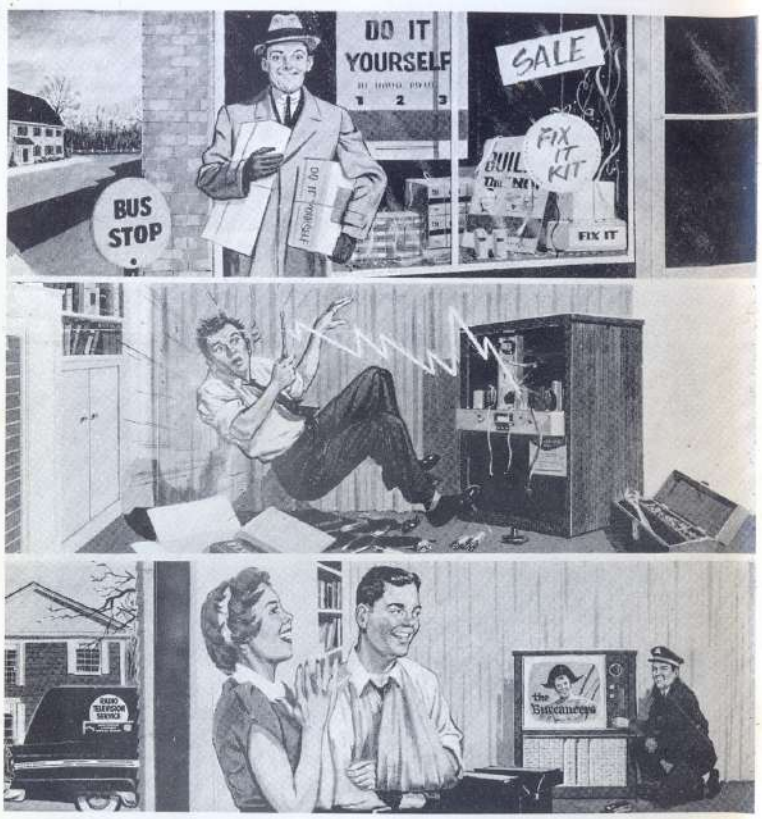

TUBE COLLECTOR

TUBE COLLECTORS ASSOCIATION

"HISTORY • PRESERVATION • APPLICATION"

Vol. 12 No. 2 April, 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**.

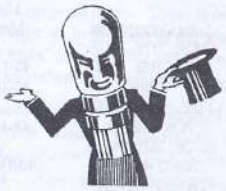
FRONT COVER: A stash of rare Philco-branded "export" tubes as recently found in Canada. See the story on page 2.

Photo: Jim Cross

REAR COVER: A memento of the fix-your-own era in television repair, from the days of how-to-do-it booklets and drug-store tube testers.

Graphic: Sylvania News, Feb. 1957

MICROPHONICS FROM THE EDITOR



CHARLOTTE NOTES

This issue of *Tube Collector* is going out a little early so as to avoid any delay from the Charlotte meeting.

At "press time," our AWA-Carolinas host Ron Lawrence and his crew are planning to include a special group of tubes from the Ernie Hite estate as part of the special auction on Thursday evening, March 25. Details on the overall conference, and photos of early radios to be auctioned at the event, are available at http://charlottearc2010.homestead.com/index.html.

IN THIS ISSUE

"Free Classes in Slide Rule"

"The Slide Rule is indispensable as a great time saver in all clerical and business offices in both commercial and industrial concerns. It is one of the most useful tools available to the chemist and physicist."

From a recruiting brochure of the Tri-State College of Engineering (now Triune University) of Angola, Indiana, ca. 1929.

THE 6AJ5 MYSTERY

Al Klase

Delaware Valley Historic Radio Club *Oscillator*, April 1999

We had the Bell Labs view of the 6AJ5 that they designed in 1944 in the December, 2008 TC. *Here's a view from a different perspective. - Ed.*

I've always been mystified by the use of the rather obscure 6AJ5 remote-cutoff pentode in the first RF stage of the original military R-390 receiver. A remote-cut-off tube offers a better noise figure in the upper HF ranges near 30 MHz, but lack of proper AGC action generally drove designers to remote-cutoff tubes - like the familiar 6BA6. Tube Lore tells us that this tube is a "6AK5 optimized for 28V plate supply," but here it is in a Collins engineering masterpiece with 180 volts on its anode. Clearly something's going on here, but the answer seemed to be lost to antiquity. As it turns out, the answer was a government secret until 1985.

The following is from the Final Engineering Report on Radio Receivers R-389( ) / URR and R-390( ) / URR, September 15, 1953 (declassified May 8, 1985).

4.2.6.4 RF Stage

From the specifications, the three most important considerations in the design of the RF stages are noise contribution, gain, and strong-signal handling capabilities.

Noise Contribution of RF Stages

Once the gain of the antenna coil has been fixed, the next method of raising the sensitivity of the receiver is to use a low-noise first RF tube. All low-noise pentodes, however, are sharp cut-off tubes, and application of full AGC to these tubes results in severe distortion above about 0.1 volt antenna input. A one-volt signal 30% modulated at the antenna has a possible peak voltage of 11.5 at the grid of the first RF tube with the antenna coils used. The first RF tube must be able to handle this voltage without serious distortion, and in order to prevent the grid from going positive with such a voltage, at least 11.5 V of bias must be supplied to the tube. For most sharp cut-off tubes, this lies far beyond cut-off, but the 6AJ5, though nominally a sharp cut-off tube, can be operated so that it has fairly satisfactory remote cut-off characteristics. This is primarily due to the fact that it was designed for 28-V plate and screen operation. Application of screen voltage to this tube through a large screen dropping resistor provides proper operation when used with a 180 V B+ supply. When AGC is applied to the control grid, the screen voltage rises, thus preventing an early cut-off and giving a much better remote characteristic than any other sharp cut-off tube tried.

As an example of its superiority, here is a comparison between it and the 6AK5:

Distortion at .7 V input (30% mod)
6AK5 16%
6AJ5 3%
Audio rise from 10 µV to .7 V (db)
6AK5 18.5 db
6AJ5 10.0 db

Despite the use of this tube, sensitivity at times rises above 3 µV, due to variations in tubes, ant. coil gain, etc. It is proposed, therefore, to raise allowable AM sensitivity to 3.3 µV below 14 mc and 4.4 µV above 14 mc. Allowable CW sensitivity is to be raised to 1.3 µV above 14 mc.

The cascode amplifier was also tried on breadboard models and seemed to offer some improvement over pentodes in regard to sensitivity, but again, their poor performance when AGC is applied disqualified them. They are often used in TV sets with AGC applied, but they will not handle signal levels of 12 V peak as required in this receiver.

CONTEMPORARY TUBE MANUFACTURE

THE TENTH ANNIVERSARY OF "EMISSION LABS®"

Abel Santoro, LU8DXI

Emission Labs is a small tube factory in the Czech Republic producing high-quality electron tubes. This is a relatively new brand, which represents very special technical products. Emission Labs is a highly motivated production team building high-grade audio tubes in the traditional way, making everything by hand.

The master of the factory is Anton (Tony), who worked in research and development in the tube factories of Prague between 1956 and 1990. He was also Research and Development manager at the Alesa Vaic tube factory in 1996-98. In the latter year Tony and some of his colleagues had to retire, after which they decided to build a small series of tubes on their own.

In May 2000 Tony was seeking a sales partner, and formed a venture with the company JAC-Music in Germany. In Figure 1 one can see Jac (left) and Tony (right) initiating the alliance.

Today the factory has several employees. In Figure 2, at top left is Jarda, the main technician; at top right is Tony.

INSIDE THE FACTORY

Figure 3 shows Tony operating a locally made machine, to form tube stems with a gas flame. Figure 4 depicts Tony at the glass lathe making a glass bulb from a section of special, very pure glass tubing. This yields reliable bulbs without built-in micro-cracks which can later break or leak air. The freshly formed bulb must be cut from the tubing as shown in Figure 5. The finished bulbs appear in Figure 6.

Figure 7 depicts Renata in another section of the plant, firing ceramic bases in a small kiln. She removes them from the oven to let them cool down.

Other tube parts are made in the factory. In Figure 8 Renata is seen inspecting tube bases before staking-in the pins. Figure 9 shows a simple but effective press used to stamp tube plates. The operator spins the horizontal weight bar at the top, causing the stamping die to travel down and punch the plate material.

Elsewhere in the plant, Figure 10 shows Jarda preparing tube filaments. The wires are coated with carbonate compounds. This is careful work, as the smallest dirt particle may cause failure of the tube.

To keep the whole process of manufacture ultra-clean, tube parts are stored under vacuum in glass jars until needed. The result of this process will be a reliable electron tube. In Figure 11 one can see eight tubes ready for pumping-down the next day. Until then they are stored in vacuum to keep them free of atmospheric gases.

The next step is exhausting and activation of the tube. The tube is evacuated on the vacuum pump, while the complete electrode system of the tube is heated to a red glow with a 3-kW RF heater. Figure 12 shows Jarda doing this work.

In Figure 13 one can see the tube tipped-off from the vacuum pump.

The finished tube must be tested rigorously: production is one thing, testing is another. Test instruments for this use have been bought from closing tube factories, and others custom-built.

Figure 14 shows a normal "burn-in bench" for tubes. Light bulbs are used as traditional current-limiting plate resistors. This apparatus can age-in ten tubes at a time, while monitoring six essential parameters of each tube.

In Figure 15, Jarda is doing computerized parameter tests on the tubes. This particular set-up measures grid current at full power, one tube at a time. The data for each tube are saved in an Excel spreadsheet.

Figure 16 shows soldering of the base pins with a stream of heated air.

At the end of the process, Figure 17, is "ever the master's eye."

TUBES MADE BY EMISSION LABS

Rectifiers (mesh-plate)

274A. Emission Labs re-introduced the 274A in 2001. The 274A and 274B are

the same tube with different bases (four-pin vs. octal). These tubes are full-wave rectifiers, electrically equivalent to the original Western Electric Co. tubes. They are intended specially for audio purposes. They can supply 140 mA with a normal C-L-C filter, derated from the 225 mA of the WE versions. Figure 18 shows the tube, while the Figure 19 gives details of the plates.

5U4G. This is a replacement for the historic 5U4G or 5Z3 (allowing for the latter's four-pin base). The 5U4Gs made by Emission Labs are slow-start tubes, protecting an audio amplifier. This tube is made in two versions, solid-plate and mesh-plate. Figure 20 depicts the EML 5U4G compared with the American 5U4G. It does not replace the 5U4GA or 5U4GB, which are rated differently.

Driver Tubes

20A / 20B / 30A. The 20A, 20B and 30A tubes are based on older principles, where high-gain tubes had much wider plate distance. This is said to be still the best way to make a very linear high-gain tube. However this results in higher working voltage and large size. This practice was reportedly abandoned after 1935, as miniaturization of tubes became important. With the tubes produced today, miniaturization is no requirement. The 20A (Figure 21) and 20B have a gain of 20, while the 30A has a gain of 32. These tubes have wide plates, shown in Figure 22.

Output Tubes

AD1-Mesh. Introduced just before the Second World War, the AD1, "highlight of European direct-heated triodes," was intended for large radios and cinema amplifiers. After the war, the market required large quantities of small-sized, low-cost tubes for the new-design radios, ending production of the AD1. The quantity of AD1s made is estimated as 50,000.

The electrical characteristics of the Emission Labs AD1-Mesh tube, Figure 23, are almost identical to those of the original AD1 as made by Telefunken. The difference is in the method of applying the cathode emissive layer. In the original tubes, the filament coating was applied by evaporating a deposit of barium inside the tube. Inspecting the earliest AD1 tube such as was made by Telefunken, the source container is visible in the middle of the plates. The result of this was the low filament current of the initial AD1. This was important in the days when radios operated with batteries, but the disadvantages of this historic method of coating are reduced lifetime and high grid current. In any event, it was possible to build first-class tubes in this way, but only Telefunken had the process under control.

The production of modern tubes uses a barium-oxide coating, which requires more filament current. With this process the tubes are said to have better lifetime, and accidental abuse will not immediately damage the tube. The AD1-mesh made by Emission Labs draws more filament current than the historical AD1 (1.5 A, vs. 0.95 A). For this reason the tube is claimed to have longer life and higher reliability.

About the base used on this tube, the AD1 side-pin base (basing diagram PP) became obsolete because it can be used only on "wired" (pressed-stem) tubes, and not on button-stem types with the pins through the glass. However, this base is among the best ever made. It pulls the tube inside the socket and closes with the socket like a lid, so dust cannot get in; tube retainers are not needed; the tube pins are self-cleaning; and the socket can be accessed for cleaning with a cloth. It is a true high-end base. Figure 24 shows the base detail.

2A3-S. This is a direct replacement for the original RCA 2A3 "monoplate" tube. Its features are gold-clad grid wire, center-tapped filament, dual oversized getters, and construction giving low microphonics. It is uprated on dissipation from 15 W to 28.

2A3-mesh. This tube is another direct replacement for the "monoplate" 2A3. It features dual mesh windows in the plate, combining the electrical stability of solid-plate tubes with the reported non-resonance of mesh material. The maker claims "When a tube is given mesh plates,

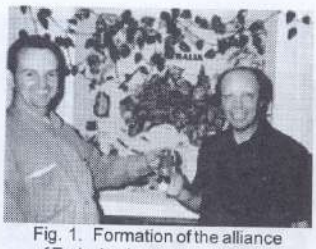


Fig. 1. Formation of the alliance of Emission Labs and JACMusic

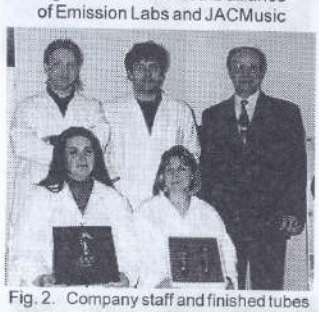


Fig. 2. Company staff and finished tubes

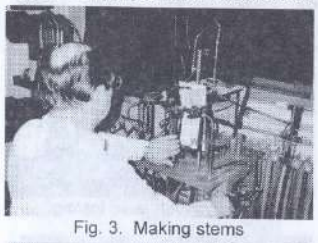


Fig. 3. Making stems


Fig. 4. Making bulbs


Fig. 5. Cutting bulb from base tubing

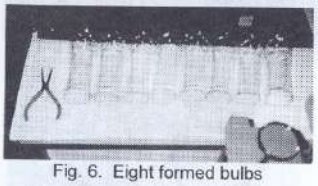


Fig. 6. Eight formed bulbs


Fig, 7. Firing ceramic bases


Fig. 8. Inspecting bases

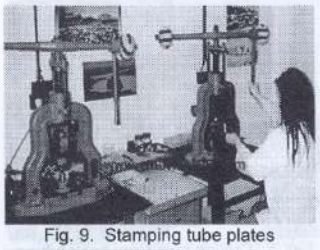


Fig. 9. Stamping tube plates

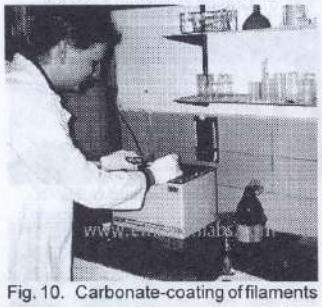


Fig. 10. Carbonate-coating of filaments

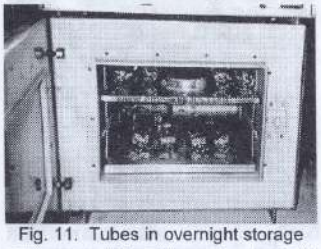


Fig. 11. Tubes in overnight storage

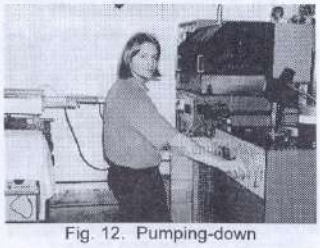


Fig. 12. Pumping-down

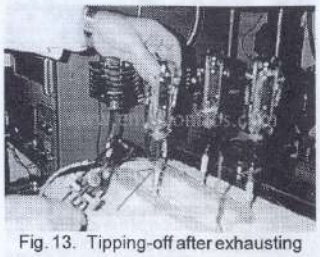


Fig. 13. Tipping-off after exhausting

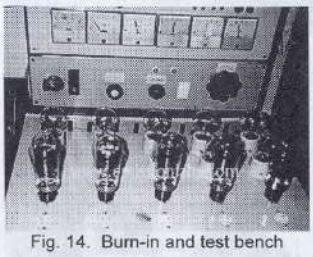
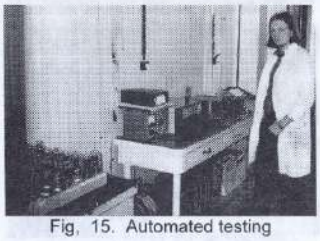


Fig. 14. Burn-in and test bench



Fig, 15. Automated testing

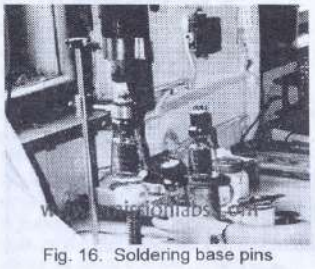


Fig. 16. Soldering base pins

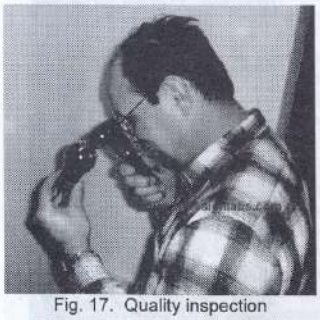


Fig. 17. Quality inspection

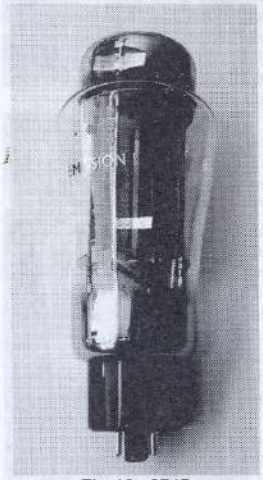


Fig. 18. 274B

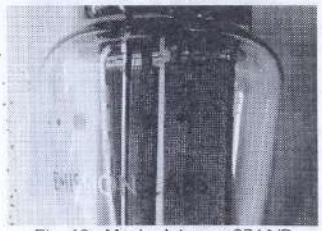


Fig. 19. Mesh plates on 274A/B

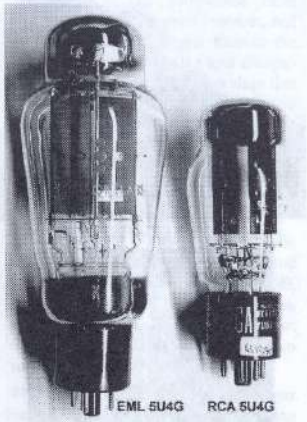


Fig. 20. New and old 5U4Gs

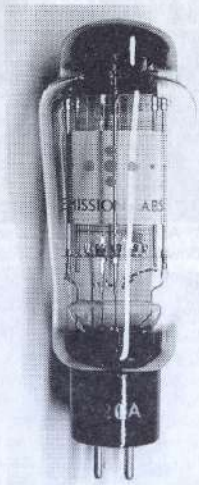


Fig. 21. 20A driver triode (20B and 30A look the same)

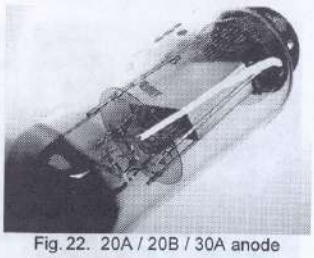


Fig. 22. 20A / 20B / 30A anode

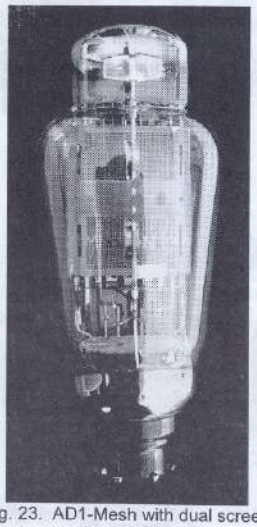


Fig. 23. AD1-Mesh with dual screen windows (2A3-Mesh is similar)

Fig. 24. Base of AD1-Mesh

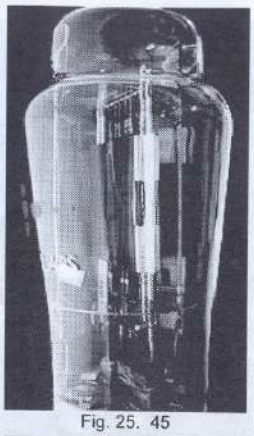


Fig. 25. 45

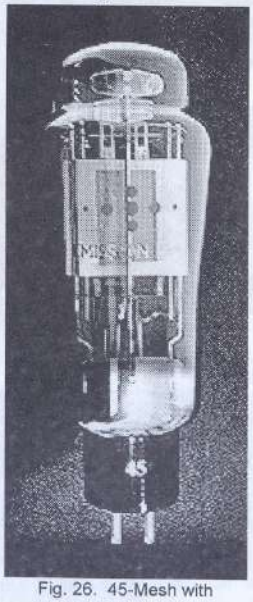


Fig. 26. 45-Mesh with single screen window

something magic happens to the sound, the people call it a most 'transparent' sound stage with a most realistic reproduction of the original sound recording."

The Emission Labs 2A3-Mesh is constructed for low microphonics. The grids and filaments are made of hard metal for higher reliability and reproducible quality. The base is attached to the bulb with vibration-absorbing rubber.

45 and 45-mesh. Forty-five years after the last American tubes of Type 45 were made, Emission Labs was the first company taking this tube back into production. That was in the year 2001, and at that time it was called the VV45. This tube is constructed for low microphonics, and all critical parts like filaments and grids are made of hard metal. The tube has an M-shaped filament like that found in vintage 45s. The Emission Labs 45 (Figure 25) has the same specifications as the American type.

The 45-mesh version (Figure 26) is the same tube but with a mesh window in the plate for a "most realistic stereo reproduction of the original sound recording."

The 45 "Globe" Project. In 2003, Emission Labs made a limited run of 45s with "S" ("globe") bulbs, seen in Figure 27. This was a special project, responding to requests from some U. S. customers. The 45 is one of the few historic tubes that can be found in the old "globe" version.

The recreated 45 "globe" version is difficult to produce, since the mount makes no mechanical contact with the bulb. This means that in sealing the stem to the bulb, the mount may be misaligned inside the glass envelope, raising "shrinkage" and production costs. Additionally, more emphasis is taken on the packing requirements for shipment. These are the realities of producing real "globe" tubes that have a floating electrode system inside.

Emission Labs, celebrating its tenth anniversary, has made a limited stock of these tubes this year.

300B. This tube is a direct replacement for the WE 300B. It boasts a center-tapped filament, plus non-microphonic plate and grid suspension. It is uprated to 44 watts.

300B-mesh. The 300B-mesh tube, Figure 28, is a "long-plate" version, and the plates are 25% longer than in the normal 300B. Because the heat dissipation of the mesh wire is lower than that of the hard metal used for the solid-plate tube, the maximun plate dissipation of the 300B-mesh tube for continuous use is derated from 40 watts to 28.

XLS-series. These tubes are based on an "extra large size" plate system.

300B-XLS. The 300B-XLS, Figure 29, has the classical grid construction and the characteristic curves of the 300B, but with a stronger plate construction, double mica tube top and slow-start filament for best lifetime. Its dissipation rating is 55 W.

320B-XLS. The 320B-XLS is a stronger version of the 300B, the difference being higher filament current (1.7 A) and power-handling capability (55 W dissipation).

520B. The 520B (Figure 30) is a very powerful tube with 0.5 mm thick plates and ten circular coolers (four single and six double plates). It is claimed to be the "world's largest available single-plate" direct-heated triode. It is promoted as a replacement for the 52B type in Vaic, KR, Mastersound, etc. amplifiers. Dissipation rating is 55 W. It comprises two subtypes: the 520B-V2 (filament 6.5 V @ 2.0 A) and 520B-V3 (5.0 V @ 1.8 A).

1605. The 1605, Figure 31, is a very powerful tube with 0.5 mm thick plates and twelve radiating fins on the anode. Compared to the 300B, this tube has higher gain, impedance and plate voltage.

The glass envelopes of all tubes made by Emission Labs are hand-blown into carbon molds. The bases and bulbs are branded with real gold metal paint, baked on, and special red glass paint which is burned onto the bulbs. The grids are made with gold-clad tungsten wire and the bases use machined, gold-plated solid pins and black ceramic material. Metal tags welded to the mount structure carry serial numbers. All tubes are

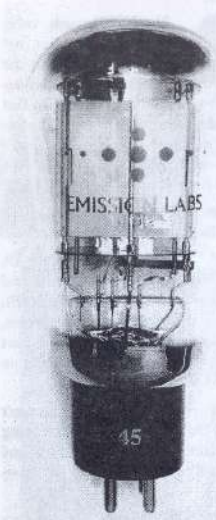


Fig. 27. "Globe"-bulbed 45

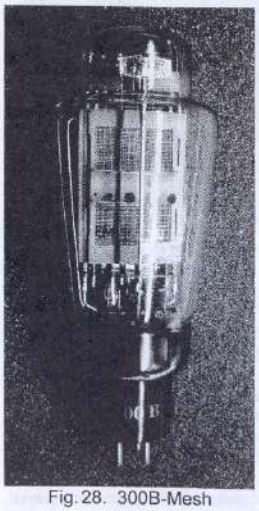


Fig. 28. 300B-Mesh

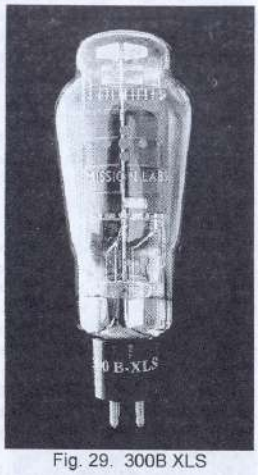


Fig. 29. 300B XLS

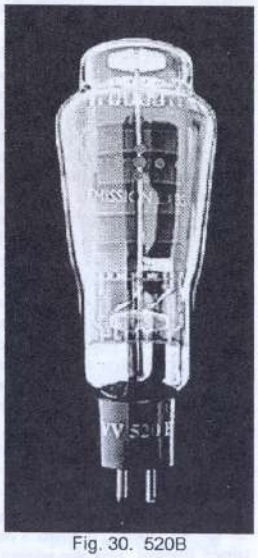


Fig. 30. 520B

controlled with computerized final testing.

"2010 marks ten years since we started production of electron tubes, we had many hiccups and struggles but we persevered, today we continue to grow our healthy business." The company has relocated to a new building and reportedly has new tube types (higher power triodes, more reissues) in the works. Happy Birthday!

ACKNOWLEDGEMENT

To Dipl. Ing. Jac van de Walle of "JAC-Music" of Germany (www.jacmusic.-com), for background material and permission to reproduce some of it.

The Web site for the factory and product line is www.emissionlabs.com. It has some interesting application notes for circuit design and hints on tube use in specific existing amplifiers.

Editor's notes: This line of tubes seems to have unusually wide stem presses, giving wide separation of the leads in the glass. This presumably avoids trouble from electrolysis in the stem under the high voltages at which the tubes are rated.

The 1605 is unrelated to the diminutive RCA 1605 of the '30s.

The "center-tapped" filaments in these tubes are designed with a common point, but that middle is not pinned-out. Several of them have eight wires.

The Emission Labs Web site advocates the use of power supplies with capacitor-input filters, with the input capacitor limited to a modest value (4 μF). The motive is to restrict the peak charging current, which stresses the rectifier tube and may radiate harmonic-rich "buzz" into low-level stages in the amplifier. Interesting reading!

The company offers two types of cement for fixing loose bases on existing tubes.

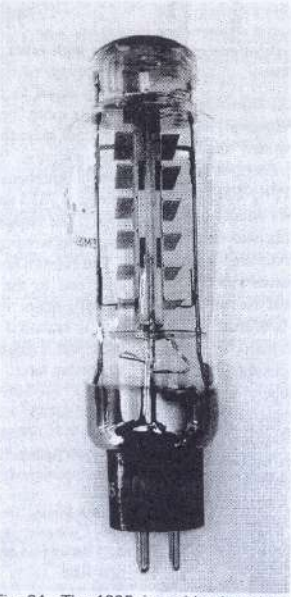


Fig. 31. The 1605, in a side view showing radiating fins and braced structure