

(003W-2)

## Excerpt from “50 Year History of Tokyo Electric Company”

### Part II: Transmitting Tubes (p.p.:437-445)- 8 Pages

#### 4) Progress of Transmitting Tubes

##### a. Production of transmitting tubes

As described earlier, it was 1919 when we completed first Japanese triode transmitting tube. At that time, we manufactured **Types A, B & C Plotron**. Those were 30W input class, and their anode was Tungsten wire wrapped around a glass frame. They were supplied to Japanese Post Office, and used in short distance wireless transmitter.

The tube manufacturing technique at that time was still very poor, and experience gained by light bulb and X-Ray tube production was utilized partially. Therefore tremendous effort has spent for their production.

At around 1921, demand for transmitting tubes for domestic users including military offices arose, and **KM-157**, **UN-151** (also called as 12V lamp), **KM-155**, **KM-156** etc. were manufactured in prototype base, and also started trial production on **Type D Plotron** by navy's order.

For such an effort spent by our company in a difficult time, we received award from army ministry, and subsidy from a government office.

In about 1923 we succeeded production of **KM-154** (250W) and **KV-204** (1kW) tubes. We also completed **MT-6** (predecessor of **UM-156**) by navy's order for 1.5kW class. This tube exhibited excellent performance at a navy's test yard. Those tubes were the first large tubes manufactured in Japan without question.

Those success was owing to progress in our research and production facility, but the huge earthquake struck about this time destroyed everything in one morning, and gave us huge casualty. But as navy and other governmental help accelerated rebuilding, and in next year, 1924, we saw tremendous recovery as producing 50-60 pieces of 150W to 1.5kW input class tube daily. The trial production of 3kW input class tube took place, and also exhaust process using liquefied air started about that time.

## **b. Adopting Trend for Shortwave; Tubes and Machinery**

Start of radio broadcast in Tokyo, Osaka and Nagoya in 1925 accelerated our tube production, and transmitting tubes of Marconi type, U.S. types, etc. were announced: **UM-154, UM-155, UM-156, UV-203, UV-204, KV-206, KV-208**, etc. were examples. Research on water-cooled tubes have also started.

As a trend of wireless field at that time was toward short wave, we started research immediately, and in 1926, introduced **SN-204, SN-206, SN-208**, etc. which show good performance in short wave area. They were forerunner of making short wave reach actual use, and we have received an award from the government for it. It has accelerated our effort further.

In 1926 we have completed **UN-208** having 5kW of input power, and also made prototype of **UV-203A** and **UV-204A** with Thoriated Tungsten filament completed.

After that, utilization of vacuum tubes arose year by year, and its demand has continuously increased. Therefore we expanded our production and research facility several times, but still never enough to catch up the demand.

In 1927 the first water cooled tube, **UV-207** with 30kW of input power was born. This gave a shock to our tube industry, and made our company's position in the industry even better.

In 1928-29, popularization of radio receiver promoted production of A.C. operated receiving tubes, and our company has led industry for success of today's broadcast business, and timing of start producing transmitting machinery came about that time.

In 1929 we completed **UX-860** and **UV-861** (both tetrodes), and used them in 40kW short wave transmitter developed with Kokusai Musen Company. This 40kW transmitter was completed in 1930, and was the first one in Japan for all domestic production of high power short wave transmitter, and all tubes used in the set were made by our company.

In particular, mercury vapor rectifier **HV-969** used in the set was superior in much lower voltage drop compared with ordinary vacuum rectifier, consuming small filament power, and exhibits excellent performance compared with U.S. product.

In 1930 **HX-966, HV-972**, etc. were manufactured, and weaken area of use of vacuum rectifier further, and then **HV-951, HV-966A, HV-972A**, etc. were marketed, and succeeded taking over the vacuum rectifier's position completely.

In the other hand, research of thyatron which added a grid in the mercury rectifier has conducted in parallel. This type of tube is much suited for controlling electric power, but have drawback as low usable frequency, and therefore range of its use had to be limited.

Thus our production technology was advancing day by day, parallel to western world's tube industry in producing high power, high performance tubes simultaneously, and made

it unnecessary for importing foreign products anymore. Therefore all governmental offices started specifying purchase of our products, and foreign products were totally eliminated from Japanese marketplace. This phenomenon is really welcoming situation in terms of our national interest, not only joy of our company.

The total number of transmitting tubes recently marketed exceeds 50 types, and picking up representative products from them as follows:

Triodes: **SN-157** (3kW input), **SN-161** (5kW input), **SN-205C** (1.5kW input), etc. and

Tetrodes: **UV-811** (5kW input), **UV-812** (500W input), **UV-814** (125W input), etc.

And the one which calls for special interest is a water cooled triode tube with 200kW of input, **UV-169**. It has completed in 1933, and made an epoch in the transmitting tube industry at that time.

In the other hand, research and production of magnetron tube was taking place. The interest in the ultra-high frequency was accelerated since realization of short wave communication. We started research on Dynatron, Barkhausen-Kurz tube, Magnetron, etc. and in 1930 succeeded production of prototype of split-anode type magnetron. Those research had faced various difficulty, and therefore was quite difficult. But after our science research, products having sizable output such as **MN-701**, ~~It was~~**MN-702**, etc. were completed.

### c. Completion of various new products

The wireless industry in Japan showed tremendous progress owing to complete domestic production of vacuum tubes, and it made high-power communication age realized, and active short wave era has arrived. This is solely result of progress in vacuum tubes, and here, too, happy to see contribution of our company.

In 1934, Cymotron **UV-171** used in 150kW transmitter for Tokyo central broadcast station has produced. This was a high power product which a step advanced than **UV-169** introduced in previous year, and marked world record class in its capacity.

Its size was: max. length: 165cm, max. diameter: 26cm, filament : 43V/500A,  $\mu$ : 15, max. Ep: 18kV and Gm: 40mS. Completion of **UV-171** must show evidence of success in research and production activity of our company.

About this time, R & D staff in the world were paying huge effort in UHF and SHF field. It was when no country showed success in product reaching desired oscillation frequency and large output power, but we challenged toward the direction by improving process in small water-cooled tube.

Namely, small water-cooled tubes are much smaller in size compared with existing natural cooled tubes, yet anode dissipation gets much higher. Cymotron **SN-209C**, **SN-601**

and **SN-605** have no difference between smaller version of large water cooled tubes.

In the other hand, Cymotron **SN-610** introduced in 1934 modified shape of anode bottom to semi-spherical, and made efficiency higher by utilizing the shape which was reducing total area of anode surface much, thus obtaining much less static capacitance between anode and grid. This was evaluated as an excellent tube for UHF application.

In the same year, a triode **SN-603** was manufactured as suited for generating electronic vibration, and many other newly designed transmitting tube were born. For aircraft application, **UX-860C** which has designed for rigid internal construction and weight reduction. As a tetrode, **UV-815** which works with relatively low anode voltage of 2,000V and have nearly 1kW of output was made. Also a water- cooled tube **UV-822** with output reaching 4kW and rated as largest tetrode at that time was also marketed in 1934. Those tubes were example of ones which kept steady improvement in the transmitting tube group which were outside the fame of UHF and high power.

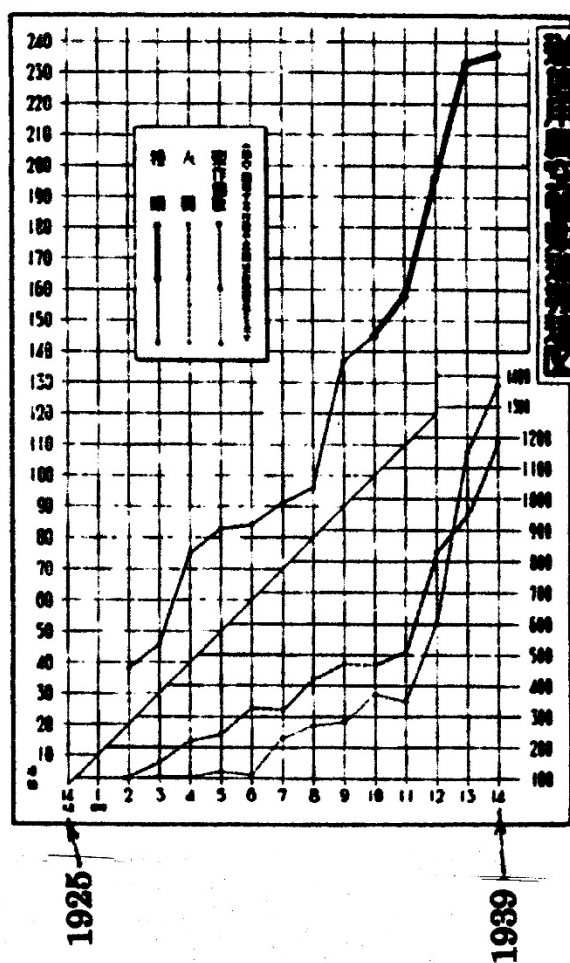
In the other area, application range of grid-controlled discharge tube names as Thyratron has expanded, and in 1934 **TX-902** was used for mobile color writing of mazda building and let a newspaper Asahi introduced as a new noted site in Tokyo. For smaller thyratron, Argon-filled types have utilized generally, and **TX-902G**, **TX-903G**, **TX-911G**, **TX-931G**, etc. were marketed.

In 1935, R & D project in UHF and SHF region have expanded further, research on magnetron has accelerated. As the first trial, water- cooled magnetron **MN-710** having 500W order of output at around 50cm of wavelength has offered for research in many areas. For less powered area, split type graphite anode model was born.

In around 1935, existing transmitters were still with triodes or tetrodes, but in cooperating the pentode area in the receiver industry, pentodes were gradually adopted in the transmitters as a trend, and its true value was recognized especially for aircraft and mobilized wireless equipment. We have marketed smallest powered **UY-47D** and **UZ-47H**, 10W class: **UY-510A** and **UY-510B**, 50W class: **UY-511B**, and for 200W class: **UV-1083** and **UV-1085**. Introduction of those pentodes brought less number of tubes and smaller sized sets as much as one-third possible, and therefore gained popularity. This promised that future mobilized and small transmitters adopt more pentodes, and pentode era will arrive in transmitter field.

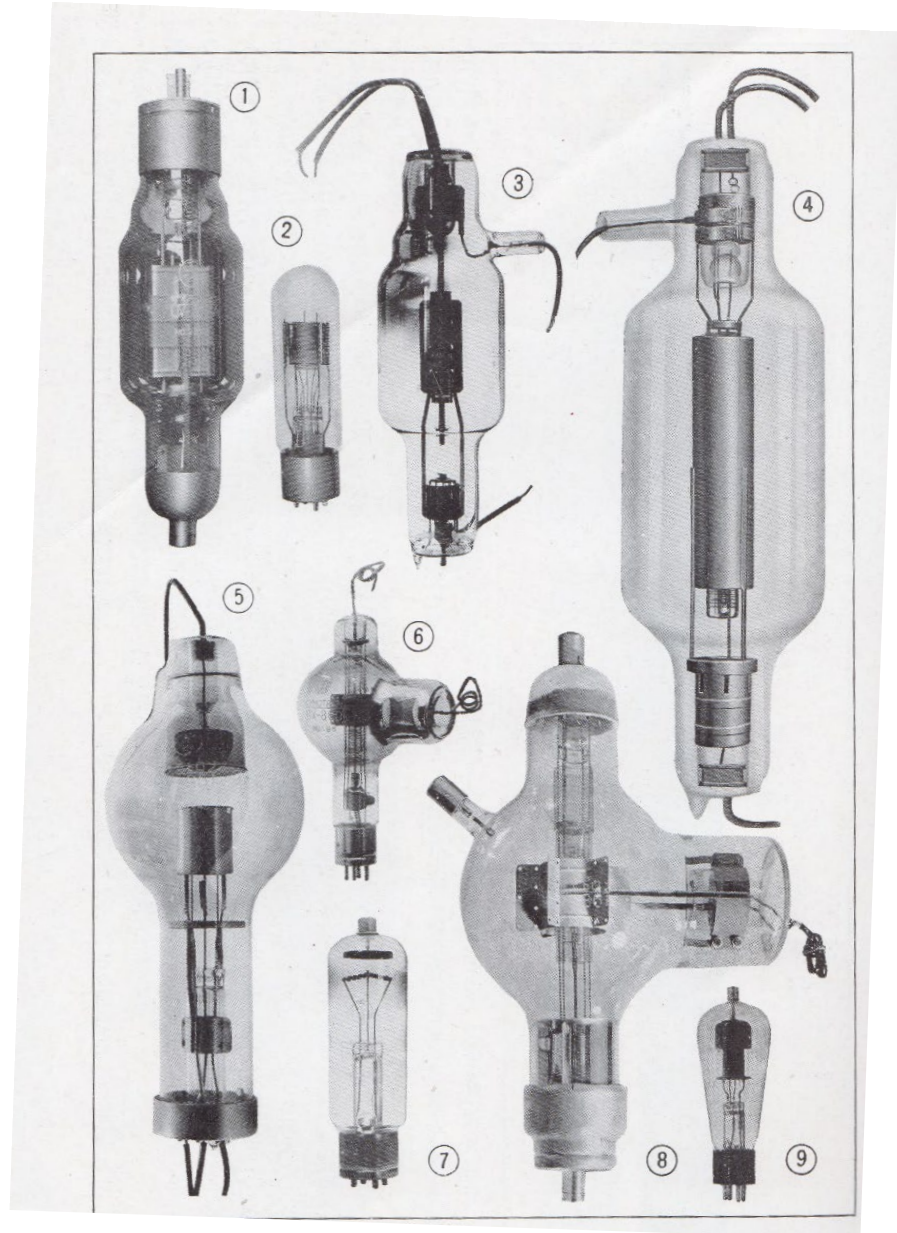
Application of grid controlled discharge tubes to high-powered communication system have also shown quick progress, higher powered models were demanded, and thyratron **TV-921** was introduced. Also Mercury-Bathed Rectifier (Ignitron) for high powered communication has started as first trial in Japan, and **IH-2001** and **IH-2002** have manufactured.

Among the products during 1935, the most notable one was a thyatron **TV-926**. This was designed as power rectifier for Tokyo's 150kW transmitter. It had rating as PIV: 18kV max., and average anode current: 30A. It was installed in Tokyo's broadcast station, and compared with a steel-bath type mercury rectifier, and its stable operation and high reliability were confirmed.



**Transmitting Tube Production**

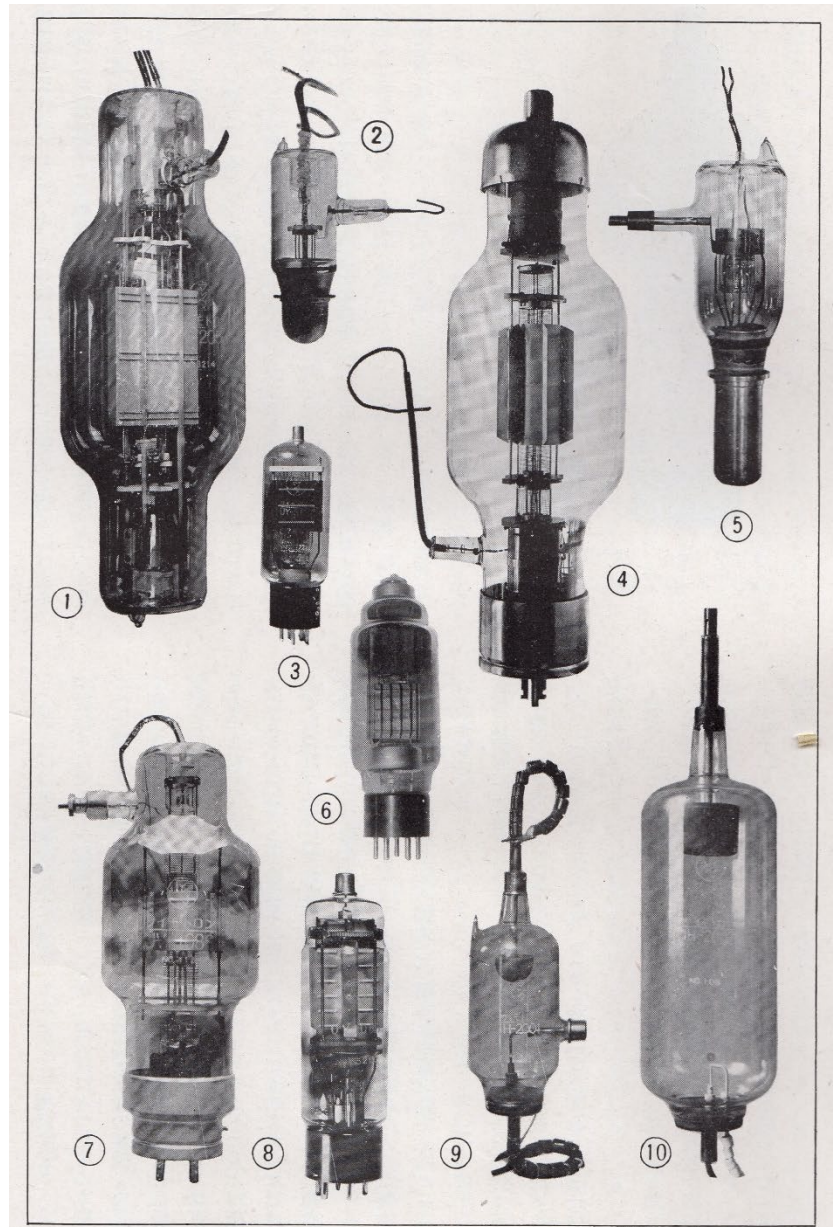
## Example of Transmitting Tubes: Part 1



① UV-204A   ② UV-203   ③ SN-204   ④ SN-208C

⑤ HV-951   ⑥ UX-860   ⑦ HV-972   ⑧ UV-861   ⑨ HX-966

## Example of Transmitting Tubes: Part 2

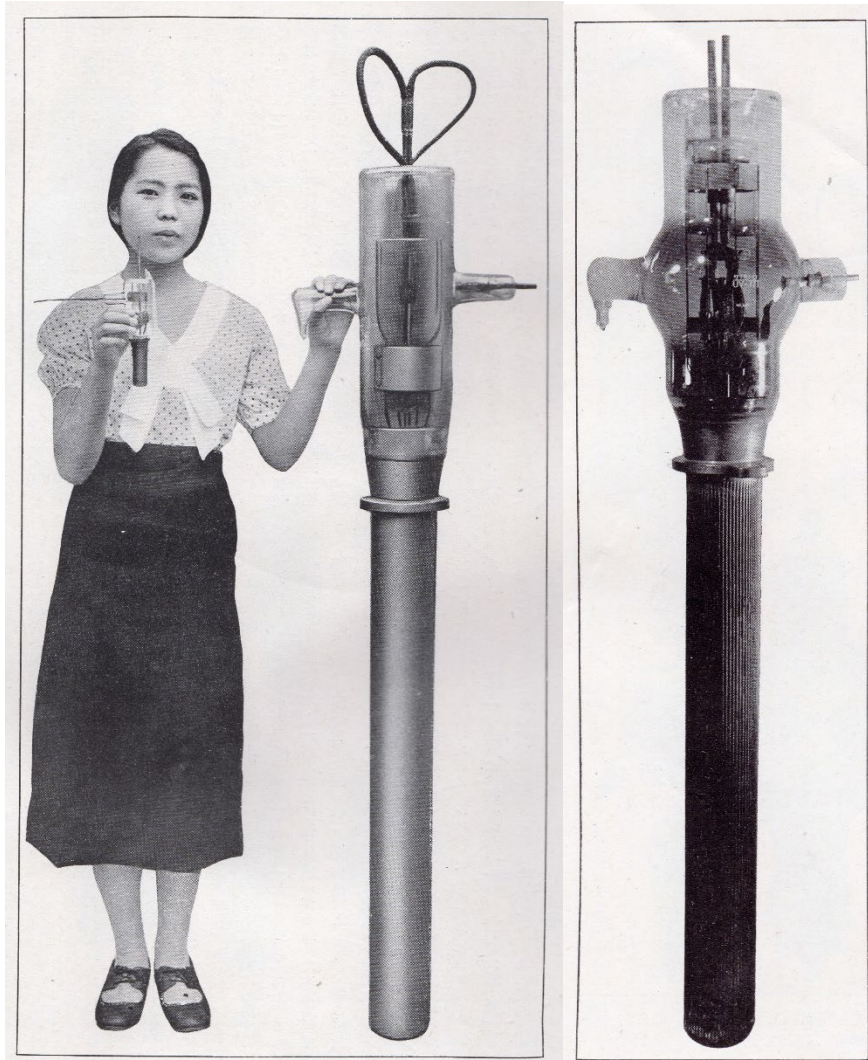


① SN-205C ② SN-610 ③ UY-510B ④ UV-815 ⑤ SN-209C

⑥ UY-511B ⑦ UV-1083 ⑧ UV-1085 ⑨ IH-2001 ⑩ IH-2002

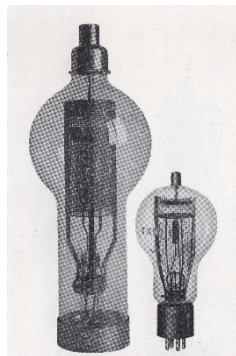


**Example of Transmitting Tubes: Part 3**



**UV-169 (200kW Input) and SN-209C**

**UV-171 (400kW Input)**



**Thyratrons**

**Left: TV-916**

**Right: TX-911**