	5	14	18	46	23	78	24	115	23	150	10	163	12
7	6	15	18	50	6	79	9	120	18	152	10	164	12
8	6	17	15	50a	6	79a	23	141	20	153	10	165	13
8a	6	18	15	50b	6	84	15	142	23	154	10	166	14
9	24	19	14	71	7	85	22	143a	21	155	10	Socket- Nummern zwischen Nr. 1000—2000	
10	24	20	14	72	7	86	21	143	19	156	12		
11	24	23	16	72a	7	86a	21	144	18	157	22		

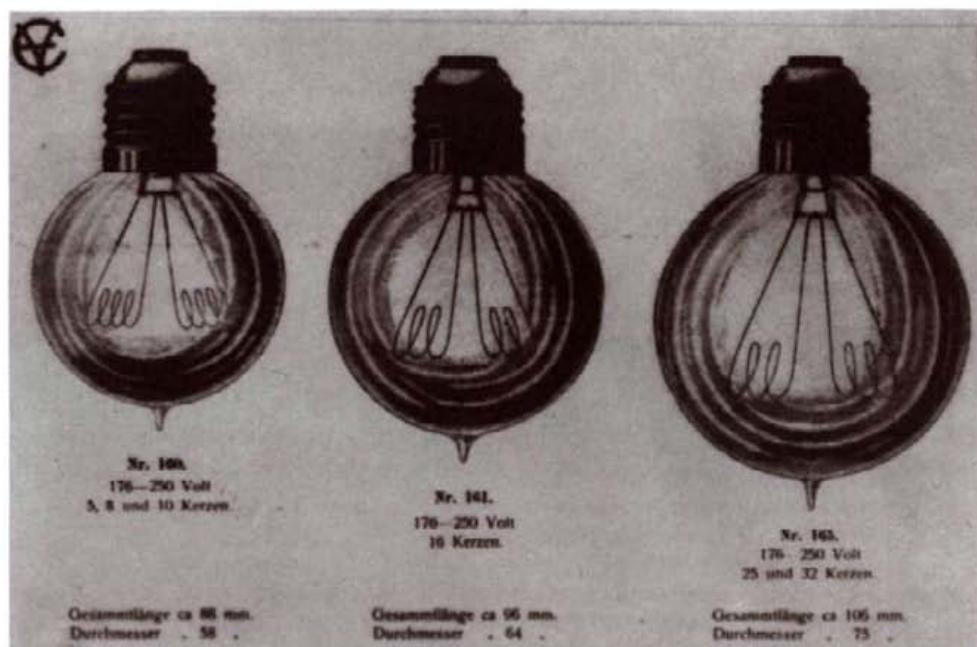


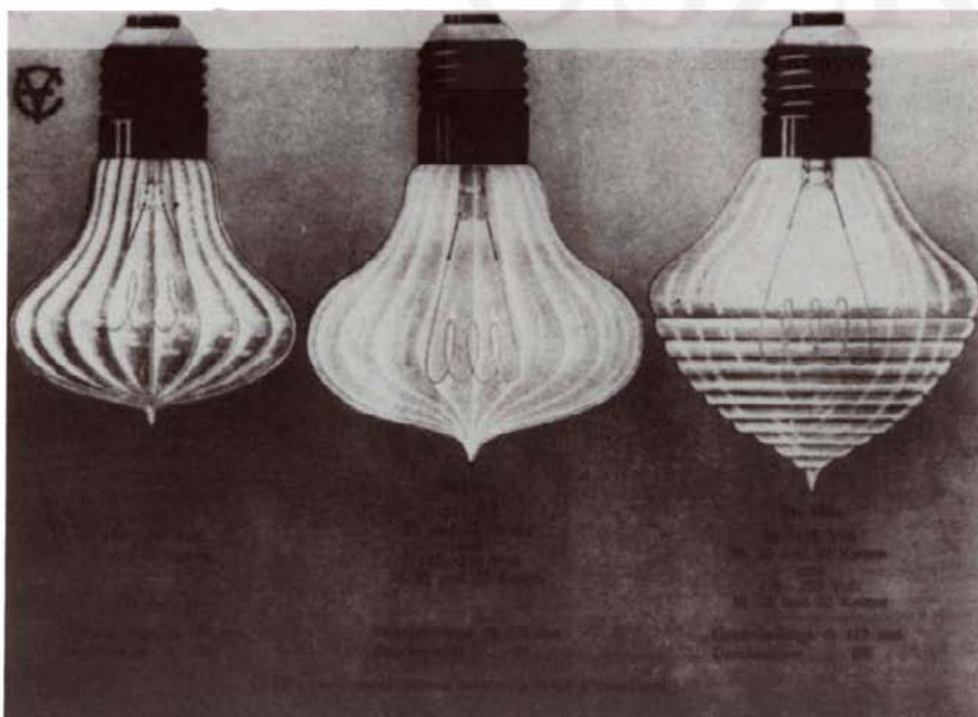
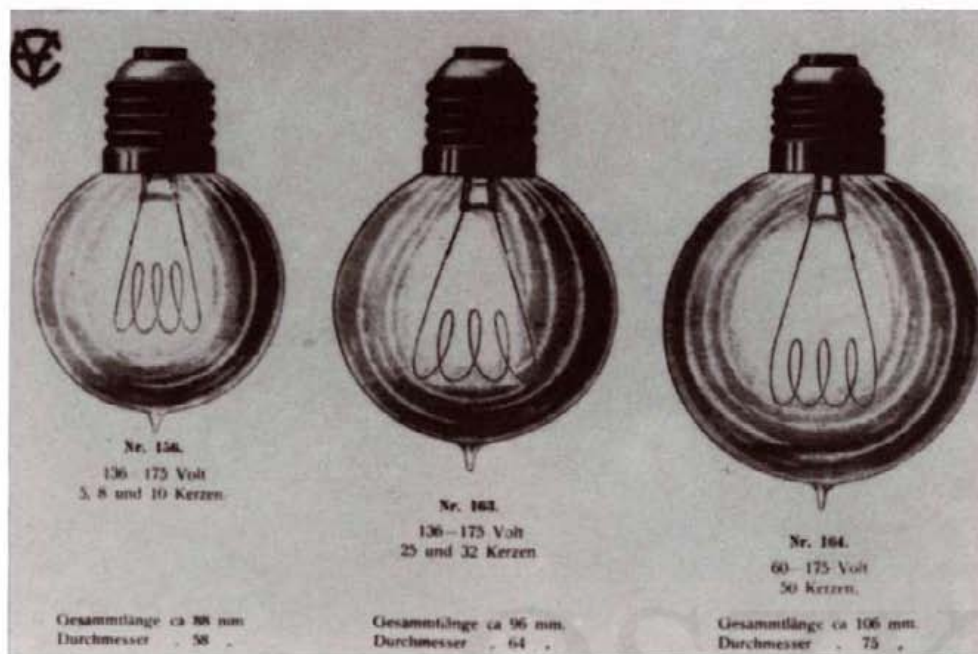
The following six pages show a selection of a characteristic assortment of TUNGSRAM carbon filament lamps towards the beginning of the century.

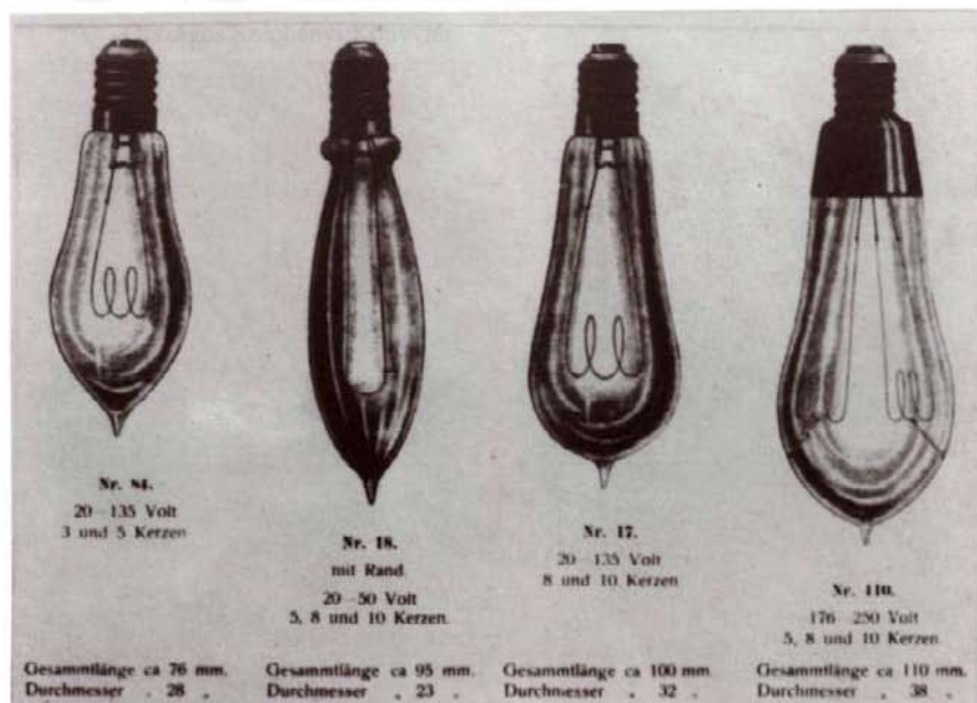
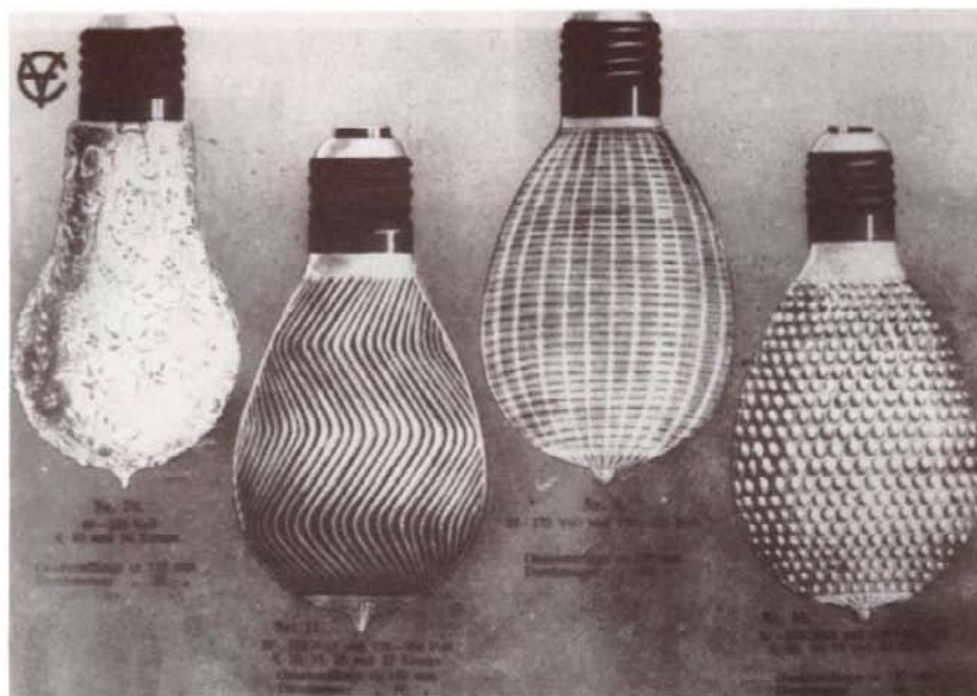




Országos Széchényi Könyvtár









Nr. 142.

40—135 Volt
8, 10 und 16 Kerzen

Nr. 46.

40—135 Volt
3, 8, und 10 Kerzen.

Gesamtlänge ca 110 mm.
Durchmesser . 50 .



Nr. 84.

Für Weihnachtskerzen; zur
Hintereinanderschaltung

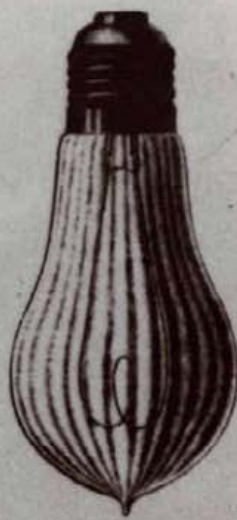
7—13 Volt
ca 3 Kerzen.

(Bei höheren Spannungen
als 13 Volt entsprechend
grössere Form.)



Nr. 118.

90—135 Volt
5, 8 und 13 Kerzen.



Nr. 78.

40—135 Volt
8, 10 und 16 Kerzen.

Gesamtlänge ca 116 mm.
Durchmesser . 40 .

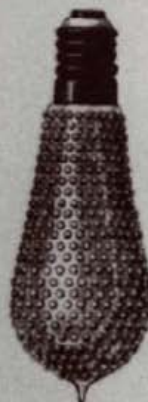
Gesamtlänge ca 116 mm.
Durchmesser . 55 .



Nr. 157.

40—65 Volt
3 und 5 Kerzen.

Gesamtlänge ca 63 mm.
Durchmesser . 42 .



Nr. 45a.

20—30 Volt
3 und 5 Kerzen.

Gesamtlänge ca 82 mm.
Durchmesser . 22 .

Megjelent 1904. évi december hó 13-án.



SZABADALMI LEIRÁS

34541. szám.

VII. OSZTÁLY.

Eljárás wolfram- vagy molybdänből elektromos izzólámpákhoz való izzótestek előállítására.

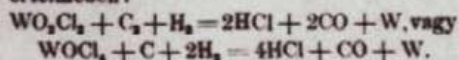
Dⁿ JUST ALEXANDER VEGYÉSZ ÉS HANAMAN FERENCZ MÉRNÖK
ELŐBB BÉCSI, JELENLEG BUDAPESTI LAKOSOK.

Bajelentésének napja 1904 június hó 6-ika. Elsőbbsége 1904 október 7-től kezdődik.

Azon fémek közé, melyek ama tulajdonságuk folytán, hogy nehezen olvadnak és nehezen illannak, főleg izzótestek gyanánt való használatra alkalmasak, egyebek közt a wolfram és molybdän is tartozik. A wolframnak és molybdännek izzótestek gyanánt való alkalmazásának gondolata egyáltalában nem új, ellenkezéleg a legkülönbözőbb eljárások ismeretesek már főleg platina- vagy szén-szállakon az említett fémekből álló bevonatok előállítására. A jelen találmány ezekkel szemben tiszta wolfram- vagy molybdänfém-ből álló izzószálak előállítását czélazza. E fémek oxyhalogénvegyületei pl. oxychloridjai, mint ismeretes, vörös izzónál, fém, halogénhydrogén és víz képződése közben a hydrogen által redukálhatnak. Ha tehát izzó fém- vagy szén-szálat wolfram-oxychlorid-gáz és főlölegesen mennyiségű hydrogen atmoszférájába hozunk, a redukált wolframfém alakjában lecsapódik a

megy végbe. Ha ugyanis szén-szálat wolframoxychloridok gőzében, csak igen kis mennyiségű hydrogen jelenlétében elektromos áram keresztülbocsátásával magas hőfoknak teszünk ki, rendkívül csodálatos változás megy a szén-szállban végbe. A szén-szál ugyanis lassan-lassan teljesen átalakul tiszta wolfram-szállá; e művelet analog módon fölhasználtatott már oszmium-szállak előállítására, szén-szállaknak oszmiumtetroxyd-atmoszférában eszközölt iztítása útján.

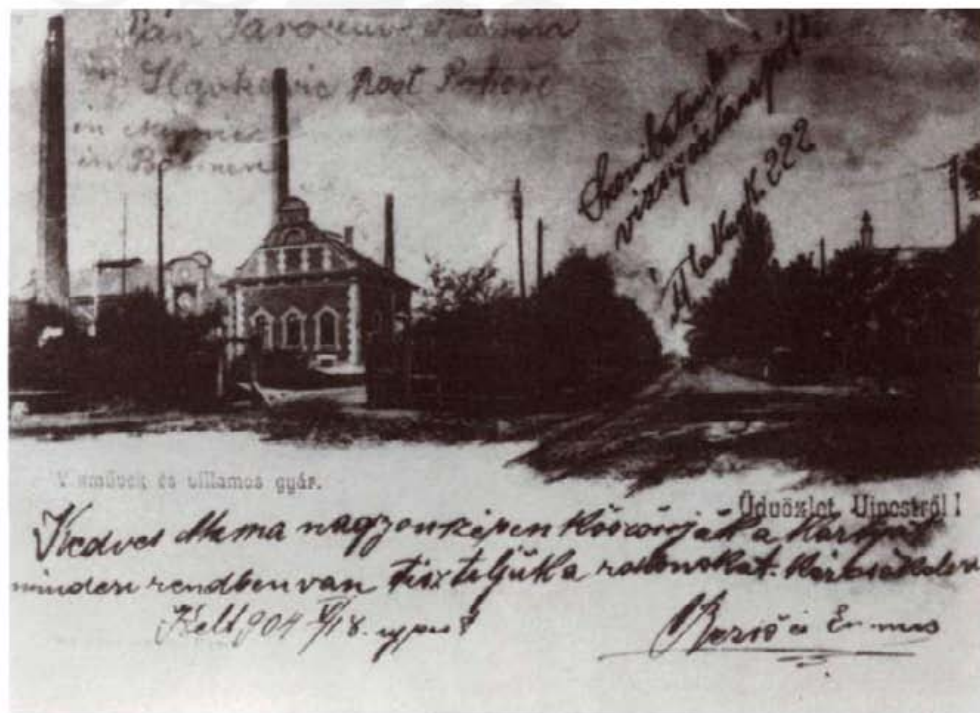
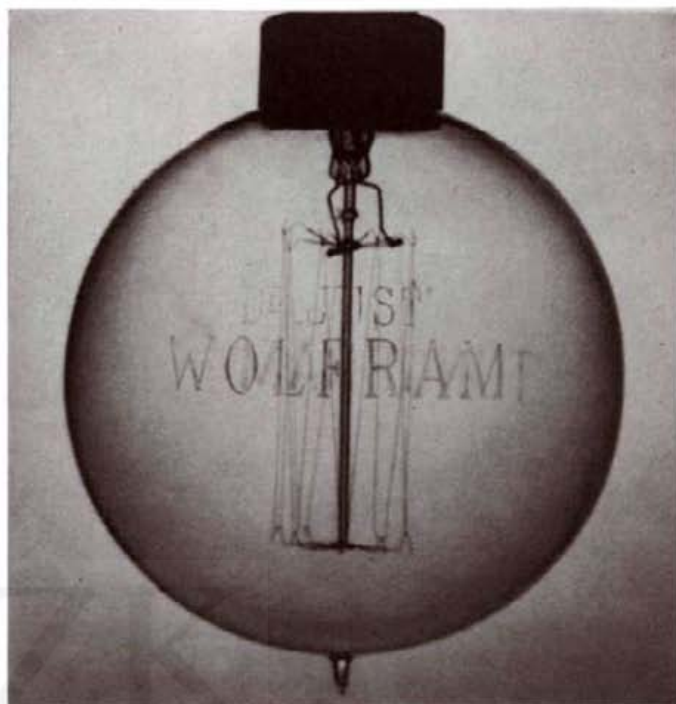
A jelen esetben a szén az oxychlorid oxygenjével szén-oxyddá vagy szén-savvá egyesül, a chlort a hydrogen chlórhydrogén-né redukálja és a wolfram a szén helyébe lecsapódik a következő egyenletek értelmében:



Ha a szén egyezzer teljesen helyettesítve van wolfram-mal, a hydrogenáramot czél-

Dr. Sándor Just and Ferenc Hanaman's patent published on 13 December, 1904, describing the tungsten or molybdenum filaments used in incandescent lamps. These were the first attempts to replace the carbon filament with one made of metal.

Just and Hanaman's tungsten lamp. The carbon filament was covered with a tungsten suspension; once the tungsten adapted to the shape of the filament, the carbon content was removed via heating. This procedure was later replaced by Coolidge's powder metallurgic method of drawing tungsten wire. TUNGSRAM, precisely on account of its own patent covering the application of tungsten as filament, was able to buy the latter patent under favourable terms.



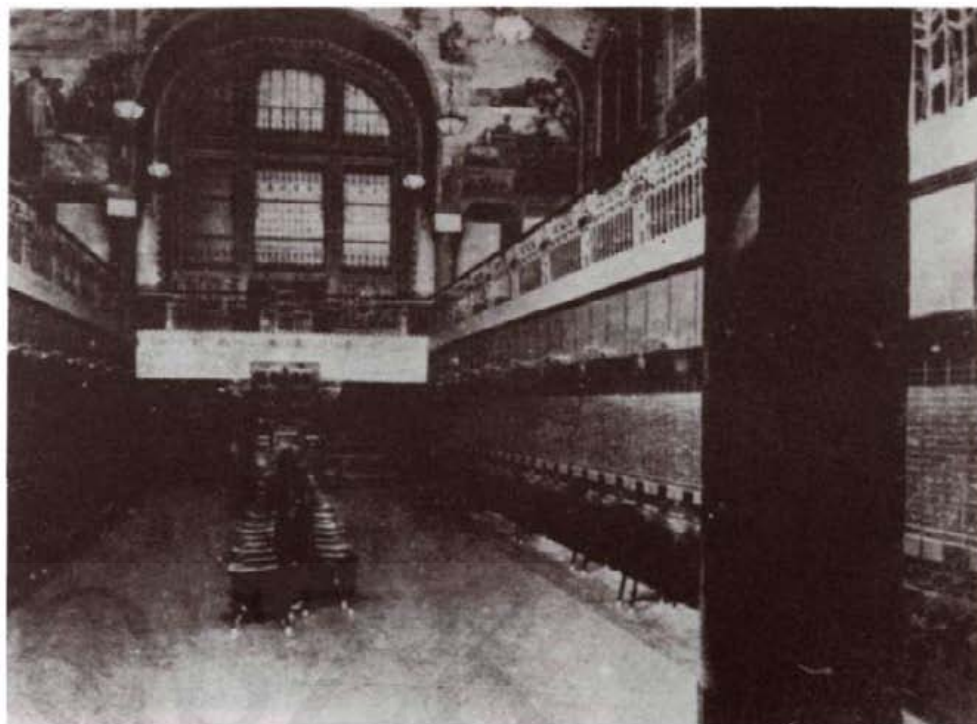
A contemporary picture postcard sent from Újpest. The picture shows how the street in front of the factory looked like some 80 years ago. The faded Czech writing on the top of the picture refers to the widely known fact that TUNGSRAM had to employ trained glass workers from the Czech-Moravian region of the former Austro-Hungarian Empire.



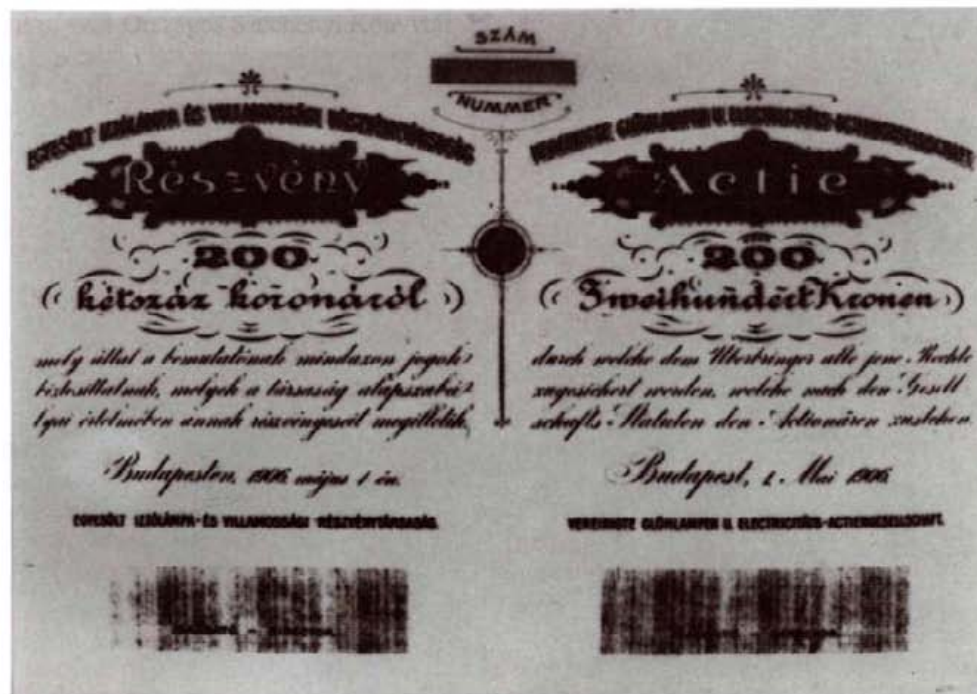
This photograph was taken in one of the workshops of the old telephone-telegraph department. Here gas lights are still competing against the electric ones. If we look at the ceiling we can see that line of electric lights alternate with lines of gas lights. For the times being!



As we have already mentioned, TUNGSRAM inherited the telephone and telegraph production profile from its legal predecessor. But the company was also involved in making and installing telephone exchanges, some of which are still working in Budapest. This photograph showing telephone operator ladies wearing romantic long skirt no doubt about the date of origin: sometime during the 1900s.



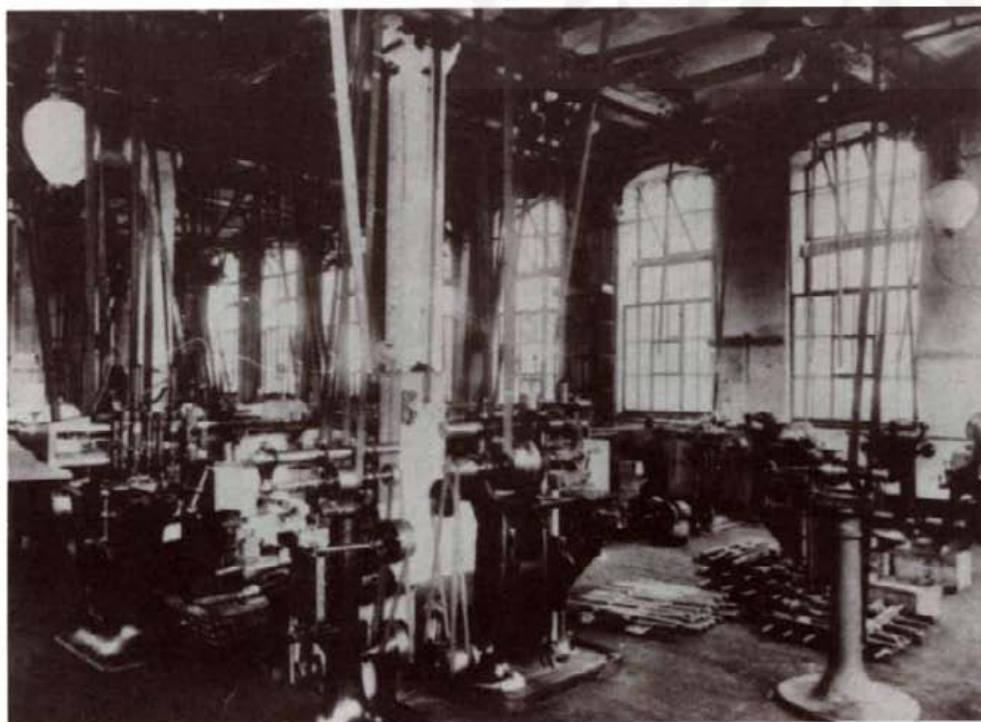
The Budapest telephone exchange known as "Teréz", manufactured and installed by TUNGSRAM, having been renewed, it is still operating today.



One of the many shares (or rather, an order form for it), dated 1 May, 1906. It is perfectly in order—except the director's signature is missing!



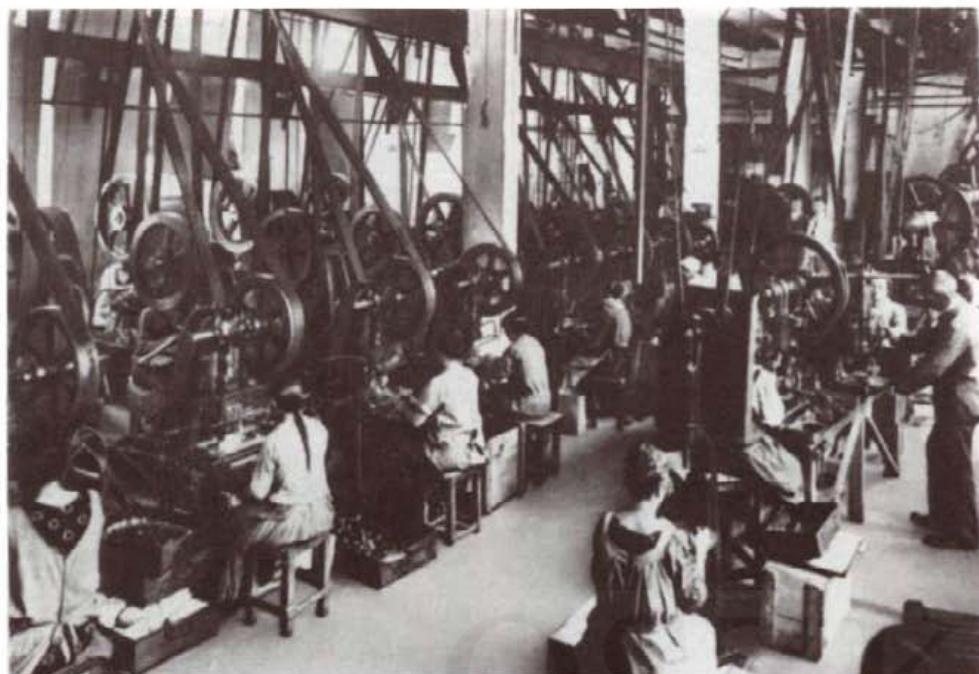
The clothing of these women –semiskilled labourers leaving the factory at the end of the shift– proves that the company's move to Újpest from the centre of Budapest, indeed, fell in the category of rural industrialization. TUNGSRAM provided good work opportunity to the population of the villages and settlements north of Budapest.



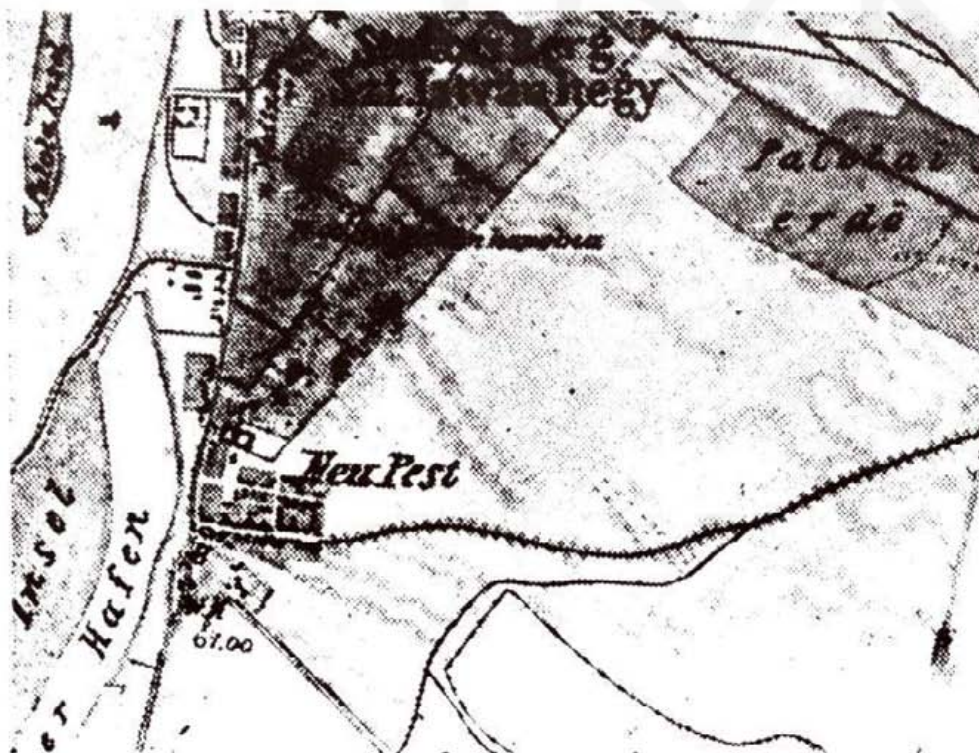
This is how the Machine Workshop looked before the First World War.

The picture, mailed as a postcard, was taken during a group outing of the TUNGSRAM employees in June, 1913. The management –Lipót Aschner and his team–is shown sitting around the big table in the front.





The bases of the lamps are being produced on stamping machines powered by a transmission system in the 1910s. The semi-skilled workers operating the machines were mostly country girls.



An old map of Újpest when it was still a separate town, and not just a district of Budapest. TUNGSRAM was built in the outskirts of this small town in the first years of the century. From the viewpoint of transportation the site had two great advantages: one was the short distance to the river Danube, the other was that the first Hungarian railway service, built between Vác and Budapest, passed through Újpest.



MAGYAR KIR.
POSTA- ÉS TÁVIRÁDGAZGATÓSÁG
BUDAPESTEN.

23682/1901 szam.

Az Egyesült Villamosági Részvénytársaságnak,

B u d a p e s t e n .

Az Újpesten most épülő gyártelepekre kért postahivatal felállítását a kereskedelemügyi m. kir. Minster ur folyó évi április hó 30-án 27296 sz. n. kelt rendeletével engedélyezte, kikötötte azonban, hogy a t. részvénytársaság a hivatal czéljaira, valamint a kinevezendő postamester részére magánlakásul felajánlott ingyenes helyiségeket, nemkülönbben a hivatali helyiségnek és a postamester lakásának díjmentes fűtését és világítását legalább öt /5:/ évre kötelezőleg biztosítsa. A hivatalnak folyó évi augusztus hó 1-én leendő megnyitása iránt intézkedem.

Sziveskedjék ennél fogva a t. részvénytársaság czéggelzéssel ellátott nyilatkozattal tudomásomra hozni, hogy ezen feltételeket elfogadják-e. Minthogy pedig a t. r. társaság megbízottja szóbelileg akként nyilatkozott, hogy folyó évi augusztus hó 1-én egyelőre csak a hivatali helyiséget bocsáthatja rendelkezésre, felkérem, hogy addig is, míg a postamester lakása rendelkezésre bocsátható lesz, a gyár környékén a kinevezendő postamester részére ingyenes lakásról gondoskodni, esetleg a kinevezendő postamesternek megfelelő kárpótlást nyújtani sziveskedjék.

Ezre nézve is kérem szives írásbeli értesítését.

Budapest, 1901 május 14.

SZÉNSZÁLAS
IZZÓLÁMPÁK.Érvényes
1914 április 1-től.

I. Körtealakú lámpák.

Gyertyalény	Feszültség voltagekban	100 darabonkénti ár korona
5 és 10	31—135	40.—
16, 25, 32	46—135	40.—
5, 10, 16, 25, 32	136—175	45.—
5, 10, 16, 25, 32	176—250	52.—

II. Síma és csavart gyertyaalakú lámpák.

Síma gyertyaalakú lámpákra a körtealakú lámpák árai 8 fillér darabonkénti felárral érvényesek.

Csavart gyertyaalakú lámpákra a körtealakú lámpák árai 16 fillér felárral érvényesek.

Gyertyaalakú lámpák a következő fajtákban készülnek:

Gyertyalény	Feszültség voltagekban
5	20—45
5, 10, 16	46—135
5, 10, 16	136—175
5, 10, 16	176—250

III. Gömbalakú lámpák.

Ezen típusú lámpákra a körtealakú lámpák árai 8 fillér darabonkénti felárral érvényesek.

Gömbalakú lámpák a következő fajtákban készülnek:

Gyertyalény	Feszültség voltagekban
5, 10, 16	25—45
5, 10, 16, 25, 32	46—135
5, 10, 16, 25, 32	136—175
5, 10, 16, 25, 32	176—250

Homályosításért, vagy a lámpák festéséért 3 fillér felárat számítunk lámpánként.

A külön kívánt egyszerűes vagy többszörös rögzítésért, amennyiben az illető lámpaaj rendszer kivételben rögzítve még nincsen, minden rögzítésért 3 fillér felárat számítunk lámpánként.

IV. Csőalakú lámpák.

Ezen típusú lámpákra a körtealakú lámpák árai 16 fillér darabonkénti felárral érvényesek.

Csőalakú lámpák a következő fajtákban készülnek:

Gyertyalény	Feszültség voltagekban
5, 10, 16, 25, 32	45—135
10, 16, 25, 32	136—175
10, 16, 25, 32	176—250

V. Körtealakú lámpák eredeti színű üvegből.

Ezen típusú lámpákra a normális körtealakú lámpák árai érvényesek a következő felárakkal:

fényképezési célra, sötétvörös ... 1.10 korona darabonként
vörös vagy opál ... 80 fillér
egyéb színek ... 40

Ilyen lámpák a következő fajtákban készülnek:

Gyertyalény	Feszültség voltagekban
5—32	45—135
10—32	136—175
10—32	176—250

VI. Izzólámpák fémzett szénfonállal (M. K.)
körtealakúban.

Ezen típusú lámpákra a körtealakú lámpák árai 24 fillér darabonkénti felárral érvényesek.

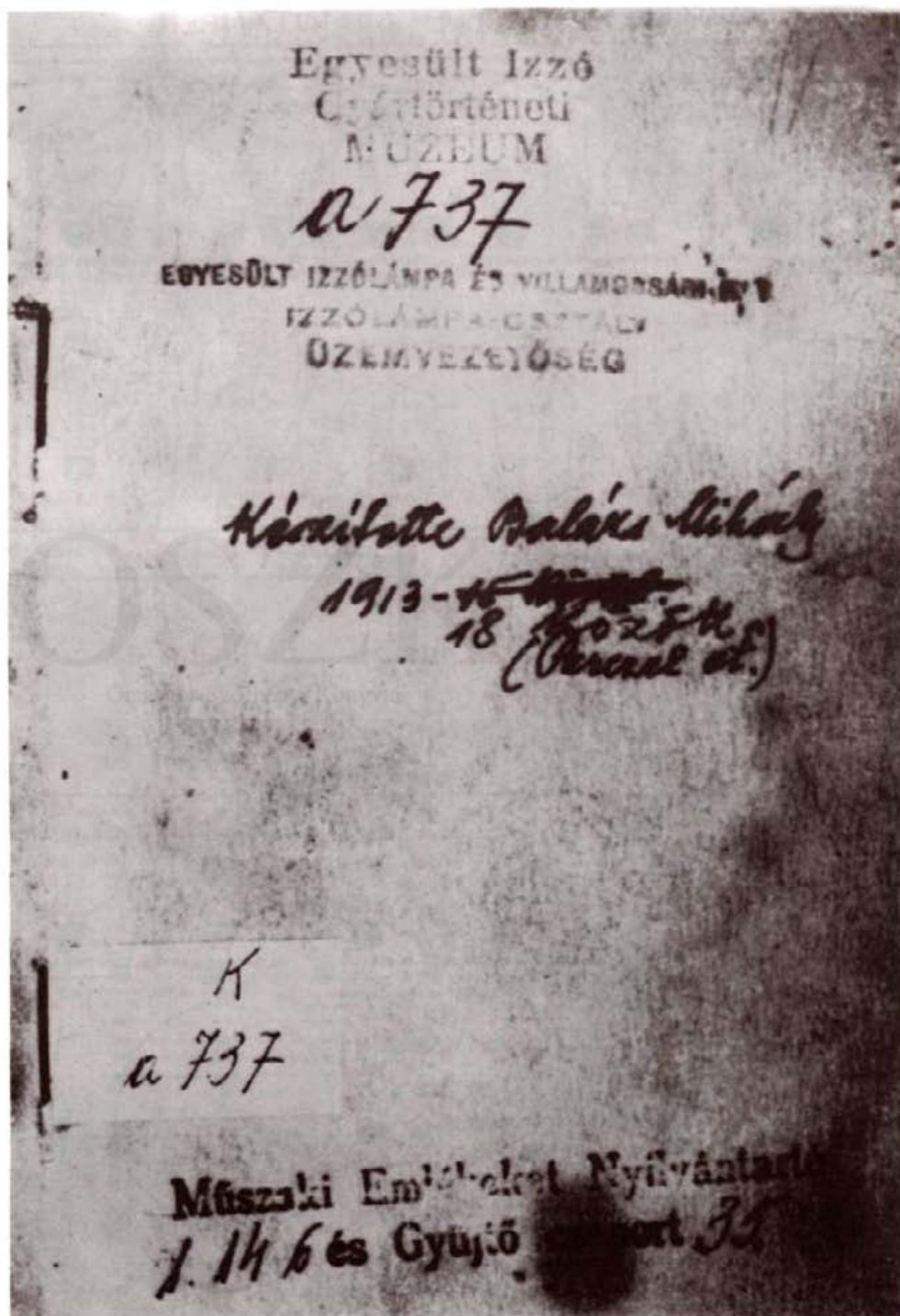
Ilyen lámpák a következő fajtákban készülnek:

Gyertyalény	Feszültség voltagekban	Áramfogyasztás
16, 25, 32	100—125	kb. 2¼ watt gyertyalényenként

Az árak legalább 50 darab izzólámpa egyszeri szállításánál bérmentes szállítással Magyarország bármely állomására értendők.

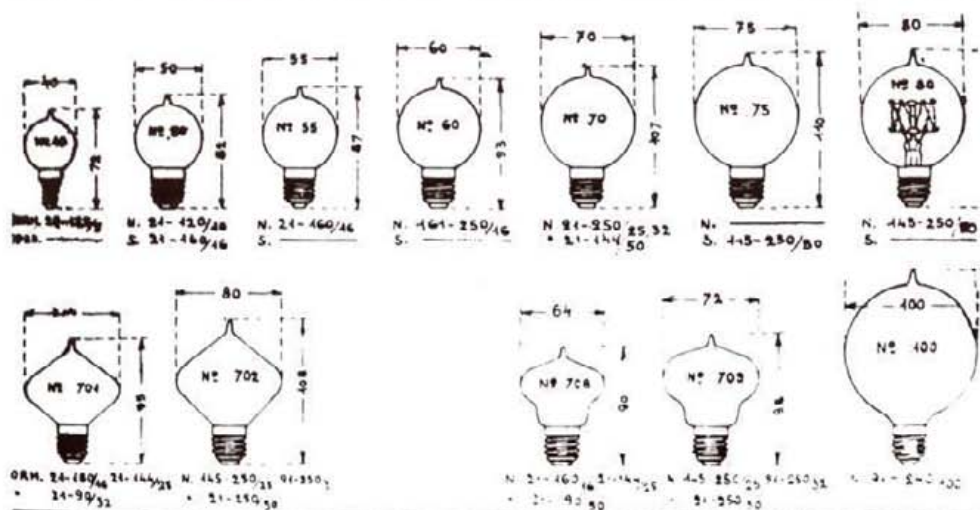
Ezen árjegyzékben fel nem sorolt különleges lámpafajták árai külön megállapodás tárgyát képezik.

Although the patent of the tungsten lamp was registered in 1904, carbon filament lamps were still being produced in 1914, as the price-list shown here reveals.



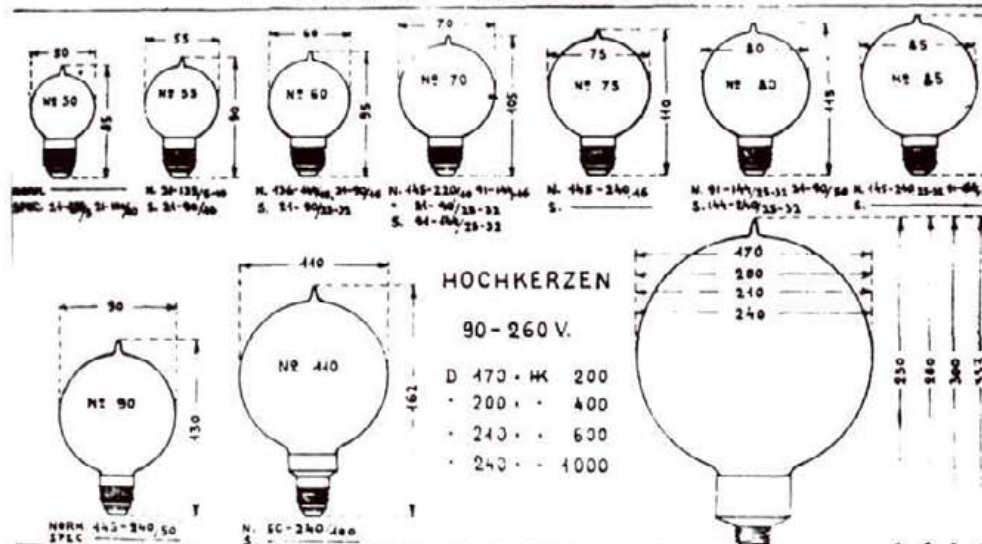
The eventual victory of the coiled filament incandescent lamps was inevitable. This little notebook, kept by one of the workshop managers of the Lamp Manufacturing Department between 1913 and 1918, discloses a number of interesting facts.

TUNGSRAM SPIRAL DRAHTLAMPEN.



E. I. V. T. - UJPEST 4 V - 2016

TUNGSRAM KUGELLAMPEN.



HOCHKERZEN

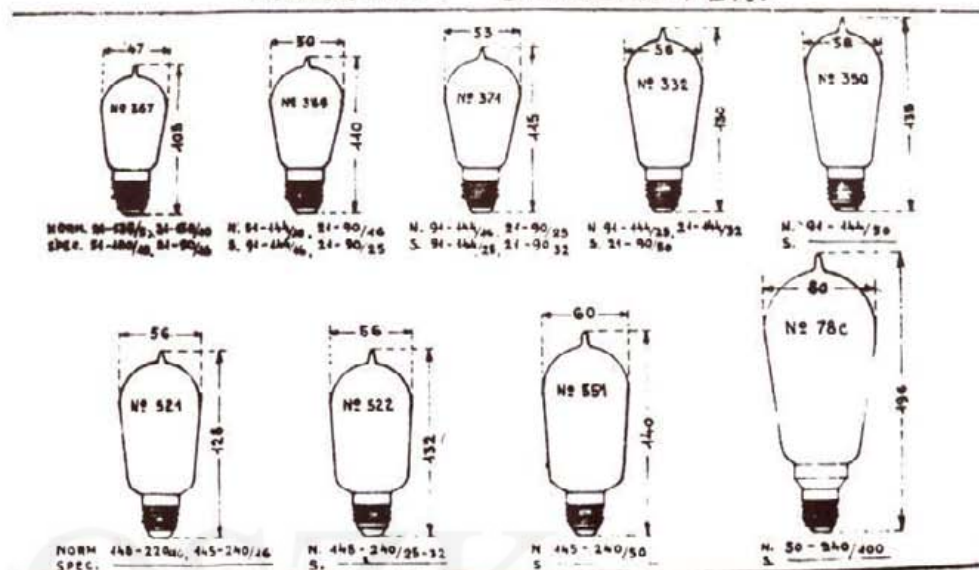
90-260 V.

D 170 - H 200
 • 200 • • 400
 • 240 • • 600
 • 240 • • 1000

E. I. V. T. - UJPEST 4 V - 2016

The following pictures show pages from this notebook. On the first page we see the dimensions of spherical-shaped and coiled-filament lamps.

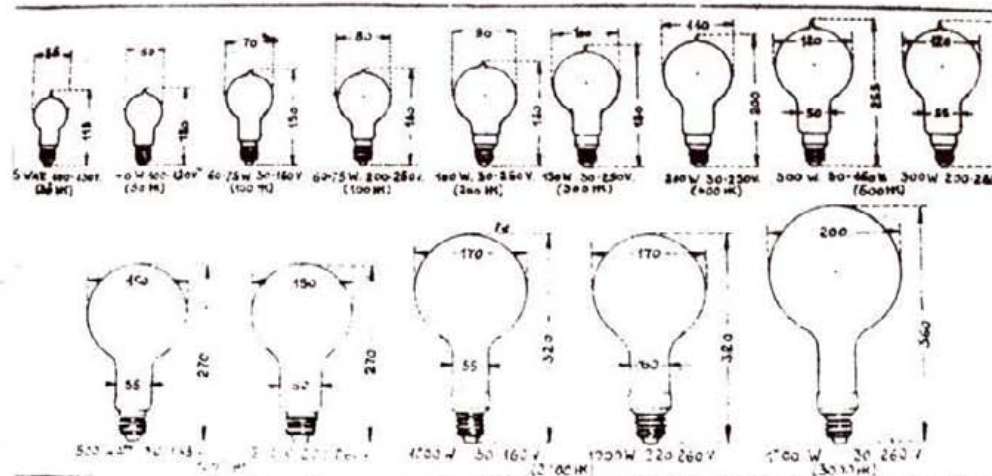
TUNGSRAM BIRNLAMPEN.



E.I.V.R.T.-UJPEST. 4/V-1916.

N° 2.

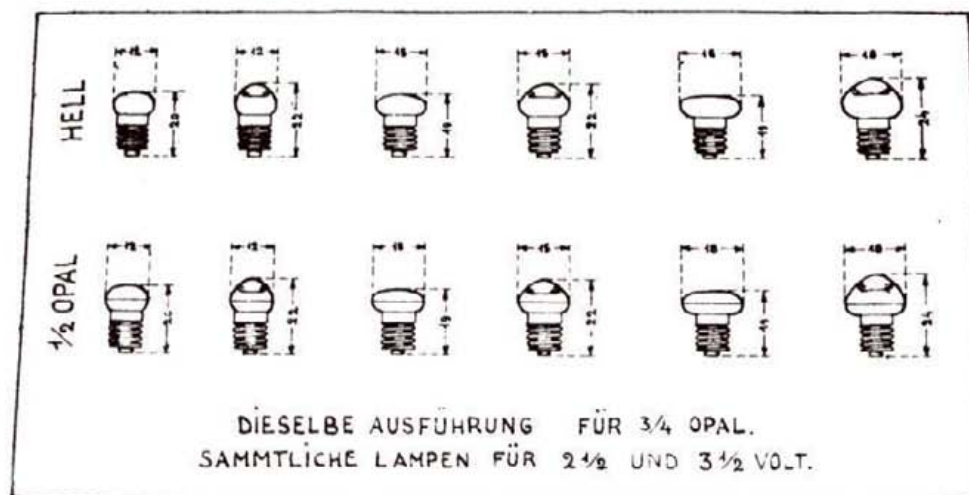
TUNGSRAM 1/2 WATT LAMPEN.



E.I.V.R.T.-UJPEST 15/V-1915-6

Pear-shaped and half-Watt lamps. The name half-Watt lamp referred to the fact that these lamps gave out 5 lumens while consuming only 1/2 Watt.

TUNGSRAM TASCHENLAMPEN.



E.I.V.R.T.-UNPEST 45V-4916.

OSZK

Országos Széchényi Könyvtár

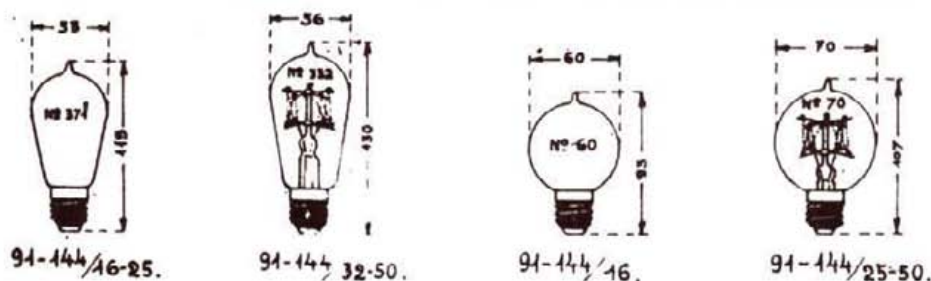
TUNGSRAM KERZENLAMPEN.

NORMAL KERZE.		GEDREHTE KERZE		ROTHSCHILD KERZE	KIRCHEN KERZE		GERADER DRAHT 21-144 VOLT
21-135 _{5/10} 16	136-144 _{1/16} 21-144 _{2/25}	21-135 _{5/10} 16	136-144 _{1/16} 21-144 _{2/25}	21-135 _{5/10} 16	21-144 _{1/16}	21-144 _{2/25}	 SPIRAL DRAHT 145-240 VOLT
136-250 _{1/16}	145-250 _{2/25}	136-250 _{1/16}	145-250 _{2/25}	136-250 _{1/16}	145-250 _{1/16}	145-250 _{2/25}	

E.I.V.R.T.-UNPEST 45V-4916.

Midget-lamps used in electric torches and candle-shaped lamps.

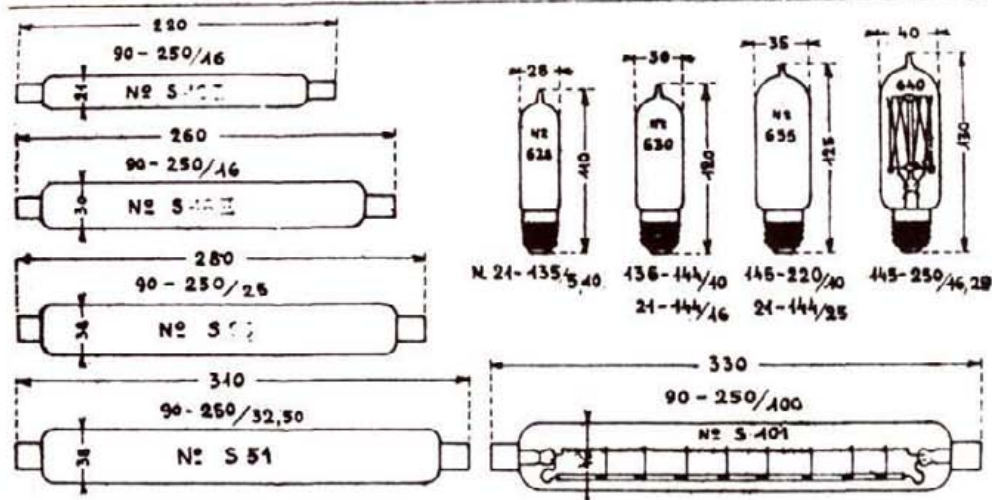
TUNGSRAM "S" (SPINNEREI SZÖVÖDE) LAMPEN.



DIESE LAMPEN EIGNEN SICH FÜR SOLCHE STELLEN, WO GRÖßERE ERSCHÜTTERUNGEN SIND, ALSO SPINNEREIEEN, MASCHINENFABRIKEN, WAGGONBELEUCHTUNG ETC. UND KÖNNEN FÜR NORMALE SPANNUNGEN ~ 16-50 KERZEN HERGESTELLT WERDEN.

E.I.V.R.T.-UJPEST-4/X-1916

TUNGSRAM SOFFITTEN UND ROHRLAMPEN.



"S" lights (S meaning Spinnerei = weaver's workshop). They stand up to shaking very well, so they can be used in weaving workshops, machine factories or in trains. The figures below show the dimensions of festoon lamps and tubular lamps.

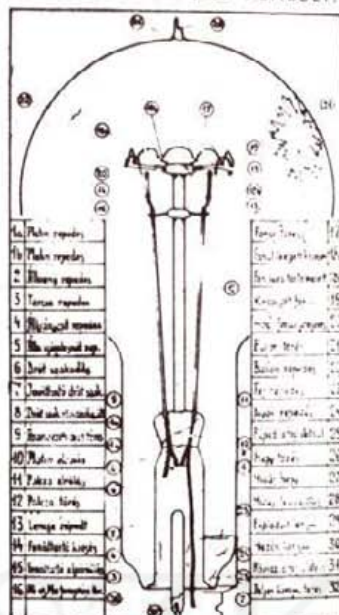
E.I.V.R.T.-UJPEST-1/V-1914

NORMAL LÁMPÁK HIBAI



E.L.V.R.T. UPEST. 4942-V. 3.

1/2 WATT LÁMPÁK TÖRÉSEI.



E.L.V.R.T. UPEST. 4942-II. 25.

The possible faults and the points of frequent breakage in the case of normal and half-Watt lamps.

Normál lámpa W/HK előírása.
(Össz. Watt kísánításával.)

90 Volt - 160 Volt. 200 Volt - 260 Volt.

HK	Ossz. Watt	W/HK	HK	Ossz. Watt	W/HK
5	6 - 7	1.2 - 1.4			
10	10 - 12	1.1 - 1.2	10	13 - 14	1.3 - 1.5
12	14 - 15	"	12	15 - 17	"
14	16 - 17	"	14	18 - 19	"
16	17 - 19	1.1 - 1.2	16	18 - 20	1.1 - 1.2
18	19 - 20	"	18	20 - 22	"
20	22 - 24	"	20	23 - 25	"
22	24 - 26	"	22	25 - 27	"
25	26 - 29	1.0 - 1.1	25	27 - 30	1.1 - 1.2
28	29 - 32	"	28	30 - 35	"
30	31 - 34	"	30	33 - 36	"
32	33 - 37	"	32	33 - 36	1.0 - 1.1
35	37 - 40	"	35	37 - 40	"

The W/HK specifications of normal lamps. (HK is short for Heffner-Kerze (Heffner-Candle) and was a measure for luminosity. The term went out of use decades ago.)

1/2 WATT LAMPEN GEWICHTS TABELLE.

TYPE	GEW. GRAMM	TYPE	GEW. GRAMM
100-120V/ 40 W (50 HK)	40	30-165V/ 500 W (1000 HK)	210
30-160V/ 60-75W (100 HK)	50	200-260V/ 500 W (1000 HK)	220
200-250V/ 60-75W (100 HK)	60	30-160V/ 1000 W (2000 HK)	320
30-250V/ 100 W (200 HK)	70	200-260V/ 1000 W (2000 HK)	330
30-250V/ 150 W (300 HK)	100	30-260V/ 1500 W (3000 HK)	460
30-160V/ 300 W (600 HK)	135		
200-260V/ 300 W (600 HK)	140	100-130V/ 25 W (20 HK)	30

E.I.V.R.T. UJPEST-20/V.4

MAGASGYERTYAFÉNYŰ - LÁMPÁK JELZÉSE.

FESZÜLTSG	FESZÜLTSG JELZÉSE	GYERTYA FÉNY	GYERTYAFÉNY JELZÉSE
65	65	200	II
73	73	300	III
80	8	400	IV
100	10	500	V
110	11	600	VI
115	115	700	VII
150	15	800	VIII
215	215	900	IX
220	22	1000	X

PÉLDÁUL: $\frac{65}{200} = 65 \text{ II}$, $\frac{110}{1000} = 11 \text{ X}$.

The table on the top shows the weight of half-Watt lamps. The one below holds the figures of high-performance lamps.

E.I.V.R.T. UJPEST 4443-VI.3



EGYESÜLT VILAMOSSÁGI RÉSZVÉNY-TÁRSASÁG

UJPEST.

vezető EGGER B. és TÁRSA.

UJPEST.

Városi iroda és csillárraktár: BUDAPEST, VI. Andrassy-út 7. szám.

Villamvilágítás, erőátvitel, izzólámpák, telefonberendezések, házisürgöny és villámhárítók.

I. évfolyam

Budapest, 1908. évi március hó 1-én

3. szám

Elektrotechnika

ELŐFIZETÉSI ÁRA

Egész évre 20 korona
Félévre 10 korona
Megjelenik minden hó 1. és 15.-én

A „MAGYAR

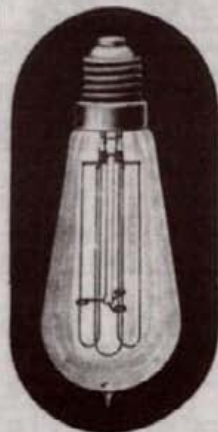
ELEKTROTECHNIKAI EGYESÜLET”
HIVATALOS KÖZLÖNYE

Szerkesztőség:

II. ZSIGMOND-UTCA 1. SZÁM

Kiadóhivatal:

VI. RÖTTVÖS-UTCA 26. SZÁM



Kapható minden viszont-
eladónál és szerezőnél.

Egyesült izzólámpa és villamossági r.-t.

Telefon:
10-01 és 10-12

Ujpest, 4.

Sürgönyvonal:
„Amplon”

»Dr. Just« - Wolframlámpa
1 watt 70%-os árammeg-
takarítás.

Telefonok, telefon-berendezé-
sek, házisürgöny berendezési
cikkék.

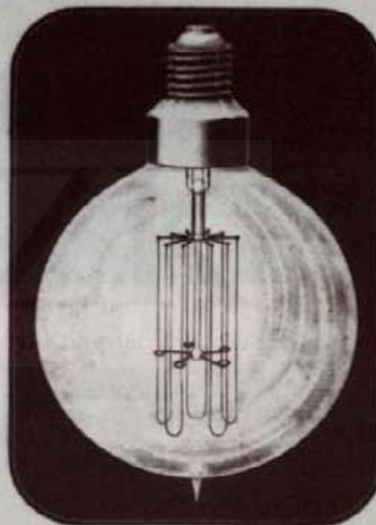


“Elektrotechnika” was the official publication of “Magyar Elektrotechnikai Egyesület” (Hungarian Electrotechnological Society) between 1900 and the end of the First World War. As such, it published numerous TUNGSRAM advertisements in the course of years. We have selected a few typical adverts from this sequence. The small advert on the top still mentions the predecessor, the Egger company. The advert on the bottom calls attention to the advantages of Dr. Just’s tungsten lamp.

Egyesült Izzólámpa és Villamossági Részvénytársaság Ujpest, 4.



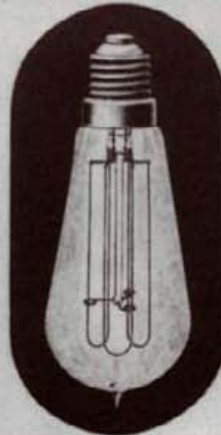
TÁVBESZÉLŐ SZÁM
10-01 és 16-12



SÜRGÖNYCZIM:
Ampere, Ujpest

Dr. Just- Wolframlámpa

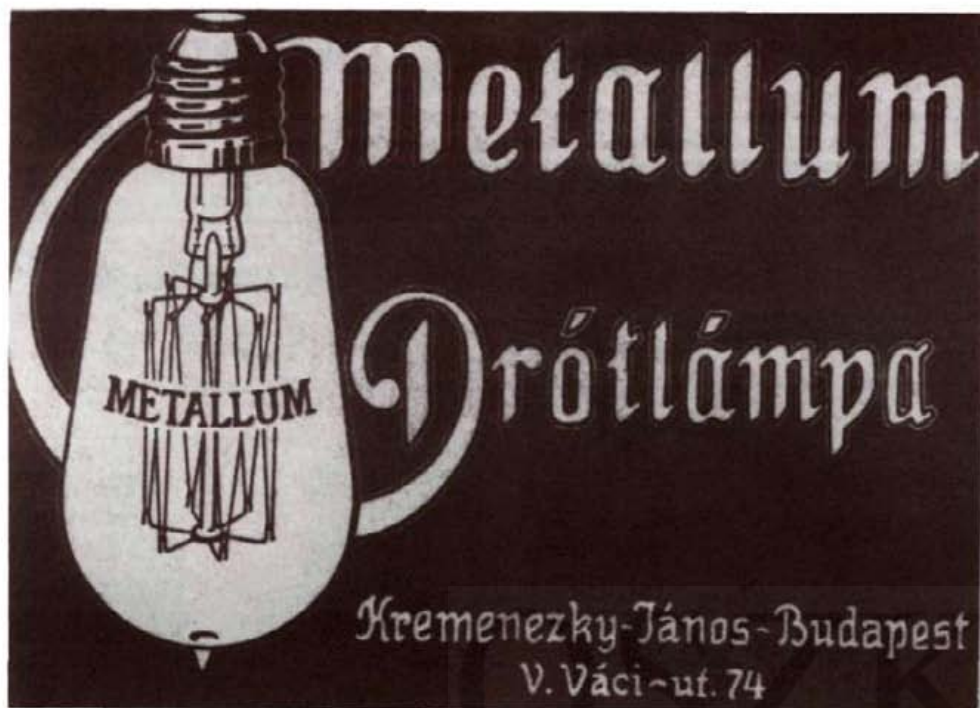
70%-os árammegtakarítás a szénfonalú izzólámpákkal szemben. Kellemes egyenletes fehér fény, fénycsökkenés nélkül. Minden viszonteladónál kapható.



Telefonok, telefonközpontok. Biztosító szerelvények.

Villamos csengőkészülékek. Villámhárítók. Villamos felszerelési cikkek. Izzólámpák mindenféle alakban.

On this advertisement the tungsten lamp still appears in the company of telegraph and telephone adverts, the profile inherited from the predecessors.



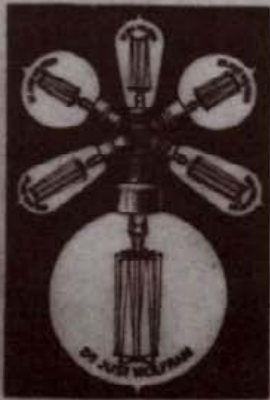
Metallum
Drótlámpa

Kremenezky-János-Budapest
V. Váci-ut. 74

II. évfolyam Budapest, 1909. évi január hó 15-én 2. szám

Egyesült izzólámpa és villamossági r.-t.

Teljesítmény: 10-12 és 15-12 **Ujpest, 4.** Helyettesítő: „Amper”



»Dr. Just« - Wolframlámpa
1 watt **70%-os** árammeg-
takarítás.
Telefonok, telefon-berendezé-
sek, hűtőszögöny berendezési
cikkék.



VII. évfolyam. Budapest, 1914 évi május hó 1-én 9. szám

POSSONY,
Budapesti közlő,
V., Rudóff-utca 9.

Közlöny R.-T.

személyek
személyek, más ut.
személyek, más ut.
személyek, más ut.



**„TUNGSRAM“
DRÓTLÁMPA**
huzott dróttal
ELPUSZTITHATATLAN.
HAZAI GYÁRTMÁNY!
A gyár **4000 személyt** foglalkoztat.
**EGYESÜLT IZZÓLÁMPA
ÉS VILLAMOSSÁGI R.-T.**
UJPEST, 4.
Telefon :
78-52, 78-53,
78-54, 10-61.
Sörgőzeim :
„AMPERE“
UJPEST.

személyek, más ut.
személyek, más ut.
személyek, más ut.

VII. évfolyam. Budapest, 1914 évi március hó 15-én 9. szám

POSSONY,
Budapesti közlő,
V., Rudóff-utca 9.

Közlöny R.-T.

személyek
személyek, más ut.
személyek, más ut.
személyek, más ut.

**„TUNGSRAM“
félwattos lámpa**
a leggazdaságosabb és leghatá-
sosabb erőforrás.
Áramfogyasztása gyertyafényként csak
1/2 Watt.
Legelőnyösebben pótolja az izzólámpát.
Kapható 600—3000 gyf.-ben.
**EGYESÜLT IZZÓLÁMPA
ÉS VILLAMOSSÁGI R.-T.**
UJPEST.



1/2-watt
Sörgőzeim : AMPERE, UJPEST.

személyek, más ut.
személyek, más ut.
személyek, más ut.

X. évfolyam.

Budapest, 1917. évi április hó 1-én.

7. szám.

EGYESÜLT IZZÓLÁMPA és VILLAMOSSÁGI R.-T.

Telefonszámok:

78-52. 78-54.

78-53. 10-01.


UJPEST 4.

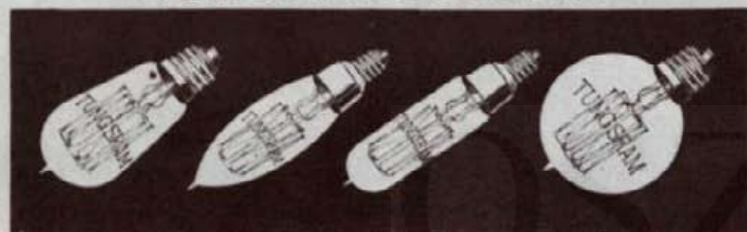
Sürgőny cím: „Ámpéra Ujpest.”



Tengo nagy gombosak.

Szálcső-lámpa.

Tengo kisebb gombosak.

Spirális drótlámpák.


Külső.

gyertya

cső.

gombosak.

Tungsrám-drótlámpák.

IX. évfolyam.

Budapest, 1916. évi április hó 1-én.

7. szám.

Tungsrám

**Drót
lámpa**

1/2
Watt

Further posters advertising coiled filament lamps. TUNGSRAM lamps are claimed to be superior, lasting longer and indestructible.



„TUNGSRAM” DRÓTLÁMPA
 huzott dróttal
a legjobb és legtartósabb!

 A central illustration within a rectangular frame shows a man in a long coat and hat, using a hammer to drive a nail into the base of a light bulb. The light bulb has 'TUNGSRAM' written on it.

Egyesült Izzólámpa és Villamossági R.-T. UJPEST 4.

TELEFON
 78-54, 78-53
 78-54, 10-04.

SÖRGÖNYCZIM
 AMPÉRE, UJPEST.



„Tungsram“ Wolframlámpa

rugékony drótszerkezettel 75% árammegtakarítás.



Rázkód-
tatásoknak
ellenáll.

Hosszú
égési tar-
tam.

Szép,
kellemes,
fehér fény.

Egyesült Izzólámpa és Villamossági R.-T.

TELEFON: 78-52,
78-54, 78-53, 10-01.

UJPEST, 4.

Sürgőnycim:
AMPÈRE, UJPEST.

This poster advertising the tungsten lamps of TUNGSRAM was drawn in a typically art nouveau style, at a time when the posters still followed the trend set by the painters. The lady is said to be modelled after Mr. Aschner's wife.

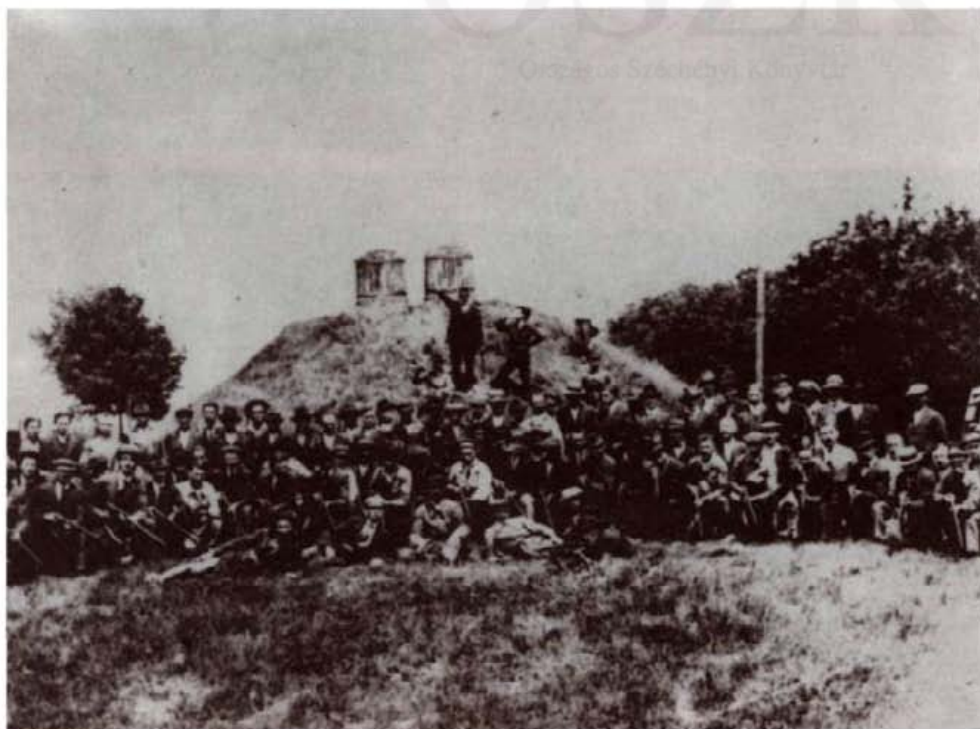
This electronic valve was one of the first ever produced by TUNGSRAM. It was built into the army field radio made by Telephone Works under the code-name KLERA during the First World War.



An incandescent lamp assembly line in the Vienna WATT WIEN A. G., the factory in which TUNGSRAM held shares.



This photograph shows the boat-house of the company's "Ampère Sport Club". It was only one of the recreation facilities where TUNGSRAM employees could relax and enjoy themselves in civilized surrounding.



This amateur photograph of the "Red Guards" of TUNGSRAM was taken in the garden of the Waterworks in 1919. László Németh, the former caretaker of the TUNGSRAM swimming pool, took considerable risks when he saved this picture during the years of the Horthy-regime.

The devaluation of the Hungarian currency peaked in the mid-1920's. In contrast, the value of TUNGSRAM's shares remained steady and when the new currency, Pengő was introduced the shares were converted to this currency. This way the company started the post-war period with good prospects.



OSZK

Országos Széchényi Könyvtár



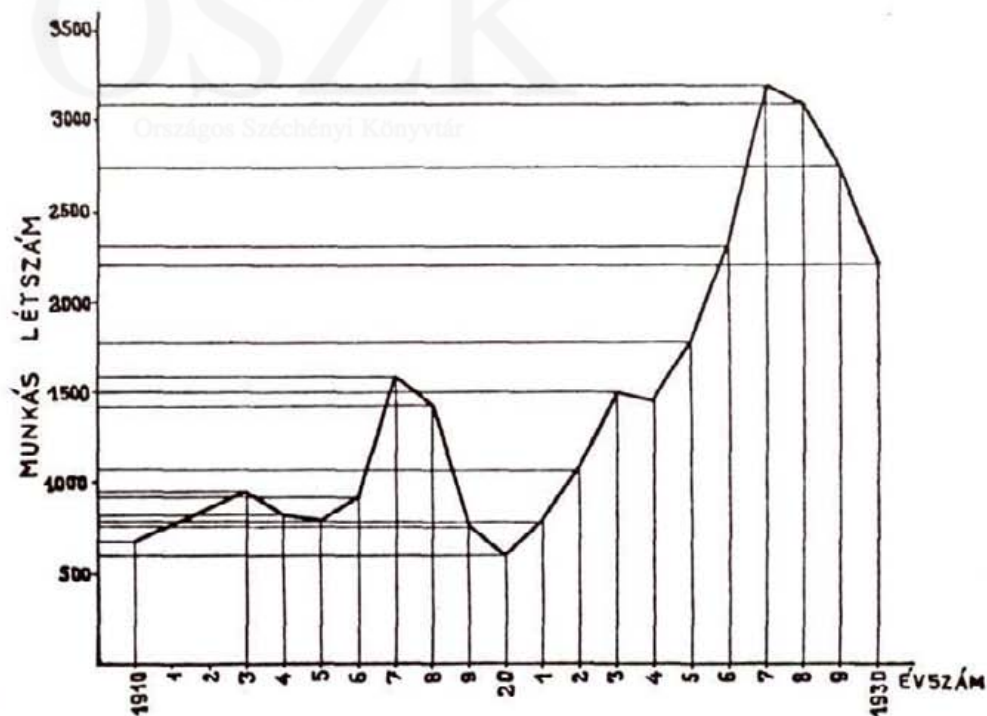
This letter-head shows the factory of TUNGSRAM as it looked in the beginning of the century. Significant alterations were only made in the 1930's. The four-digit telephone-number shows that the company's customized stationery was in use during or before the First World War.



In the 1920s, when this picture was taken, telephones were still being assembled in the Machine Works of TUNGSRAM.



The manual switches of the telephone exchanges were also made here.



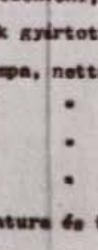
This diagram, taken from a Hungarian technical publication, shows the number of workers employed by the Telephone and Telegraph Department of TUNGSRAM between 1910 and 1930.

AZ E.I.V.R.T. TEL. ÉS TÁV. FŐOSZTÁLYÁNAK ILL. A STANDARD VILL.R.T.-NAK MUNKÁS LÉTSZÁMA 1910—1930.

Egyesült Villamosági és Erőátviteli Gyár

EGYER B. ÉS TÁRSÁI

BUDAPEST — BÉCS

VILLAMOS VILÁGÍTÁS
ÉS ERŐÁTVITEL
JELZŐLAMPÁK,
TÁVIRÁDÓK,
TÁVIRALAI KESZÜLEMÉNYEK,
VILLAMOS JELZŐLAMPÁK,
VILLAMOS ÉS MECHANIKUS JELZŐK
ÉS SEMAPHOROK VASÚTAK
RÉSZEIRE

Budapest, 1897 augusztus 5.
VII. Múzeum utca 7.

Tekintetes

BUDAPESTI KERESKEDELMİ ÉS IPARKAMARA,
B u d a p e s t .

Van szerencsénk jelenteni, hogy a következı részletesen felsorolt csomagokban levő általunk gyártott árukat :

V.E.A.G. 3 láda	801a 6 ivlámpa,	netto 37.500,	brutto 74.000	Ry
" " " 1 "	802. 6 " "	37.500, "	73.000	
" " " 1 "	803. 6 " "	37.500, "	74.000	
" " " 1 "	804. 2 " "	12.500, "	25.000	
" " " 1 "	805. 10 armatura és üveggömb,	netto 68.000,	brutto 134.000	
" " " 1 "	806. 8 " "	" "	51.000, "	111.000
" " " 1 "	693. 9 ellenállás	" "	45.000 "	63.000

a Società per l'Illuminazione Elettrica-nak az Apua szándékomunk, Metzner & triesti szállító cég útján elszállítani, miért is bátorkodunk tisztelttel felkérni, hogy a szükséges származási bizonyítványt részünkre kiállítani sziveskedjék.

Kiváló tisztelettel

EGYESÜLT VILLAMOSÁGI ÉS ERŐÁTVITELI TÁRSASÁG

4 195-13674 / 1897

KÖZLEKEDÉSI LEVELEZŐ I. osztály

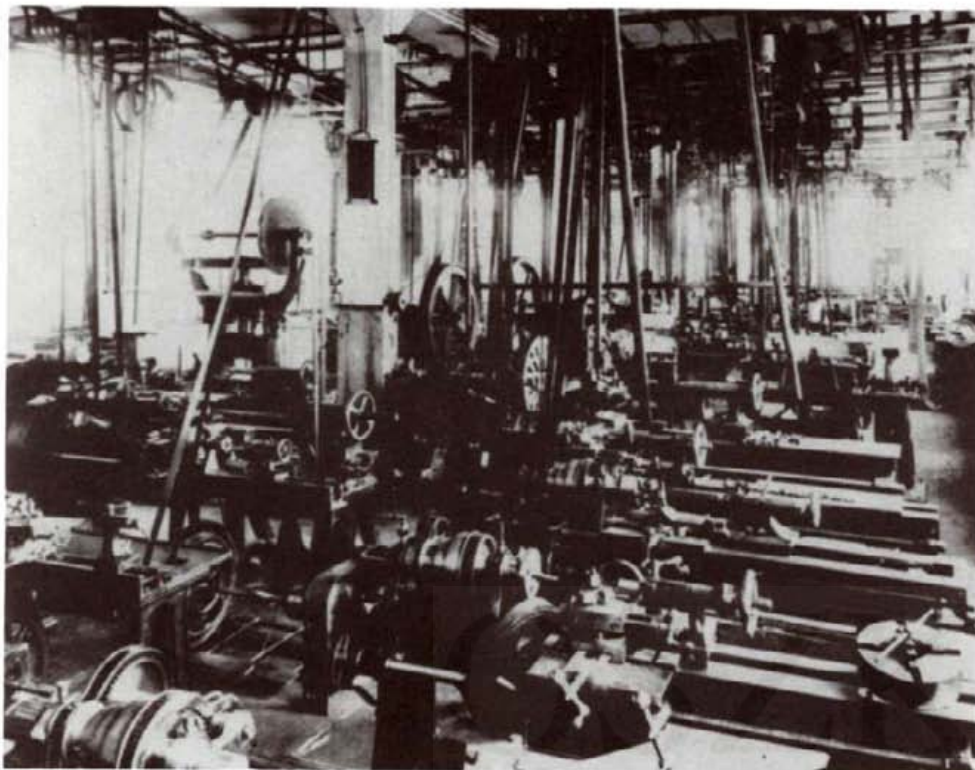
This letter is very interesting for two reasons: on the one hand it tells about a consignment of dispatched to Capua, on the other hand it was written on the stationery of the original company, with its name effaced on the letterhead. At the bottom, however, where the signature is, the stamp already mentions a public company, even though this was still an intermediate designation before "United Incandescent... that is TUNGSRAM, since the word 'Iz-zólámpa' (that is incandescent lamp) of the final name was still missing.

We might find this 'jungle' of transmissions fascinating, but it was a perfectly usual sight in the TUNGSRAM Machine Works during the 1920s.



The assembly workshop of telephone and telegraph equipment in the 1920s.





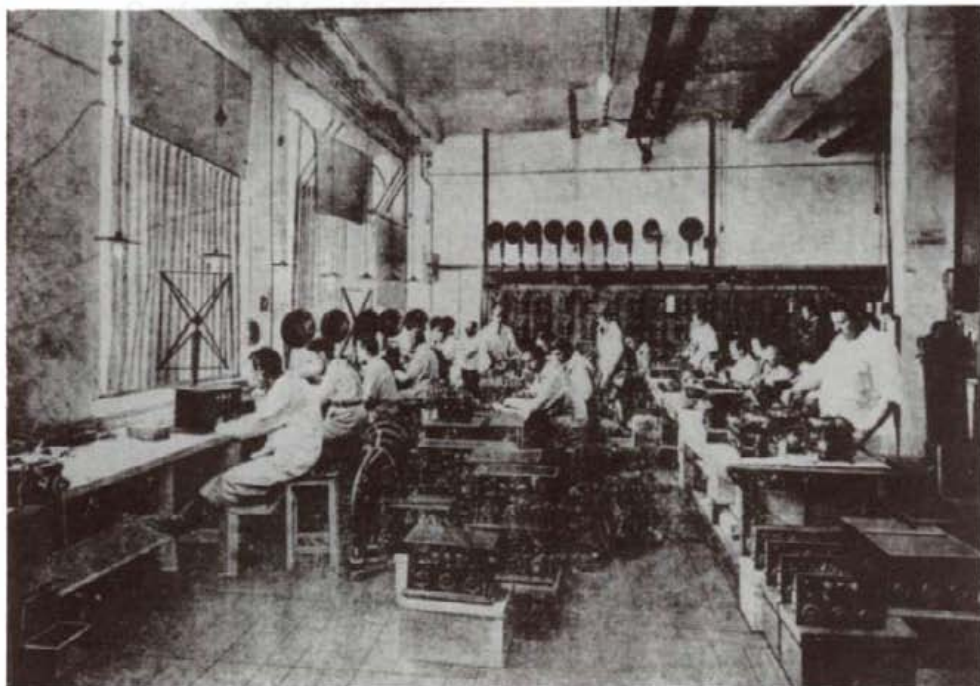
The lathe workshop of the Machine Works (later became a separate company called Standard) between 1925 and 1930. Today here is the Machine Development Department and the workshop known as Preventive Maintenance.



This room in the Machine Works was used for the inspection of telephone sets (1925).



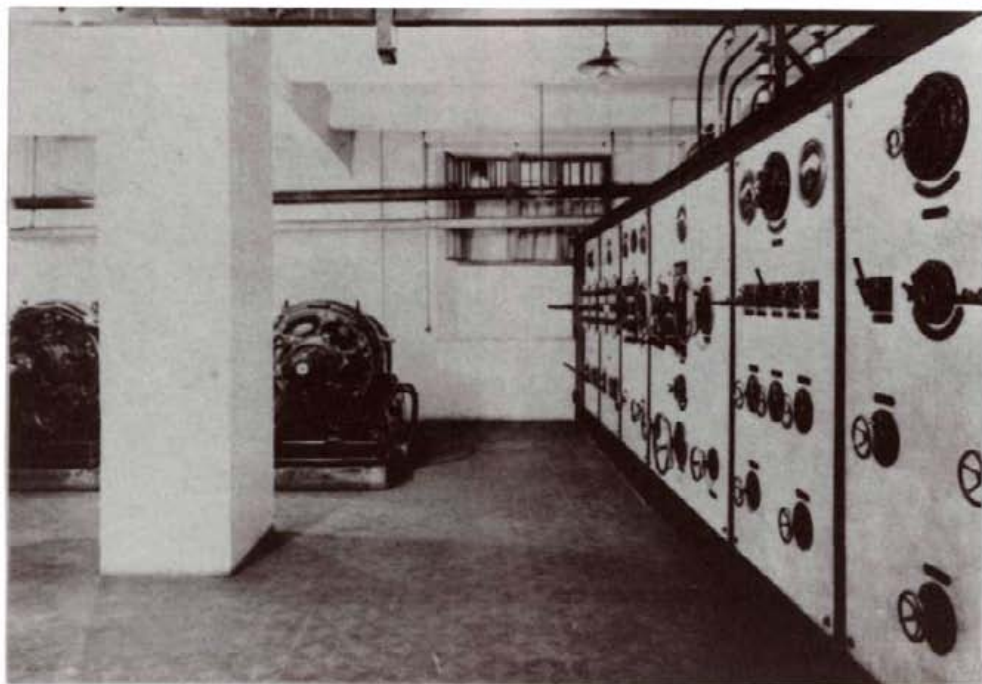
The assembling and testing of manual telephone exchange systems in the Machine Works during the early 1920s.



Telephone assembly line in the 1920s.



The József Telephone Exchange was manufactured and installed by TUNGSRAM in the early 1920s. (It is still operating.)



The engine-room and the switch boards of the József Telephone Exchange. TUNGSRAM had contracts to manufacture complete telephone exchanges and subcontracted other Hungarian companies to supply the power units which it did not manufacture.

Alle im Zusammenhange mit dem
 world agreement geschlossenen Sonderabmachungen
 gelten auch für den vorstehenden, veränderten
 Vertrag (siehe jedoch Absatz 2).

Das anliegende Sonderabkommen
 wegen Gewährung eines Sonderkontingents an
 Hoch Premererky gilt nur, solange das vor-
 stehende geänderte Abkommen in Kraft
 ist und anstelle des Sonderabkommens mit
 der gleichen Firma vom 4. 11. 24 in Hamburg.

Berlin, den 19. November 1924

gez. Meinhardt
 gez. H. F. Philips
 gez. Ischner

gez. Premererky
 gez. C. C. Rothweiler

This is a photograph of the German version of the PATENT AND BUSINESS DEVELOPMENT AGREEMENT (otherwise known as the Phoebus Agreement), which was the founding document of an international lamp cartel. It played an important role in the history of TUNGSRAM. The signatures belong to the leading figures of incandescent lamp industry in the heroic early days.

Anlage B.

Liste der Tochtergesellschaften.

~~General Electric Co. Ltd., London.~~~~Papa Electric Lamp Co. Ltd.~~~~International General Electric Co., Paris.~~~~China General Edison Co., Inc., Shanghai.~~~~General Electric S. A. (Fabbrica Munda), Rio de Janeiro.~~

Johann Kremenezky, Wien.

Ungarische Wolframlampen Fabrik Joh. Kremenezky A.G.,
Budapest.

Osram G. m. b. H. Kommanditgesellschaft, Berlin.

Wolframlampen A.G., Augsburg.

Drammens Lampefabrik, Drammen.

Osram Fábrica de Lámparas, Madrid.

Osram A.-G., Prag.

Polska Żarówka Osram S.A., Warschau.

N. V. Philips Gloeilampenfabrieken, Eindhoven.

Fábrica de Lámparas Electricas „Z“, Barcelona.

Société Anonyme Suisse Fournitures Electriques, Stäfa.

Polska Holenderska Fabryka Lampek Elektrycznych „Philips“.

Sp. Ak., Warschau.

N. V. Metaaldraadlampenfabriek „Volt“, Tilburg, mit ihrer

Untergesellschaft „Volta“ Fabrique de Lampes Electriques.

Deurre-Antwerpen.

N. V. Pope's Metaaldraadlampenfabriek, Venlo.

Vereinigte Glühlampen- und Electricitäts A. G., Ujpest.

Elektrische Glühlampenfabrik Watt A.G., Wien.

Cyreon Glühlampenfabrik A.G., Warschau.

Glühlampenwerke Aarau A. G., Aarau.

Vertex Elektrowerk Ges. m. b. H., Atzgersdorf.

The German copy of the aforementioned cartel agreement, listing the founding companies and their subsidiaries.

PHOEBUS S. A.

GENÈVE

DEVELOPMENT DEPARTMENT

1932 SEP 1

U.Q.C. (UNIFORM QUALITY COMMITTEE)

GENERAL LETTER No. 63

September 3, 1932

Next Meeting.

Gentlemen,

L. Aschner
 J. Ayrat
 F. Baumann
 G. Chailoti
 K. Finckh
 J.Y. Fletcher
 W. Geiss
 F.J. Hawkins
 J.C. Lokker
 C. Reiter

The next meeting is definitely called for Tuesday October 11 in Budapest. We are preparing an agenda and a program, and would be glad to receive any suggestions in connection therewith.

Please let us know, if for any reason, it will not be possible for you to attend the meeting.

Yours very truly
 S.A. PHOEBUS
 C.A. Atherton

C.A. Atherton

This letter was sent from Phoebus S. A., confirming the date and place of the next meeting. The names of the invited parties were listed in alphabetical order on the left margin.



The assembling of stems with drawn tungsten filament for tungsten lamps in the beginning of the 1920s.



The production of discs sometime during the 1920s.

Stem production in the end of the 1920's.

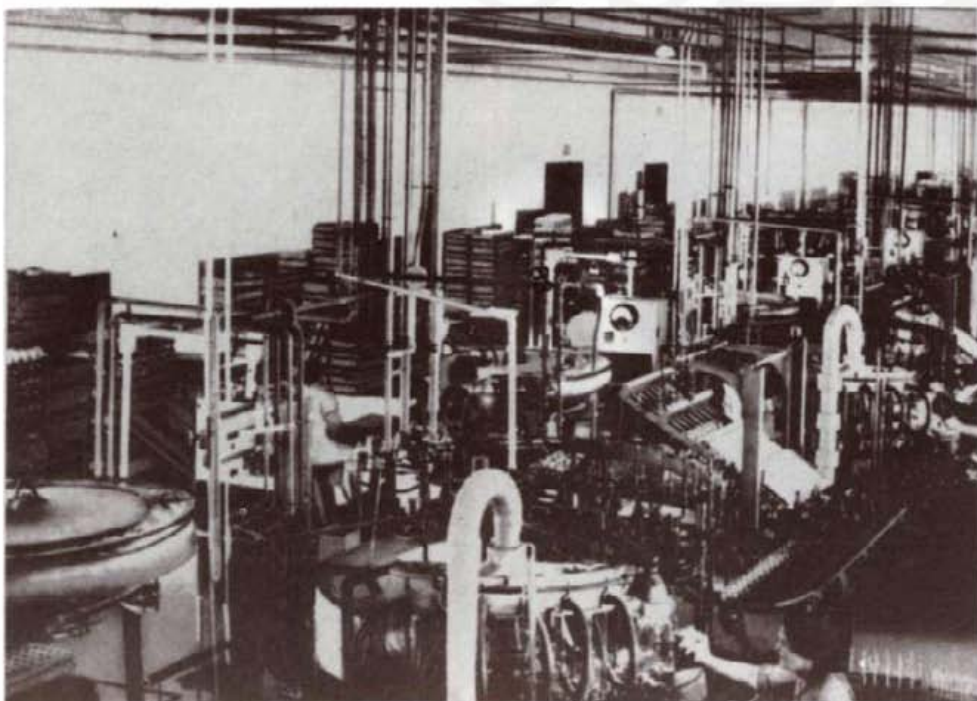


Lamp production had the following phases at that time:
1st phase: stem construction and assembling
2nd phase: sealing-pumping
3rd phase: the fitting of bases, final quality control, packing.





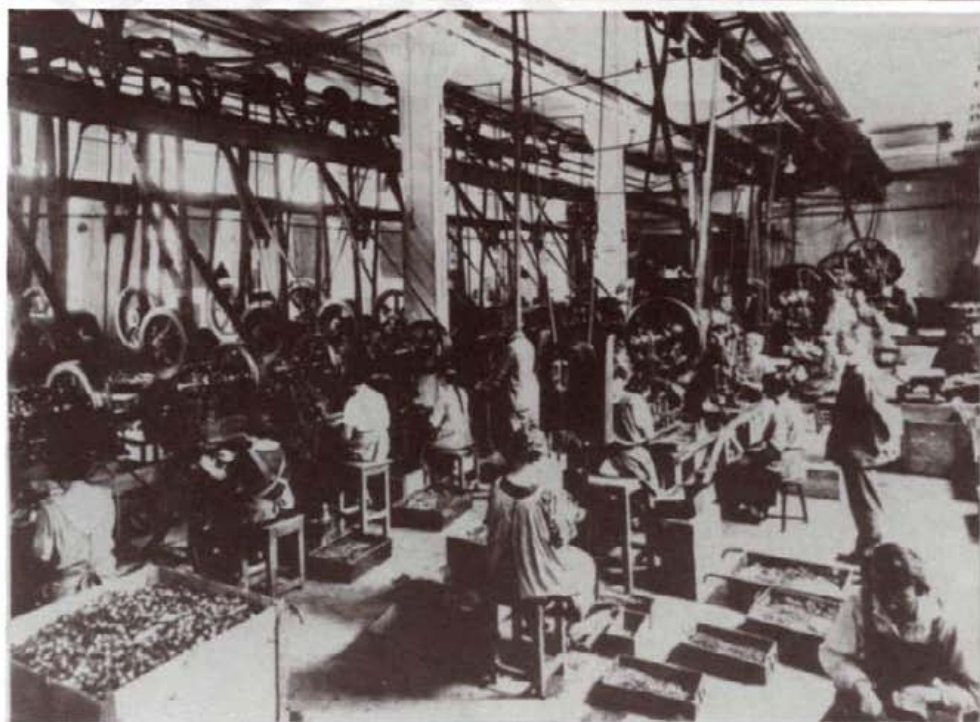
Lamp production using 24-way automatic vacuum pumps in the 1920s.



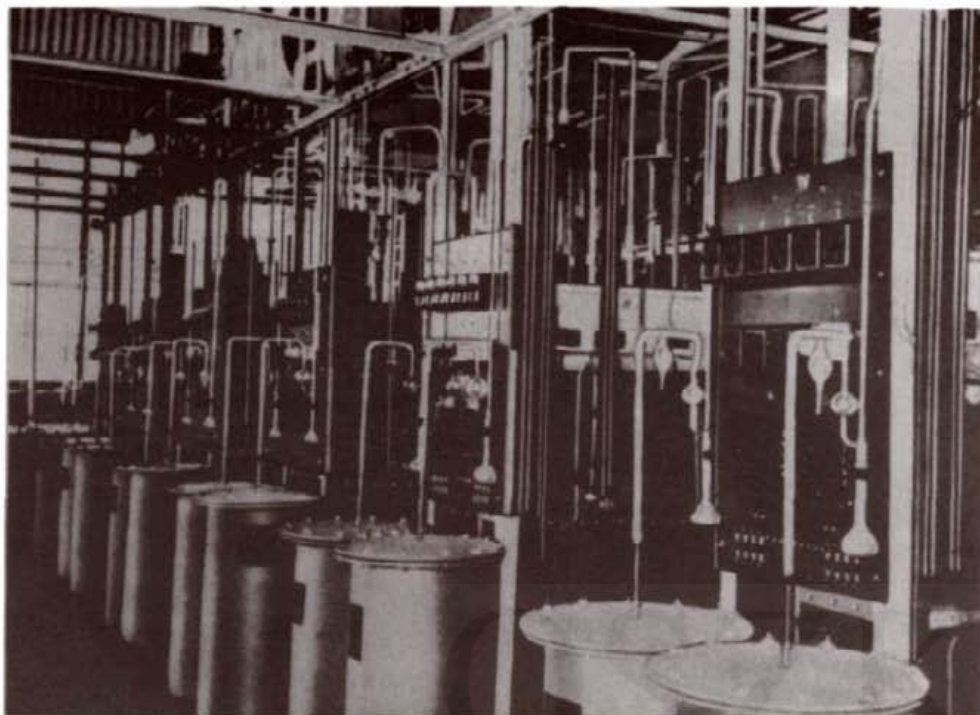
Lamp production in the end of the 1920s, following the automatization. In the right-hand line we see units consisting of a 16-way sealing machine and a 24-way automatic vacuum pump.

Lamp production in the 1930s with "unit"-type production lines.

On the left side of the photograph we see the basing and the preheating machines, on the right, the so-called "Sealex" automatic unit. At this time the fitting of stems was still manual, but the fixing of the glass bulbs was already automatic. On the right hand side of the picture we can see the conveyer belt with the complete stems.



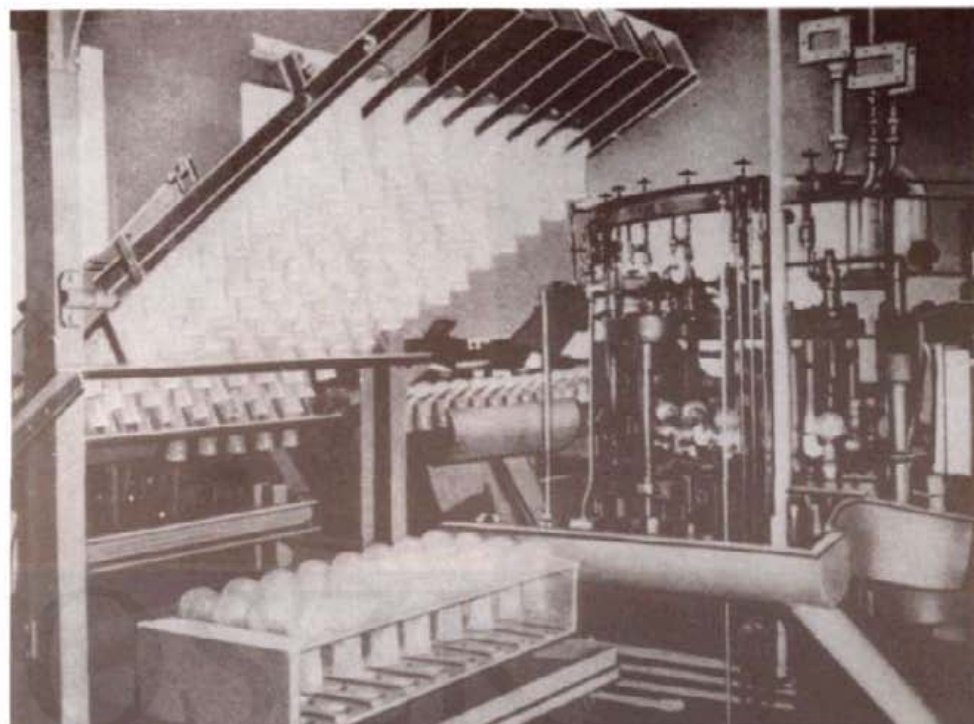
Incandescent lamp base production in 1920.



The workshop producing vitrit glass for lamps before the introduction of automatization in the 1920s.



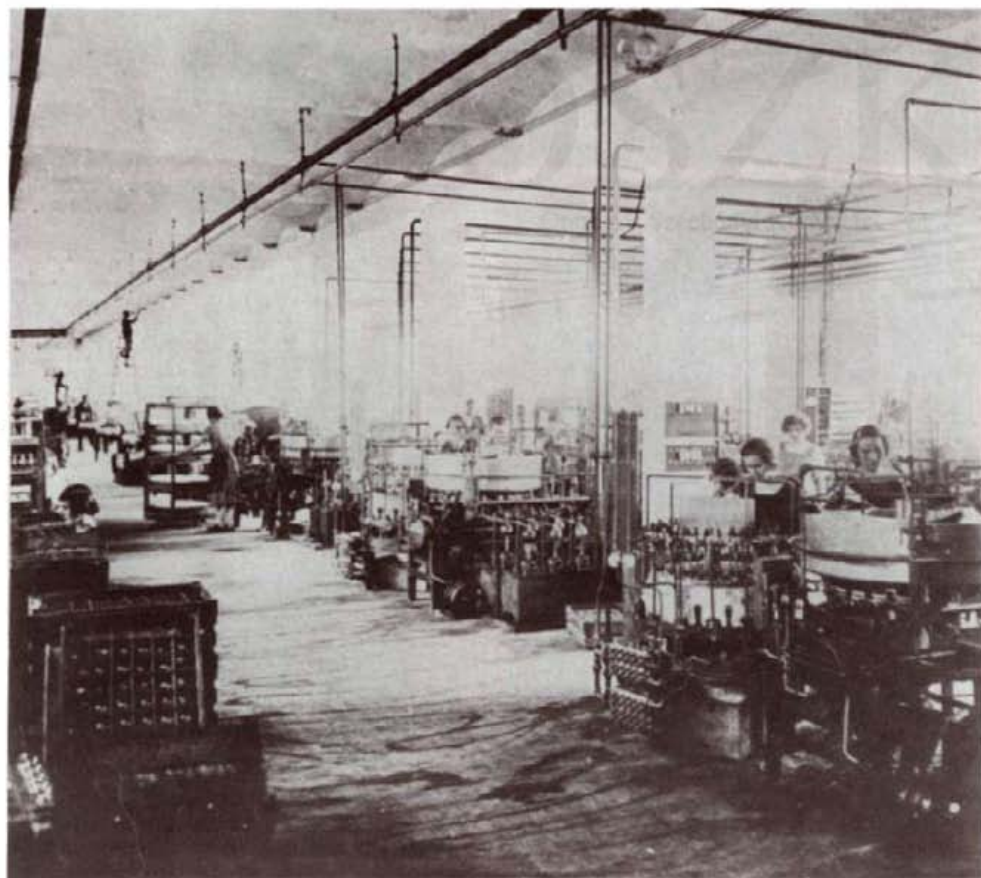
The purification of low-pressure inert gases in the 30s.



Automatic sealing of lamps in the 1930-s. On the left we can see TUNGSRAM's own construction: an automatic glass-bulb feeder.



Assembling the stems of gasfilled lamps. The company, by the way, is known for the frequent reconstruction of its existing facilities according to the varying demands. Today this hall accommodates TUNGSRAM's internal telephone exchange.



The pumping and sealing of vacuum lamps with General Electric's 16-way sealing machine and 24-way automatic pump at the end of the 1920s.



"Replace a coiled-coil lamp! Your eyes, as well as your valet will benefit from it!"—says the TUNGSRAM advert in the Marc 17, 1935 issue of the periodical of the Association of Hungarian Engineers and Architects. The "D" sign and the 'Dlm' (decalumen) stamp referred to the luminosity of the lamp. The cartel members had the edge on the outsider firms in production technology. They were able to produce lamps which provided more light without using more electricity. The 'Dlm' stamp, therefore, distinguished the Phoebus lamps from the other companies' products. The same stamp was used on the exported lamps and only went out of use when Phoebus was abolished.



Measuring the luminosity of incandescent lamps in a photometer sphere in the 1930s.

For your information—as well as in way of remembrance—we would like to show you the choice of Tungstram lamps from the period preceding the introduction of krypton lamps. The diagrams come from TUNGSRAM's catalogues published between 1926 and 1928.

Figure 1: Vacuum GSL (General Service Lamp) with coiled filament

Figure 2: Spherical shaped lamp with coiled filament for decoration

Figure 3: 'Resista' (vibration-resistant) vacuum lamp with coiled filament

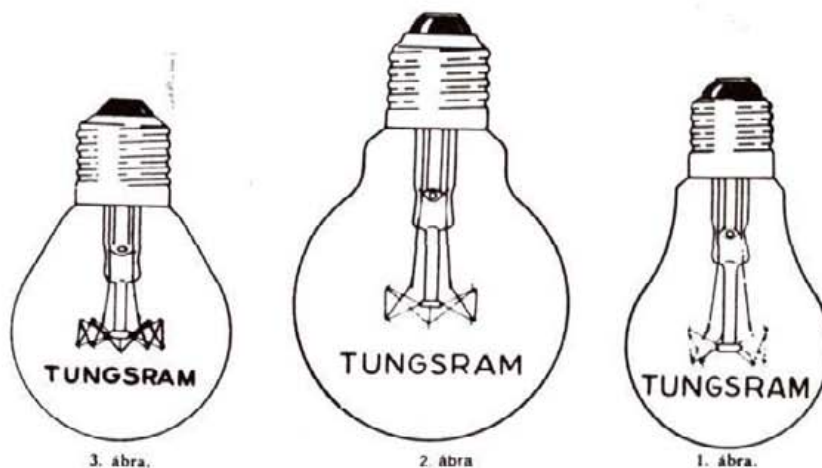
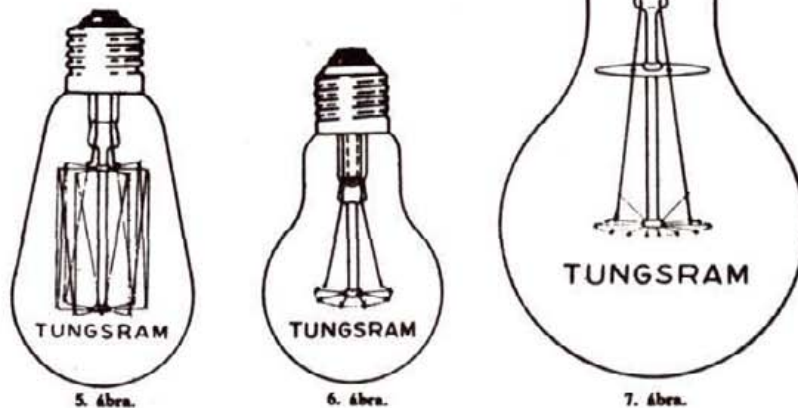


Figure 4: Coiled-filament vacuum lamp with reinforced structure, used in public roads and electric trams

Figure 5: Pear-shaped vacuum lamp with drawn wire

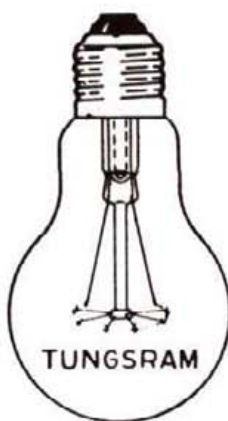
Figure 6: Gas-filled GSL lamp with single coil, having a luminous efficiency superior to that of the vacuum lamps

Figure 7: Gas-filled GSL lamp over 100 Watt output for industrial use, with single coil, having a luminous efficiency superior to that of the vacuum lamps

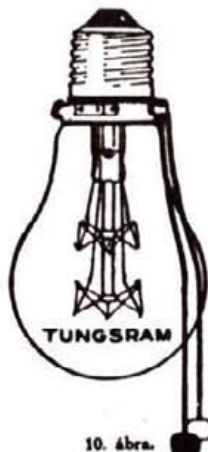




8. ábra.



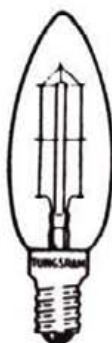
9. ábra.



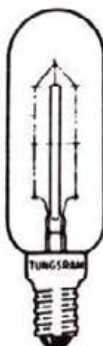
10. ábra.



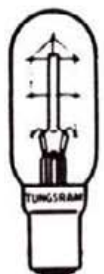
11. ábra.


Sima
12. ábra.

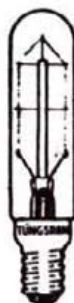
Csavart
13. ábra.

Kúpos
14. ábra.


15. ábra.



16. ábra.



17. ábra.

Figure 8: Gas-filled GSL lamp over 100 Watt output for industrial use, with single coil, having a luminous efficiency superior to that of the vacuum lamps, and fitted with opal bulb to reduce glare. It could be used without a separate luminaire.

Figure 9: Gas-filled GSL lamp over 100 Watt output for industrial use, with single coil, having a luminous efficiency superior to that of the vacuum lamps and fitted with blue glass bulb to give out light similar to daylight.

Figure 10: Economy lamp with two separate filaments. By pulling the string it switched from normal to economy mode, giving off less light. It was designed for bedrooms, hospitals and hotels.

Figure 11: It had the same characteristics as the lamp in figure 9, except it came in various colours to be used for decoration and in dark rooms.

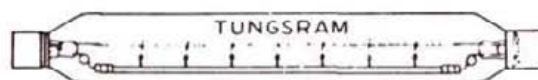
Figure 12, 13, 14: Candle-shaped vacuum lamps with coiled filament, having straight, twisted and conic glass bulbs of Askania type.

Figure 15: Tubular vacuum lamp with coiled filament

Figure 16: Vibration-resistant tubular vacuum lamp with coiled filament for sewing machines

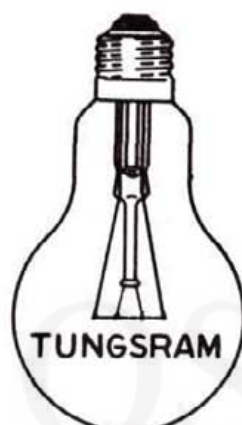
Figure 17: Slim tubular vacuum lamps with coiled filament used for inspecting wine-barrels

Figure 18: Festoon lamp with horizontally mounted coiled filament. Made especially for illuminating mirrors, shop-windows and paintings



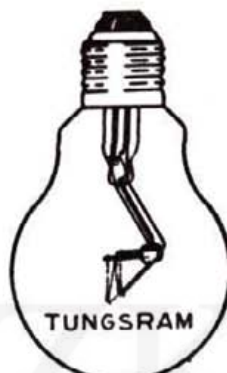
18. ábra.

Figure 19: Gas-filled lamp with single-coil filament running on low voltage (20–60 V)



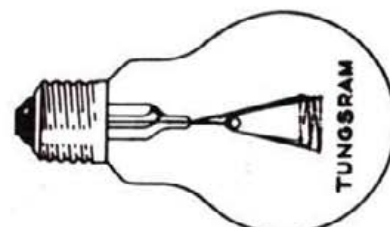
19. ábra.

Figure 20, 21: Vertically and horizontally mounted projector lamp



Függőleges helyzetben való használatra.

20. ábra.



Vízszintes helyzetben való használatra

21. ábra.



22. ábra



23. ábra



24. ábra



25. ábra



26. ábra



27. ábra

Figure 22, 23, 24, 25: Vehicle lamps for American cars

Figure 26, 27: Vehicle lamps for British cars

Figure 28, 29: Vehicle lamps for German cars

Figure 30: Vehicle festoon lamp for cars



28. ábra



29. ábra



30. ábra



31. ábra

Figure 31: Vehicle lamp for French cars

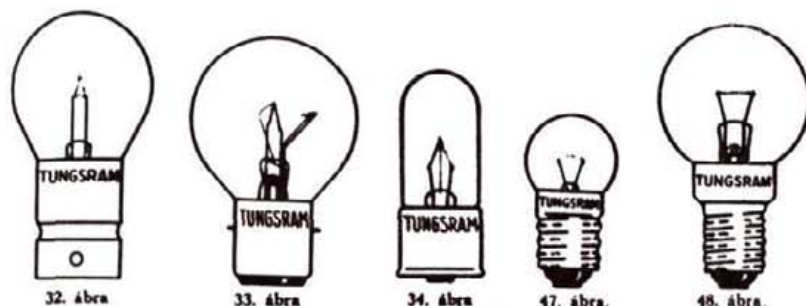


Figure 32, 33, 34: Vehicle lamps for various cars

Figure 47, 48: Battery operated vacuum lamps

Figure 49, 50: Gas-filled lamps operated with battery

Figure 51: Xmas tree lamp

Figure 52: Low-voltage lamp for decoration

Figure 53: Vacuum lamp for decoration, operated from the mains

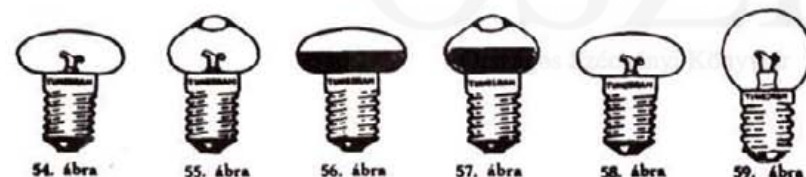
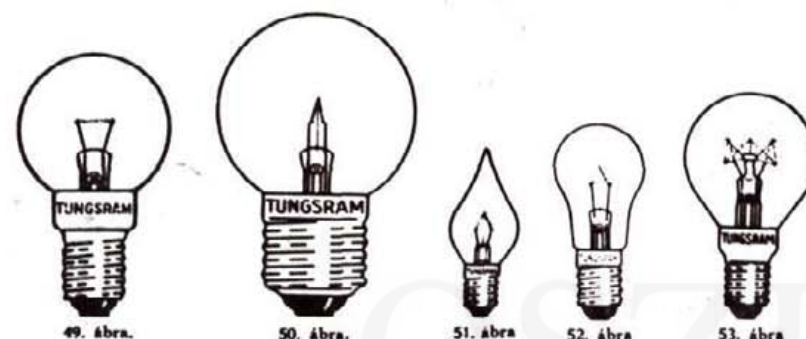


Figure 54, 55, 56, 57: Flat-ball head miniature lamps operated by dry batteries

Figure 58, 59, 60: Bicycle headlight lamp and battery operated miniature lamps

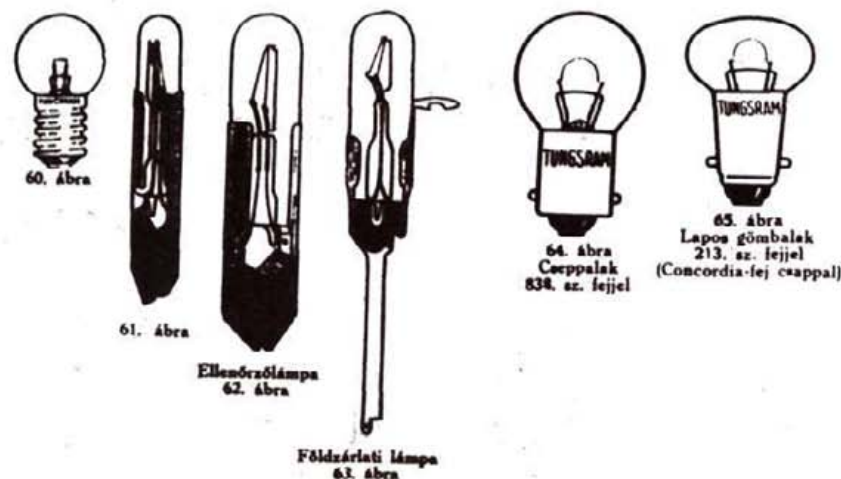
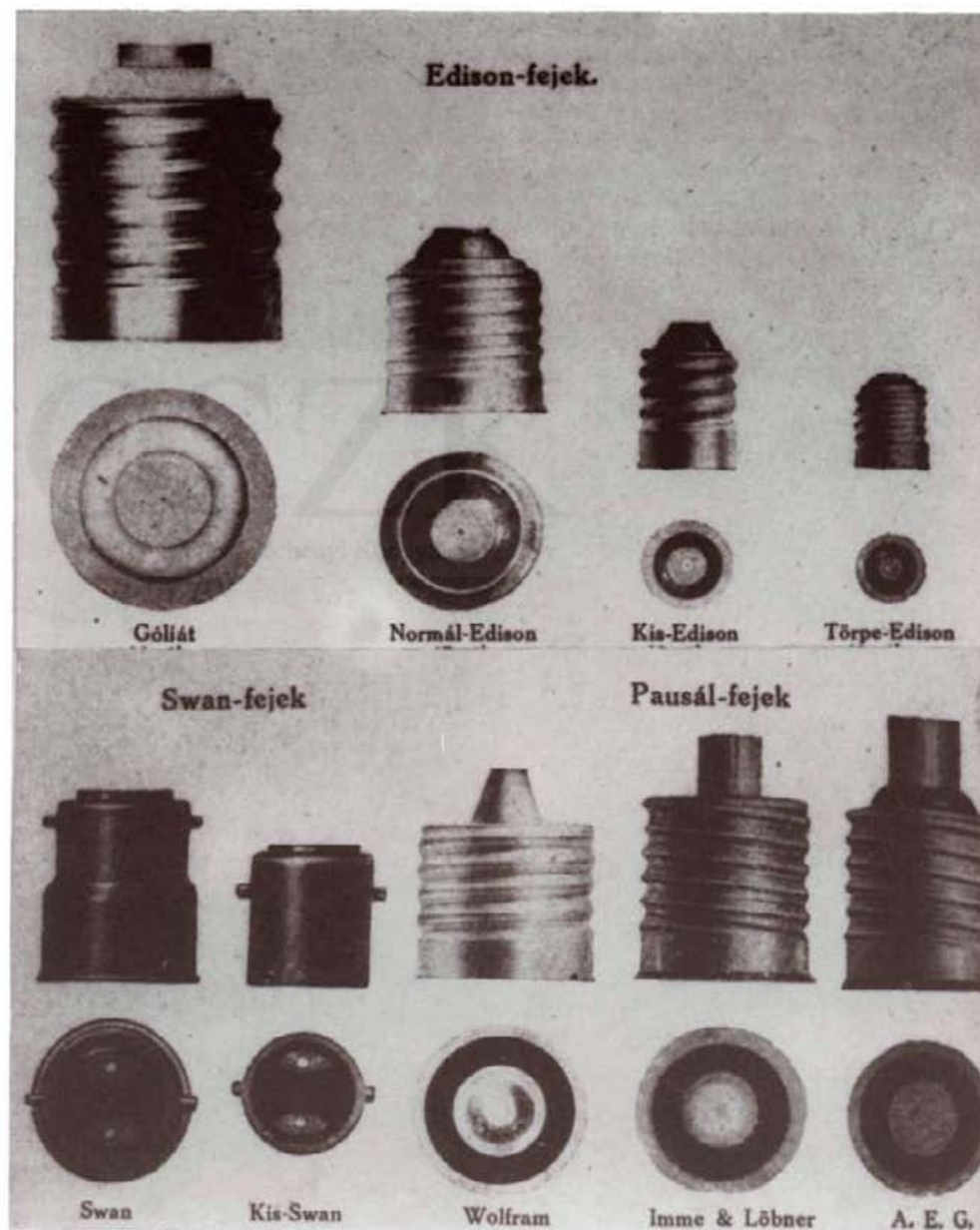


Figure 61: Telephone pilot lamp

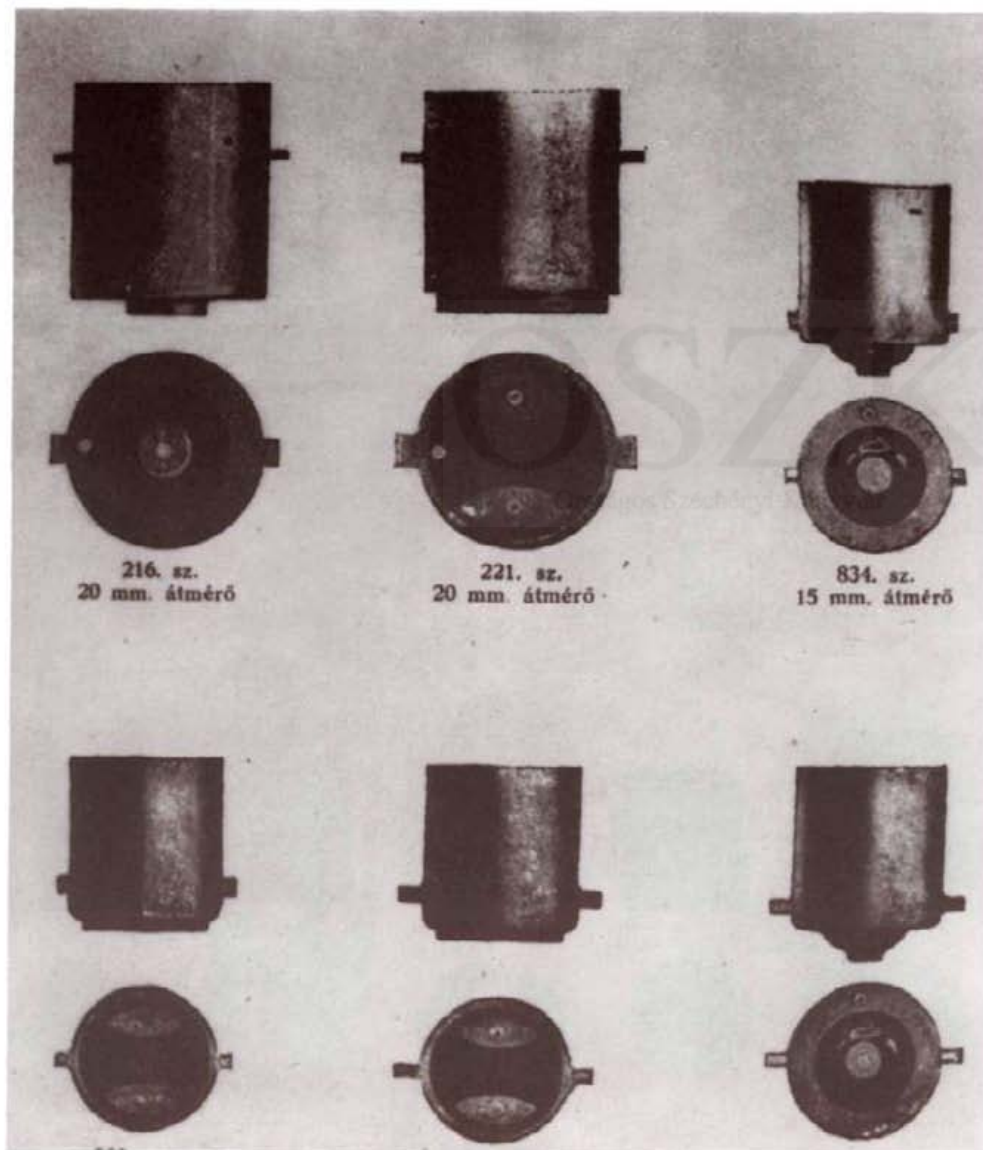
Figure 62: Telephone check lamp

Figure 63: Earth leakage indicator lamp

Figure 64, 65: Vacuum lamps with drawn filament used in mines



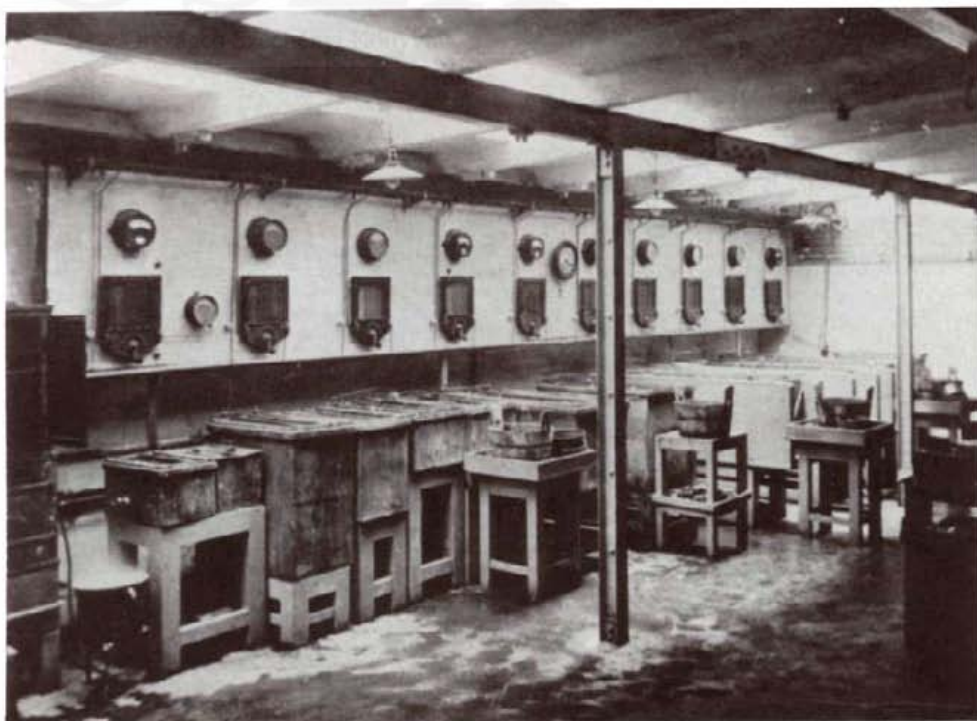
The most frequently used bases for the above-listed TUNGSRAM lamps



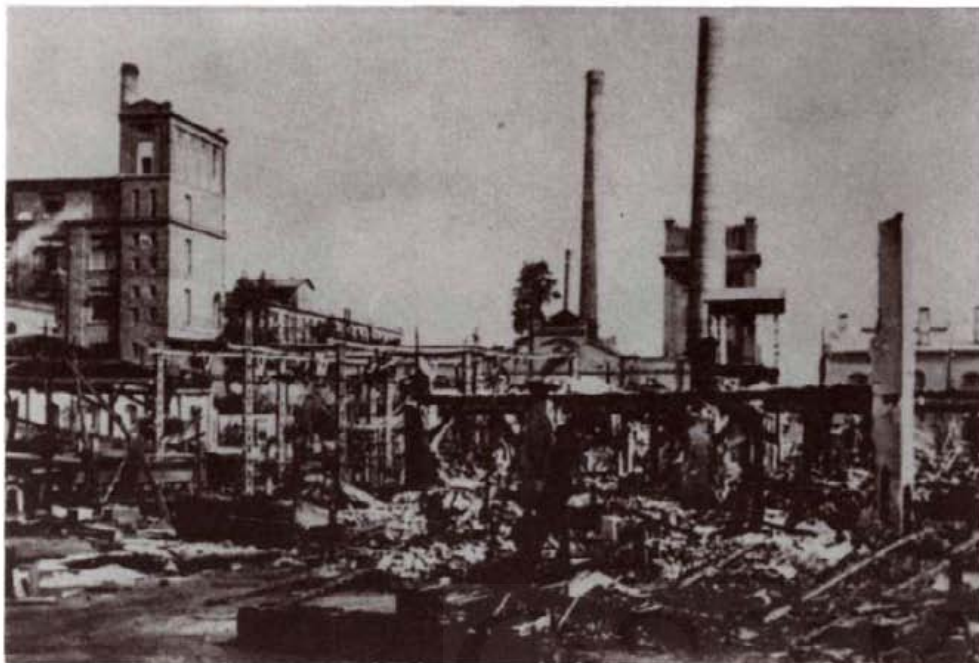
Bases used for TUNGSRAM vehicle lamps



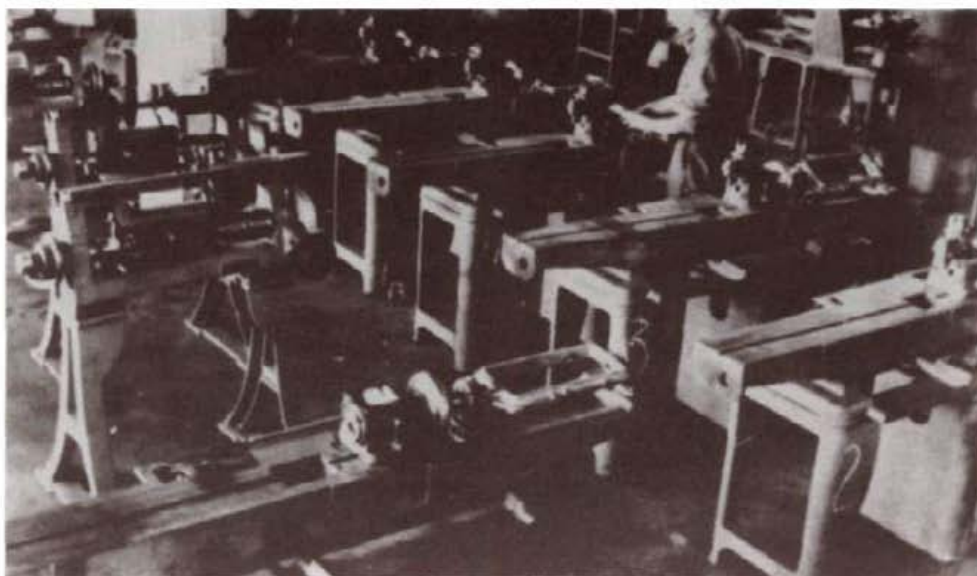
The radio workshop of the Machine Works in the second half of the 1920s.



This is how the electroplating workshop looked like in the end of the 1920s.

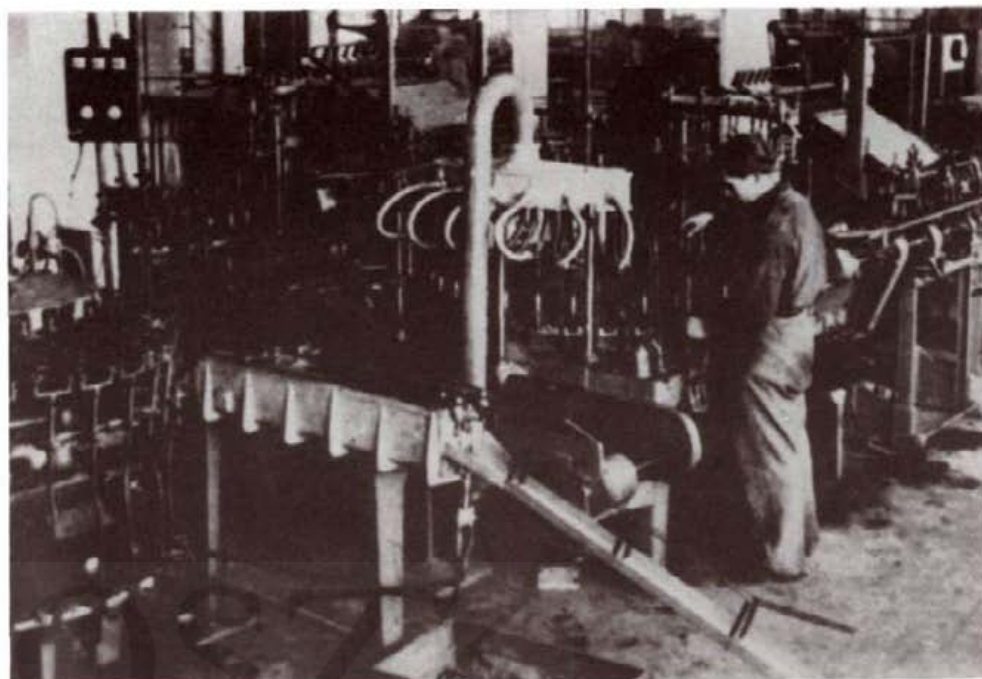


This is what was left after a devastating fire broke out on 15 July, 1928. On the other hand, this fire cleared the ground for the large-scale construction work launched in the 1930s.

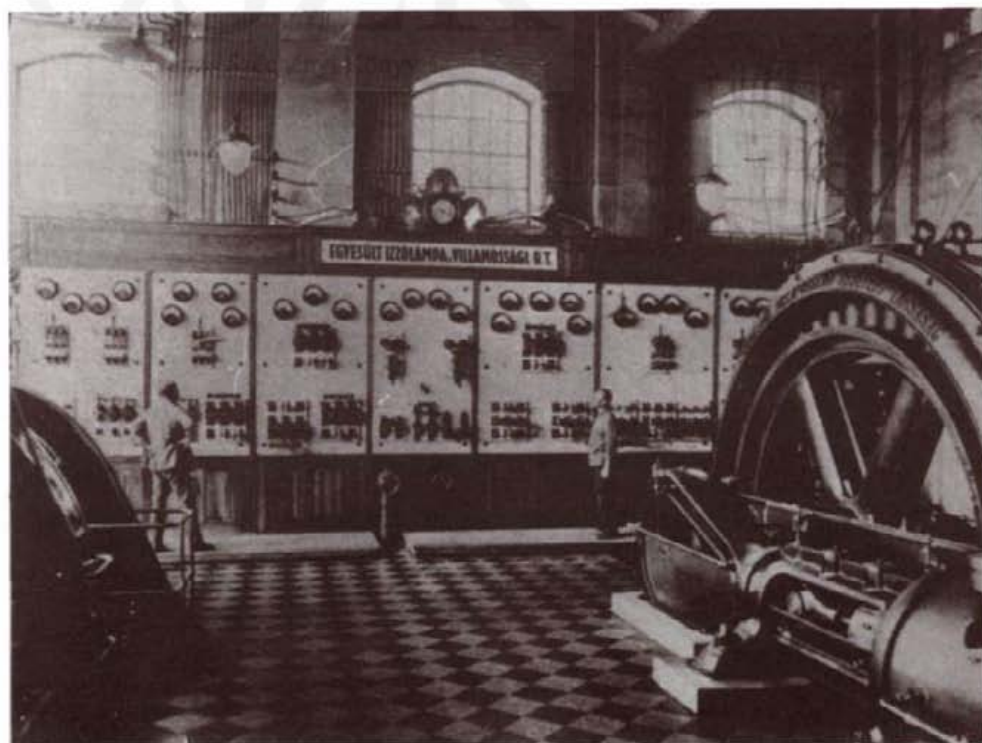


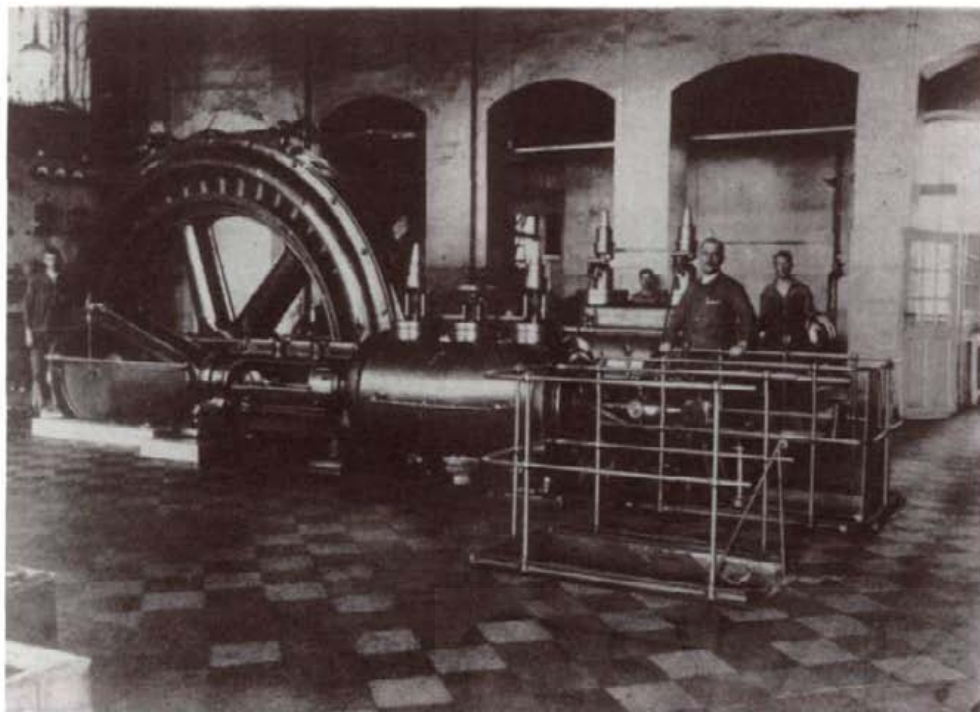
Machines, used for producing electrodes and grids, are assembled in the early 1930s.

Machine assembly line in the beginning of the thirties.

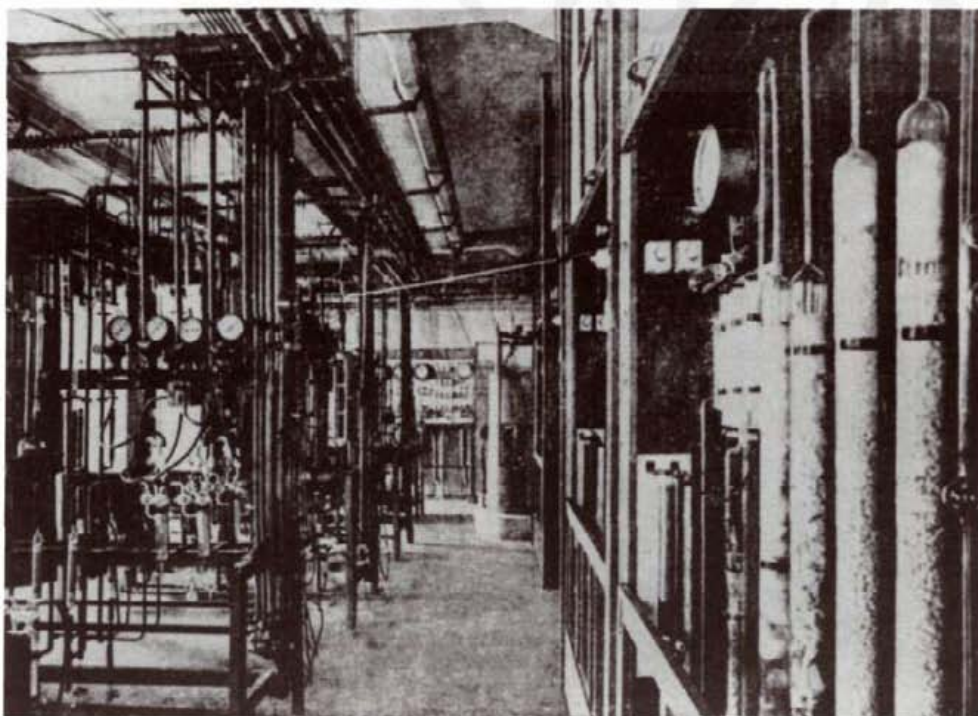


The company's own electric power plant was built in 1900 and worked for more than 50 years.





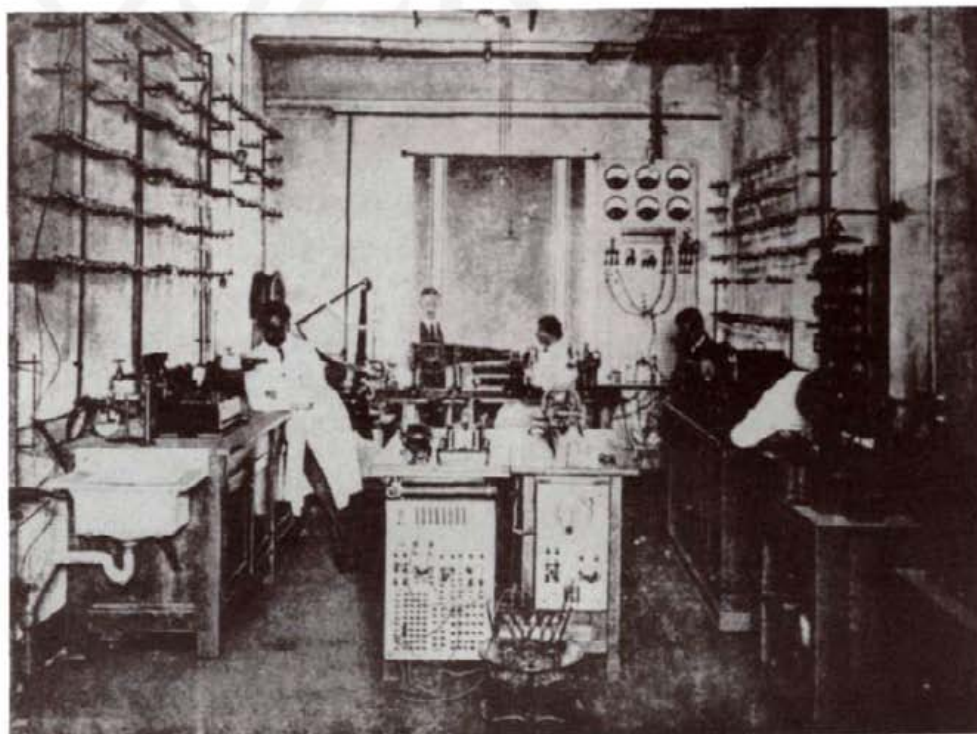
This compound steam engine made by Láng Plant was also put into service in 1900, at the time when the Újpest factory was built. It worked in full time until 1928. Later it was used as a back-up, in order to provide electricity during electric power cuts to those machines which could not be stopped.



This gas purifying equipment operated until 1941. Then the company switched to purification on high pressure.

Ignác Pfeifer left his professorship in protest against the general political atmosphere in the universities between the two world wars. He was then invited by Lipót Aschner to head TUNGSRAM's Research Laboratory. It was here that he established his own 'school' of vacuum engineering.

Lipót Aschner (1872–1952) was employed by TUNGSRAM ever since its foundation (1896), right until 1952. From December 1918 as chief executive officer, he was contributing to the building up of TUNGSRAM's world-wide reputation and the trade mark TUNGSRAM for decades.



This photograph was taken still back in the heroic days of the Research Laboratory's history. The person in the background, sitting in the middle, is Imre Bródy, while the director Ignác Pfeifer is shown on the right, in dark clothes.

Die Neudimensionierung der Vacuumlampen.-

von Dr. M. Brody.

Die Bestimmungen des General Technical Comitee of the Incandescent Lamp Manufacturing Companies, veranlassen uns, unsere Lampen neu zu dimensionieren. Wir haben mit den Vacuumlampen begonnen mit der Halboct und der Vacuumspiral Lampe weil es bis zur betriebsmässigen Einrichtung des "C"-Drahtes warten. Aber auch von diesem Anlass abgesehen, war es notwendig, einmal eine rationelle Methode zur ~~Bestimmung~~ unserer Lampen auszuarbeiten, um viele kostspielige und unzureichende Proben überflüssig zu machen.

Von Herrn Dr. Brody habe ich mir diesen neuen Bericht erhalten.

§

Wegen der Dimensionierung Salpeter auch in mehreren Beispielen ist es nötig, dieselben im

ge und den Durchmesser des Konsument braucht dagegen mit einer gegebenen Licht-

eine gegebene Spannung mit der Leistung und den Durchmesser in den die ersten die Energie während des Brennens als gleich sein. Die von elektrischen Leit-

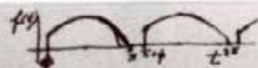
Die Neudimensionierung der Vacuumlampen.

von

Dr. M. Brody.

$$n = i \cdot V = \frac{V^2}{R} = \frac{V^2 \cdot L}{4 \pi l}$$

The first page of one of Brody's scientific papers, written in 1924. The text suggests that he was commissioned to write the paper most probably by one of the committees of the incandescent lamp cartel.



$$f(t) = \frac{1}{2}a_0 + a_1 \cos t + b_1 \sin t + a_2 \cos 2t + b_2 \sin 2t + a_3 \cos 3t + b_3 \sin 3t + \dots$$

$$a_1 = b_1 = a_3 = b_3 = \dots a_{2n-1} = b_{2n-1} = \dots = 0$$

$$a_0 = \frac{2}{\pi} (1 + \cos \phi)$$

$$a_2 = \frac{1}{\pi} \left(-\frac{2}{3} - \cos \phi + \frac{\cos 3\phi}{3} \right)$$

$$b_2 = \frac{1}{\pi} \left(-\sin \phi + \frac{\sin 3\phi}{3} \right)$$

$$a_4 = \frac{1}{\pi} \left(-\frac{2}{15} - \frac{\cos 3\phi}{3} + \frac{\cos 5\phi}{5} \right)$$

$$b_4 = \frac{1}{\pi} \left(-\frac{\sin 3\phi}{3} + \frac{\sin 5\phi}{5} \right)$$

$$a_{2n} = \frac{1}{\pi} \left(\frac{-2}{(2n-1)(2n+1)} - \frac{\cos(2n-1)\phi}{2n-1} + \frac{\cos(2n+1)\phi}{2n+1} \right)$$

$$b_{2n} = \frac{1}{\pi} \left(\frac{\sin(2n-1)\phi}{2n-1} - \frac{\sin(2n+1)\phi}{2n+1} \right)$$

Külves Kiell is!

Olvasdham a hyperbommal rabályozott
áram Fourier sorának a vámitéit
Érnek. Öt kűl is eredményt. Ha a
nű ö kűl is kűl, az is megvárja, nek adja
meg a adatrak.

Hol van a_2 -nek széles értéke? Valószínű

$$\frac{d}{d\phi} \left(-\frac{2}{3} - \cos \phi + \frac{\cos 3\phi}{3} \right) = +\sin \phi - \frac{3}{3} \sin 3\phi = 0 \quad \sin \phi = \sin 3\phi$$

$3\sin \phi = 4\sin^3 \phi$

$$\sin \phi = 3\sin \phi - 4\sin^3 \phi \quad 0 = 2\sin \phi - 4\sin^3 \phi \quad 0 = \sin \phi - 2\sin^3 \phi$$

$$\sin \phi = x \quad 2x^3 - x = 0 \quad 2x^2 = 1 \quad x = \frac{1}{\sqrt{2}} = \sin \phi; \phi = 45^\circ$$

Bródy jotted down this message on a square ruled paper for Endre Rédl. The mathematical calculations—the Fourier series of the signal of an electrical component—had been done by his daughter Éva. Father and daughter both fell victim to the Holocaust within the next couple of weeks.



Two eminent persons from the staff of the TUNGSRAM Research Institute

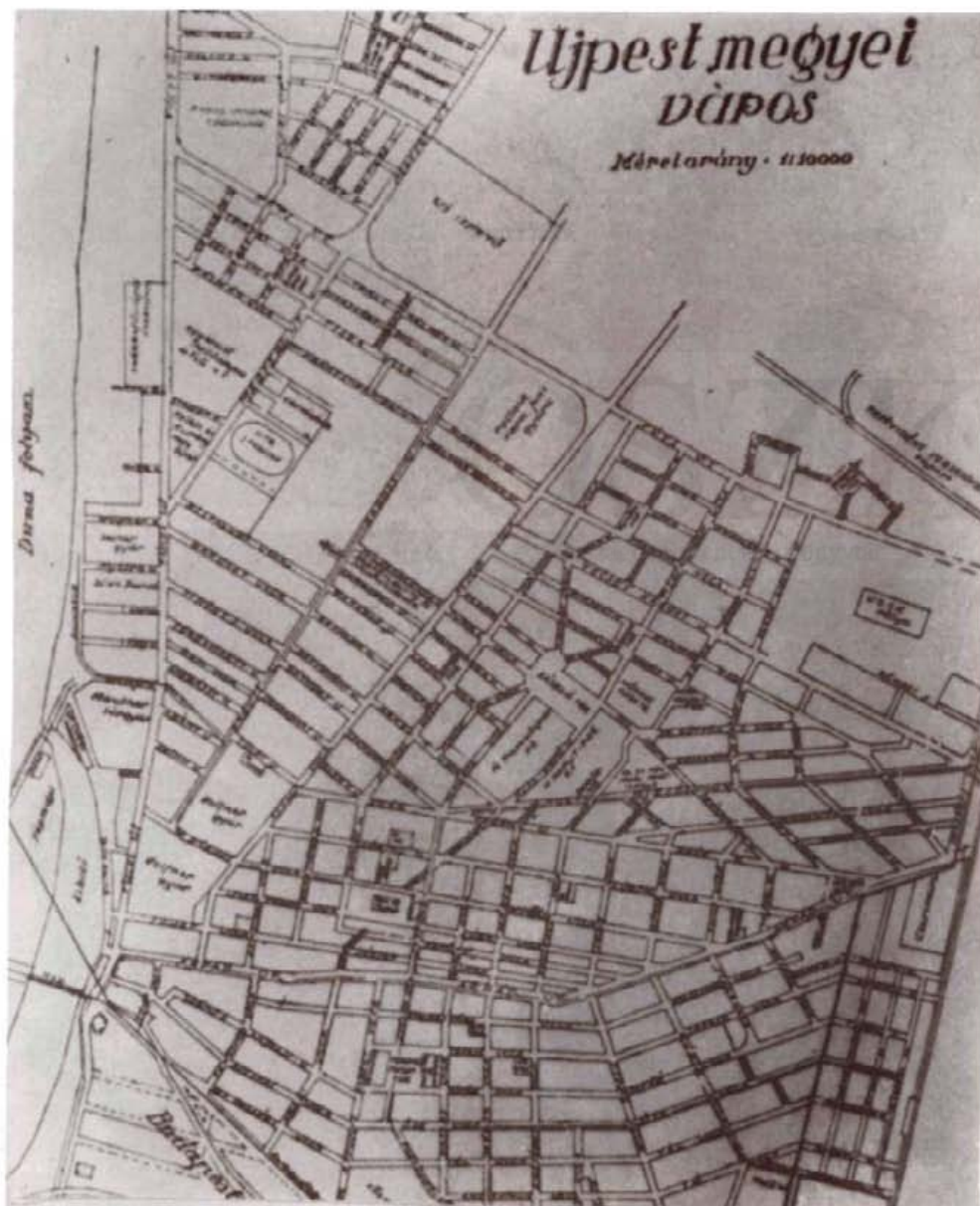


The physicist György Dallos took the lead doing experiments in TUNGSRAM in the field of microwave technology. Later also he became a victim of the fascist genocide in a labor camp.

This photograph shows the physicist Pál Selényi with his favourite electrostatic image transmitter which was later bought by the Americans for a ridiculously small sum. It worked on a similar principle as the modern Xerox machines do.

*Vaszily György**Rédl Endre**Millner Tivadar**Theisz Emil**Dr. Knapp Oszkár**Pillitz Dezső**Winter Ernő**Bródy Imre**Lévai János*

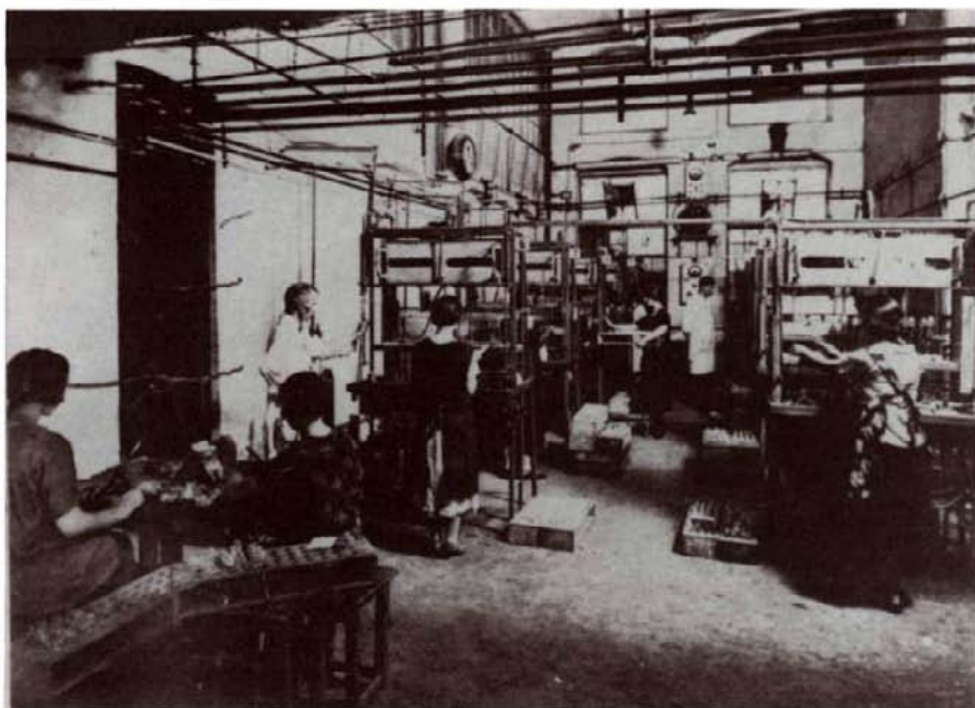
A few of the faces recorded for posterity in the I-department's collection of cartoons—without anyway ranking them. Several of these people gained international recognition as researchers or played prominent role in the administration of TUNGSRAM.



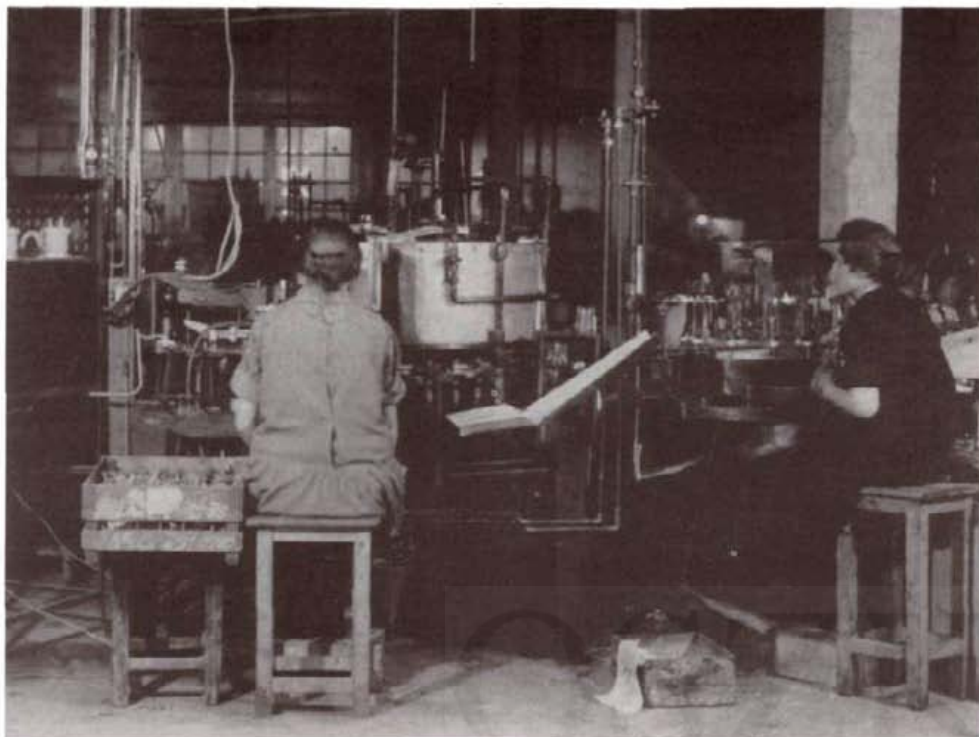
The map of Újpest when it was still a separate town and not the 4th district of Budapest. The trapezoid shape of TUNGSRAM is shown on the map between the Danube and the sports fields of UTE (Újpest Athletic Club).



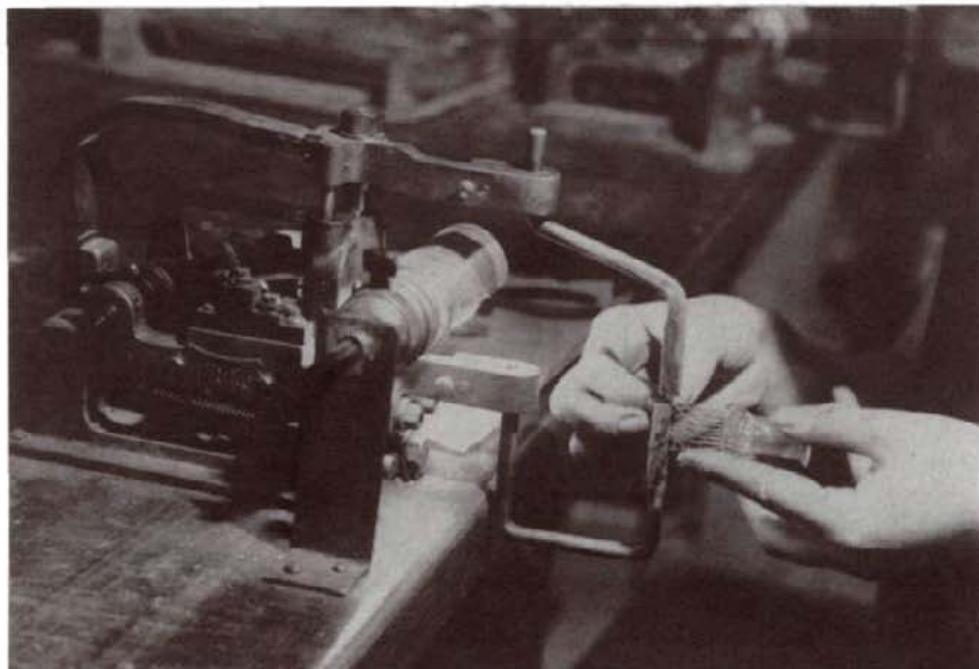
The production of radio valves in the 1920s. We can see the assembling and sealing of the MR valves.



The production of radio valves in the 1920s. The vertical pumps seen here are used to create vacuum inside the valves.

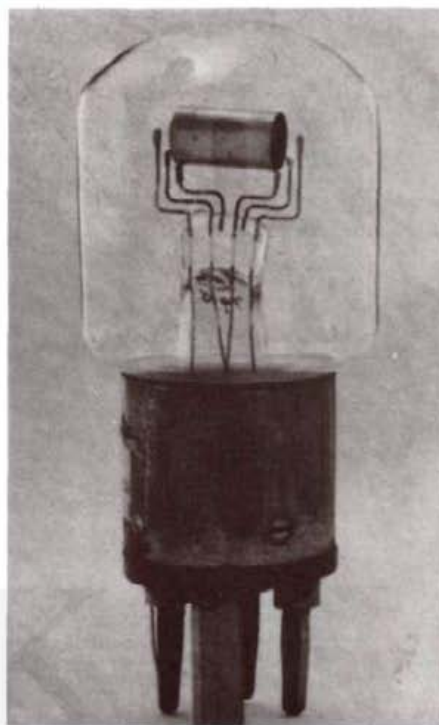


Trained labourers work on the vacuum pumps in the Radio Valve Department in the 1920s.

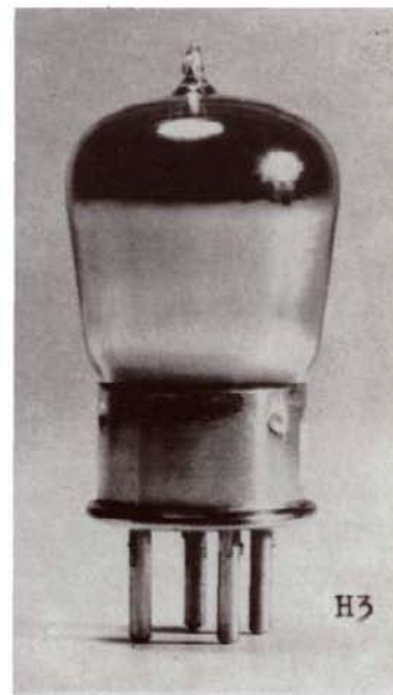
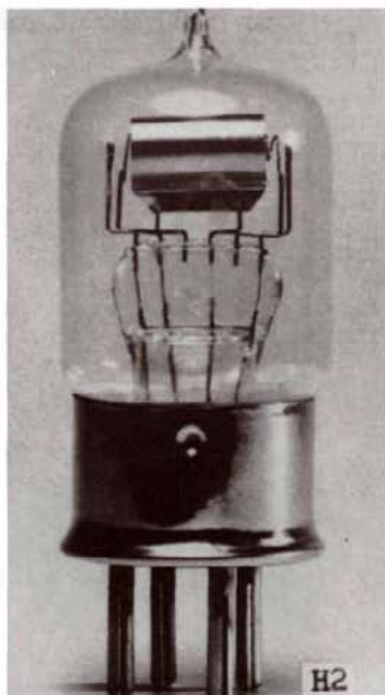


The assembling of radio valves required perfect eyesight and a light touch. For this reason this work was almost exclusively done by young women. Needless to say that when they were not so young anymore and their eyesight was going, they had to go, too.

Before the mass-production of electronic vacuum tubes—in 1920, for example—experimental prototypes of the various designs were made in small series. Some of them are shown in the next pictures. The pear-shaped tube is obviously one of the direct predecessors of the H2 and H3.



The tubes shown here were designated as H2 and H3. These were the first two radio valves which were produced by TUNGSRAM in large quantities. These tubes had tungsten filaments and consumed only slightly more energy than two flashlight lamps. Of course, their luminous intensity was also in the same range. They had a transconductance of 0.3 mA/V.

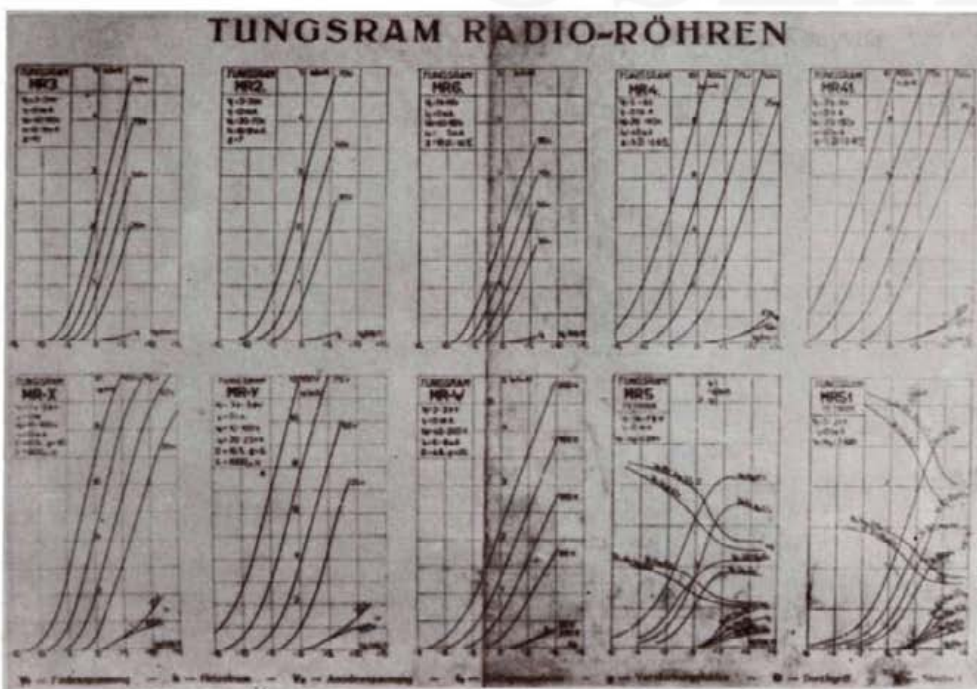


TUNGSRAM RADIO-RÖHREN

TYPE	Verwendung	Heizfaden- Volt	Heizfaden- Strom (Amp.)	Faden- spannung Volt	Heizfaden Amp.	Anoden- spannung Volt	Heizfaden- Mittelpunkt	Sättigungs- strom Milliamper.	Verstär- kungsfaktor	Durchgriff %	Strom- verbrauch Watt	Interne Widerstand Ohm	
Empfänger- röhre	MR 5	H. A. N.	4	35	3-3.5	0.06	80-90	2-2.5	6-8	10	10	0.45	25000
"	MR 2	A. N.	4	35	3-3.5	0.06	30-70	2.5-3	6-8	7	15	0.45	15000
"	MR 6	H. A. N.	2	5	1.6-1.8	0.15	40-90	1.6	5	10	10	0.4	25000
"	MR 4	H. A. N. E.	6	10	5-6	0.20	20-150	14	40-50	5	20	0.6	6000
"	MR 41	H. A. N. E.	4 ²	5	3.5-4	0.30	20-150	12	30	5	20	0.65	7500
"	MR-Y	H. A. N.	4	15	5.5-5.8	0.06	10-100	7	12	10	10	0.6	15000
"	MR-Y	A. N. E.	4	15	5.5-5.8	0.10	10-100	12	20-25	6	16	1.0	7500
"	MR-W*	H. N.	4	35	3-3.5	0.06	40-200	2.5	6-8	25	4	0.5	50000
Doppel- empfänger- röhre	MR 5	H. A. N.	2	5	1.6-1.8	0.15	2-20	1-1.5	5	5	35	0.4	1000
"	MR 51	H. A. N.	4	35	3-3.5	0.06	3-20	1-1.5	6-8	5	35	0.6	5000

Die Heizfaden ist bei den angegebenen maximalen Anodenspannung zu versetzen.
Die Röhren werden in der Regel auf normalen festgesetzten Steckersystemen geliefert.
Auf Wunsch können sie auch auf andere geeignete Steckersysteme versehen werden.
Die angegebenen Daten sind nur als Anhaltspunkt genau zu betrachten.

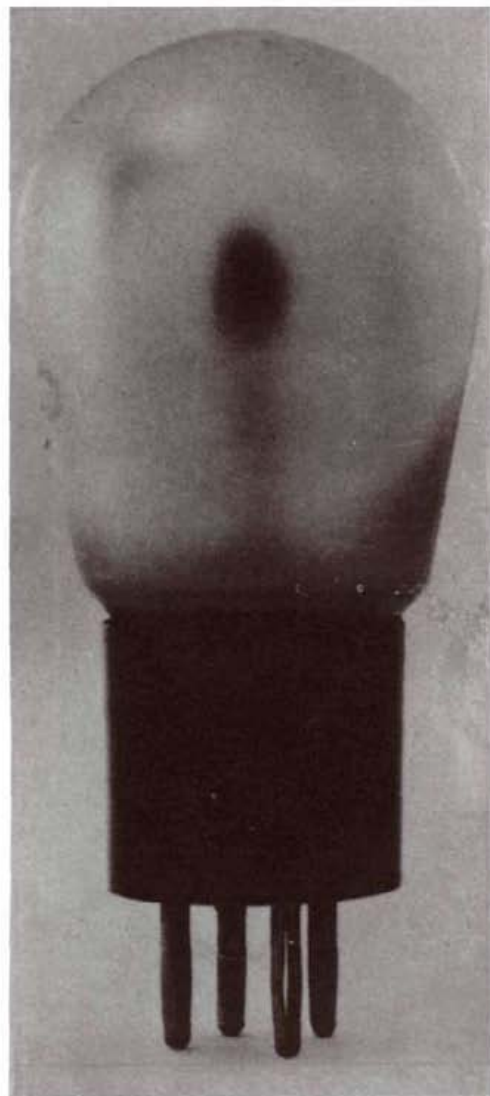
VERWENDUNG: ■ = Hochfrequenzverstärkung,
A = Audion (Elektronen),
N = Niederfrequenzverstärkung,
E = Endverstärkung,
* = Wärmehaushaltsröhren.



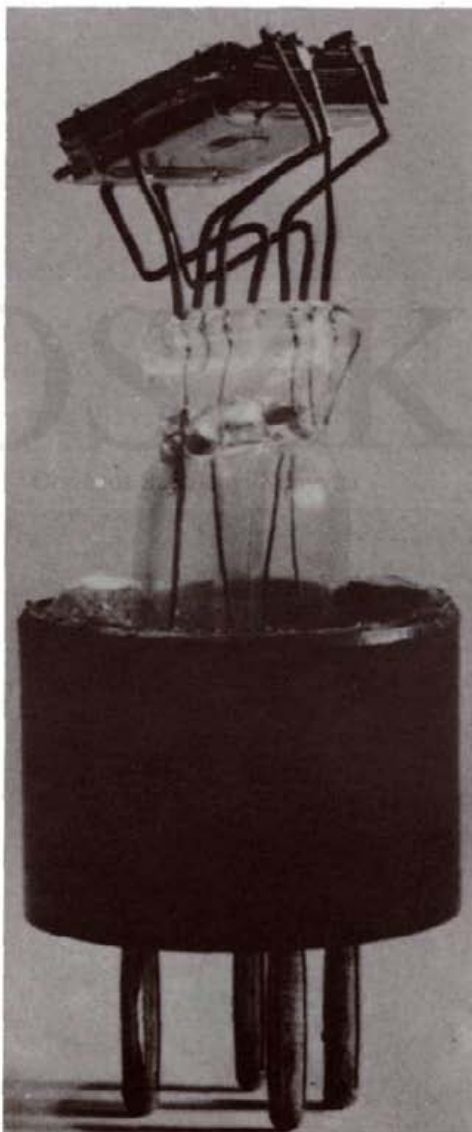
This information sheet listing various radio valve designs in German was printed in 1925 in colour. By then the valves MR41 and MR-Y, both considered to be very modern designs, had also been added to the range.



The first loudspeakers came out in the late 1920s; before that the listeners had to use earphones. The period loudspeaker on this poster, the style of which is in harmony with the times, was produced by TUNGSRAM on a Western Electric licence.



The first design of the barium-cathode era was known as MR-406 (1927). This still had a platinum wire as filament.



In the next—admittedly very long—phase of the barium-cathode era the filaments were already made of tungsten. The design shown here—one of the first types in the phase—was called G-406.

There was an illustrated advert in the 18 December, 1927 copy of the newspaper Magyar Hírlap, selling electronic vacuum tubes designated as P-410, P-415, G-408 and R-408. The following little verse appeared in that advert:

"Here come the BARIUM VALVE boys, with the compliment of TUNGSRAM, sounding a divine and lovely voice, Here come the BARIUM VALVE boys."



The **P 215** is a special low frequency amplifier but can advantageously also be used as detector or as oscillator and modulator in heterodyne apparatus. Owing to its fine slope this valve operates large loudspeakers at 90 volts, and at 120 volts it even operates loudspeakers for large halls. For an undistorted reception the grid bias should be taken as follows:

with an anode voltage of 60 volts, about 4 volts

90	"	"	8	"
120	"	"	12	"
150	"	"	16	"

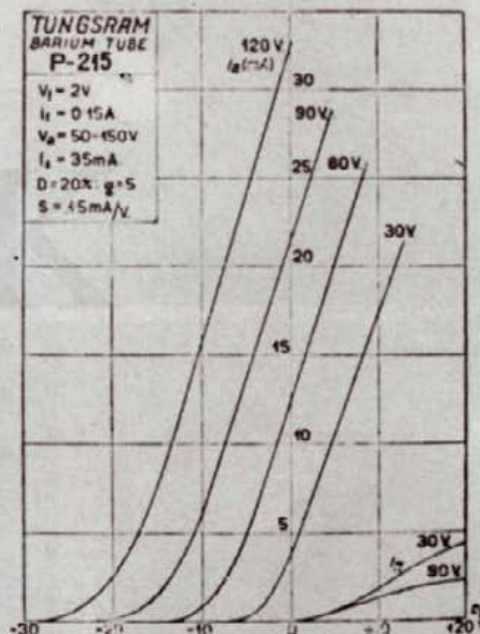
The design P-215 was made in 1912 and belonged to the 2-Volt series. Here the barium cathode made the heat-controlling resistor superfluous, but the batteries had to match the heating voltage.

TUNGSRAM BARIUM VALVES.

2 VOLT SERIES.

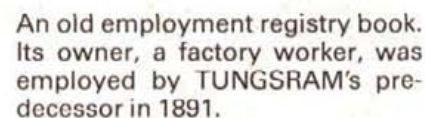
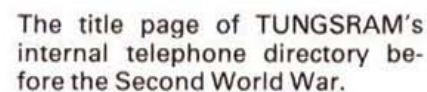
P 215 LAST STAGE POWER VALVE.

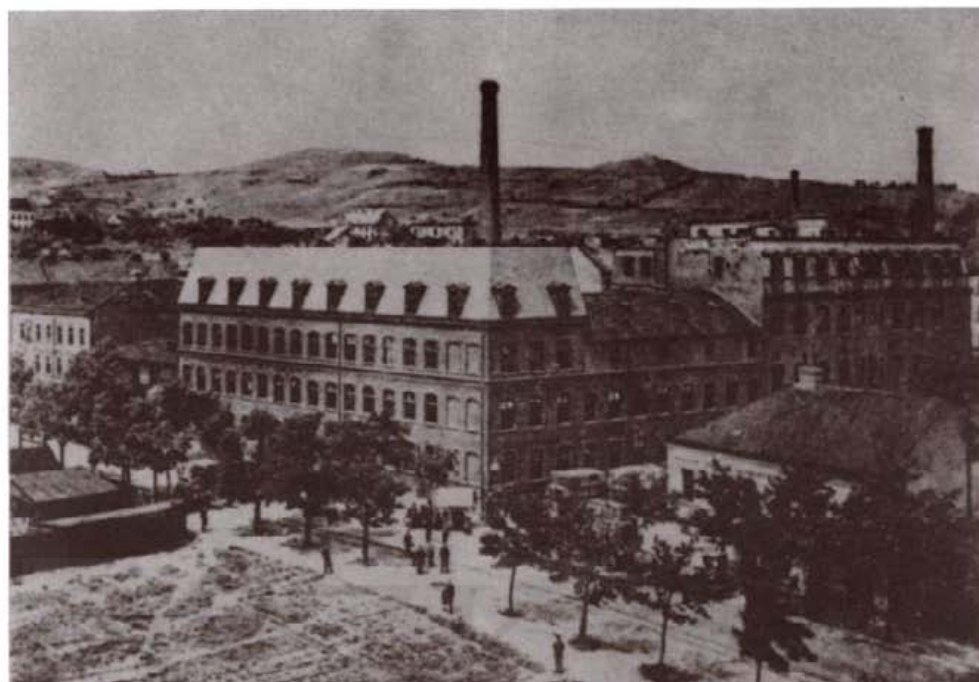
CODEWORD : DUFOR.



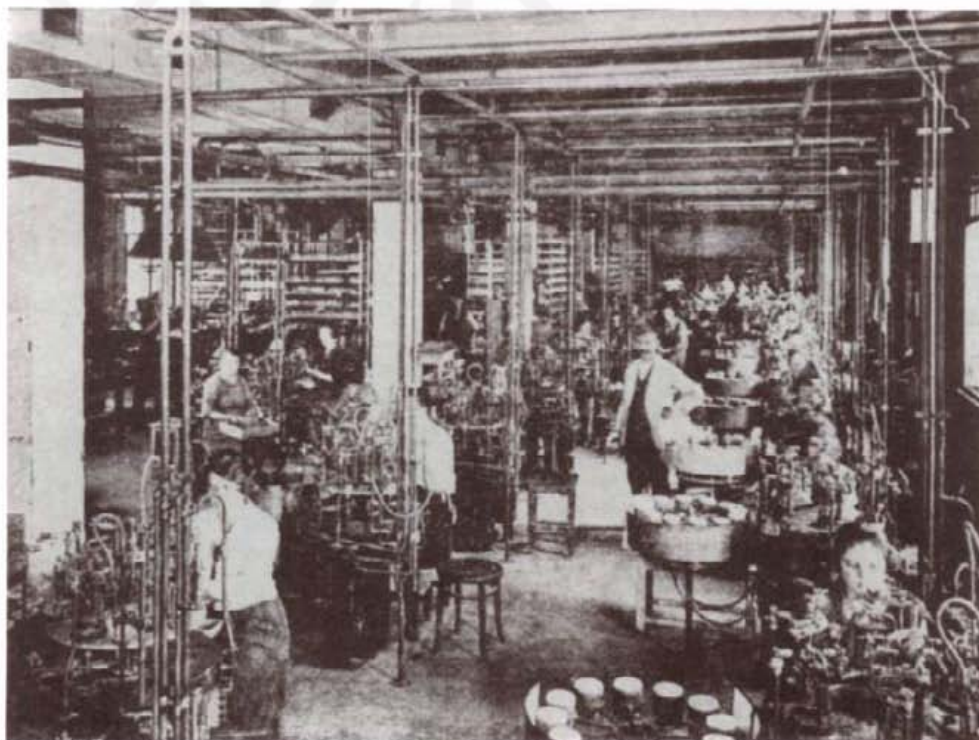
Filament Voltage	2 Volts.
Filament Current	0,15 Amp.
Anode Voltage	50—150 Volts.
Normal Anode Current Consumption	12 mA.
Total Emission	35 mA.
Amplification Factor . .	5.
Slope	1,5 mA/V.
Impedance	3300 Ohms.

The valves can be supplied with European or American (UX) base according to needs.





The Viennese factory in the early 1920s.



The production of incandescent lamps in the Viennese factory.



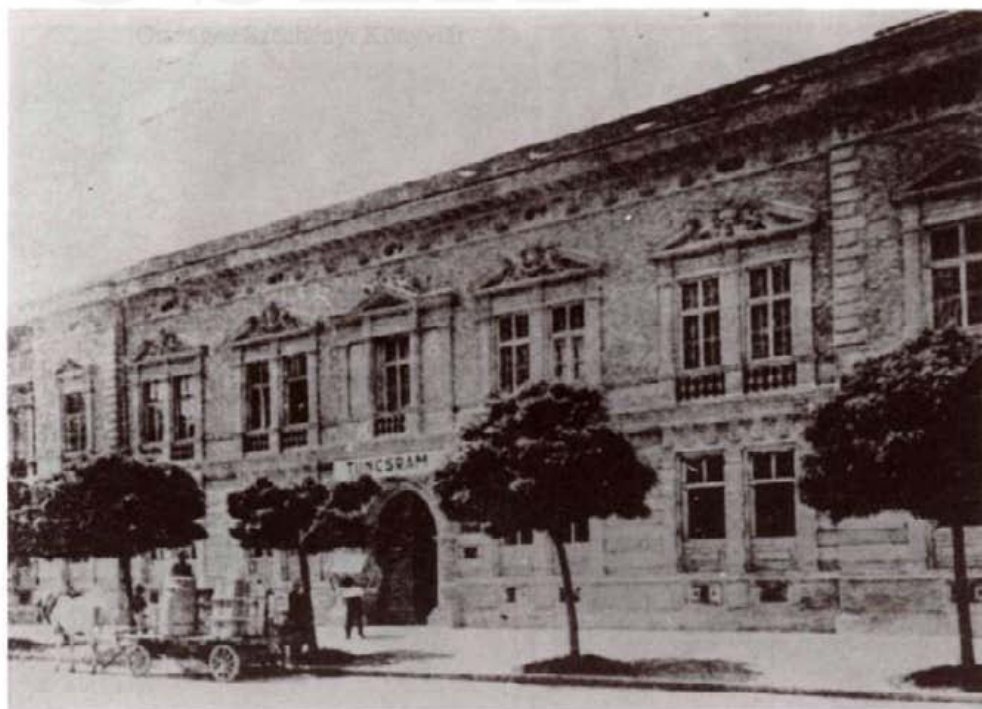
The basing of incandescent lamps in the Viennese factory in the 1920s.



The photometric workshop of the Viennese factory in 1925.



The packing of incandescent lamps around 1920.



The TUNGSRAM building in Zagreb at the beginning of the 1920s.



The TUNGSRAM sales office in Bucharest.



A couple of TUNGSRAM adverts from the various yearbooks of the Society of Hungarian Engineers and Architects. The one on the left is from 1927, and the one on the right, from 1933.

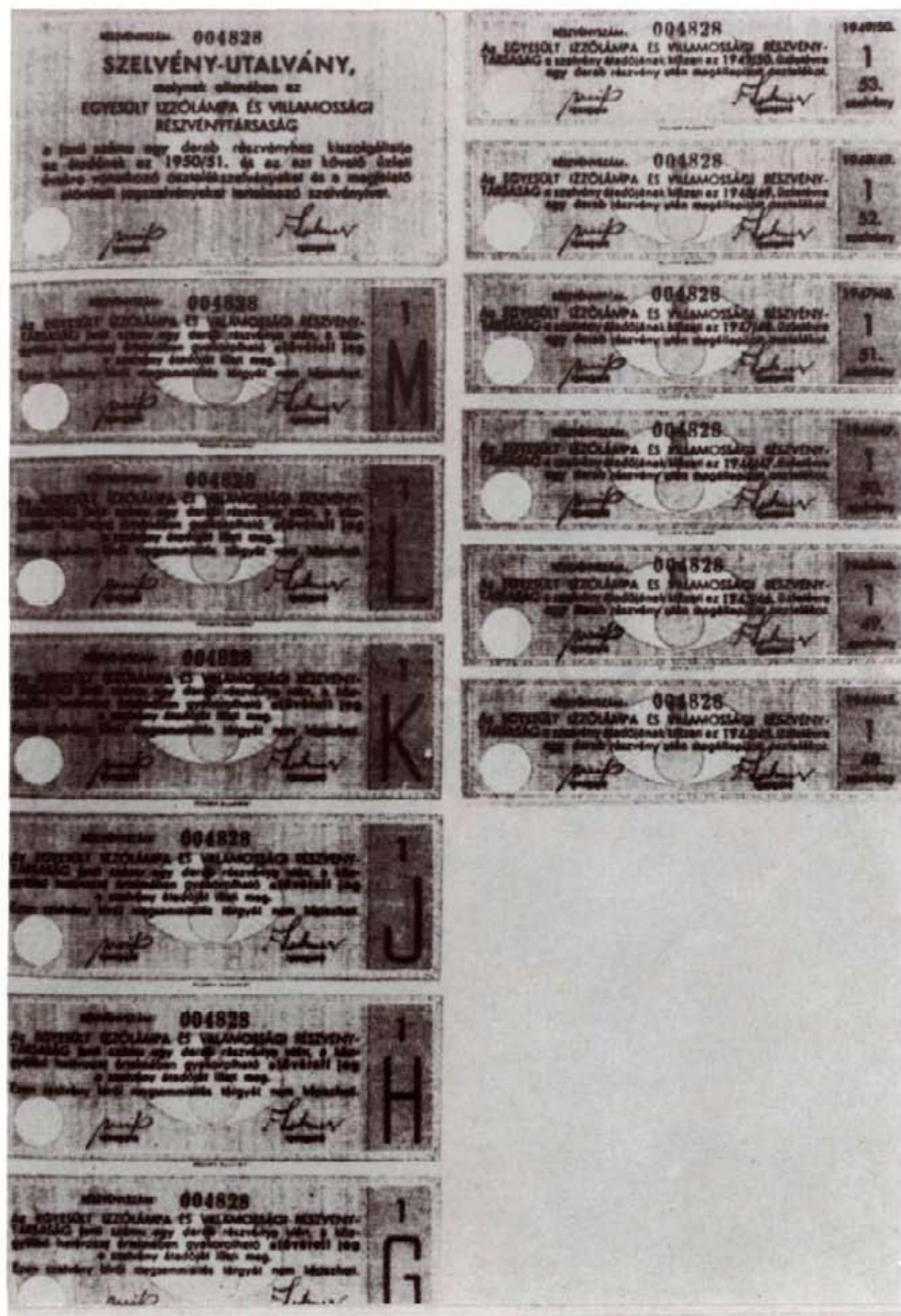
This advert announces the coiled-coil filament's arrival on the market in 1937.



The advert on the right features the Hungarian translation of the popular German slogan "besser sehen, besser hören TUNGSRAM-Lampen, TUNGSRAM Röhren". ("better see, better hear = TUNGSRAM lamps, TUNGSRAM tubes")



A TUNGSRAM share from 1930.

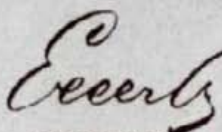


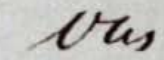
And those much-talked-about
coupons...

Részvény-szám

SZELVÉNY-UTALVÁNY.

AZ „EGYESÜLT IZZÓLÁMPA ÉS VILLAMOSSÁGI RÉSZVÉNYTÁRSASÁG”
 EZEN SZELVÉNY-UTALVÁNY BEMUTATÓJÁNAK KISZOL-
 GÁLTATJA A FENTI SZÁMÚ RÉSZVÉNYHEZ TARTOZÓ
 1921. ÉVBEN KIBOCSÁTANDÓ TOVÁBBI 25 SZELVÉNY-
 NYEL ELLÁTOTT SZELVÉNYIVET.
 EGYESÜLT IZZÓLÁMPA ÉS VILLAMOSSÁGI RÉSZVÉNYTÁRSASÁG.

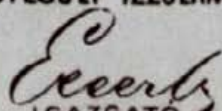

 IGAZGATÓ

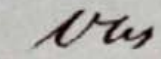

 IGAZGATÓ

Részvény-szám.

Szelvény

AZ „EGYESÜLT IZZÓLÁMPA ÉS VILLAMOSSÁGI RÉSZVÉNYTÁRSASÁG”
 KIFIZETI E SZELVÉNY BEMUTATÓJÁNAK A KÖZGYÜLÉSI HATÁ-
 ROZAT ÉRTELMEBEN AZ 1920/21. ÜZLETI ÉVRE ESŐ OSZTALÉKOT.
 EGYESÜLT IZZÓLÁMPA ÉS VILLAMOSSÁGI RÉSZVÉNYTÁRSASÁG


 IGAZGATÓ


 IGAZGATÓ

This certificate enabled the holder
 to pick up the due dividends in the
 form of a sheet of coupons.



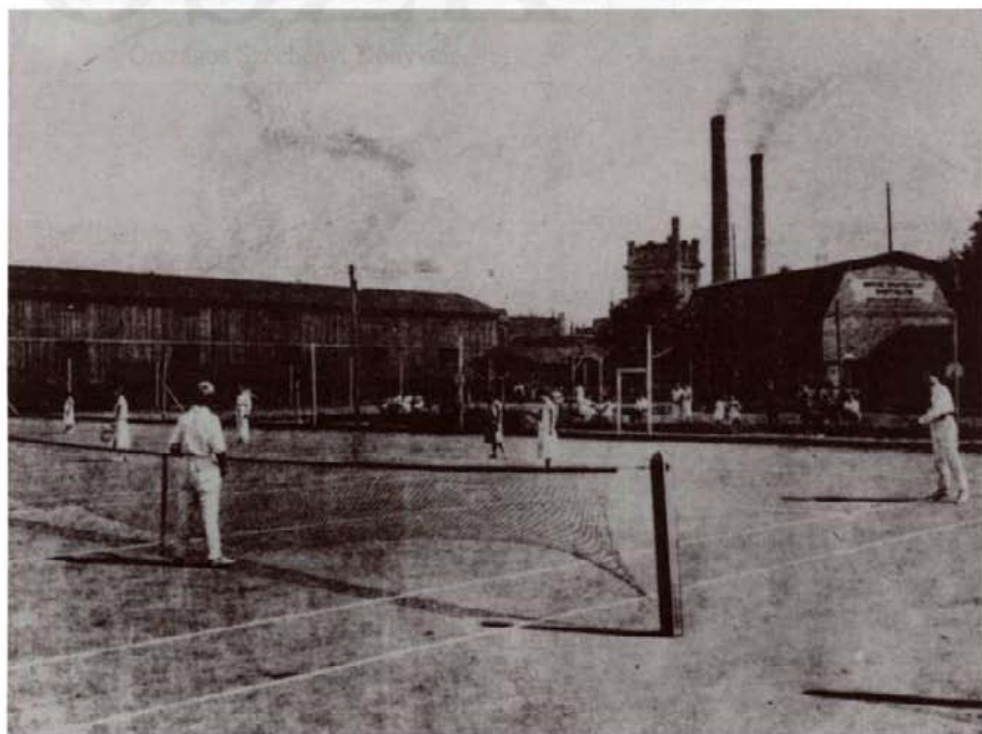
The central executive and marketing offices in 1930. Before moving to the new office building in 1962, the top management ran the affairs of the TUNGSRAM concern from these offices for roughly half-a-century.



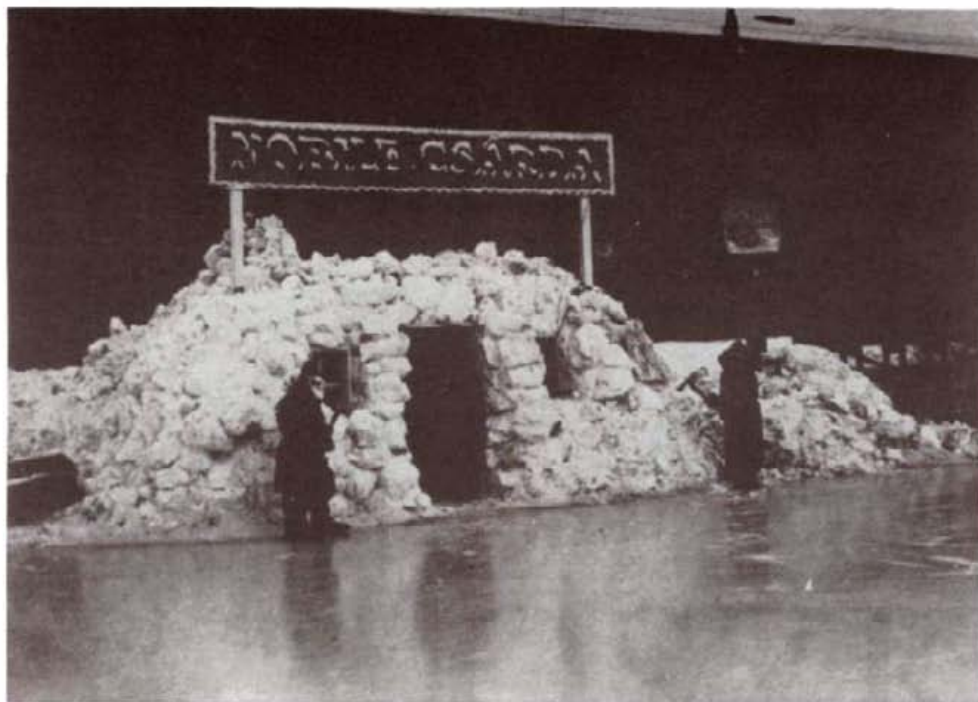
The main gate and the front view of TUNGSRAM was left unchanged for decades. Here we see the female work-force—mostly from the assembly lines—heading for home at the end of the shift. Their clothes prove that the company's moving to Újpest was, indeed, an example of "rural industrialization".



The hall, where this technical training was held in the 1920s, was later known as the "Home of innovators."



Once there had been tennis courses in the factory yard. With the passing of the years this area gradually shrank, as a result of the continuing development of the surrounding grounds. Today there is a park here.



In cold winters the tennis courts were turned into an ice-rink. This photograph recorded an episode from the winter fancy-dress carnival.

Országos Széchényi Könyvtár



The great development projects of the 1930s largely determined the TUNGSRAM's general appearance. Certain elements of that image are still around.

The dispatch department, or 'expedition' as it was called before 1928. The lamps, which once had been packed in barrels, were already put in boxes here.



There is still more packing here. This time the destination is South America, according to the message written on the boxes in the bottom left corner of the picture.





Originally, this building was raised in 1929 to house the Machine Works. Its major reconstruction took place when the modern Machine Development Department, the central unit of the Maintenance Department and the workshop producing precision instruments were moved here after the Second World War. Later the laboratories, where the development of semiconductor technology took place, were also set up here, on the upper floors.

OSZK
Országos Széchényi Könyvtár



The building known as the 'Audion' was completed in 1930. Incandescent lamps and radio valves were produced here. With its 170 metres long front and its 21 metres long internal span the construction was claimed to be one of the largest factory buildings in Europe at the time. Because the building material—alumina cement—showed signs of fatigue, the building had to be thoroughly renovated in the early 1960s.



The final touches are being put to the recently finished 'Audion' building at the beginning of the 1930s; the workers are painting the utility system and install the so called "sealex" machines.

A vállalatra vonatkozó adatszolgáltatás.

1. A vállalat megnevezése és telephelye:

Remix Ltd., 59. sz.

2. Üzletkörének pontos megnevezése:

Rádióellenőrzés, - kondenzátor és

potenciálcsatlakozók.

3. Saját tőkéje (az 1940 VII. t. c. 19. § 2. bek. foglaltak szerint számítva):

F 547.000.-

4. Ha a vállalat valamely a R. I. §. 1. bek.-ben említett külföldi vállalatnak magyarországi telepe

a) a külföldi vállalat megnevezése:

b) belföldi saját tőkéje:

5. A vállalat évi forgalma az utolsó 3 évben

külön-külön:

1.

1941. év		1942. év		1943. év	
P	ELL.	P	ELL.	P	ELL.
11.550.62	571.477.0	30909711			
17.676.02	405.323.6	506.75977			
95.696.74	146.100.90	218.05547			

6. A vállalat által az utolsó 3 évben belföldön kifizetett

a) munkabérek összege:

b) tisztviselői illetmények összege:

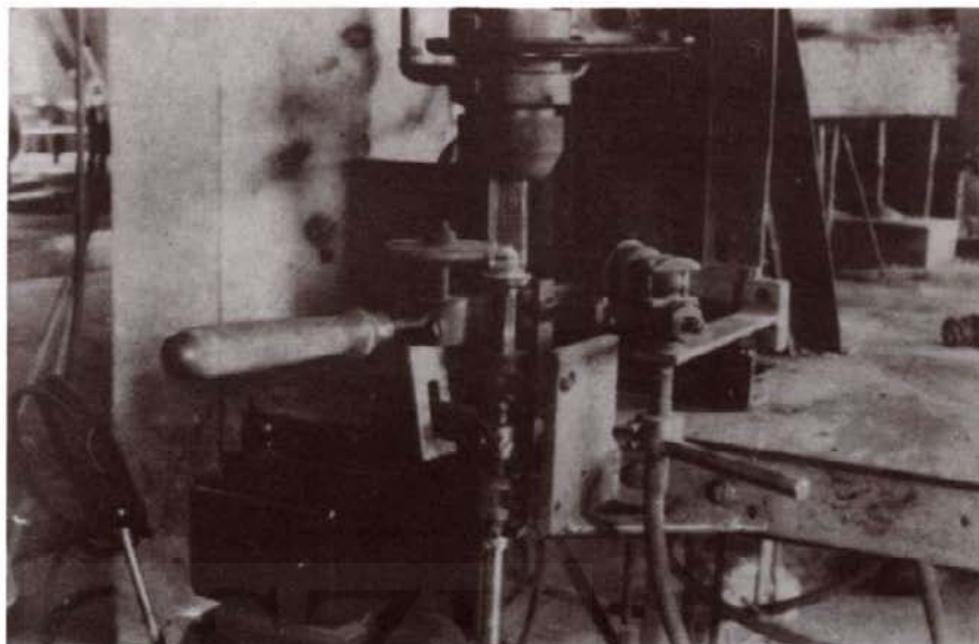
(magyar) vállalat külföldi telepei telephelyenként részletezve:

vállalatnak a 7140/1941. M. E. számú rendelet 1. § 2. bek. alá vonatkozó érdekköri vállalata? Ha a bejelentett alkalmazott, vagy megbízott az érdekköri vállalatok valamelyikétől javadalmazásban vagy juttatásban részesül, külön pótvíven feltüntetendő a fenti 1-3. és 5., 6. pontok szerinti adatok az érdekköri vállalatra is.

A vállalat az Magyar Rádió és Vill. R.T. kongzern érdekkörében tartozik.

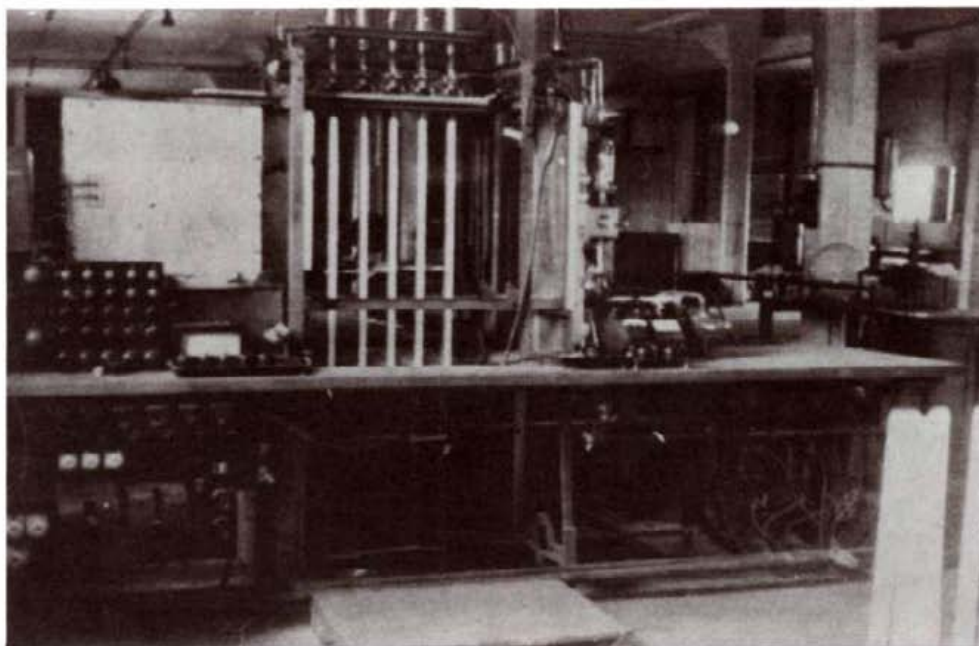
This questionnaire gives details of the business done by Remix Ltd during the years 1941, 1942 and 1943. (Remix Ltd was a member of the TUNGSRAM corporation.)

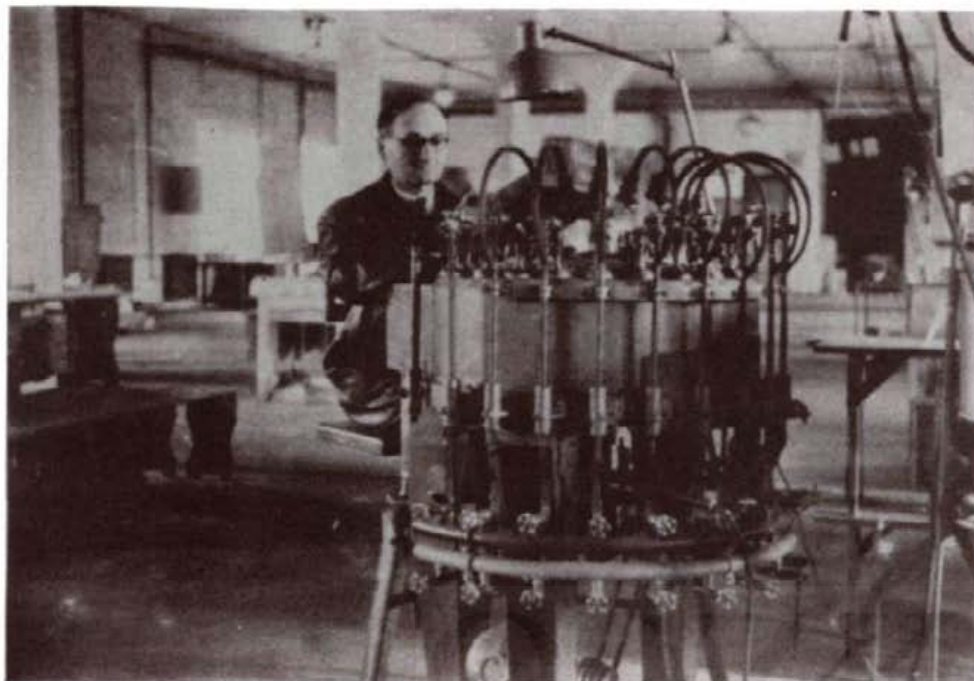
In the early days the rim of the fluorescent tubes was shaped, flared out on this machine.



Országos Széchényi Könyvtár

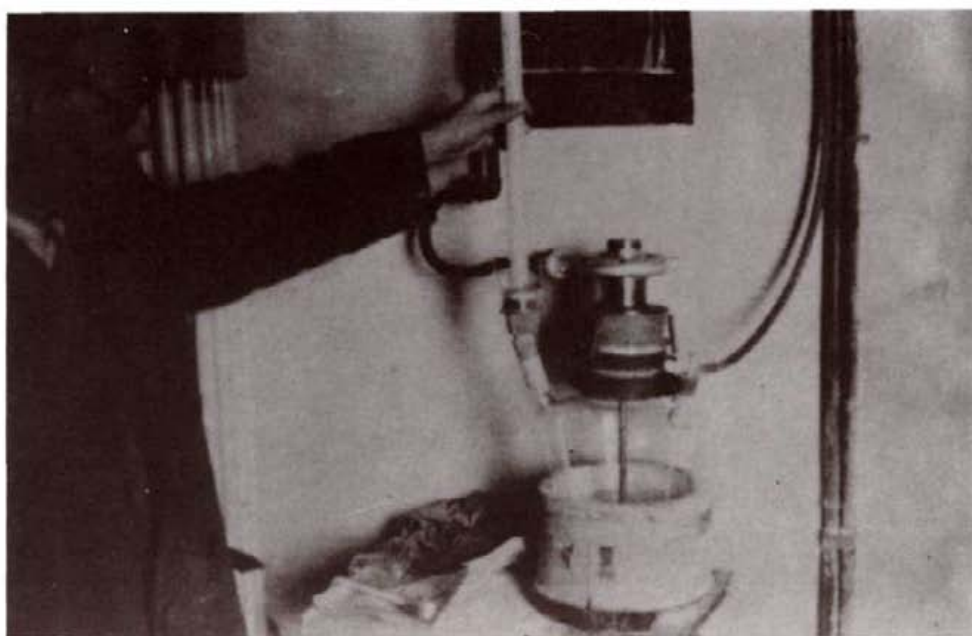
Before the Second World War, when the trial runs of fluorescent lamp production were held, this vertical pump worked on five fluorescent lamps at a time.





We see László Gács in this picture, one of the pioneers of our fluorescent lamp development sitting by the machine producing the stems of fluorescent lamp's.

Országos Széchényi Könyvtár



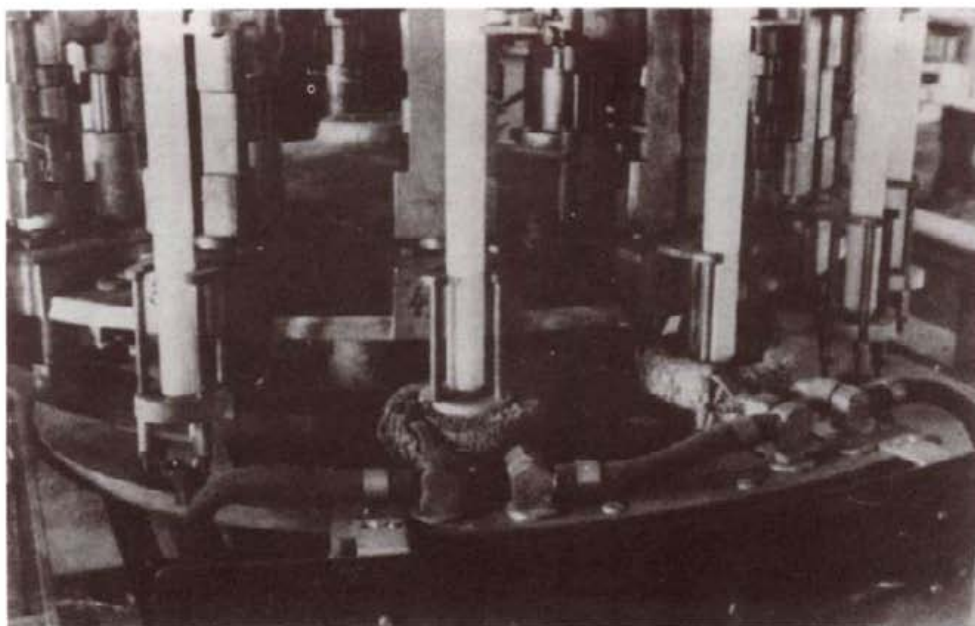
This machine was designed by Dr. Oszkár Knapp in 1940, and was used to coat both sides of a one-inch fluorescent lamp. During the Second World War the machine worked in the experimental fluorescent lamp production on the second floor of the glass factory.

The 'crew' of the newly launched fluorescent lamp production from the late 1930s. György Szigeti and László Gács are shown sitting in the middle of the front row.



Országos Széchényi Könyvtár

The first sealing machine for flared fluorescent lamps.





Országos Széchényi Könyvtár

These were the people who produced the chemical components necessary for making fluorescent lamps (glass, cathode paste, mercury, etc.): Horváth, Dr. Knapp Dr. Kardos and their colleagues.

TUNGSRAM HIGANYGŐZLÁMPÁK

A Tungram higanygőzlámpák fénykihasználása lényegesen jobb, mint az izzó- vagy ivlámpáké. A Tungram higanygőzlámpák rendkívül gazdaságossága a mesterséges világítás számára egészen új területeket tár fel.

Az izzólámpákkal ellentétben a higanygőzlámpák színeke főképp zöld és kék sugarakat tartalmaz, míg a vörös szín teljesen hiányzik. Természetes színhatás elérésére ezért higanygőz- és izzólámpát együtt kell alkalmazni és az u. n. kevert fény különösen szép, fehér, ha a keveréshez Krypton-izzólámpákat veszünk.

A higanygőzlámpák táplálása váltóárammal történik és az üzembentartáshoz a lámpával sorbakapcsolt fajtólékcserre, illetőleg szórótranszformátorra van szükség. A lámpákban egyébként nincs izzószáll, hanem két elektroda között magas nyomású higanygőztérben elektromos kisüléssel fényjelenséget hoz létre. A higanygőzlámpák részletes üzemi adatait kívánnra külön ismertetjük és a helyen csak a Tungram higanygőzlámpák néhány fontosabb alkalmazási lehetőségére akarunk kitérni.

Közvilágítás: A Tungram higanygőzlámpák a rendkívül gazdaságos áramfogyasztás és a jellegzetes zöldes-kék fény révén utak megvilágítására különösen alkalmasak. Olyan utakon, amelyeket fák szegélyeznek, a lombosai a higanygőzlámpák fényében igen hatások.

Gyárvilágítás: Udvarok, csarnokok, műhelyek világításánál a Tungram higanygőzlámpák más fényforrásokkal szemben két-háromszoros közepes megvilágítási erősséget adnak az áramfogyasztás minden növekedése nélkül.

Reklámvilágítás: A Tungram higanygőzlámpák különleges fényszíne a megvilágított reklámtárgyakat a környezetből rendkívül hatásosan kiemeli.

Kirakévilágítás: Itt elsősorban a rendkívül gazdaságos áramfogyasztás érvényesül. Üveg, porcellán, kristály, fém stb. anyag a higanygőzlámpákban különösen hatások.

Belső helyiségek világítása: Itt is a gazdaságos áramfogyasztás van a hangsúly. Általában izzólámpákkal kevert világítást kell alkalmazni.

Természeti szépségek, épületek, műemlékek megvilágítása: Tungram higanygőzlámpákkal csodálatos hatások érhetők el.

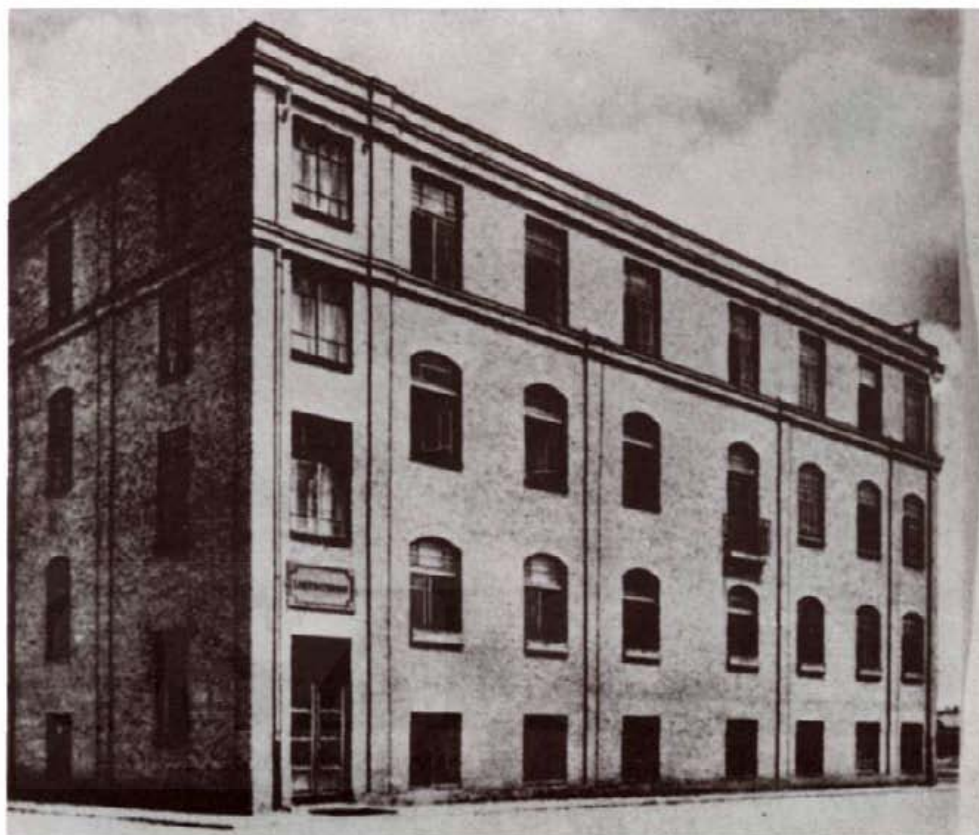
Sportcsarnokok, pályaudvarok, sínek stb. megvilágítása: A gazdaságos áramfogyasztás és különleges fényszínű Tungram higanygőzlámpáknak ezen kívül is számtalan alkalmazási lehetősége van.

Minden érdeklődésre készséggel válaszolunk és kívánságra részletes világítástechnikai tanácsadással is szolgálunk.



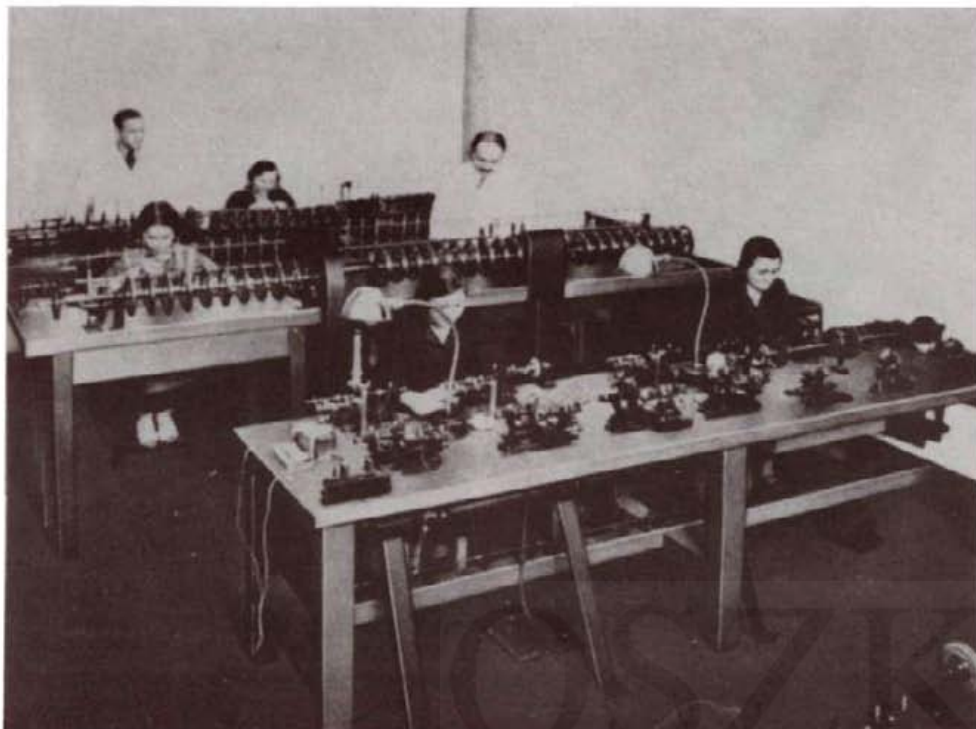
This TUNGSRAM catalogue dated from 1939 reveals that the high pressure mercury vapour lamps came on the market in the last years of the 1930s, which meant that the production of them using sintered cathodes already began parallel with the research and development work.

The building of TUNGSRAM's Research Laboratory. The institute was the first of its kind in Europe.



This group photograph showing the heads and the staff of the Research Laboratory was taken sometime in the early 1930s. We only try to list the names of those who are sitting in the front row. From left to right: Dr. Knapp, I. Bródy, Dr. E. Blum, S. Lázár, ...L. Aschner, Z. Pfeiffer, Z. Bay, P. Selényi, Z. Szász, T. Krassói, Gy. Szigeti, Mrs. Mende, M. Strasszer, D. Orovan and G. Vészi (all esteemed names in the history of the TUNGSRAM).

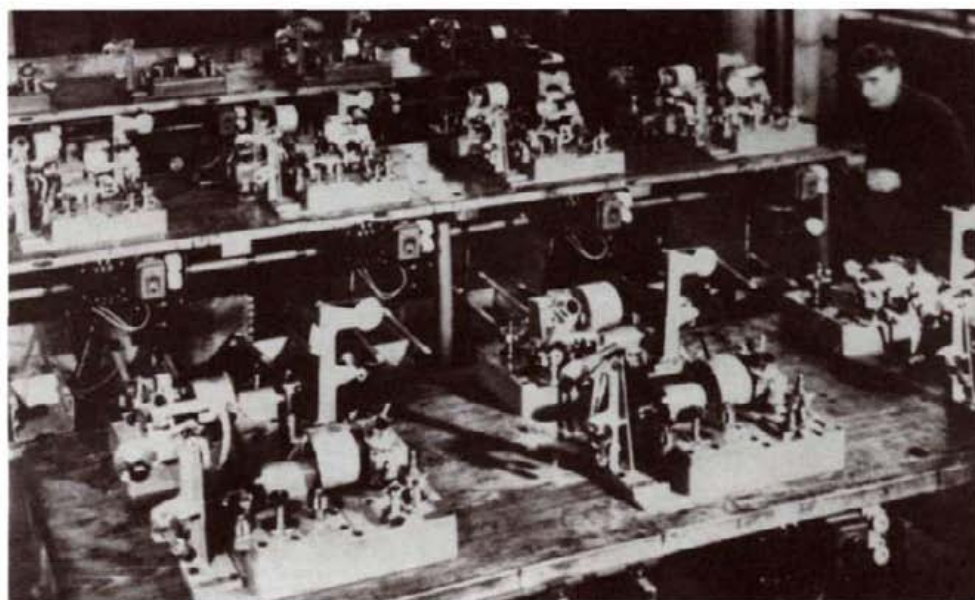




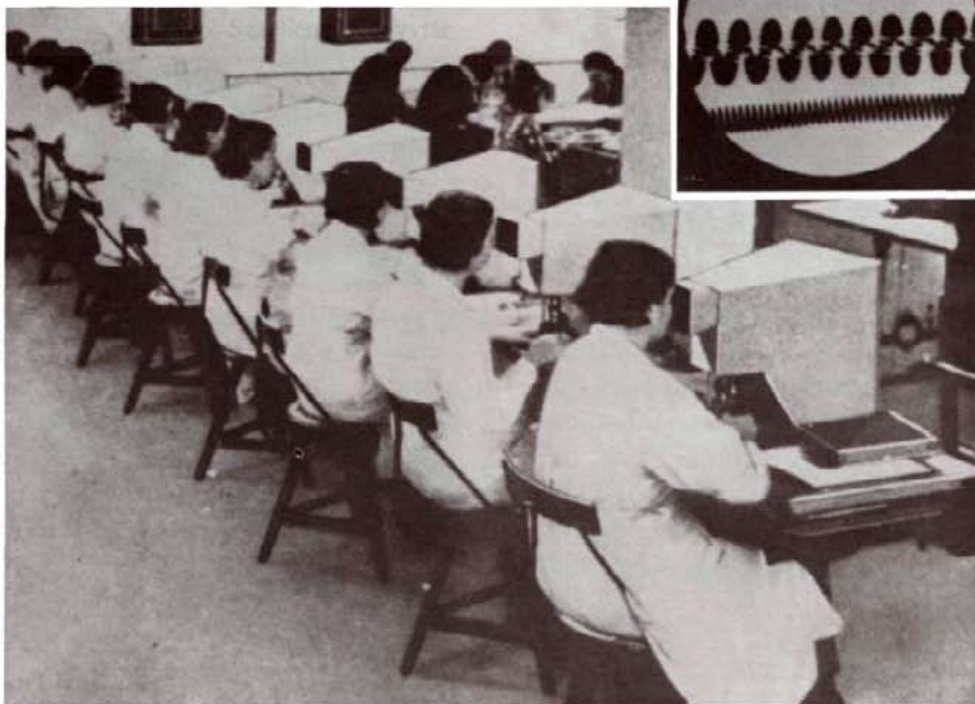
The tools used in drawing the tungsten filaments had components made of industrial diamond. The picture shows the workshop where these diamonds were cut and drilled sometime in the 1930s.



The industrial mass-production of coiled filaments began in the late 1930s.



The FO-1 coiling machines were first employed in production in the early 1930s.



The quality control of coiled tungsten filaments, using projectors called 'ball-optics' during the 1930s.

Megjelent 1931. évi május hó 1-én.

MAGYAR KIRÁLYI

SZABADALMI HIRŐRÁS

SZABADALMI LEIRÁS

102488. sz. — VII/b. osztály.

Gátlódó elektronos izzólámpa.

Egyesült Izzólámpa és Villamossági Rézvénytársaság
cég Újpest.

A bejelentés napja 1930. évi december hó 15-én.

Elektronos izzólámpák gázzal való töltésénél alkalmazott eljárás.

Megjelent 1931. évi november hó 16-án.

MAGYAR KIRÁLYI

SZABADALMI HIRŐRÁS

SZABADALMI LEIRÁS

103551. sz. — VII/b. osztály.

Gátlódó fémzárnal elektronos izzólámpa.

Egyesült Izzólámpa és Villamossági R.-T. Újpest.

A bejelentés napja 1930. évi augusztus hó 11-én.

A gátlódó fémzárnal elektronos izzólámpák töltésénél alkalmazott eljárás.

Megjelent 1930. évi július hó 15-én.

MAGYAR KIRÁLYI

SZABADALMI HIRŐRÁS

SZABADALMI LEIRÁS

104186. sz. — IV/a. osztály.

Egyesült Izzólámpa és Villamossági R.-T. Újpest.

Egyesült Izzólámpa és Villamossági R.-T. Újpest.

A bejelentés napja 1930. évi október hó 20-án.

eljárás, amellyel jellemzően, hogy azokat
termikus diffúzióval töltjük alá és a
disszociációt külön elválasztjuk.2. Az 1. igényben védett eljárás fogantatási módja, amellyel jellemzően, hogy a
kriptonban és xenonban, vagy ezek
egyesített, disszociált gázkeverékét egy-
szer vagy többször megismételt ter-
mikus diffúzióval töltjük alá.3. Az 1. és 2. igényekben védett eljárás
fogantatási módja, amellyel jellemzően,
hogy a disszociált gázkeverék a köze-
légben nyomással magasabb nyomásra
vetjük alá termikus diffúzióval.4. Az 1. és 3. igényekben védett eljárás
fogantatási módja, amellyel jellemzően,

Szabadalmi igények:

1. Eljárás kriptonban és xenonban vagy
ezek együttesen vagy más gázkeverék-
keverékben.amelynek nagysága
vagyis legalább 10 mm.
parciális nyomásnak megfelelő.

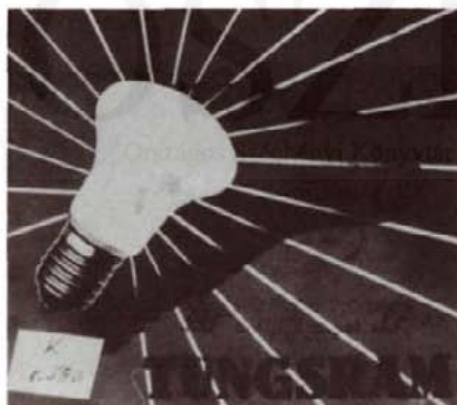
Szabadalmi igények:

1. Gátlódó elektronos izzólámpa, mel-
lyen wolframot, kénült, töltött
elektronos izzólámpa, amellyel jellemzően,
hogy a gátlódó elektronos vagy osz-
triumos izzólámpa.2. Az 1. igényben védett gátlódó elek-
tronos izzólámpa fogantatási módja,
amellyel jellemzően, hogy az az eddig is-
mert gátlódó elektronos izzólámpa legalább 10
mm. higanyoszlopnyi parciális nyomá-
sának megfelelő mennyiségben tartalmaz
wolframhexafluoridot.

Szabadalmi igények:

3. Gátlódó fémzárnal elektronos izzólámpa,
amellyel jellemzően, hogy a gátlódó
fémzárnal egy gátlódó fémzárnal, melynek
a molekulái legalább 10 mm. és
izotóptól alkotó anyag gátlódó molekulái
száma.4. Az 1. igényben védett gátlódó izzólámpa fo-
gantatási módja, amellyel jellemzően,
hogy az 1. igényben védett gátlódó izzólámpa
töltésénél gátlódó legalább 10 mm.
nyomású higanyoszlopnak megfelelő parci-
ális nyomásnak megfelelő mennyiségben
tartalmaz.5. Az 1. és 2. igényekben védett izzólámpa fo-
gantatási módja, amellyel jellemzően,
hogy a gátlódó fémzárnal egy-
gátlódó, vagy annak valamely eleme
gátlódó, vagy annak valamely eleme
gátlódó, vagy annak valamely eleme
gátlódó.6. Az 1-3. igényekben védett izzólámpa fo-
gantatási módja, amellyel jellemzően,
hogy az izotóptól alkotó anyag
wolfram.7. Az 1-4. igényekben védett izzólámpa,
amellyel jellemzően, hogy a gátlódó
fémzárnal vagy részben wolfram
hexafluorid (WFO).These were only some of the pa-
tent descriptions which were re-
gistered to protect invention of the
krypton lamp.

One of the first experimental krypton lamps, primarily made to economize on the amount of krypton necessary, are shown on the four lamps in the background, feeling about the final, elongated mushroom shape.



TUNGSRAM KRYPTON LAMPAK

Power Watt	Pressure mm Hg	Base Type	Notes	Price HUF	Price USD
100-120	11	Edison type		150	1.50
120-150	11	"		150	1.50
150-180	11	"		150	1.50
180-200	11	"		150	1.50
200-220	11	"		150	1.50
220-240	11	"		150	1.50
240-260	11	"		150	1.50
260-280	11	"		150	1.50
280-300	11	"		150	1.50
300-320	11	"		150	1.50
320-340	11	"		150	1.50
340-360	11	"		150	1.50
360-380	11	"		150	1.50
380-400	11	"		150	1.50
400-420	11	"		150	1.50
420-440	11	"		150	1.50
440-460	11	"		150	1.50
460-480	11	"		150	1.50
480-500	11	"		150	1.50

TUNGSRAM KRYPTON GYERTYALAMPA

Power Watt	Pressure mm Hg	Base Type	Notes	Price HUF	Price USD
100-120	11	Edison type		150	1.50
120-150	11	"		150	1.50
150-180	11	"		150	1.50
180-200	11	"		150	1.50
200-220	11	"		150	1.50
220-240	11	"		150	1.50
240-260	11	"		150	1.50
260-280	11	"		150	1.50
280-300	11	"		150	1.50
300-320	11	"		150	1.50
320-340	11	"		150	1.50
340-360	11	"		150	1.50
360-380	11	"		150	1.50
380-400	11	"		150	1.50
400-420	11	"		150	1.50
420-440	11	"		150	1.50
440-460	11	"		150	1.50
460-480	11	"		150	1.50
480-500	11	"		150	1.50

TUNGSRAM KRYPTON GOMELAMPA

Power Watt	Pressure mm Hg	Base Type	Notes	Price HUF	Price USD
100-120	11	Edison type		150	1.50
120-150	11	"		150	1.50
150-180	11	"		150	1.50
180-200	11	"		150	1.50
200-220	11	"		150	1.50
220-240	11	"		150	1.50
240-260	11	"		150	1.50
260-280	11	"		150	1.50
280-300	11	"		150	1.50
300-320	11	"		150	1.50
320-340	11	"		150	1.50
340-360	11	"		150	1.50
360-380	11	"		150	1.50
380-400	11	"		150	1.50
400-420	11	"		150	1.50
420-440	11	"		150	1.50
440-460	11	"		150	1.50
460-480	11	"		150	1.50
480-500	11	"		150	1.50

TUNGSRAM KRYPTON R LAMPA

Power Watt	Pressure mm Hg	Base Type	Notes	Price HUF	Price USD
100-120	11	Edison type		150	1.50
120-150	11	"		150	1.50
150-180	11	"		150	1.50
180-200	11	"		150	1.50
200-220	11	"		150	1.50
220-240	11	"		150	1.50
240-260	11	"		150	1.50
260-280	11	"		150	1.50
280-300	11	"		150	1.50
300-320	11	"		150	1.50
320-340	11	"		150	1.50
340-360	11	"		150	1.50
360-380	11	"		150	1.50
380-400	11	"		150	1.50
400-420	11	"		150	1.50
420-440	11	"		150	1.50
440-460	11	"		150	1.50
460-480	11	"		150	1.50
480-500	11	"		150	1.50

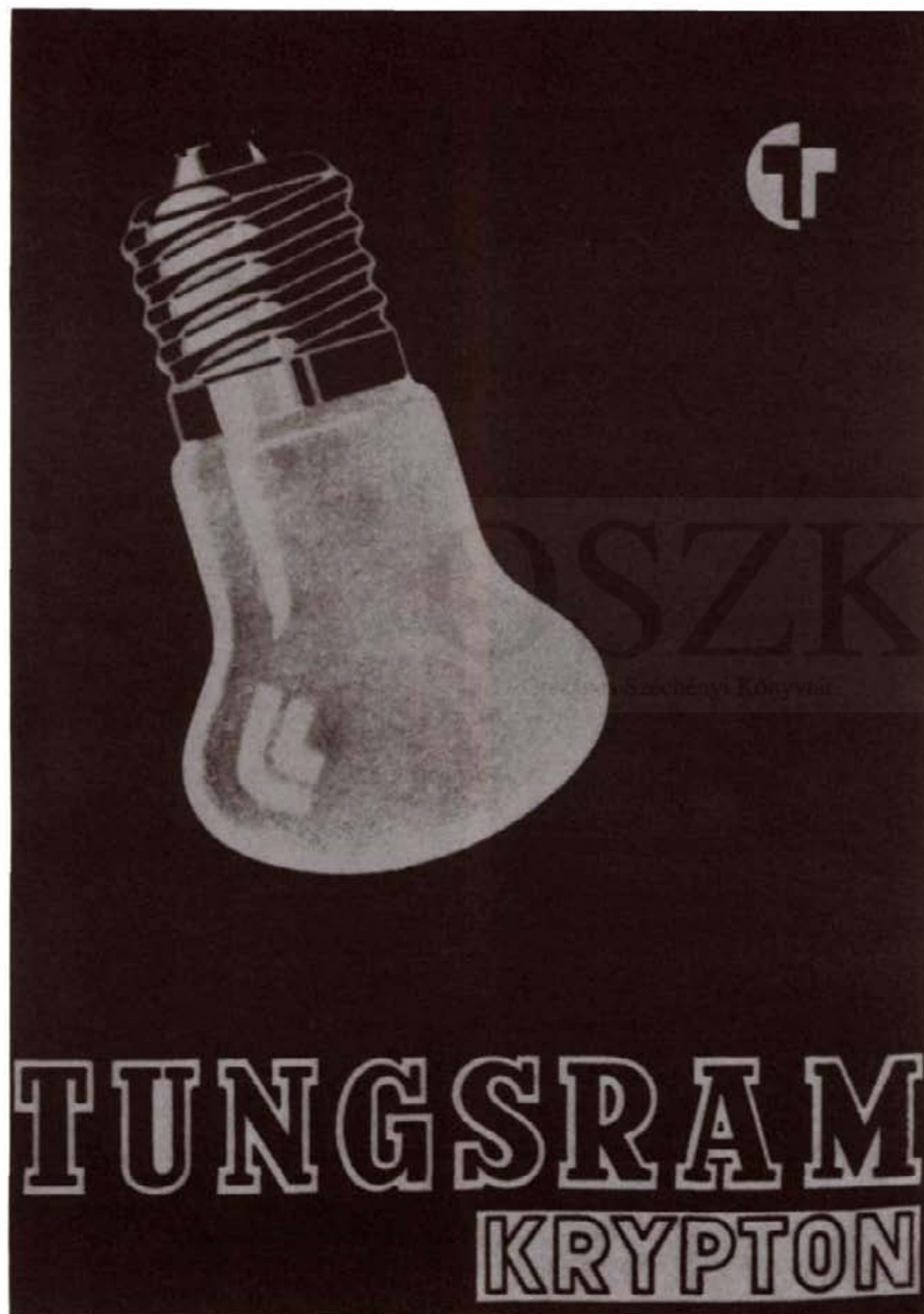
The first patents of Bródy's krypton lamp were registered in the early 1930s. The trial runs and the setting up of the mass-production, however, required time. The complete series of krypton lamps appeared in the catalogues in the late 1930s. In the next few pages we are going to show pictures from some of these catalogues.

TUNGSRAM LAMPAK ALTAJÁNOS VILÁGÍTÁSA

Power Watt	Pressure mm Hg	Base Type	Notes	Price HUF	Price USD
100-120	11	Edison type		150	1.50
120-150	11	"		150	1.50
150-180	11	"		150	1.50
180-200	11	"		150	1.50
200-220	11	"		150	1.50
220-240	11	"		150	1.50
240-260	11	"		150	1.50
260-280	11	"		150	1.50
280-300	11	"		150	1.50
300-320	11	"		150	1.50
320-340	11	"		150	1.50
340-360	11	"		150	1.50
360-380	11	"		150	1.50
380-400	11	"		150	1.50
400-420	11	"		150	1.50
420-440	11	"		150	1.50
440-460	11	"		150	1.50
460-480	11	"		150	1.50
480-500	11	"		150	1.50

REGI WATT SOROZAT

Power Watt	Pressure mm Hg	Base Type	Notes	Price HUF	Price USD
100-120	11	Edison type		150	1.50
120-150	11	"		150	1.50
150-180	11	"		150	1.50
180-200	11	"		150	1.50
200-220	11	"		150	1.50
220-240	11	"		150	1.50
240-260	11	"		150	1.50
260-280	11	"		150	1.50
280-300	11	"		150	1.50
300-320	11	"		150	1.50
320-340	11	"		150	1.50
340-360	11	"		150	1.50
360-380	11	"		150	1.50
380-400	11	"		150	1.50
400-420	11	"		150	1.50
420-440	11	"		150	1.50
440-460	11	"		150	1.50
460-480	11	"		150	1.50
480-500	11	"		150	1.50



TUNGSRAM launched an intensive advertisement campaign to popularize its latest product, which performed better and looked more attractive than its previous designs.

In way of illustration, in the next few pages we show original documents, posters, advertisements and even picture postcards which were used in the campaign. Beside the major European languages—English, German, French and Spanish—the less familiar languages, such as Arabic, Greek, Hebrew and Armenian, are also represented.

DEPUIS EDISON...



*La plus grande innovation
dans l'Eclairage.*

...tous les efforts ont tendu à "blanchir" les rayons rougeâtres des premières lampes à incandescence. Avec les nouvelles lampes Tungram-Krypton et grâce à l'énorme température de 2800° atteinte au filament, la lumière électrique coule en nappes merveilleusement blanches et reposantes aux yeux. Il a fallu 60 ans de recherches scientifiques pour obtenir cette "blancheur solaire". Ajoutez à cela élégance et économie, et vous aurez



**TUNGSRAM
KRYPTON**

la nouvelle lumière



Strahlendes Licht

KRYPTON

egy a sok-sok német változat közül...

La nueva Luz

**BOMBILLAS ELECTRICAS
TUNGSRAM
KRYPTON**
LUZ CLARA COMO EL SOL

ez pedig a spanyol szöveg arról, hogy az „új fény” olyan világos, mint a nap

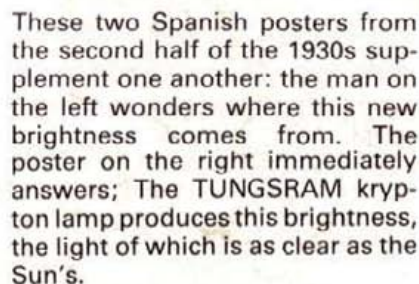
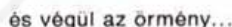
ez a görög...

*Εξαιρετικώς
ομοιάζουν...*

ΤΟΥΓΚΣΡΑΜ
ΤΟ ΦΩΣ ΤΟΥ ΗΛΙΟΥ ΣΕ ΛΑΜΠΤΗΡΑΣ

وفرتنا %

توئجسرام
د بئالومين

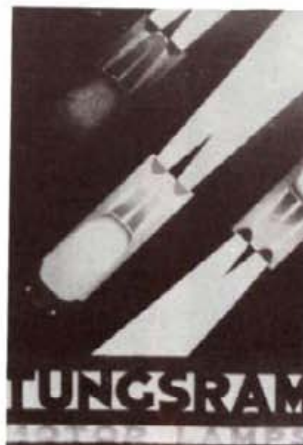




jó munkához
 **TUNGSRAM**
 KRYPTON

Országos Széchényi Könyvtár





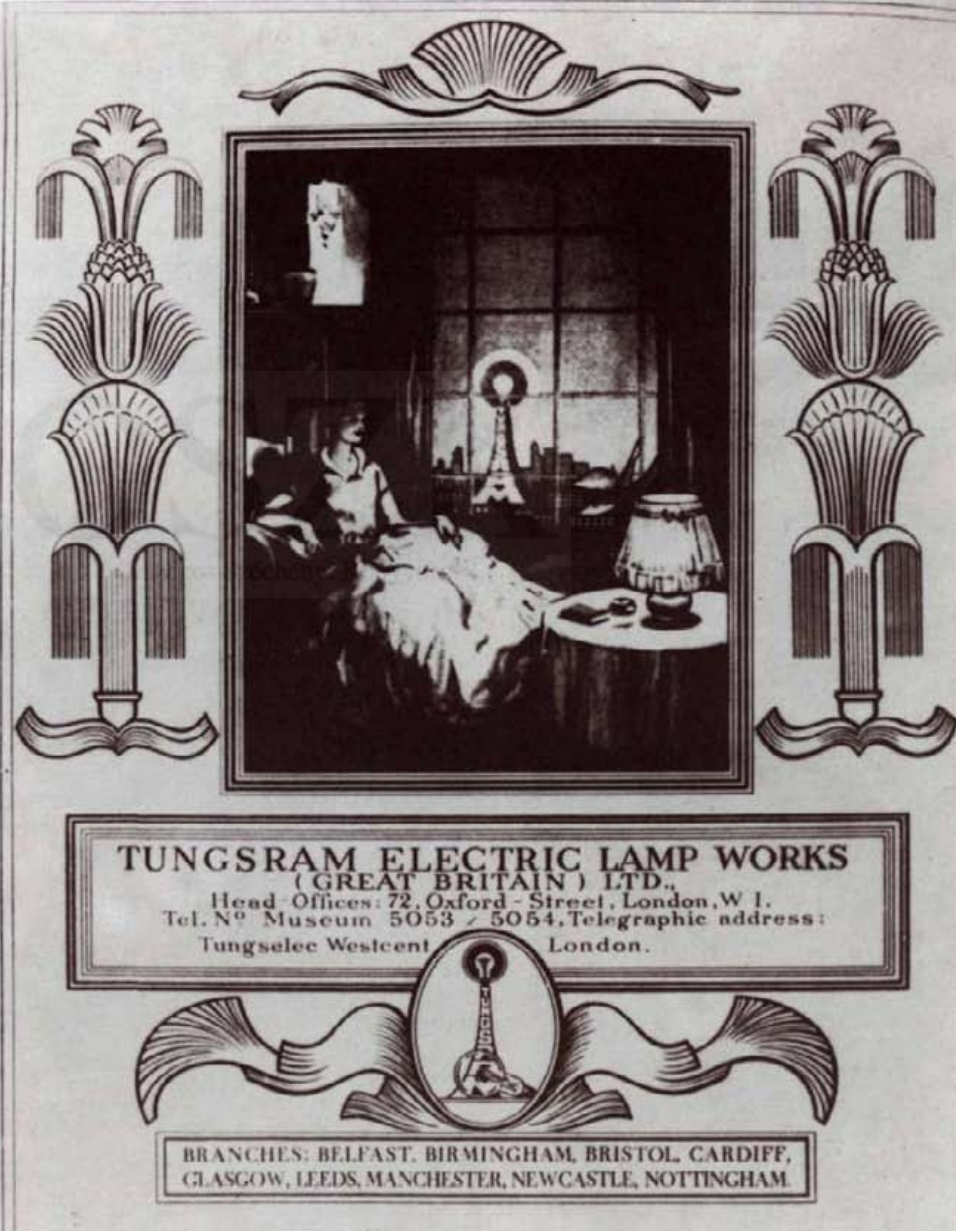
Various posters, adverts and title pages of catalogues advertising TUNGSRAM lamps from the 1940s.



Posters advertising TUNGSRAM light sources and radio valves in the years before the Second World War.



Further posters advertising TUNGSRAM lamps in the years before the Second World War.



TUNGSRAM ELECTRIC LAMP WORKS
 (GREAT BRITAIN) LTD.,
 Head Offices: 72, Oxford - Street, London, W 1.
 Tel. N^o Museum 5053 / 5054. Telegraphic address:
 Tungselec Westcent London.

BRANCHES: BELFAST, BIRMINGHAM, BRISTOL, CARDIFF,
 GLASGOW, LEEDS, MANCHESTER, NEWCASTLE, NOTTINGHAM.

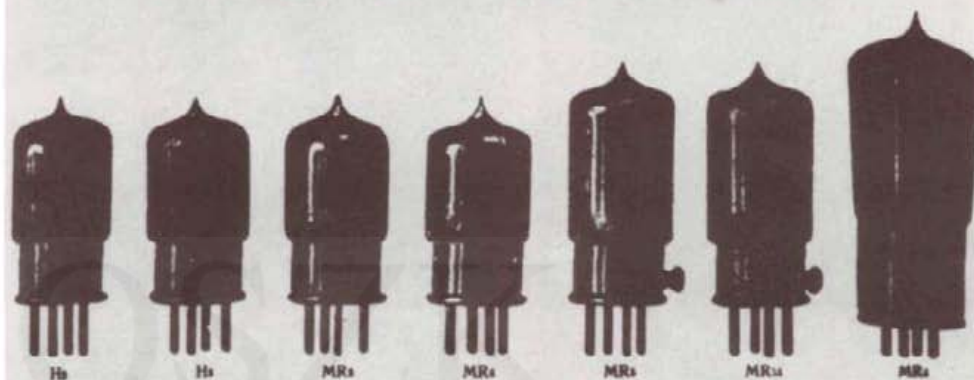
The catalogue of TUNGSRAM
 Electric Lamp Works (Great Brit-
 ain) Ltd. from the 1930s.



The technical staff of radio valve production in 1939: Winter, Horváth, Monostori, Glasner, Grósz, Ermer and many others... similarly all esteemed names, in the trade.

TUNGSRAM

RÁDIÓ-CSÖVEK



TYPUS	Főáram feszítésgye Vált	Főáram smp.	Teljes áram smp. smp.	Áramkör feszítésgye Vált	Hűtési áram smp. smp.	Átjárás Ω/g	Merőkhöz mm smp. / smp.	Alkalmazás	Száll száma	Ár korona
MRs	3-3.5	0.06	6-8	30-70	2.5-3	14	0.4	E. A.	20000	173.000
MRs	3-3.5	0.06	6-8	40-90	2-2.5	10	0.4	M. E. A.	25000	173.000
MRs	5-6	0.25	40-50	20-100	8	20	0.6	M. E. A. V.	8000	300.000
MRs	3.5-4	0.300	30	20-100	5	20	0.6	M. E. A. V.	8000	300.000
MRs	1.6-1.8	0.15	3-4	2-12	1-1.5	3.5	0.3	M. E. A.	100000	303.000
MRs	3-3.5	0.05	3-4	3-12	1-1.5	3.5	0.3	M. E. A.	100000	303.000
MRs	1.6-1.8	0.15	6	40-90	1.8	10	0.4	M. E. A.	25000	173.000
Hs	3-3.5	0.55	4	30-70	1.5	14	0.3	E. A.	25000	86.500
Hs	3-3.5	0.55	4	50-90	1.5	10	0.3	M. E. A.	30000	86.500

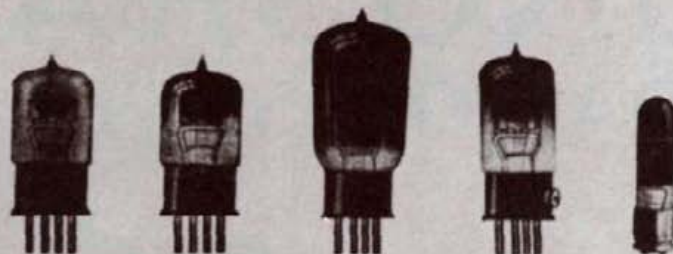
Jelmagyarázat. **M** = Magasváltakozású erősítő
E = Egyenirányító (Audion)
A = Alacsonyváltakozású erősítő
V = Vágerősítő

A megadott számbeli értékek csak megközelítő értékek.

EGYESÜLT IZZÓLÁMPA ÉS VILLAMOSSÁGI
R-T.
UJPEST

One of the first promotion leaflets, giving the specifications of TUNGSRAM radio valves from 1925.

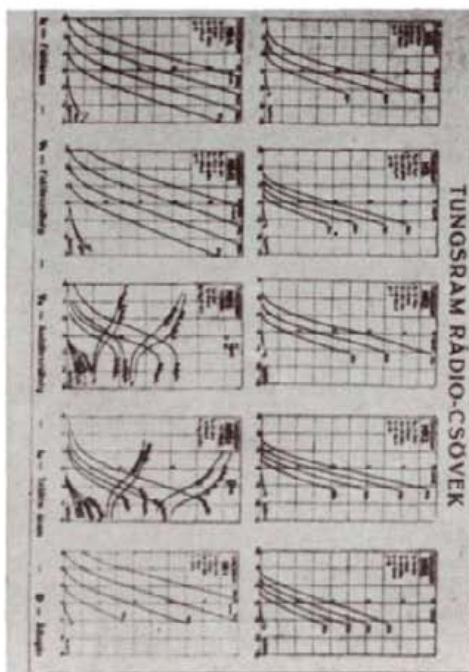
TUNGSRAM RÁDIO-CSÖVEK



Típus	Fűtőáram [mA]	Fűtési teljesítmény [W]	Elektron- áram [mA]	Amplitúdó [V]	Hangfrekvencia- tartomány [kHz]	Áramerősség [mA]	Maximális nyomás [mmHg]	Elektron- áram [mA]	Állapot
Triódcső MR 2	3-3,5	0,06	6-8	30-70	2,5-3	15	0,4	20000	F. A.
MR 3	3-3,5	0,06	6-8	40-90	2-2,5	10	0,4	25000	M. F. A.
MR 6	1,6-1,8	0,15	5	40-90	1,8	10	0,4	25000	M. F. A.
MR 4	5-6	0,20	40-50	20-100	8	20	0,6	8000	M. F. A. V.
MR 41	3,5-4	0,30	30	20-100	8	20	0,6	8000	M. F. A. V.
MR 5 kétfélecső	1,6-1,8	0,15	3-4	2-12	1-1,5	35	0,3	10000	M. F. A.
MR 51	3-3,5	0,06	3-4	3-12	1-1,5	35	0,3	10000	M. F. A.
Wolfram-katódos cső H 2	3-3,5	0,55	4	30-70	1,5	15	0,3	25000	F. A.
H 3	3-3,5	0,55	4	40-90	1,5	10	0,3	30000	M. F. A.
Oxid-katódos cső OR 1	0,85-1,1	0,25	8	20-90	1,2-2,5	20	0,3	15000	M. F. A.

A megadott számok az alábbi ábrák alapján vannak meghatározva.
A csővek működési hőmérsékletét a Tungsram-féle hőmérővel lehet ellenőrizni.
A csővek működési hőmérsékletét a Tungsram-féle hőmérővel lehet ellenőrizni.

ELMAGYARÁZAT: M — Megvezetőcső, rézcső
F — Fűtőcső, fűtőcső
A — Anódszál, anódszál
V — Vákuum



TUNGSRAM RÁDIO-CSÖVEK

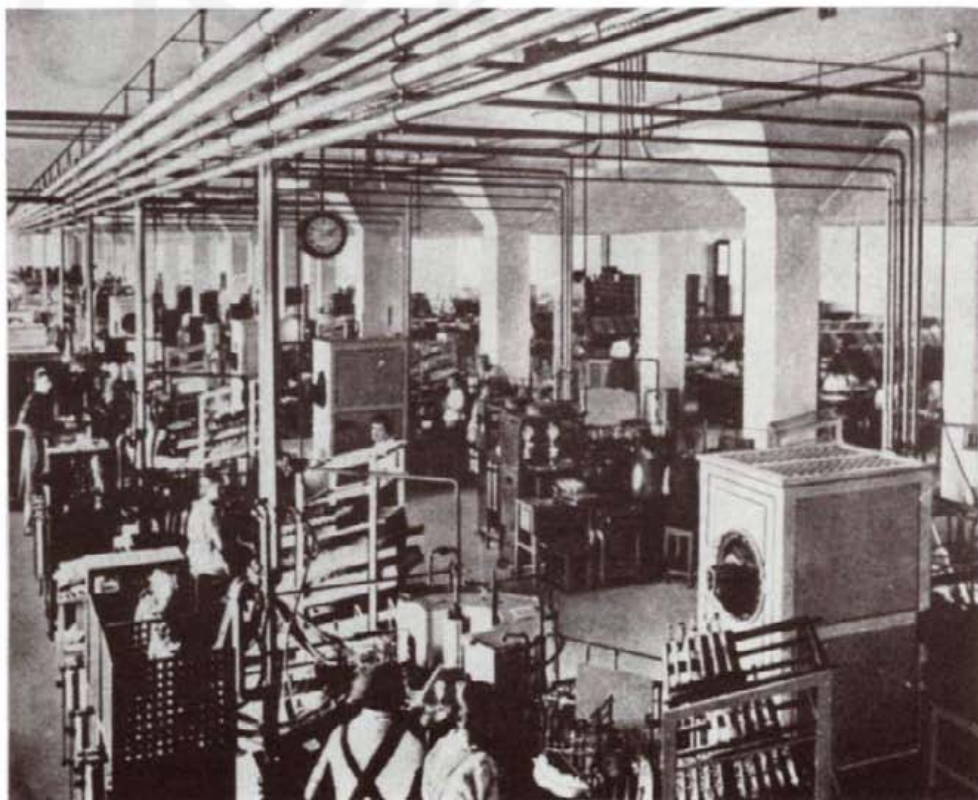


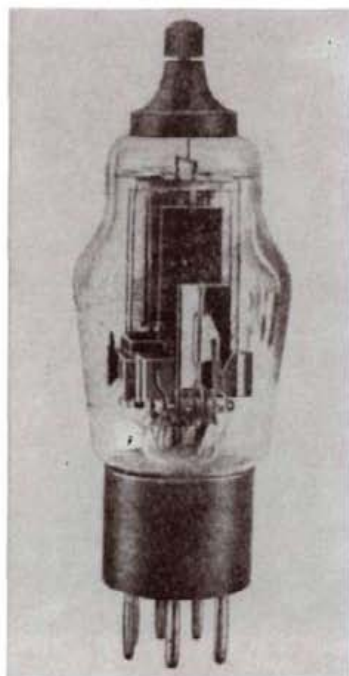
A promotion leaflet similar to the previous one, except this already included the first design provided with oxide cathode, the OR 1.

Assembling radio valves in the recently completed 'Audion' building in the early 1930s.

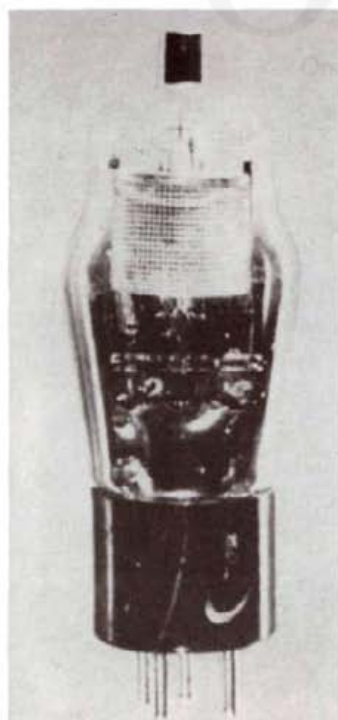


A section of the Radio Valve Department sometime in the 1930s.





The combined valve produced by Tungsramp, the diode-tetrode called DS-4100 was first used in 1933. This design combined two different valves in this case the demodulator-diode and the screen-grid amplifier.



TUNGSRAM radio valves fitted with oxide cathode.



Title page of the TUNGSRAM catalogue selling the 'Philips base' radio valve in the late 1930s.

Első betű	Fűtés	Második betű	Elektródarendszer
A	4 V-os váltóáramú sorozat	A	Egyszerű dióda
C	200 mA-es univerzális sorozat	B	Kettős dióda
E	6,3 V-os váltóáramú sorozat	C	Trióda
K	2 V-os telepfűtésű sorozat	D	Végerősítő trióda
U	100 mA-es univerzális sorozat	F	Feszültség erősítő pentóda
V	50 mA-es univerzális sorozat	H	Hexóda vagy heptóda
		K	Októda
		L	Végerősítő pentóda
		M	Hangolási jelző
		Y	Féloldalas egyenirányító
		Z	Kétoldalas egyenirányító

Példa: ECH 4: E = 6,3 V váltóáramú fűtés, C = trióda-rendszer, H = heptóda-rendszer, 4 = sorszám. A cső tehát trióda-heptóda keverőcső, váltóáramú csatlakozású hálózati készülékhez.

Országos Széchényi Könyvtár

6CS-603
6AE-604
(92)

8A1

112

80H

4172
6-6

6BH15
6B6A5

112

8A1

MISCHROHREN

TYPE	HEIZUNG		ANODEN		SCHNITTSTRE		GAS-ANODE		Dia. Spinnung	Gehäuse-anschl.	Trenn-Struktur	Max. Strahlstrom	Max. Strahlstrom	TYPE		
	Art	Spannung Volt	Strom Amp.	Spannung Volt	Strom mA	Spannung Volt	Strom mA	Spannung Volt							Strom mA	
Bündel-Oktoden:	CK	2	1	19	0.2	100	2.5	100	3.5	100	6	12	-2.5...-27	800	CK 1	
EK	2	1	6.3	0.65	250	2.5	100	5.5	100	6	12	-2.5...-28	0.65	4.5	2000	EK 1
EK	2	1	6.3	0.65	250	2.5	100	5.5	100	6	12	-2.5...-28	0.65	4.5	2000	EK 1
Oktoden:	AK	1	1	1	0.15	250	1	70	30	8.5	-1.5...-20	0.65	2000	AK 1		
AK	2	1	1	0.65	250	1.5	70	3.8	90	2	8.5	-1.5...-25	0.6	1600	AK 2	
CK	1	1	13	0.2	100	1.5	70	3.8	90	2	8.5	-1.5...-25	0.6	1000	CK 1	
EK	2	1	6.3	0.2	250	1	90	6.8	200	2.5	8.5	-2...-25	0.6	2000	EK 2	
KK	2	D	2	0.15	90	0.7	42	6.7	135	2.1	8.5	-0.5...-12	0.27	2000	KK 2	
KK	2	D	2	0.15	135	0.7	42	6.7	135	2.1	8.5	-0.5...-12	0.27	2000	KK 2	
Triode-Hexoden:	ACH	1	1	1	1	250	2.5	70	3	150	5	15	-2	0.6	ACH 1	
CEH	2	1	20	0.2	200	3.25	100	8	100	2	8	-2.5...-28	0.75	6	1500	CEH 2
ECH	2	1	6.3	0.9	250	3.25	100	8	100	7	8	-2.5...-38	0.75	6	1500	ECH 2
Heptoden:	MH 1118	1	10	0.18	90	3.5	100	2.6	90	3.7	8.5	-2...-45	0.48	400	MH 1118	
MH 4195	1	1	0.5	250	3.5	100	2.2	700	6	8.5	-2...-45	0.48	800	MH 4195		
Hexoden:	EH	2	1	6.3	0.2	250	1.85	100	3.8	—	—	14	-2	0.4	2000	EH 2
KH	1	D	2	0.135	135	0.75	50	1.1	—	—	—	10	-1.5...-11	0.4	500	KH 1

Als Abkürzungen: Dia. Durchmesser; Spinnung; Anode; Gas; Strahlstrom; Gehäuse-anschl.; Trenn-Struktur; Max. Strahlstrom; Max. Strahlstrom; TYPE.

The steadily increasing number of tube designs forced the radio valve cartel to introduce standard European designs, marked with standard designations. This way the imported valves became compatible with the domestic ones.



A poster advertising a valve from the 'Philips base' series.

6.3 Voltos univerzális E sorozat

Típus	Fajta	Fűtő		Áram		Áramszelvény		Vezeték		Szegély		Max. áram	Max. áram	Max. áram	Max. áram	Max. áram	Max. áram
		hossz m	áram A	hossz m	áram A	hossz m	áram A	hossz m	áram A	hossz m	áram A						
EV 4	Kathódizált	0-3	0-2	300	0-8											24	18
EV 3	Kathódizált	0-3	0-3	350	5			0-5	3	300	0-8	3	30	15000		1-5	3
EV 2	Kathódizált	0-3	0-3	350	5	100	1-6	0-3	3	300	0-8	18	0-10	2700	1-2	Rg2-950000	1-5
EV 1	Kathódizált	0-3	1-6	350	36	250	5	0-4	1	300	0-8	0-5	475	50000	7000	4-5	0
EV 11	Trüde-egység	0-3	1	350	36	250	4	0-5	0-7	300	2	0	450	50000	7000	4-5	0
EV 2	Trüde-egység	0-3	0-9	350	3-25	100	7-6	0-3	3	300	0-5	0-75	400	1-5	Vase	0-5	1
EV 3	Trüde-egység	0-3	0-2	350	3	100	3	0-3	3	300	3-3	0-65	400	1-5	Vase	0-5	1-2
EV 4	Trüde-egység	0-3	0-35	250	3	100	0-2	0-35	3	300	3-5	0-75	400	1-5	Vase	0-5	1-5
EV 5	Stabilitás	0-3	0-2	350	4	100	2-8	0-3	2-5	300	0-8	1-7	0-8	2000	1-5		2
EV 6	Stabilitás	0-3	0-3	350	3	100	0-8	0-2	3	300	0-8	1-8	4000	2-5		1	1-5
EV 8	Stabilitás	0-3	0-3	350	3	250	0-25	0-3	3	300	0-8	1-8	4000	2-5		2-5	2-5
EV 9	Stabilitás	0-3	0-2	350	4	100	1-7	0-3	3	300	0-8	1-8	4000	2-5		2-5	2-5
EV 10	Stabilitás	0-3	0-2	350	4	100	1-7	0-3	3	300	0-8	1-8	4000	2-5		2-5	2-5
EV 1	Kathódizált	0-3	0-2	350	1	250	0-35	0-3	3	300	0-8	1-8	4000	2-5		2-5	2-5
EV 2	Kathódizált	0-3	0-2	350	1	50	0-8	0-3	3	300	0-8	1-8	4000	2-5		2-5	2-5
EV 3	Kathódizált	0-3	0-65	350	2-5	100	5-5	0-3	3	300	0-8	1-8	4000	2-5		2-5	2-5
EV 4	Kathódizált	0-3	0-9	350	36	250	4	0-5	1	300	0-8	1-8	4000	2-5		2-5	2-5
EV 5	Kathódizált	0-3	1-6	350	72	250	0-2	0-7	0-7	300	0-8	1-8	4000	2-5		2-5	2-5
EV 6	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 7	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 8	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 9	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 10	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 11	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 12	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 13	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 14	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 15	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 16	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 17	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 18	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 19	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 20	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 21	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 22	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 23	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 24	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 25	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 26	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 27	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 28	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 29	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 30	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 31	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 32	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 33	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 34	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 35	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 36	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 37	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 38	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 39	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 40	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 41	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 42	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 43	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 44	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 45	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 46	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 47	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 48	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 49	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 50	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 51	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 52	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 53	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 54	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 55	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 56	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 57	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 58	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 59	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 60	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 61	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 62	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 63	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 64	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 65	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 66	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 67	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 68	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 69	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 70	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 71	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 72	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 73	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 74	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 75	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 76	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 77	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 78	Kathódizált	0-3	0-2	350	0-3					300	0-8	1-8	4000	2-5		2-5	2-5
EV 79	Kathódizált																

6. Beauftragte/r: Herrmann, Michael, sehr gut, kritisch, leistungsfähig. Bei 30 Stunden von vorliegen finden, aber kundenorientiert hat sich an eigene Aufgaben, hat auch sehr viele Ideen von vorliegen gesehen. Ist bei 30 Stunden leistungsfähig.



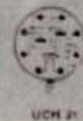
TUNGSRAM RÁDIÓCSŐ
A FEJLŐDÉS ÉLÉN



The extremely successful E-series very soon were extended to meet every possible demand. Today there still exist radio sets which use the red E-series valves.

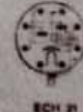
The competition to design smaller and smaller valves became fiercer every day. The so-called 'all-glass' tubes of the 6.3 Volt E-series and the universal 100 mA U-series resulted from this competition. The versatility of the series is best illustrated by the fact that four designs were enough to satisfy every possible construction.

Univerzális							
TÍPUS		Fűtő-		Anód-		Árnyékolórács-	
		feszültség Volt	áram Amp.	feszültség Volt	áram mA.	feszültség Volt	áram mA.
UBL 21	Kettős dióda végerősítő pentóda	55 i	0.1	100 180 200	32.5 61 55	100 180 200	5.5 10 9.5
UCH 21 mint kiverőcső	Trióda-heptóda	20 i	0.1	100 200	1.5 3.5	$R_{g1.4}$ 15500 Ω	3 6.5
UCH 21 mint nagyfrekv. és hangfrekv. erősítőcső				100 200	2.6 9.2	$R_{g1.4}$ 30000 Ω	1.7 3.5
UF 21 mint szabályozó nagyfrekv. cső	Pentóda	126 i	0.1	100 200	3.2 6	R_{g2} 60000 Ω	0.85 1.7
UF 21 mint hangfrekv. erősítőcső				100 200	0.33 0.65	R_{g2} 0.5 M Ω	0.04 0.17
UY 21	Egyoldalos egyenirányító	50 i	0.1	250	140		



Váltoáramu							
TÍPUS		Fűtő-		Anód-		Árnyékolórács-	
		feszültség Volt	áram Amp.	feszültség Volt	áram mA.	feszültség Volt	áram mA.
EBL 21	Kettős dióda végerősítő pentóda	6.3 i	0.9	250	36 44	250	4 5
ECH 21 mint kiverőcső	Trióda-heptóda	6.3 i	0.33	250	3	$R_{g1.4}$ 24000 Ω	6.2
ECH 21 mint nagyfrekv. és hangfrekv. erősítőcső					3.3	$R_{g1.4}$ 45000 Ω	3.5
EF 22 mint szabályozó nagyfrekv. cső	Pentóda	6.3 i	0.2	250	6	R_{g2} 90000 Ω	1.7
EF 22 mint hangfrekv. erősítőcső					0.67	R_{g2} 0.8 M Ω	0.26
AZ 21	Kétoldalos egyenirányító	4 d	1	2 x 580 2 x 300	70 120		

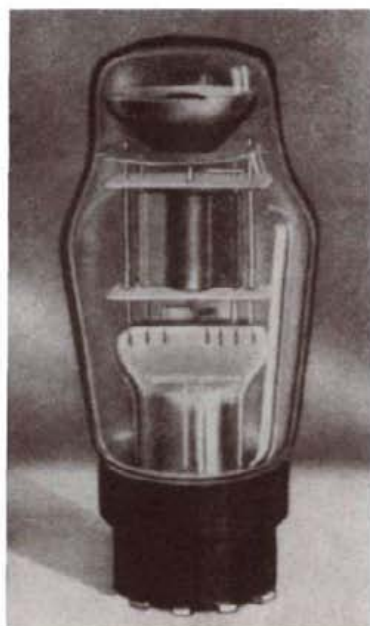
szünetelt fűtés
közvetlen fűtés



Two pages from the catalogues promoting the 'all-glass' TUNGSRAM valves in the late 1930s.



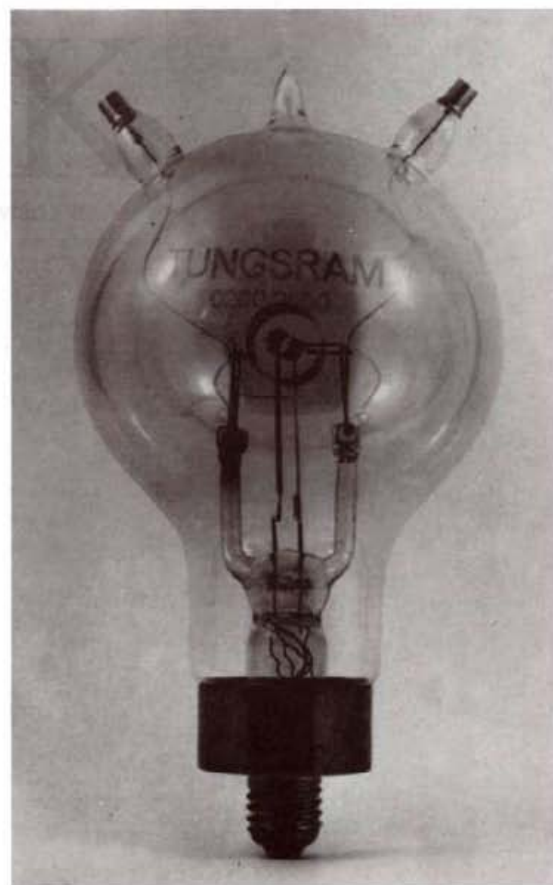
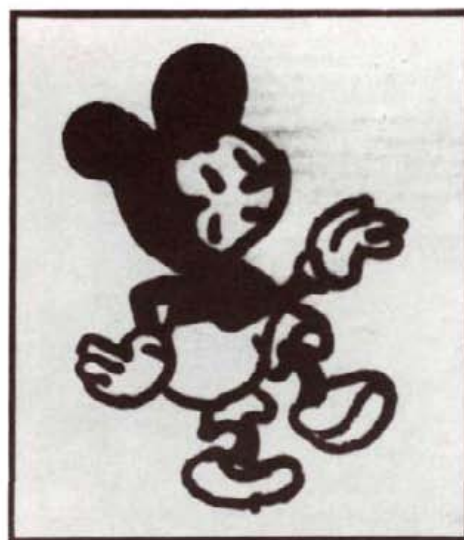
This picture shows the combined amplifier VCL-11 and the rectifier VY-2. These were the valves built into the very popular, cheap (48 Pengős) and energy-saving radio sets which ran both from alternating and direct current.



The 'magic eyes' ME-4 and ME-6 were used to improve the selectivity of the radio sets and also, to help in tuning the stations.



These were the images successfully transmitted in 1937, during TUNGSRAM's experimental television transmission: a TUNGSRAM trademark and Mickey Mouse.



A VHF transmitter triode designated C-200/2500 (1946).

Tel. lab.

*Tarabon**Hegedüs i. u.*

1940. december 13.

J e l e n t é s

A Televíziós laboratórium új munkaprogramja.

A laboratórium a következő cső gyártásfejlesztéssel és műszaki információkkal kapcsolatos kérdéseket vette munkába:

1./ Adócsőgyártásnál felmerülő laboratóriumi munkák:

a./ Thoriumos fonalak törékenységeinek vizsgálata és megszüntetése és ezzel kapcsolatban a fonal aktiválás /karbidizálás/ vizsgálata.

b./ Getterproblémák.

2./ Adócsővekkel kapcsolatos áramtörési kérdések és kapcsolódások kidolgozása vevőink részére /műszaki service/.

Adócsővek vizsgálatára szolgáló berendezések és mérőműszerek kidolgozása.

Adócsővek műszaki adatainak felülvizsgálata és információk egyesítése, illetve információk szerkesztése eladási szervizünk számára.

3./ Vevőcsővek vizsgálatára szolgáló készülékek tervezése és eladási célokra való megismerkedése.

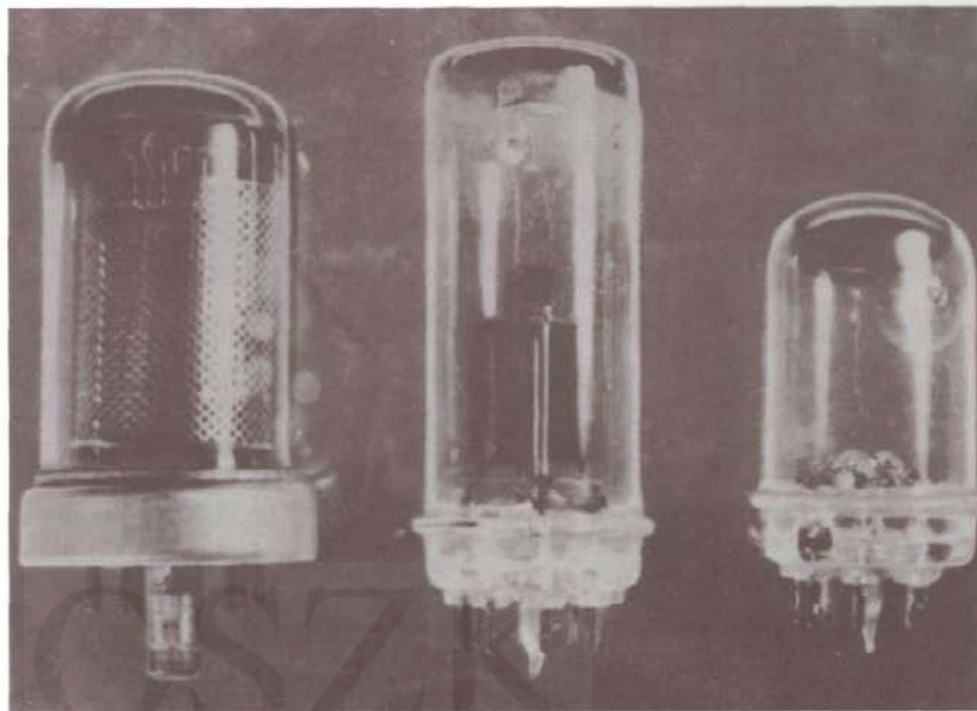
A 2./ pont alatti munkálatokat erősen hátráltatja a helyiség hiánya, mert a Televíziós laboratórium helyisége teljesen megtelt kész televíziós berendezésekkel.

C.	4
Teljesítés a. b. c.	23
Ellenőrzés a. b. c.	18

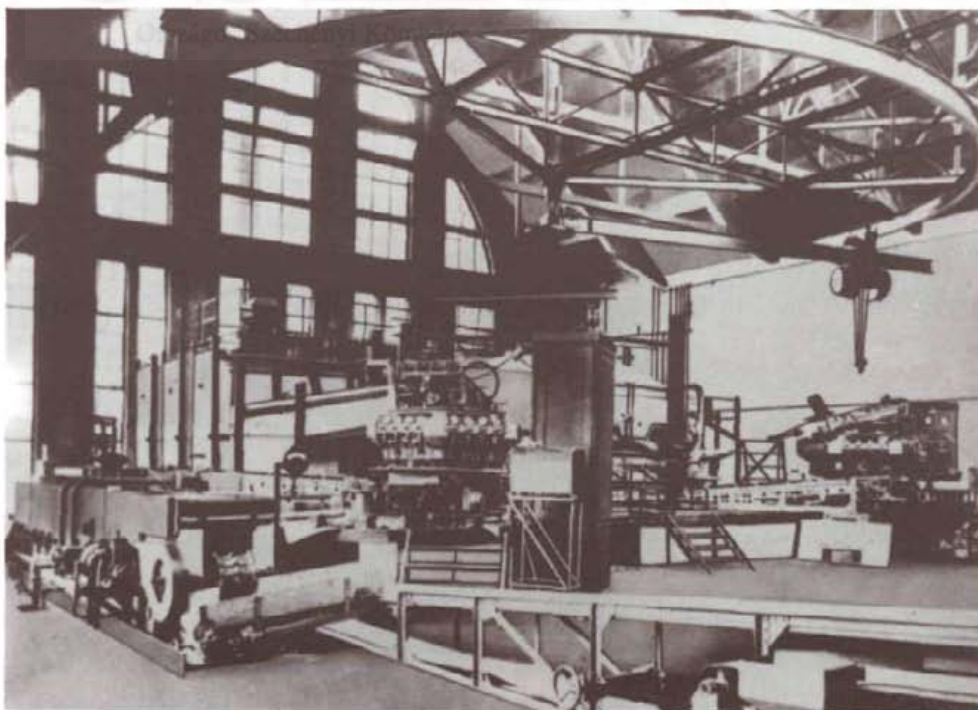
Bukor

In this report the head of TUNGSRAM's Television Laboratory—Dr. Károly Czukur complains about the lack of space, as the Laboratory is completely filled up with finished television sets. The date is—wait for it!—1940. Then the war broke out and the production of TV sets had to be postponed for another 15 years.

These microwave amplifier transmitters and diodes operated over a broad range of frequencies were designed in 1941–1942 under pressure from the Ministry of Defense of the Horthy-regime, which wanted to equip its fighter planes with them. The valves were completed too late to be used in their intended function. On the other hand, the results accumulated in the course of developing these valves proved to be great asset to Dr. Bay in his radar experiment with signals sent to the Moon.



The glass—being one of the basic components of light sources—played an important role in TUNGSRAM's history from the outset. Even as late as the 1920s, the glass bulbs of the incandescent lamps were still made manually. In the 1930s this method gave way to the mechanized production—to machines such the one shown in this picture.





A disciplined work-force sorting the glass bulbs in the Glass Factory of Utekac (Slovakia). The director is shown in the middle of the background.



The workers are packaging glass bulbs in the spacious factory yard of TUNGSRAM's glass factory in Tokod.

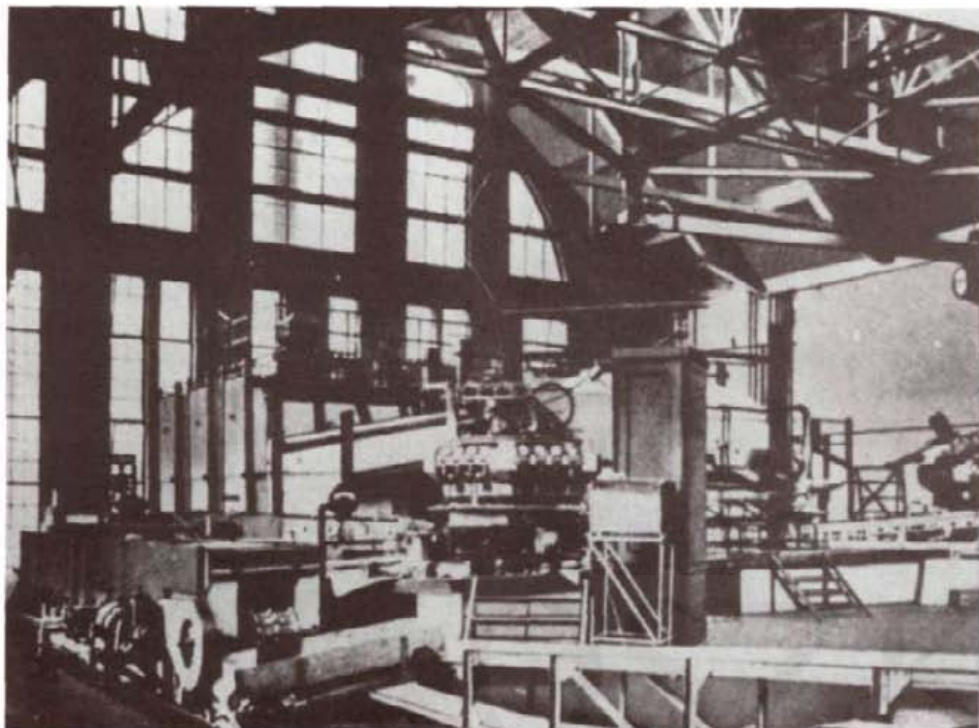


This picture, as well as other contemporary documents, prove that in the 1920s the incandescent lamps were still being transported in barrels.

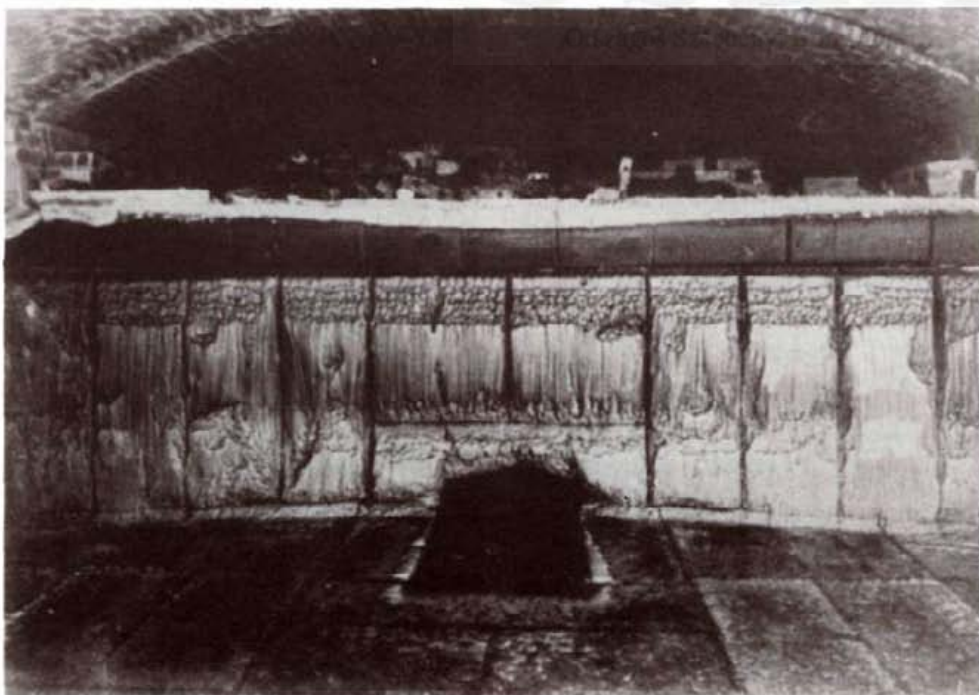
Országos Széchényi Könyvtár



The symbol of a new area. The mechanized glass factory of TUNGSRAM was built in 1931 and has been running continuously since 1932. The volume of glass components has multiplied in the meantime, which necessitated the construction of further glass factories.

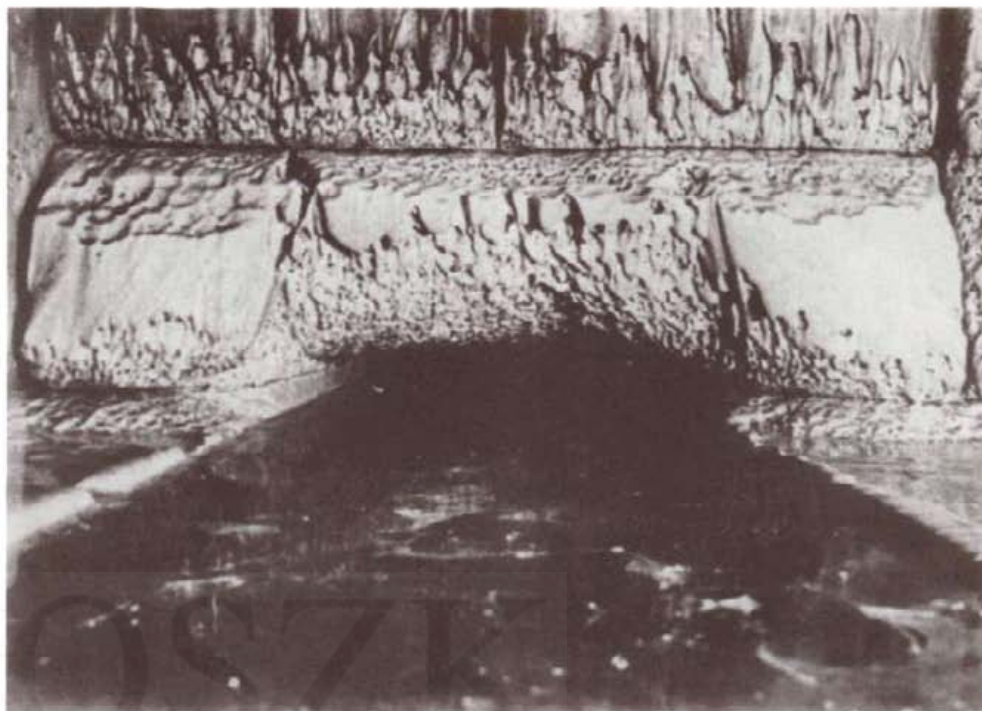


The furnaces and the glass blowing machines meant a giant leap forward, when compared to the era of manual glass blowing.

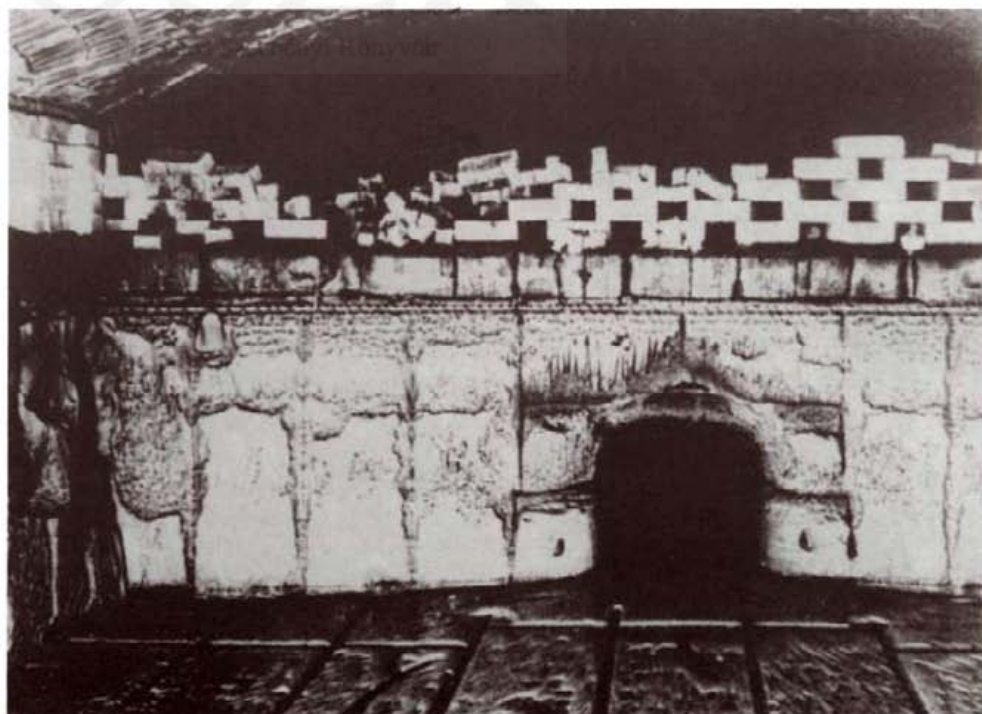


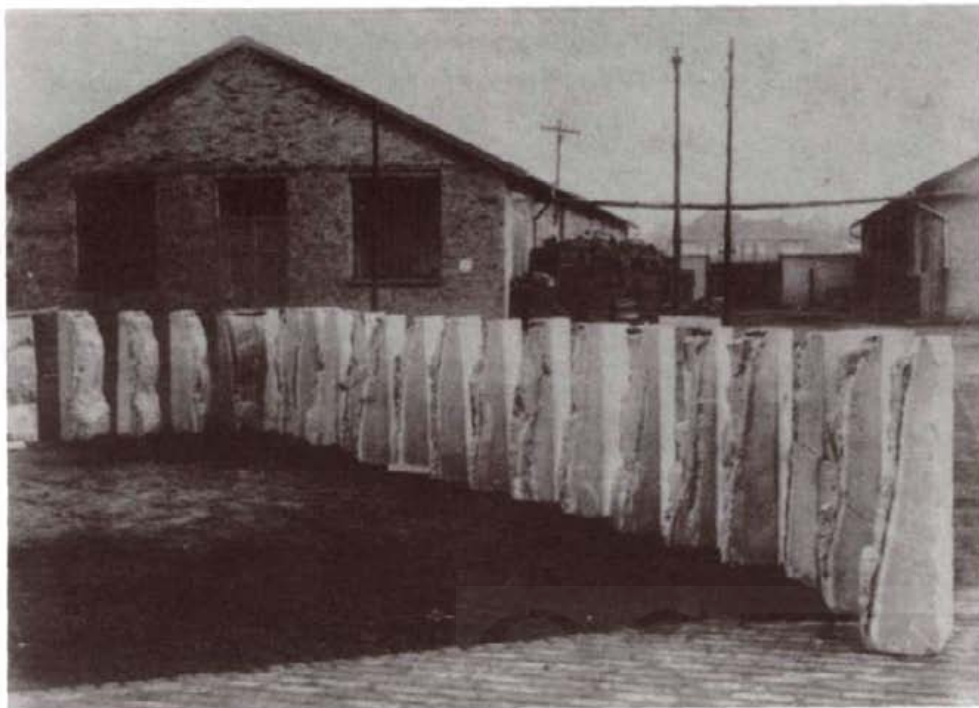
This melting block was designed by foreign experts for the mechanized glass factory in 1930–1931. The following pictures were taken of the interior of the melting block when it had been drained after three months of operation.

The strong erosion of the blockstones, especially of those in the bottom, is evident in the picture. On the other hand, the stone of the neck is less worn-out, indicating that the necessary thermal convection between the furnace chamber and the work block could not be formed.

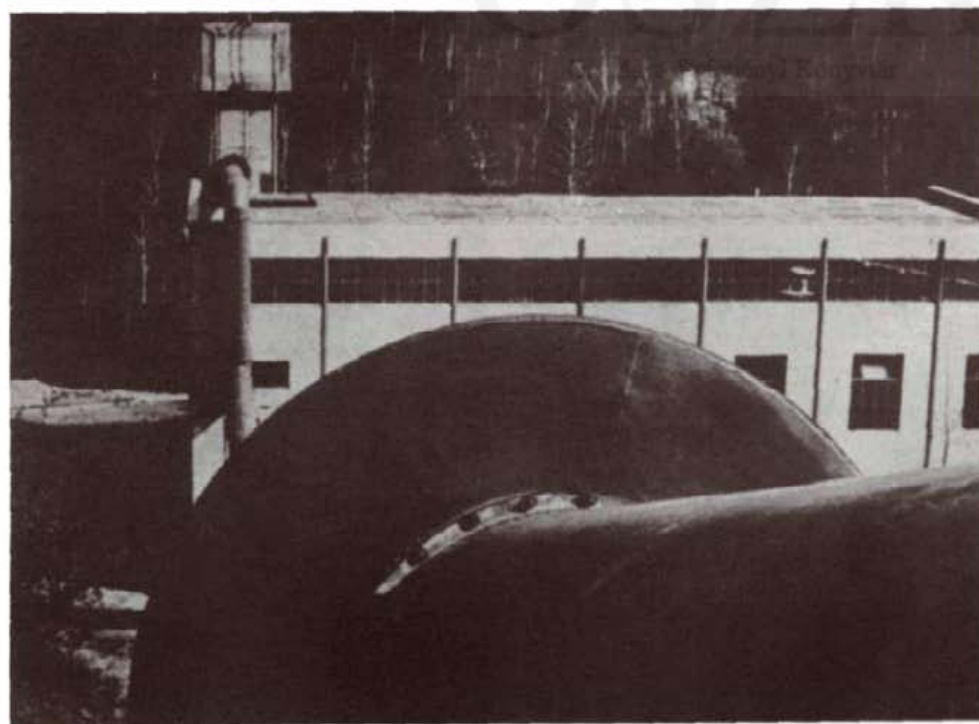


This picture was taken of the block after ten months of operation, following major alterations in its design by the company's own experts. The block was fitted with a new neck above the bottom level. It is apparent that the intensive convection between the furnace chamber and the work tub strongly wore out the stone of the neck.





When the block was taken apart, the stone components provided a lot of clues to the experts studying the convection of melted glass.



Beside the production of glass and the other components of modern light sources, the production of krypton was also given considerable attention when Bródy's new invention appeared. The next four pictures were taken of the occasion of opening TUNGSRAM's own krypton factory in Ajka. Their special interest is due to the fact that, beside the top management of TUNGSRAM, representatives of the Ministry and prominent figures from all the associated areas of the industry put in an appearance on the occasion.

A group of the people taking part in the grand opening of the krypton factory of Ajka (from left to right);

Béla Naményi, Dr. N. director of the legal department; Vilmos Rosenfeld, Dr., marketing director; (partially covered) Leo Fischmann, vice president; in the middle of the front row, Fülöp Weisz dominant personality in the Hungarian industry in those time; on his left, turning sideways, Béla Jánosi, director of the concern; Ernő Haidegger, Dr. N. director of the Electrical Works Corporation; István Péter, departmental head in the Ministry of Industry; László Heller, lecturer at the Technical University; between the two of them is Gábor Bajcsy-Zsilinszky; chief executive officer of 'Bauxit'; Lipót Aschner, chief executive officer of TUNGSRAM; Vilmos Meinhardt, chief executive officer of the Coal Mines of Ajka; József Mados, chief engineer of the Coal Mines of Ajka; Ignác Pfeifer, director of TUNGSRAM's Research Laboratory; and finally, Tibor Mihalovits, engineer.



OSZK

Here is another group of the TUNGSRAM management, visiting the factory on the same occasion.

(Sitting row, from left to right): Miklós Hegedűs, Hugo Wohl, Vilmos Hirschbein, Oszkár Rónai.

(Standing row, from left to right): István Gábor, Kálmán Sárközi, Zoltán Kis, János Lévai, Leo Fischmann, Vilmos Meinhardt, Mrs. Cekeliusz, Lipót Aschner, Günther Cekeliusz, Árpád Arányi





And finally, another typical group photography taken in Ajka:

(From left): Béla Jánosi, Árpád Telegdy, Ernő Haidegger, Dr., István Pétery, (in the background, turning sideways) Gábor Bajcsy-Zsilinszky, László Heller, József Mados and Tibor Mihalovits

Országos Széchényi Könyvtár



This picture shows a group of the technical staff of TUNGSRAM when—on an unknown occasion sometime around 1942—they posed for the photographer. Some of them became prominent executives and scientists, others are only recognized by the surviving members of their generation by their face. A number of them fell to the fascist devastation—their memory is still with us. The names of those we can recognize are as follows (always from left to right):

First row: Schiller, F. Krassó, Dr., F. Lendvai, J. Gábor, J. Lévai, A. Telegdy, P. Tury, T. Millner, J. Gyurikovits.

Second row: S. Szalai, J. Szentkirályi, Gy. Vaszi, István Kerényi, J. Kaczor, J. Gazsi.

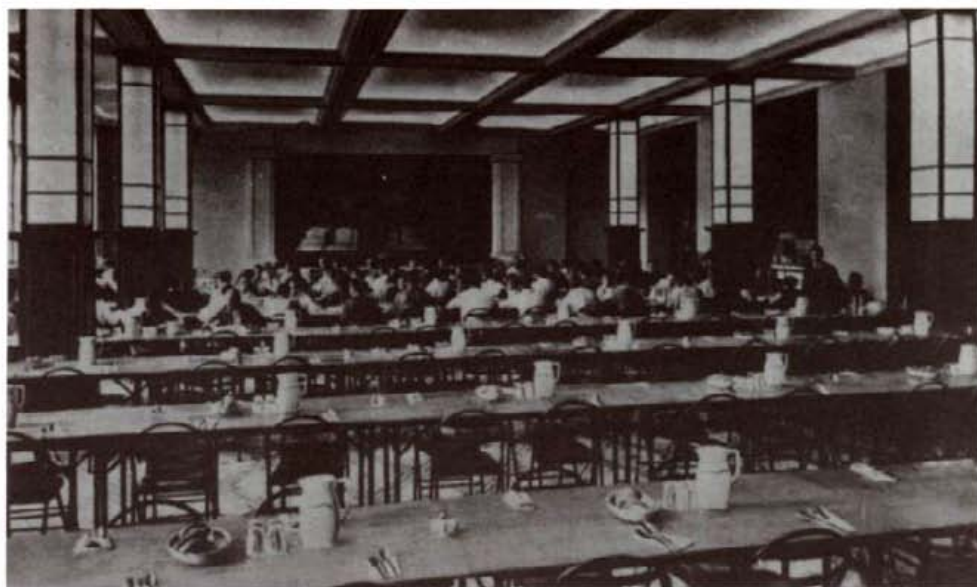
Third row: F. Messo, M. Stolzner, B. Mersva, O. Knapp Dr., F. Neuberger, B. Reiss, A. Holzer, I. Jámboz.

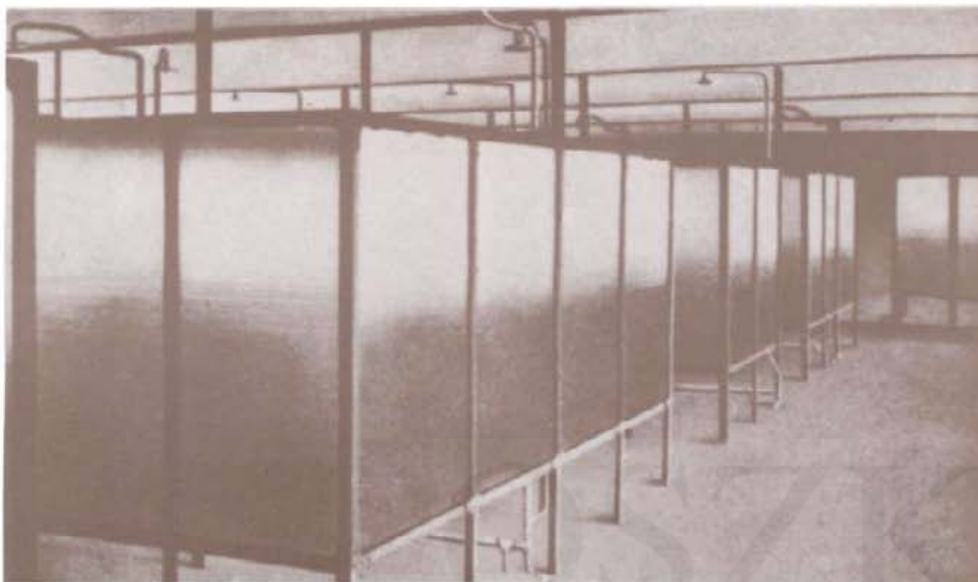
Fourth row: J. Ádám, J. Bucsovsky, Z. Kövér, Singer, Klein, Rogocz, E. Theisz, P. Steiner, Appel (the glass blower).

Fifth row: J. Mikuss, M. Hrabcsák, N. Jelínek.

Already between the two world war the factory hygiene, the public meal service and the recreation and cultural facilities all reached a higher standard in TUNGSRAM than in any of the surrounding factories. TUNGSRAM had a culture centre, a public literary lending library, a holiday camp and a boat house. The company was

The picture shows the assembly hall of the factory which was used as a canteen on weekdays and which could quickly and easily be converted into a proper theatre with a well equipped stage.





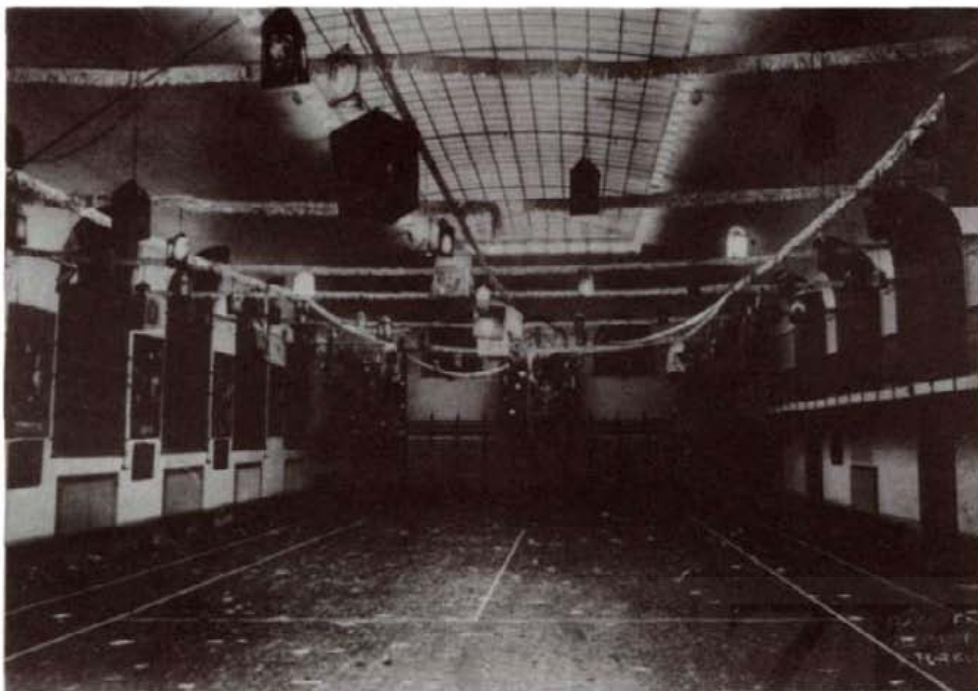
The development boom of the 1930s provided a good opportunity for TUNGSRAM to carry out a general modernization programme in its existing buildings, beside starting new constructions. By looking at the shower rooms shown on the next two pictures it is evident that the standard of hygiene was set high in TUNGSRAM.

The kitchen fitted with electrical cooking facilities was adequately equipped to provide a civilized catering service in the 1930s. Elsewhere in Újpest one could quite often see workers sitting on the pavement outside the factory in lunchtime, eating the food brought to him by his wife.



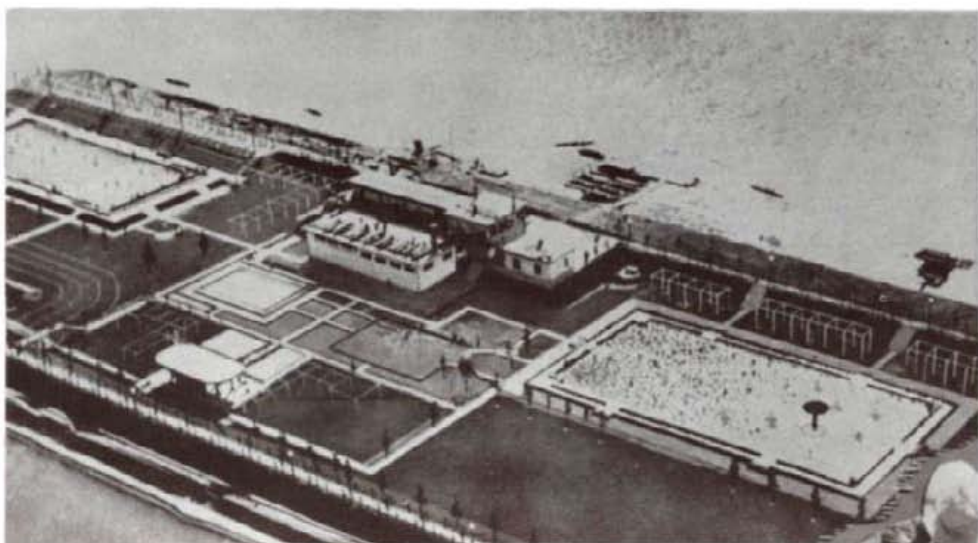
The TUNGSRAM Culture House was completed in 1932 and very soon became the recreational and cultural centre of not only the TUNGSRAM but also that of the entire neighbourhood. This building housed the public library, the choir, the workers' amateur theatricals, public functions, ceremonies and dances. The hall on the ground-floor, used as canteen in weekdays, could quickly be converted into a theatre hall. The only indoor tennis court in entire Budapest was here, in the imposing hall on the first floor.





The tennis court could be converted into a pleasant dance hall.

Országos Széchényi Könyvtár



The TUNGSRAM swimming pool and boat house was a very popular place.

This is an announcement made by the TUNGSRAM trade union representatives, calling on the TUNGSRAM workers to make use of the company's newly built holiday camp. The facilities were available to employees and their family free of charge.

Cooking facilities in the central area of the TUNGSRAM holiday camp, available to everyone free of charge. All this is still there today, except the saplings have grown into huge chestnut trees.



Felhívás

a Standard Vill. R. T. és az
Egyesült Izzó R. T.
minden alkalmazottjához!

**Az élet legnagyobb kincse
az egészség!!**

Ennek a mindenkiere nézve oly rendkívül fontos életkörülménynak elősegítése a Bizalmitestület kezére a gyár igazgatósága Budán, a „Bivalv"-csatornától 2 percrenyre

egy hatalmas üdülő- és strandtelepet

leltetett.

Ezen telepet mindkét gyár összes alkalmazottja, valamint azok közvetlen hozzátartozója, minden időben díjlanul használhatja.

Ennek igazolására csupán a két utolsó kifizetési boríték közül az egyik felmutatása kötelező.

Az üdülőtelep a Duna partján ketholdnyi bekerített területen, öltöző-beliiségekkel, fedett tartózkodási hellyel, vízvezetékkel, villanyvilágítással, tornaszerekkel, csónak-garázssal, zuhanyrudókkal, kádfürdő- és tetői kelleme a gyár alkalmazottainak üdülési igényeit.

Az üdülőtelep területi nagysága megengedi, hogy a sátorral rendelkező munkástársaink az egész nyári időny alatt sátorukkal a telep területére költözzenek, ahol egy nagy tábort tűzhely lehetőséget nyújt számukra, hogy a vacsorakészítést is el-egéztessék.

Az üdülőtelep megközelítésére minden lehetőséget kihasználunk, ha a telep látogatottsága azt lehetővé teszi: egyelőre a Záhly-utcai komp nyújt kedvezményes átkelést.

Ha az üdülőtelep látogatása olyan méretet ölt, hogy külön járatot indíthatunk oda, akkor ezt is kieszékeljük.

A Bizalmitestület azzal a felhívással fordul ugy a Standard, mint az Egyesült Izzó munkásságához, valamint minden alkalmazotthoz, hogy az üdülőtelepet a saját egészségük érdekében nagy tömegben keressék fel, hozzátartozóikkal együtt.

Napiény! • Erő! • Egészség!

Bizalmitestület.

MEGHIVÓ

A Tungvám Dal- és Önképzőkar ez év november 23-án, szombaton este 8 órai kezdettel a Tungvám Kulturház színháztermében, (Újpest, Váci ut. 79. sz.) színelőadást rendez, amelyre Önt, b. csodálat és ismerőssel szeretettel meghívja a Rendezőség

És alkoholmal színe kerül:

Fekete gyémántok

rimu grinzosa 4 telefonazioni.

Zakaj bide razpisati?

John J. Merviel, Editor

SZEREPLŐK:

Berend Irén börtényhajdóné	Szerbirczy László
Dömöt Tusi	Nemesi Václav
Kaulman Felső borb.	Pancsics Pál
Rendeház Winklerné herceg	Mészáros Sándor
Rudné bánya malmát	Borhidi Lajos
Belenyi Árpád	Schiffauer János
Tavcs	Vizslai Sándor
Sztráhan Péter	Váncsó László
Sztychovics	Váncsó Endre
Ejt	Pákozti László
Panna	Bali Margit
I. Munka	Hunyos István
II. Munka	Székely László
Isas	Székely László
Sztyeg	Gábor Ferenc
Jánoska	Elsch Gyusika

Богданов, Александров

Tördök: I. fele. IV. fele. Bandorban, II. fele. Bácsán, III. fele. Pálban
Főrendek: SUGÁR KÁROLY. Szószedek: PÁNCZEL PÁL

ELŐADÁS UTÁN TÁNC REGGEL 3-10
Befutás di. előz. váltás 70 félép., pontórási váltás 90 félép.
BUFFET **RUHA TÁR**

Előadás előtt az alítók sárga lesznek.

Meghivó



A „Tungvan” Dal és Örökségkör 1939. évi febrár hó 18-án, szombatán este 8 órai kezdettel a Kultur-palota színháztermében (Váci ut. 77.

Hangverseny

rendez, melyre Önt és b. családját hűbérijével
meghívja a PÉNZDŐSEG.

PENDÉZÓSEK

Fővándorló: KNAIF ÖSZKÁR dr. vezgészmenő.

© "Luncheon" Doi es Obituário, página 4

SZANTÓ DEZSŐ művelési területe 0,1 ha.

vom* Das ist Österreichs Gesetzgebungspläne

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Hoàng Văn Hiến, tác giả báo

Belépő jegy előre vált

pénztárral

Fontos megjelölni kérem, mert előadás előtt az

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MŰSOR: zéchényi Könyvtár

1. *Észtig F.* Halberg szed sz. 83.
Prigali: A békébe – Gyözele – Áru – Kigazdod.
Előzet: Az Újpesti Zenei és Értékelő (Conservatorium)
váltószekélyek Vezetői. Fenyő Jend a Conservatorium
tanára.
2. *El 1. sz. dala (Szegyi munkái).*
Előzet: S. Magyar népdala.
Fekete a Tungsum! Dalkör: Vezetői: Endre Bela karnagy.
3. *Szűz Szent. A hattyu.*
Előzet: A szűz kislány.
Előzet: Frank Lajos gondnokvezet.
Zenei sz. kislány. Fenyő Jend az újpesti Conservatorium
tanára.
4. *Előzet: Tarka (Kop Áru).*
Előzet: Carmen (Varga Áru).
Előzet: Manna (Álom Áru).
Fekete: Jaka György a Tungsum! Dalkör tagja.
Zenei sz. kislány. Endre Bela karnagy.
5. *Kendős Z. Kardi nővér.*
Fekete a Tungsum! Dalkör Vezetői: Endre Bela karnagy.

SZÖNET

6. a) *Enkei Pannu midsja.*
b) *Bihari kaszerjaja.*
Előadás: a Conservatorium vonószekere.
Veszély: Fenyves József az úpesti Conservatorium tanára.
7. *Rozsni: Savellia borbély (Aria).*
Éneki: Barabás Sári operatőrkész.
8. *Arrang. S. Jaruff: Orosz népdalok.*
a) Pétervári utca.
b) A tizenelv. szobá.
c) Pálutaj pajtás.
Éneki: „Tunguram” Dalkör. Veszély: Endre Béla harmos.
A szöveg: ezelek. Jákó György és Moller Gyula a „Tunguram” Dalkör tagjai.

J. A. Sauerbrey

and the following:

Today, when there are regular TV and radio programmes, superb quality record players and tape recorders, it is hard to imagine what kind of a cultural attraction the TUNGSRAM theatrical performances or the amateur concerts had, not only for the company's work-force, but also, for the entire neighbourhood. We would like to present a few of the posters announcing the various cultural evenings. This first one, for example, invited the audience to come along and see the stage adaptation of Jókai's novel, "Black Diamonds", as performed by the TUNGSRAM Choir and Literary Society.

One poster of the many announcing concerts. The programme featured the orchestra of the Újpest Conservatory playing a suite by Grieg and a cello player performing the Swan by Saint Saens. The works of Puccini, Bizet, Massenet and Kodály were also included. Not a bad selection, by any standard.

The TUNGSRAM theatre group scored one of its greatest successes with the staging of the 'Returning Ghost', a play by the internationally acclaimed playwright Lajos Zilahy. This was not an easy piece for amateur actors.

Nevertheless, they were given a very generous appraisal by the author himself, who came to see the premiere. This picture shows Lajos Zilahy among the amateur actors, standing in the middle.



Zilahy Lajos darabjának szereplői között. Vörtes Imre, Kulcsár Sándor, Kelecsényi Ferenc, S. Balogh Bóna, dr. Morvay Jenő, Zilahy Lajos, Frisch Károly, Jónás Gyula, Balogh Etel, Sárközy Károly, Hermann Béla, Janovits István, Hörömpöly Lajos

(Fotó Menyhért)



This was the stage which meant so much to the amateur actors of TUNGSRAM. The stage design, this time a very modest one, was most probably set for a concert.

This picture shows the literary TUNGSRAM lending library during the 1930s. The workers volunteered to come in and put protective jackets on the new acquisitions. There was a sizeable group of regulars. In those days there was still no television to divert people's attention from reading.



This crowd came to the theatre (which was used as canteen during the day) to see a play performed by the workers' amateur theatre group sometime during the 1930s. The little girl standing in the middle must be more than sixty years older today.



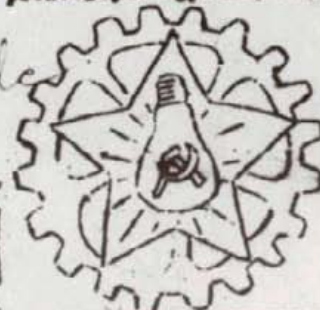


The amateur theatre group of the TUNGSRAM workers. They just won a cup on the drama competition organized jointly with another local theatre group.

Olvasd és add tovább!

Világ proletárjai egyesüljétek!

VÖRÖS TUNGSRAM



I. évfolyam. 1. szám.

1932. március.

Kiadja a Kommunista Magyarországi Pártja és Komünista
Ifjúságunk Magyarországi Szövetsége Izzó és Standard gyári sejtjei.

A VÁLSÁG HATÁSA.

Az utolsó három év alatt a munkások helyzete nagy mértékben rosszabbodott. A munkanélküliek tábora szaporodik. Olyan hatalmas üzemek álltak le, mint a Weiss Manfréd, Schlicht, Feudloff, Orser stb. stb. A kapitalista termelés válsága minden esetben érezteti hatását. Csökken az üzemidő, lezárítják a berkeket, racionalizálnak, lejáró gépeket. A Standard Izzólámpa és Standard Villamosági R. T. sem kerülte ki a válságot. Vannak pár pillanatát az elmúlt három évre. Milyen változást észlelhetünk a tőkés oldalon egyrészt és a munkások helyzetén másrészt? Ha a munkások sorsának javításért harcot folytat, a tőkésnek kedvező évré, hogyha nagyobb fizetést adnának, úgy ez a gyár tönkremenését okozná. Sokszor hivatkoznak a válságra. A válság azonban egyáltalában nem jelenti a tőkés gazdaság elcsúszását. A "Pénzügyi Kompass" szerint az Izzó P. 16.500.000.-vel tőkével dolgozott az utolsó három évben, míg a Standard P. 15.000.000.-vel.

A vagyon a következőképpen növekedett:

Izzó	1929	44.255.275 P.
	1930	45.203.712 "
	1931	47.424.823 "
Standard	1929	33.148.018 P.
	1930	38.368.543.

Nyereség az Izzóban	1929	3.168.146 P.
	1930	3.897.712
	1931	3.921.488
Standard nyeresége	1929	1.929.843 P.
	1930	1.410.559 "

Azint látjuk, egyáltalában nem csökkent a nyereség, a vagyon. Azonban tévedés volna azt gondolni, hogy csak annyi a nyereség, amennyit tényleg bevéllének. Ezzelkülön a vagyon sok kintlevő követelése van a tőkésnek. Ugyanezen időre esik a nagy építkezés, amit a gyár területén eszközöltek. A kutató laboratóriummal kezdtek, majd a Standardnál határozottan műhelyeket, kulturháza, strandot, kóborokot, gasztrot, teljesen új lémpagyárat és üvegyárat építettek. Egyedül az új lámpagyár felépítése P. 5.000.000.-be került. De nemcsak az Izzó és Standard hozza a hasznát a részvényeseknek, hanem a Tokodi üvegyár, az Újpesti üvegyár r. t. stb. vállalat is. Annál a pénzük a tőkésnek és elsősorban a fő részvényesek számára látnak, hogy nem is tudják, mit csináljanak vele. Az a schner tárgyalásokat folytat a Talbot Centralre megvételéről. Nem két krajáros az üzletről van szó, tehát van ott pénz bőven.

Stencilled illegal message of the one time underground Hungarian Communists Party in the thirties with the heading "Red TUNGSRAM" and with a rather questionable influence



Országos Széchényi Könyvtár

The working class movement—both the legal and the illegal kind—was organized regionally, rather than inside the factory. Nevertheless one of the important centres of the political activities was the Workers' Home of Újpest. The building had now to be pulled down when a vast, modern housing estate was raised in the course of rebuilding Újpest.



Even the joy of the peace-time experienced after the bloody war and the fascist terror could not relieve the shock that people felt seeing the human losses in the work-force of TUNGSRAM. Only a few names are mentioned in the plaques. Beside the known victims we ought to commemorate the masses of nameless martyrs.

IN MEMORIAM.

A háború alatt és abból kifolyólag meghalt, illetve elhunyt alkalmazottak és nyugdíjasok névsora.

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| 1. Aradi István | 16. Csapó György | 91. Flath István |
| 2. Adler Sándor | 17. Csontos József | 92. Finger Imre |
| 3. Amster Jenő | 18. Csab Margit | 93. Finger Gyula |
| 4. Amster Miklós | 19. Dr. Csukor Károly | 94. Finger Gyula |
| 5. Antal Dezső | 20. Dr. Csukor László | 95. Fischer Anna |
| 6. Appel József | | 96. Fischer János |
| 7. Aschner Ilona | | 97. Flach György |

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Halottaink legnagyobb részének nem jutott osztályrészül a csendes elmúlás. Mint katonák, munkaszolgálatosok, deportáltak szenvedtek hősi, vagy mártír halált. Emlékeiket kegyeletül őrizzük.



In 1945 we had to rebuild the factory's lost machinery and tools by the thousands—mostly relying on nothing more than our memory. But this was nothing compared to the human losses, the intellectual losses. The 538 names listed in the IN MEMORIAM is definitely incomplete. We had to make a start from such a 'zero' level. And we have made a start...

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