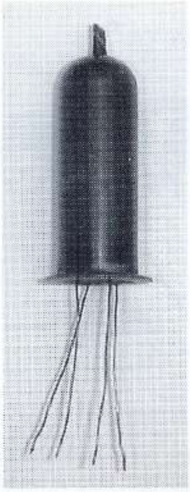
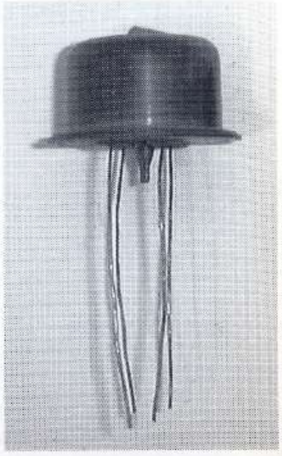
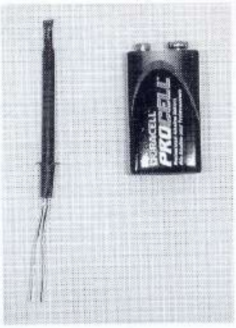
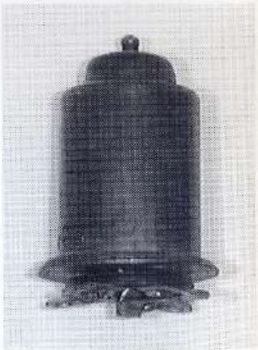
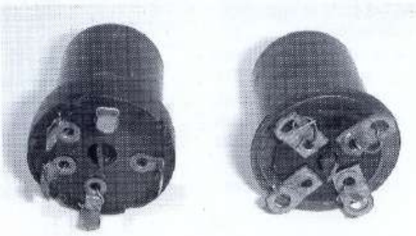








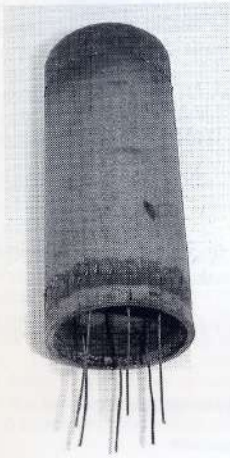


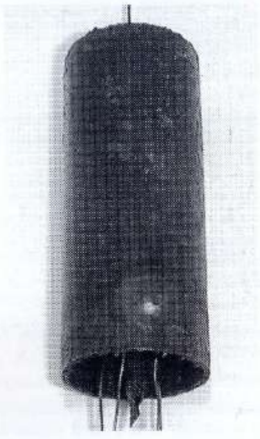
TUBE COLLECTOR

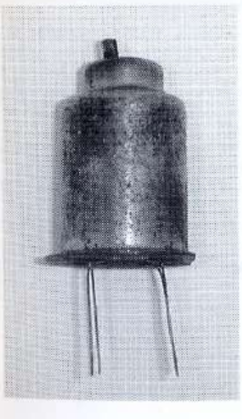
TUBE COLLECTORS ASSOCIATION

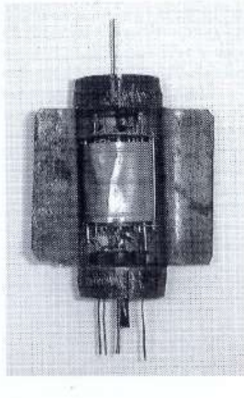
"HISTORY • PRESERVATION • APPLICATION"

Vol. 12 No. 4 August, 2010









TUBE COLLECTOR

TUBE COLLECTORS ASSOCIATION, INC.

PO Box 636, Ashland, OR 97520, USA

The Tube Collectors Association is a nonprofit, noncommercial group of individuals active in the history, preservation, and use of electron-tube technology. *Tube Collector*, its bulletin, appears six times per year.

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To join TCA: annual dues is $20.00 (in North America; $25.00 elsewhere), to the address above. Please make checks payable to "Tube Collectors Association." Payment by PayPal is welcomed, to *tca@jkasystems.com*. The membership year runs January-through-December. Those joining after February receive the year's back issues of TCA publications. Multi-year memberships are offered: in North America, $37 for two years or $54 for three; elsewhere, $49 for two years or $73 for three.

Articles on tube topics are invited. Editorial correspondence should go to the editor at *tubelore@jeffnet.org* or **102 McDonough Rd., Gold Hill, OR 97525**.

Renewals, changes of address, and other membership business should go to Bob Deuel at *tca@jkasystems.com* or **PO Box 636, Ashland, OR 97520.**

COVERS: Part of a fine collection of developmental metal tubes. See inside for more details. *Photos: Bob Millard*

MICROPHONICS FROM THE EDITOR

2010 TCA MEMBER MEETING

The date is Saturday, September 25, 9 AM. We'll be returning to Oregon, specifically the Old Sams Valley School outside Gold Hill. See the enclosed brochure for details.

We expect to have the same great food as previously. Please let us know if you're coming so we can have enough.

"RADIOLA" BOOK REDUCED

Eric Wenaas' excellent history, Radiola - The Golden Age of RCA - 1919-1929, was reviewed in TC for October 2007. This book has become something of a standard. Lately, at least one vendor, Antique Radio Classified, has reduced it price on this hard-cover volume from $65 to $45. A great reference at a lesser price.

IN MEMORIAM

Allen W. Moore, W3QO
John V. Smith, W4ACG
Milo Turnpaugh, KC7PRV

The 6SR5 - another "whatzitron" from the International Components Corporation. Unknown to science . . .

IN THIS ISSUE

WEIRD TUBE OF THE MONTH

RCA 20-kW VHF TETRODE

Here's a novel tetrode, developed by RCA in 1939, just before the opening of commercial TV service in the U. S. The developers were A. V. Haeff, L. S. Nergaard, W. G. Wagener, P. D. Zottu, R. B. Ayer, and H. E. Gihring. Haeff and Nergaard are perhaps better known as the originators of the RCA 825 inductive-output tube. Wagener soon after became the chief engineer at Heintz & Kaufman in California. The developers made presentations on the tube at the 1939 IRE Convention in New York.

Components of the tube: filament assembly, control grid, screen grid, and anode assembly with water jacket

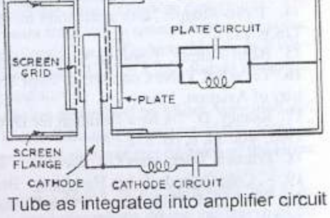
The completed tube

Internal design

This is a mid-anode design with integral cooler, in the basic form of the Western Electric 240( ) and the RCA 887 and 888 triodes. However, it is higher in power rating and is a *tetrode*.

The basic objective was to deliver 20 kilowatts, peak-of-sync, at 120 MHz. It was necessary to avoid insulating members in the active portion of the tube. The control-grid support and the filament leads were water-cooled along with the anode. The tube was 30-½ inches long and 5-½ inches in diameter.

The tube operated up to 80 MHz or more, giving up to 25-28 kW with an efficiency of about 55%. A pair of the tubes gave 56 kW at 100 MHz with better than 50% efficiency.



Tube as integrated into amplifier circuit

This was apparently a purely experimental device - it does not appear in the developmental-tube files in the Dowd-RCA archive. - Ed.

REFERENCES

1. - , "I. R. E. Convention, 1939," *Electronics*, Oct. 1939, pp. 17 and 71.

2. - , "A 20-kW Tetrode for Ultrahigh-Frequency Transmitters," *Electrical Engineering*, March 1940, p. 107.

CLASSICAL PHILIPS TRANSMITTING VALVES

Translated and adapted by **Abel Santoro**, LU8DXI

A view of the power-tube situation before the wide adoption of ceramic construction in the late '50s.

CLASSIFICATION

Transmitting valves may be classified as diodes, triodes, tetrodes, pentodes, and combined valves. The diodes are employed in power supplies for the other valves.

A brief comparison of tetrodes and pentodes with triodes shows that for the same power output, the drive power required for tetrodes and pentodes is very much less. Additionally, because the capacitance between anode and control grid of the tetrode or pentode is smaller than in the triode, neutralization is often unnecessary in transmission work. The effect produced by the screen and suppressor grids in the pentode, may give it a preference over the tetrode.

It is possible to classify valves according to power as low, medium or high output power. Up to 2 kW of power the anode of the valve is cooled by radiation and the envelope of the valve is glass. For higher-power valves, forced cooling by means of air, water or oil is necessary.

TECHNOLOGY AND CONSTRUCTION OF TRANSMITTING VALVES

PHILIPS VALVES WITH PURE-TUNGSTEN FILAMENTS

The filaments of early transmitting valves were made of tungsten for its known electron emission in a high vacuum. The working temperature is near 2600° Kelvin, at which the evaporation rate of the filament is low enough to give a long life, but the current needed to produce this high temperature is considerable.

Today the tungsten filament is superseded in high-power transmitting valves by carburized thoriated tungsten, which requires less current to heat it.

The Philips TA 20/250 valve is a water-cooled triode with tungsten filament, an anode voltage of 20 kV, and a power output of 250 kW. The filament voltage is 35 V and the consumption is 420 A. The resulting filament power is 14.7 kW. Such high filament power necessitates a special valve construction. The filament of this valve is composed of 12 wires of 1.3 mm in diameter, each wire of 426 mm in length and arranged in two series groups of six parallel wires, with a current per wire of 70 A. The connection between the filament and the external terminal of the valve is made with thick copper rods attached to the glass with chromium-iron flanges. The TA20/250 is shown in Fig. 1, where one can see the two connections for the heater and the two for the grid.

Fig. 2 depicts the TA18/100 tungsten-filament triode with water-cooled anode, which runs with a filament voltage of 33 V and a current of 207 A, an anode voltage of 20 kV, and a power output of 100 kW. Other Philips triodes with pure-tungsten filaments are the TA12/35 with water-cooled anode and the TAL12/20 with air-cooled anode and with a dissipation of 20 kW as seen in Fig. 3. In the case of the TA12/35 the envelope is not the conventional glass bulb. Here the anode itself is copper and is part of the envelope of the valve. Fig. 4 shows the triode TA12/35 and its separate water cooler which needs 20 liters of water per minute for an anode dissipation of 18 kW. The filament wattage is 4.44 kW.

In Fig. 5 is shown the air-cooled triode TAL12/20, placed in an appropriate air distributor in which this valve can run at 18 kW of anode dissipation. The air is applied from below under pressure in order to ensure proper heat transfer from the anode and its cooling fins.

PHILIPS VALVES WITH THORIATED-TUNGSTEN FILAMENTS

The higher specific emission of thoriated-tungsten filaments lies between 70 and 100 mA per watt at a working temp-

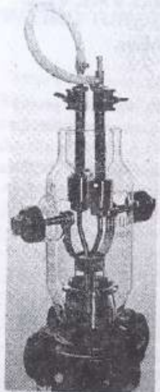


Fig. 1 - TA20/50

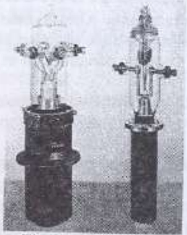


Fig. 3 - TAL12/20


Fig. 6 - TBW12/100


Fig. 4 - TA12/35


Fig. 7 - TBL6/6000


Fig. 2 - TA18/100


Fig. 5. TAL12/20


Fig. 8 - TBW6/6000

erature of 2000° Kelvin, for wire containing 2% thorium oxide. This is much higher than that of pure-tungsten wire.

Fig. 6 shows the Philips triode TBW12/100, with water-cooled anode delivering 100 kW. Fig. 7 depicts the TBL6/6000 triode with forced-air-cooled anode. Fig. 8 shows the TBW6/6000 triode with water-cooled anode. Other transmitting triodes with thoriated-tungsten filaments are the following: TB2.5/300, which delivers 390 W at 2500 V anode potential (Fig. 9), the TB3/750 giving 840 W at 3000 V (Fig. 10), and the TB4/1250 producing 1750 W at 4000 V (Fig. 11).

Fig. 12A shows the Philips QB3/300 power tetrode, which delivers 375 W at 3000 V, and Fig. 12B shows the QB3.5/750 tetrode, rated at 1000 W with 4000 V of anode voltage.

PHILIPS VALVES WITH OXIDE CATHODES

Oxide cathodes give the highest electron emission. They may be heated directly or indirectly. The first are made of a simple wire of nickel or tungsten. The indirectly heated cathode is made with a nickel tube with a tungsten heater inside it. These two types of cathodes are coated with a mixture of barium, calcium and strontium carbonates in an exact proportion. The emission of electrons in these types of cathode occurs at a temperature of 1060° K with a value of 200 to 300 mA/W. These cathodes are used in small transmitting valves to 100 W. Above this power these types are rarely employed because of undesirable barium deposits in the cool zones inside the valve in the manufacturing process.

Fig. 13 shows the Philips QQE06/40 dual tetrode with indirectly heated cathode, which delivers 85 W at 600 V of anode potential *(familiar to North American observers as the 5894, registered by Philips' U. S. subsidiary Amperex in 1951 - Ed.)*. Fig. 14 illustrates the QQC04/15 dual tetrode with directly heated cathode giving 20 W at 400 V on the anode. In Fig. 15 is shown the PE1/100 pentode with its indirectly heated cathode, which delivers 132 W at 1000 V anode voltage. Fig. 16 depicts the PE05/25 pentode, also indirectly heated, giving 33 W at 500 V on the anode.

ANODES FOR TRANSMITTING VALVES

The anode in a transmitting valve is made in accordance with the temperature that it reaches under working conditions. In low-power valves with oxide cathodes, the anode is made of nickel with surface blackened to give a more efficient dissipation of heat by radiation. A high anode temperature tends to produce grid emission. The nickel has a melting point of 1450 °C. This valve type includes a getter of barium. The anodes of the valves of the figures 15 and 16 are of blackened nickel.

In valves of high power with thoriated filaments, the anode is made of molybdenum, tantalum or graphite. Molybdenum melts at 2600°C. The getters of these valves are usually made of zirconium, which is introduced in the form of a fine powder on the anode. The Philips QQE 06/40 valve shown in Fig. 13 has a molybdenum anode.

Another anode material often employed is graphite, which has excellent radiating properties, but because of its brittleness, it requires a thicker wall in comparison with metal. The glass valves shown in Figures 9 to 12 have graphite anodes.

In valves with higher anode dissipation, special methods of cooling are employed, water cooling being the most common. In these the anode is made of copper which is part of the envelope. In Figures 3 and 4 one can see the Philips TA12/35 with and without the separate cooler.

Cooling of the valve by air under pressure is the other method employed, with the copper anode mounted in the air distributor or chimney. The Philips TAL12/20 is shown in Figures 3 and 5 with and without the air distributor. Fig. 7 illustrates the TBL6/6000 with forced-air-cooled anode. In Fig. 8 one can see the water-cooled TBW6/6000.

THE GRIDS

As with the anode, the grids must dissipate the heat developed by them quickly. In order to keep the tempera-

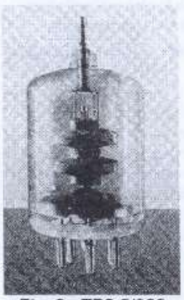


Fig. 9 - TB2.5/300


Fig. 12A - QB3/300

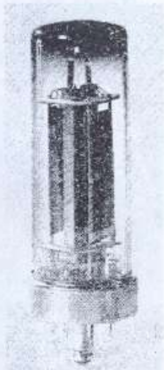


Fig. 14 - QQC04/15

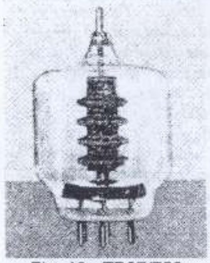


Fig. 10 - TB37/750

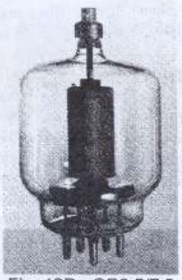


Fig. 12B - QB3.5/7.5

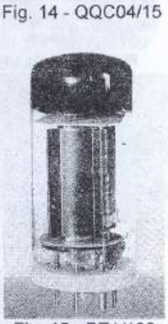


Fig. 15 - PE1/100

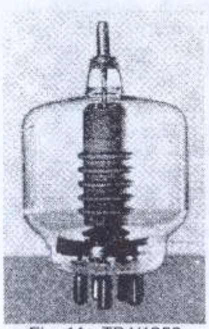


Fig. 11 - TB4/1250


Fig. 13 - QQE06/40

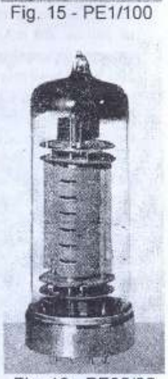


Fig. 16 - PE05/25

ture low, thick grid supports of a highly conductive metal are used. A method of preventing electron emission from the grid consists in plating the grid wire with gold in the case of valves with oxide cathodes, and plating with platinum if the filament is thoriated. In valves with pure-tungsten filaments, molybdenum wire is employed in the construction of the grid or, in the largest types, tungsten wire.

THE ENVELOPE

For valves of small and medium size a glass bulb is used, which is closed at one end by a pressed glass base with the leading-in wires for the connections with the electrodes.

With valves of low power, a soft formulation may be used, mainly lime glass and lead glass. In valves with high anode temperature a hard or borosilicate glass, which has a much higher softening point than lime or lead glass is preferred.

In the Philips high-power valves the connections of the filaments, grids and anodes are made by means of chromium-iron or fernico flanges. For use at high frequencies the metal is coated with a highly conductive material to reduce the heat produced by the radio-frequency currents. In the valves with sintered glass bases molybdenum is used for the leading-in wires.

Since the dielectric losses in the glass increase at higher radio frequencies, in valves for this work the envelope is made of hard glass.

Before assembly of the valve, the envelope must be cleaned throughly in several chemical baths and then degassed.

Mica is usually employed for holding the electrodes of the valve in position, but at high frequencies the use of insulating materials is avoided wherever possible because their dielectric losses.

All inner components of the valve must be individually cleaned and degassed before assembly of the valve to minimize the liberation of residual gases when the valve is put to work.

The glass valves are heated in an oven to release adsorbed gases and water vapour, which are then removed by the vacuum pumps. Now the anode is heated to cherry-red heat with an RF current, and the grids are heated by electron bombardment. With water-cooled valves the anode is degassed in a special oven. In the case of thoriated tungsten, the filament is formed by raising it to a specific voltage, giving the exact temperature at which the emitting layer is formed. Then the getters are fired by RF currents. Some valve types use a special paint of zirconium on the anode as getter which is activated when the anode is heated.

In the case of small oxide-cathode valves, the vacuum pumping operation is carried on the rotary pumping machine ("sealex"). Larger valves of high power are pumped individually.

In valves with thoriated filaments the pumping operation is different from that employed for oxide valves. In these the filament is carbonized and this operation is completed before pumping begins.

Technical data on some classic Philips transmitting valves are given in the tables. The coding scheme for the type numbers is as follows:

First Letter(s) (General Type):

D	Rectifier
M	Audio triode
P	Pentode
Q	Tetrode
QQ	Dual tetrode
T	RF triode

Second Letter (Filament):

A	Tungsten
B	Thoriated tungsten
C	Oxide-coated
E	Indirectly heated

Third Letter (Fill Gas or Cooling Method)

G	Mercury vapor
L	Forced-air-cooled
W	Water-cooling
X	Xenon Fill

ACKNOWLEDGEMENT

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