Below is a rough translation of "A vas´t hosszúhullámú rádióhálózata", pp. 384-387 in "XX. Század 1926-1950" ["20th century 1926-1950"], Chapter 6 (pp. 317-414) of "A magyar vasúti távközlés rendhagyó krónikája" ["Unusual chronicle of Hungarian railway telecommunications 1846-2000"], János Pap, 2019, 940 pp. Source: bgok.hu. This translation is a Google translation, optimized by Frank Dörenberg, November 2021, ©.

The longwave railway radio network

When the first railway started in our country, it immediately became open, and even committed itself, to the use of new telecommunications technology (Bain-Baumgartner telegraph, Morse telegraph manufactured by Siemens & Halske, later Bell telephone), for it recognized the significance and importance that it would serve the railway business well.

It should be noted that at the turn of the century, wireless telegraphy was already practiced, not only in public life, but also at the railways, although not at the Hungarian railways. Edison, Phelps, and Marconi were at the forefront of this. However, MÁV [*FD*: *Magyar Államvasutak* = Hungarian State Railways] waited until 1940 to use it.

Although Morse's commercial telegraph connections networked the railway network by the 1930s, the desire of MÁV's management - accepting the proposal made in 1937 by two telegraph operators - that the so-called business telegrams should reach their destination faster, in a given case, and transportation management to be renewed as well - the telegraph service has set a goal.

Some telegraph equipment had already been procured for the short-distance sending of telegrams and business data, but for a longer period of time, in the absence of physical lines, they were put into operation only at stations and business offices. Such an overhead-line network cannot be replaced only by cabling, the acquisition or expansion of transmission technology, which cannot be solved due to MÁV's financial situation. Instead, it seemed expedient to build the aforementioned radio network, which would be much cheaper to implement, according to experts of the telegraph service.

To design and implement the long-wave radio network, Alfréd Röhmer and Ottó Barátfalvi, mechanical engineers, were commissioned to assess and prepare the plan.

The designers, taking into account the international political processes, the increase in line lengths with the increase of the country area, the increase in the number of business telegrams, the appearance of military deliveries, performed with excellent expertise and technical optimization, specific radio types, etc.

In the first completed plan, the designers defined a “national administrative radio network” that connected the central and district governing bodies and major traffic hubs. (However, due to the territorial growth of the country, the designers were happy to change the completed plan). The plan addressed the necessary equipment park, other technical and material equipment, and even the required number of staff, as well as the provision of training. The designers selected the radio systems from well-tested equipment in German practice, taking into account the recommendations of the army, such as the TELEFUNKEN AS33 and LORENZ 100, 200, which proved to be excellent in operational reliability.

MÁV procured important long-wave radio equipment for its network (9 radio stations with a power of 1 kW, and 20 radio stations with an antenna capacity of 100 & 200 W), waived tariff fees, and maintained the network. With the knowledge of the Post News Department, the 960.684 / OM biz. They applied for a permit from the Ministry of Trade and Transport under number 1940. The Hungarian Postal Administration issued the 206.104 / 1941. ARC.5, instructed by the Hungarian King of Budapest. Telegraph and Telephone Board of Directors (Bp. VIII. Mária Terézia Square 17-19, later at Horvát Mihály Square) contacted MÁV to clarify the fee payments (2 Pengő 40 Fillér / month) and the exact location of the 29 radio stations. (Note: for the correspondence, the post office asked MÁV for a postage stamp of 2 or 10 Ps, but received only a stamp of 2 Ps. It asked for a monthly subscription fee, however, MÁV was always in arrears, which the post office constantly urged).

The equipment was already installed at the railway military authorities designated by the KSzV before the permits were issued, so from December 1, 1940 at the MÁV Board of Directors office, the Southern, Szombathely, Pécs, Szeged, Debrecen, Miskolc, Cluj-Napoca Business Offices, and in Târgu Mureș. These were followed by Szolnok, Košice, Subotica, Oradea, Győr, Dés, Békéscsaba, Újdombóvár from April 1, 1941 to January 2, 1944, and Madéfalva at the very end.

The radio transmitters were provided by the Hungarian army.

The management of MÁV and the Hungarian Armed Forces (KSzV), in early 1944, probably seeing the Soviet advance, did not order or install equipment at foreseen additional sites, such as Érsekújvár, Novi Sad, Sepsiszentgyörgy, Déda, Békéscsaba, Nagykanizsa, etc. stations.

The Hungarian Post office, by Decree No. 267,323 / 1941.IV No. 8, ordered an exam for radio operators (theory, operation, error detection, correction, knowledge of the rules for switching radio communications, general geography, and knowledge of telecommunications routes, sending five-letter code groups at 16-words [*FD*: per minute] speed, receiving them during 5 minutes). The managers had to have a high school diploma.

By 1943, their number was 75. (The best of them was György Papp, and Tibor Spitzer and László Hidvégi also stood out).

The plan also included a radio team, to carry out all operational work on the new radios and to carry out maintenance work. The leader of this group was Sándor Köteles (radios), while the foreman was János Várszegi (antennas).

The competent management of MÁV, getting to know the plans prepared at a high technical and ethical level, and the aspects contained in them, “enthusiastically” supported the construction of the long-wave system. Accordingly, the top management of MÁV accepted the establishment of the best radio system in existence. The plan had shown that the telecommunications needs of rail transport could be best served by this radio network.

The designed system focused on three tasks:

1. reliable coverage of all areas to be marketed,
2. be independent of the time of day and weather, and
3. in reality, as few transmitters as possible should be used.

According to the plan, the long-wave radio network would be designated in the country by the so-called radio stations (Member States). Existing and possibly future wired telegraph points were taken into account in the selection of sites. The aim was for radio and telegraph telegraphs to perform similar tasks and complement each other in the safest way possible, and to maintain the controllability of rail traffic. The topology of the long-wave radio network can be traced on a country map of the areas.

With point-to-point radio network connections, the system was able to invite radio stations and member states established at the headquarters of the store management, as well as at important railway junctions, from the control station operating in the MÁV Board building (Andrássy u 73-75) and to establish two-way connections with them (individual and public broadcast) calls. The same possibilities applied to all Member States, which, without the involvement of the driving station, were also able to establish direct, point-to-point or even “round-the-clock” connections, or between the stations at Szombathely and Sepsiszentgyörgy. This means that any radio station could establish a reliable connection throughout the country, with a high probability of about 98%.

The term radio telegraph means a telegraph station, set up for radio transmission and reception. The radio station itself consisted of a long-wave transmitter and receiver, and a **Hell telegraph** connected to the transmitter and receiver.

All radio stations and all equipment in the network were on 24-hour operation. The telegraphs provided 12/24 hours of service. Each telegraph room had a standard radio telegraph table. At the hands of the telegraph were the Morse code for delivering telegrams and the Hell telegraph transceiver. At the top of the table was the Siemens 150 Hell rhythmic (150 beats per minute) fast transmitter. At the bottom right of the table was the so-called connection to the radio keyboard.

The applicable radio frequencies were specified in Hungarian law. It was allocated by the competent authority, on the recommendation from the post office. Under license, railway radios received in the longwave frequency band between 295 and 370 kilocycles (later kHz). Within this frequency band, 5-6 frequencies were allocated to MÁV. Stations in constant reception were called by Morse-ABC keystrokes on the first frequency of the calling and called stations. After contacting, the two stations switched to the other, the national postal frequency. The Management Board received calls starting with HAV1, HAV2, and other Member States.

According to the plan, the long-wave equipment was supplied by the German companies Telefunken and Lorenz. The Telefunken transmitter had an output of 500 to 1000 W for the AS33, and 100 to 200 W for the Lorenz one. Communication used the Morse code alphabet.

The operating waveband of the Telefunken AS33 long-wave transmitter: 100-1000 kHz, with operating modes: "A1 keyed-carrier telegraphy"; b) "A2 tone-modulated telegraphy"; and (c) “A3: AM voice transmission”.

The telegraphy mode A1 is realized by transmitting a carrier and interrupting it at the rate of the telegraphy signals, and this mode can provide the highest radiated power for a given transmit power. At the same time, it occupied the smallest bandwidth in the frequency band. In principle, MÁV could only use the A1 mode, but - if necessary - the A3 voice mode was also used (secretly) by the radio telegraphs and the maintenance staff. This mode was not enabled for security reasons, because the transmissions were not documented and were difficult to verify. Here, the output power was less than that of the A1 system. For MÁV, the otherwise unfavorable A2 system, the so-called tone-modulated telegraphy mode, was also not enabled. The system was also suitable for shortwave transmission, which was not used by MÁV.

Telefunken's transmitter was MÁV's most powerful and most important transmitter, consisting of three cabinets. One unit was the transmitter, the second was the antenna tuner, and the third was the power supply unit. The transmitter and antenna tuning cabinets could be mounted on the wall, whereas the power cabinet, due to the high-performance and heavy-duty transformer, stood on the floor. Pictures of the transmitter and power supply unit are shown in Figure 1.

The two-stage transmitter. The first stage is a self-excited oscillator with an RL12T15 type vacuum tube, which provides the drive power for the RS384 type power amplifier tube. An RS384 transmitter tube can supply 0.5 kW of power to the antenna. Two such tubes have a socket so that 1 kW of power can be supplied as required. The two tubes are then connected in parallel, as is customary in long-wave radio. The modulator unit also has an RL12T15 tube. At the top of the transmitter is the power output connection. From here, a finger-thick copper tube was connected to the antenna tuner unit, to reduce losses.

The antenna tuning and coupling unit is a very ingenious solution. The tuning, due to the capacitive behavior of antennas commonly used on long waves, with a variable inductance is the so-called variometer, which is a variable porcelain coil with a large porcelain body constructed with a rotatable other inductance that is connected to a larger diameter fixed and connected in series therewith, i.e., a variometer coil placed on two ceramic bodies. For the sake of completeness, it can be mentioned that (for example, considering the use of too long inductive antennas), the antenna tuning unit also included a fixed-value capacitor that could be installed. Tuning could be done in large steps by switching the branches of the fixed inductance gently with the variometer. The magnitude of the coupled energy was indicated by an indicator instrument with a thermocouple system. With this solution, any system antenna can be matched to the output stage of the transmitter.

Because the transmitter and antenna tuning units were mounted on a wall far away from the remote-control table, it was difficult for the telegraphist to see the movement of the instrument, and so that he could see the signals clearly during transmission. During transmission, a lightbulb flashed at the rate of the given signals, indicating that the transmitter was operational and the rate of transmission.

Description *Transmitter cabinet* *Power supply cabinet*

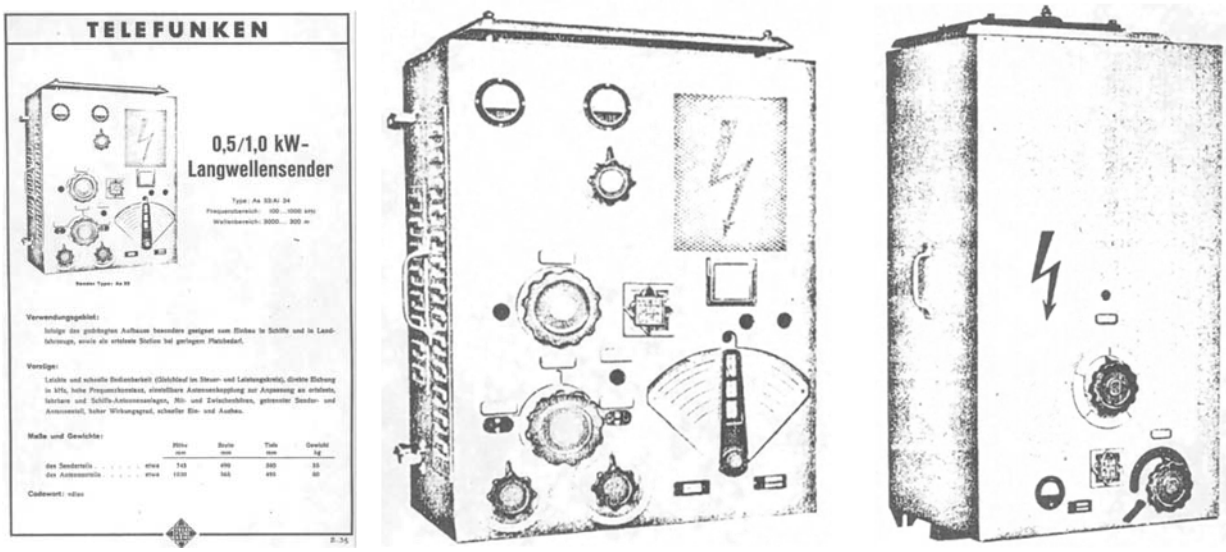

Figure 1. Telefunken AS 33 radio equipment

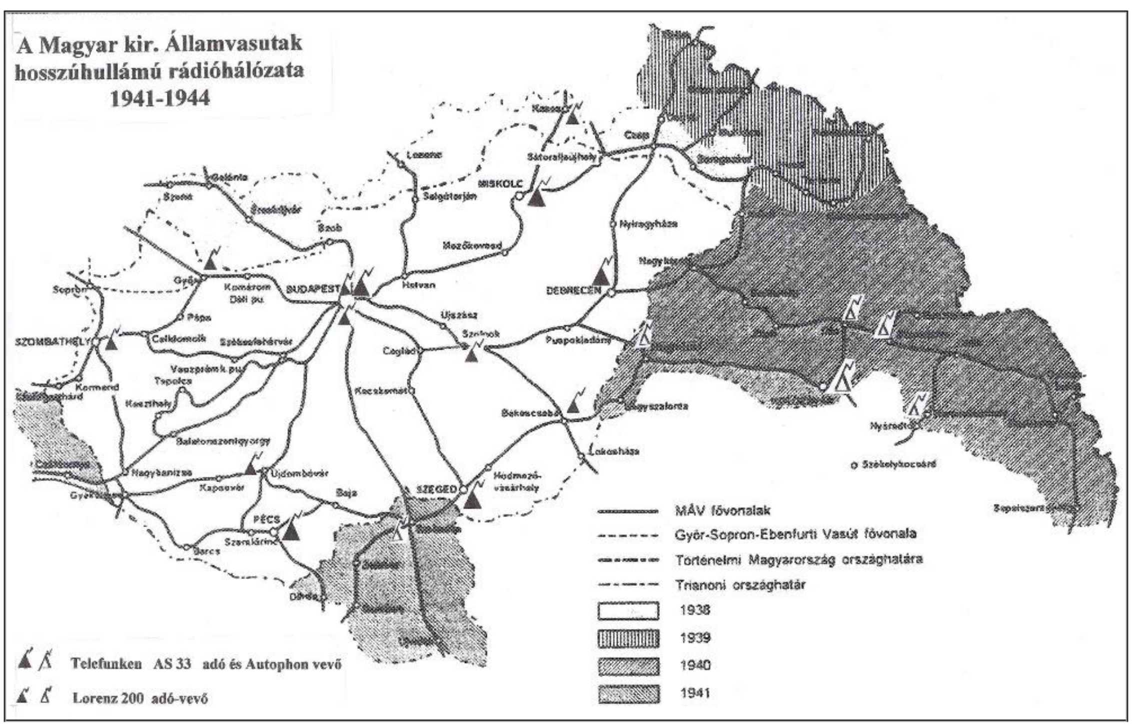

Figure 2. The long-wave radio network [*PJ*]

The rectifier was powered by a three-phase, 3x380V 50 Hz network. The power supply provided a 2-3 kV anode voltage. By inserting a transformer, selenium rectifier cells consisting of many hundreds of plates provided this voltage, as only a maximum of 17-20 V of voltage could be applied to a single selenium cell. It is conceivable how many selenium cells were required to accommodate the 6 complete series of selenium required for a three-phase full-wave rectification of 3000 V.

An unpleasant problem could be experienced after commissioning, as these cells are sensitive to humidity, as well as to surges that often occur on the mains. When a cell broke through, the load in this branch reached the other serial, still intact cells, and the whole row could be expected to hit, which, after a series of condensing bursts, eventually led to the tripping of the large fuses (6). Then the whole line of selenium had to be dismantled and disassembled, the faulty one found, replaced, reassembled, hoping that there was no weak cell left in it, which could soon fail. This attentive work was always given to the youngest technician in the class.

The long-wave antenna has proven to be a key element for radio transmitters. Two steel pipe masts, 30 m high, had to be built on top of a building or on the ground, 80-100 m apart. The masts were secured by steel wire cables, at every 6 meters height, in three directions. Between the two masts three strips of insulated wire were strung, as top capacity for the vertical antenna line. In addition to tuning the frequencies needed for transmission, they also had the task of tuning the antennas.

The Lorenz 100/200 transceiver was MÁV's most reliable radio equipment - it almost never failed. The transmitter consisted of a tall narrow cabinet. The two RS268 power amplifiers were driven by a self-excited oscillator stage. It worked at two output levels: 100 and 200 watts, respectively. The power change could be done simply by inserting or removing a jumper. Rectification was done with a full-wave rectifier tube, probably a PV4200. Knowing from their previous references, their loads were recorded for about 30,000 hours, which is equivalent to a period of about 4 years, assuming 24-hour operation. The equipment could only work on long waves.

Finally, this long-wave system was dismantled at the end of World War II, with the West or part of it falling into the hands of other nations. [*SzT*]