(004W)

Excerpt from "55 Year Step of Japan Radio Company"

(1971) in Japanese

Chapter 16: History of Vacuum Tube (I)- Before the war

(p.p.:280-285)- 7 Pages

1) The Beginning

When our company has established, the wireless equipment in use was spark transmitter and crystal receiver. As to the vacuum tubes, post office and navy/army have just started investigation, research and trial production.

But in our company, we forecasted that the age of wireless equipment using vacuum tubes will come in the near future, and decided to proceed full scaled R & D project of vacuum tubes and wireless machinery using them. In March, 1917, this plan has materialized, a vacuum tube factory has built and R & D work has accelerated aiming completion of tube receiver for ships. This was one year behind TEC's start of R & D project.

In the next spring, the first vacuum tube for detector, **C1** has born, and named as **Lumion**. And in September of the same year, completed a receiver for ship using the tube, and received good reputation. This was a low vacuum triode, so-called soft valve, and its anode was made of aluminum sheet, and grid was spirally wound nickel wire. As exhaust process was only with a rotary pump, and therefore vacuum level was low.

Next, in September 1920, we developed a receiving tube **C3** by navy's order. This was our first triode for amplifier, and hard valve using a diffusion pump. At this time, army called it as vacuum bulb, and navy called it light bulb.

As our high vacuum process has advanced, development of transmitting tube was accelerated from about 1921, and in June of the year, first transmitting tube **TR 1** with input of 10W was completed. At the same time, our factory has modernized, and preparation has completed for development and production.

As the result, **TR V** with 100W, **TR VI** with 250W, **TR VII** with 500W input tubes were completed in 1922, and in the next year, transmitter for ship using these tubes

were designed, and in March 1924, 500W input transmitter has first installed in Meiji Maru, a training ship of Tokyo Marine High School. And also, supplied the similar transmitters to post office and army, and made record as their forerunners as domestic vacuum tube transmitter.

The development of transmitting tubes has further advanced. In 1923 **TR IX** having 1.5kW input was completed, and in next year, a vacuum tube wireless communication system with 3kW input (using two **TR IX**s) has supplied to central weather station, and started weather forecast broadcast from February, 1925. This transmitter made a record of highest power for domestic production at that time.

In the other hand, as to radio receivers, each company in Japan started active advertising preparing for start of radio broadcast, and therefore demand of receiving tubes have inflated. We have marketed **C7** for detector, **C4C** for audio amplifier and **C4D** for H.F. amplifier in October 1924. Our catalog at that time said "**C7** has a great sensitivity, and usable for long time. Not many of such product exist even in the western countries' ".

Tough problems in receiving tube production about that time were burning of filament wire, reduction in emission, and difficulty in development of good cathode material with low heating power and high efficiency.

We started research in this area, and in the spring of 1925, produced a receiving tube **C12** having dull emitter i.e. thoriated tungsten filament with low temperature cathode. After this, serious research has continued in this area.

As to the oxide coated cathode, application in receiving tubes by Western Electric Co. in U.S. has introduced in 1926, and started development here first time, and convert to eliminator radio in Japan has accelerated. In 1929 this effort was fulfilled and used in many radio receivers.

Also at this time, research on the iron resistor tube for power supply voltage stabilizer started by request of navy. This was to be used in 60-80V of working voltage at 135mA of current, and big volume of this have produced up to approx. 1935.

2) Transmitting Tubes

In mid. 1920s, vacuum tube transmitters were getting popular in Japan, and at the same time, short wave age was about to begin. At that time, our company was already cooperated with Telefunken Company in Germany, and was planning a big progress in R & D of vacuum tubes and wireless equipment.

Under this policy, continued improvement in transmitter, tried to unifying to **S-series** of transmitting tubes, and spent effort in development of short wave

transmitting tubes.

First, in 1928, completed **S300** (with 6kV of anode voltage and 1kW of input), an improved version of **TR VIII** (10kV of anode voltage and 1kW of input), and it has greatly contributed to transmitter for ships, and also completed various new specifications. And in 1929, moved the factory to Osaki, expanded the facility, accelerated development activity, and organized production activity of S-series transmitting tubes. For those transmitting tubes, pure Tungsten wire was used for filament.

Also, for application of thoriated tungsten filament to transmitting tubes, needed to solve problems on increasing emission capability and stability. In 1932, after solving those problems, RCA type transmitting tubes; **UV-203A, UX-860, UV-812, UV-861** etc. were produced. In those days, U.S. styled tetrodes were used much, but after developing transmitting pentodes by technical assistance from Telefunken Company, completed the series by the end of next year, and saw pentode age in transmitting tube.

3) Patent Right of General Electric Company

The vacuum tube production by our company was expanded smooth up to late 1920s, but in February 28, 1930, a patent which 3/2 power law on the high vacuum tube held by G.E. has extended, and as TEC who held this patent insisted charging tough conditions. As the result, all of other Japanese tube makers faced a confusion, and some companies had to terminate tube production.

After tough negotiation, we were allowed a small part of high vacuum tube production. It was a big problem in our tube development history, not only for our company. We, therefore needed establishing a new policy as shown in the following sections. By the way, this patent has extended up to February, 1935.

4) Expanding Plan of Tube Facility and building Senzoku Factory

In 1932 we made an expanding plan of tube facility during waiting resolution of the patent. This policy aimed tube development without infringing G.E. patent.

For this policy, we picked up two major plans i.e. R & D of microwave tube and its associated equipment, and same of discharge tube, and immediately started proceeding it. This was based on our engineers' strong will for making bright future of vacuum tube.

First, hiring research engineers (electric, physical and chemical experts) and training them in Telefunken Company are planned, and gradually executed.

Also continue expanding research activity and factory, and in 1934 moved to

Senzoku in Tokyo. The space was 660m^2. By this expansion, we occupied 20% of whole Japanese transmitting tube production, and reaching one million yen's sale in the year.

5) Research on Micro Wave Tubes

We started R & D project on micro wave tubes since 1932 by expecting future success, and first of all, opened a research room. At this time, it was far from realization of micro wave technology.

This research activity led to cooperation between Japanese navy's research laboratory next year, and then same thing has realized between army's laboratory.
By around 1941, our microwave laboratory member reached 300.

6) Research on UHF Tubes

As to UHF tubes, we started from early days, but in 1934, obtained data on **RS329g** tube (wavelength: 5m, output: 500W) from Telefunken, and the activity has rapidly advanced. By next year, **U242Tg** (wavelength: 3.5m, output: ar. 500W) has developed. This tube has used in UHF medical treatment machine named Aloka, and mass produced 'till even after WWII.

In 1936, **U330T** was used in Japan's first TV broadcast experiment. This tube was an UHF tube having 2.5kW of output.

In 1941 a tube with wavelength of 9m and output of 250W has developed and used in blind landing system of aircraft adopted by army.

7) Moved to Mitaka Factory

In 1938 we have moved into newly built Mitaka factory expecting a bold leap of research and production. This factory had 1,320m^2 of tube research division area and 1980m^2 of transmitting tube factory area. After moving, we put a great effort in top secret research in micro- wave tubes, and transmitting pentodes developed with Telefunken's technical assistance, and various discharge tubes headed by Sendaitron lead by Prof. Watanabe of Tohoku University, and also proceeded research on getter materials.

8) Development of Discharge Tubes

Production of hot cathode mercury vapor rectifier was started from 1929, and

marketed in 1932. But in shipboard wireless equipment, frequency of power source was 400Hz, and had poor voltage stability. Therefore a problem arose for short life of rectifier tubes. As a remedial work, utilization of getter, use of special material for cathode (mixing activated impurities) etc., were applied, and adopting a specially designed model against 400Hz of power line, and finally succeeded completion of products suited for shipboard application.

Also completed **Type A Sendaitron** by leadership of Dr. Y. Watanabe of Tohoku university, and widely marketed as discharge tube for magnetic fault detector, metal welder, magnetizer, etc. We added types B, C & D later for similar application.

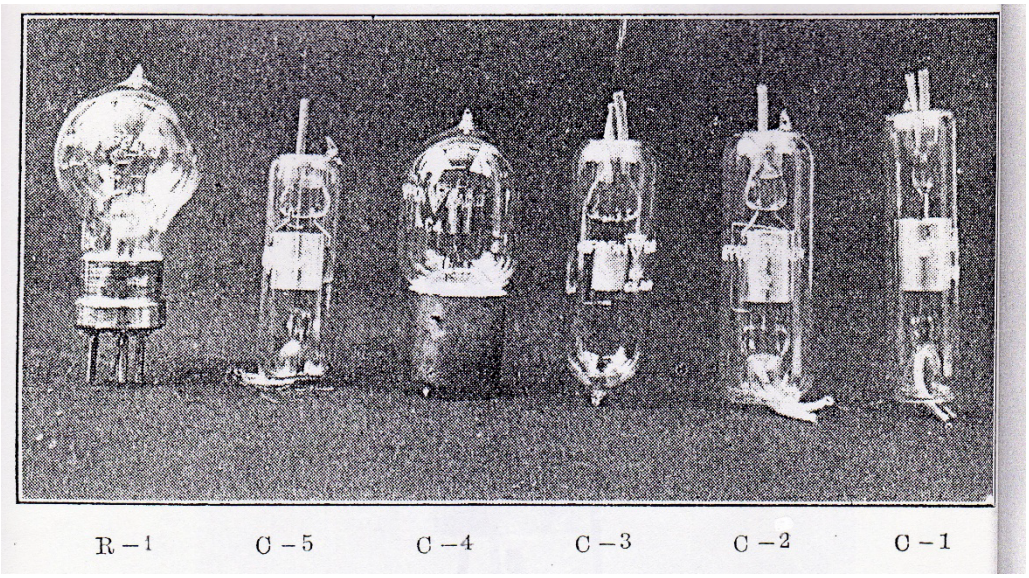
9) Receiving Tubes

Entered new emperor' age as Showa, copy of U.S. type tubes were getting popular, and in 1927, **NM201A** with thoriated tungsten filament, and in 1929 **NM226R**, **NM227R, NM112A, NM80K**, etc. were completed, and mass produced.

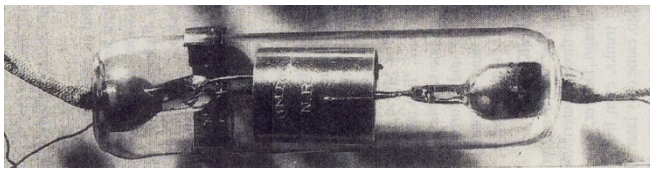
But we have decided terminating production of radio products in view of war time, and concentrated production of military products. In 1939, manufactured Telefunken **NF2** used for landing position locator for aircraft, and in 1941, completed Telefunken type receiving tubes **RE3** and **FM2A05A**, and supplied them to military offices.

FM2A05A was an all- purpose tube with an excellent characteristics used in aircraft receiver. But it required high production technique, and many engineers and workers were concentrated, but its required volume was too much for our capability. Therefore asked Matsushita Electric Company for help by giving our know-how, but still could not fulfill military demand, and also asked manufacturing in TEC and Kawanishi Machine Company as well.

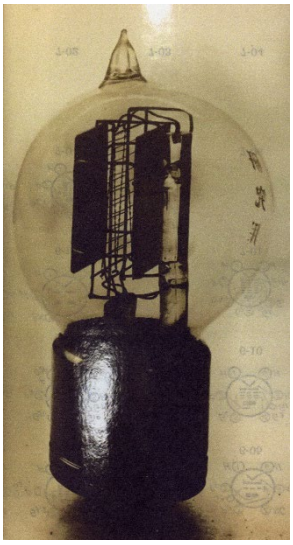
We have acquired Hamamatsu factory of Toyo Spinning Company in 1944 by military direction for additional production, and started producing receiving tubes and getter. But within a year from its start, faced repeated bumming from U.S. aircraft and ships, and was totally destroyed with many loss of life. This was only casualty by the war in our company.



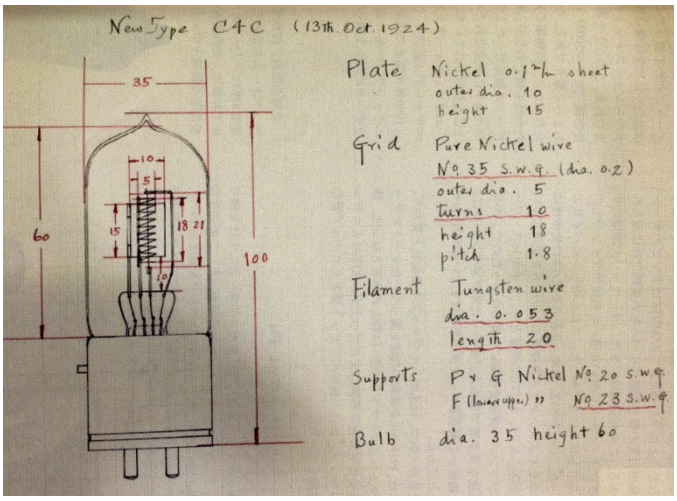
Earliest production of Receiving Tubes by JRC

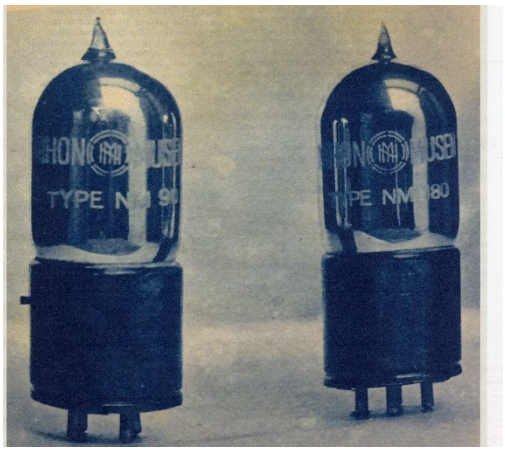


Lumion **C1** by JRC (1918)
Photo from OTB Vol.37-3, Aug.,1996
By John W. Stokes



C4B





C4C (1924) NM90 NM180

(First Dull-Emitter by JRC)