TUBE COLLECTOR

TUBE COLLECTORS ASSOCIATION

"HISTORY • PRESERVATION • APPLICATION"

Vol. 14 No. 1 February, 2012

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 membership is invited, at: 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 welcomed. 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 celebration of the addition of an LRS Relay and its AEG amplifier to the museum of the University of Electro-Communications in Chofu City, Tokyo. The celebrants are, left-to-right, Hisashi Ohtsuka (who assembled the collection), Prof. Yukawa (museum curator), Bengt Svensson (who played a major role in having the LRS transferred from the Technical Museum in Stockholm), and Björn Forsberg (another LRS enthusiast).

REAR COVER: A small portion of the museum, with its professional display cabinets and custom-made tube holders. This is suspected to be the largest tube museum open to the public in the world. *Photos: Bengt Svensson.*

MICROPHONICS FROM THE EDITOR

CHARLOTTE PREREG OPEN

This event, comprising the annual antique-radio conference of the Carolinas Chapter of the Antique Wireless Assn., a half-day of meeting of TCA people (and CC-AWA enthusiasts), and the Charlotte International Cryptologic Symposium, will occur on Thursday through Saturday, March 22-24, 2012. Preregistration is now open and welcomed. A printable form, details on the hotel, schedules, etc., are available at http://antiqueradiocharlotte.homestead.com. Also see Page 2.

The TCA session will occupy Thursday morning, with talks, tube-trading (full disclosure: your editor plans to offer a variety of interesting items), etc. Plan on bringing a novel tube or tubes to show off.

The speaker schedule for the crypto sessions is available at http://www.cryptosymposium.com/schedule.html.

This is going to be a very busy event!

BORING BUT IMPORTANT

Sometimes the basics get lost. Let's start the *TC* year with some reminders:

Address changes should go directly to our good secretary – treasurer – circulation manager Bob Deuel. Running those through the editor just adds steps, delay and exposure to error, to the process. See the flyleaf for details.

Letters-to-the-editor and editorial material – stories – are welcome and should go directly to the editor at the address on the flyleaf. Running that sort of thing through the Ashland club address adds steps, delay, and exposure to error to the process.

Proposed articles should comprise a text file (or paper, here in the OCR era) and separate files for the graphics. We routinely find ways to improve digitally the quality of images, but sending them embedded in, say, a Word file makes that impossible. Format doesn't matter much: JPG and bitmap are the usual around here.

Membership expirations are indicated on address labels: EXP=12/2012 means, sure enough, that membership will end with the end of December 2012.

BACK ISSUES

We continue to offer "perpetual availability" of past TCA publications. To repeat the details on the TCA Web site (http://www.tubecollectors.org), a year's worth of back issues, including the Special Publication(s) for that year, are $18 a year postpaid in North America, $23 postpaid elsewhere, with a 15% discount for two years or more. Regarding the Special Publications, Page 25 lists what's available.

WEB SITE FEATURES

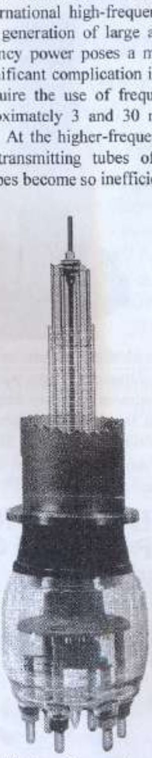
Our Webmaster Norm Wilson has been adding features to the TCA site. Try the "Archives" tab for some scarce tube catalogs, and the "Tube Search" tab for connection to data sheets for several thousand tubes.

IN THIS ISSUE

MANUFACTURE OF A HIGH-FREQUENCY TRANSMITTING TUBE

Adapted from Electrical Communication *(International Telephone & Telegraph Corporation), Sept. 1951. Article discovered by Abel Santoro*

Whenever radio communication over very long distances must be established, as for point-to-point commercial telegraph service and for international high-frequency broadcasting, the generation of large amounts of radio-frequency power poses a major problem. A significant complication is that such services require the use of frequencies between approximately 3 and 30 megacycles per second. At the higher-frequency end of this band, transmitting tubes of the conventional types become so inefficient as to be unusable.



Finished tube with anode cut away

To meet the demand for high-power high-frequency transmitting tubes, Federal Telephone and Radio Corporation of Clifton, New Jersey, has developed and is now manufacturing the type F-5918 triode. As may be seen in the accompanying cutaway view of this tube, simplicity of construction has been stressed along with sturdiness. A multi-strand thoriated-tungsten filament is used, each of its six hairpin strands being mounted separately to prevent any stresses from warping the filament assembly when it heats up. The filament and the grid connections are made to the pins on the glass base of the tube.

The F-5918 triode is suitable for use as radio-frequency amplifier, oscillator, and class-B modulator. Maximum ratings apply up to frequencies of 22 megacycles. The plate dissipation of this water-cooled tube is 70 kilowatts, and two tubes in push-pull class-C telegraph service will give an output of 400 kilowatts. As a class-C plate modulated amplifier, two tubes will deliver in excess of 200 kilowatts. The manufacturing processes shown on the following pages characterize the production of most external-anode transmitting tubes.

Fig. 1. Forming the anode

Figure 1 shows the first operation in the fabrication of anode A thick disk of oxygen-free high-conductivity copper about a foot in diameter is centered over the die on a 250-ton drawing press. The ram of the press descends, forcing the copper through the die to produce a cupped shape. Successive drawings reduce the diameter of the cup and the thickness of the walls until the final form is

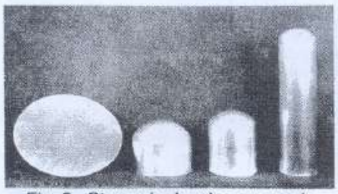


Fig. 2. Stages in drawing an anode

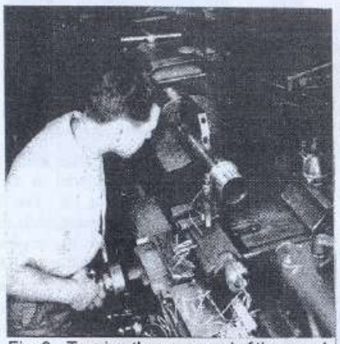


Fig. 3. Turning the open end of the anode

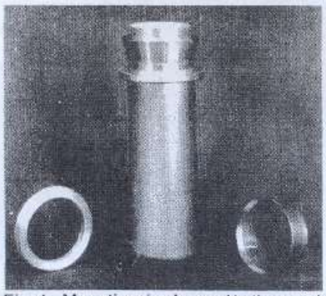


Fig. 4. Mounting ring brazed to the anode

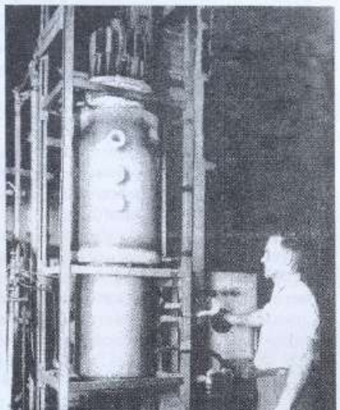


Fig. 5. Brazing furnace

Fig. 6. Sealing glass ring to anode

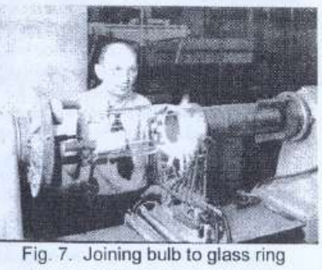


Fig. 7. Joining bulb to glass ring

obtained. Several stages of draw are shown in Figure 2.

In Figure 3 a lathe operator is machining the open end of the anode in preparation for the brazing operation. The copper mounting ring and skirt are brazed to the machined end of the anode, shown in Figure. 4. A sturdy vacuum-tight seal must be obtained.

The parts are assembled and placed in the furnace (Figure 5), where radiant heating raises the temperature until the brazing alloy melts. Inert gas prevents oxidation of the parts.

The next step is to fuse a glass blank to the end of the skirt. This blank will later be fused to the base assembly. As the first step, flames are played on the metal skirt for a few seconds to form a layer of oxide to which the glass will adhere. Next, a large glass tube is cut off leaving about a half-inch of free glass that is bent inside the skirt and fused there (Figure 6). To form a perfect seal, glass must be fused to both the inside and outside of the skirt.

The final step is illustrated in Figure 7, where the end of the large glass tube has been squared off and high-temperature oxygen-hydrogen flames are used to fuse the glass tube to the glass-beaded skirt. When the final shape has been obtained, the anode will be placed in an annealing oven where it will be slowly brought down to room temperature.

Extreme cleanliness is absolutely necessary throughout the manufacture of any transmitting tube that employs high operating voltages. If any dirt is left in the finished tube, even fingerprints, sparking is liable to occur or gas may be liberated and the tube is useless. In Figure 8, the finished anode, with the glass attached, is being washed with distilled water after being cleaned with hot acid. In addition to chemicals, sand-blasting is often used to remove scale and oxides from various parts. The anode will next be dried and the filament and grid assemblies sealed in it.

In Figure 9 are illustrated the various parts that make up the base assembly of the tube. The large dish-shaped piece was pressed out of molten glass. The shorter terminal-pin assembly (bottom center) is one of three that will support the filament, and three of the longer ones will hold the grid. The parts that constitute one of these supports have been laid out to show the terminal cup (which will be glassed before fusing to the dish), and the various copper parts that are brazed to the terminal cup with the two brazing-alloy rings.

Fig. 8. Washing the anode assembly

In Figure 10, all the parts that are joined to the glass dish have been placed in their proper positions on a rotating jig. The jig holds the parts in exact alignment while the glass of the dish, and that on the terminal cups, are brought to a soft plastic state. The six small pipes on each side of the jig are oxygen-gas blowpipes; in addition, the operator is using a Mecker burner and a hand blowtorch to apply localized heat in various parts. Thick glass parts such as these must be heated and cooled very slowly or cracking is certain to occur.

Fig. 9. Bulb top and terminal parts

Figure 11 shows how an operator prepares to punch one of the supporting parts for the filament assembly from a smoking white-hot bar of molybdenum. This metal is extremely hard, having physical properties somewhat like tungsten, and can be punched only after being heated in a gas-fired furnace visible behind the woman's outstretched arm. Some of the finished pieces are on the table of the press. In Figure 12 an operator has completed assembly of the base and the supports for the filament and is installing the thori-

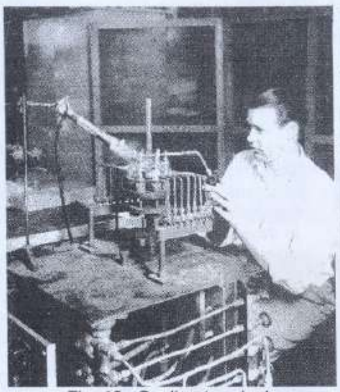


Fig. 10. Sealing terminals to glass-dish bulb top

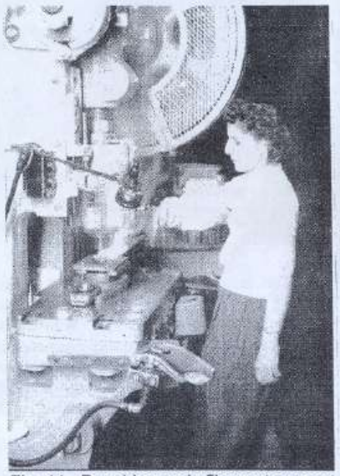


Fig. 11. Punching moly filament support

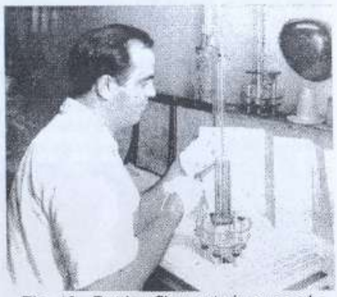


Fig. 12. Putting filaments in supports

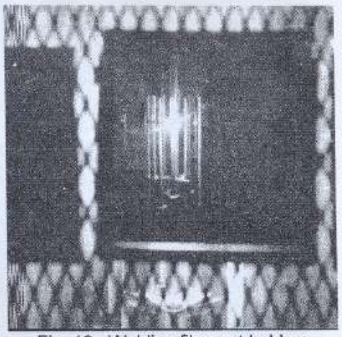


Fig. 13. Welding filament holders

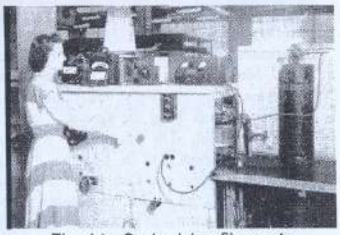


Fig. 14. Carburizing filaments

ated-tungsten hairpin filaments. He wears gloves to avoid contaminating the parts. Small clips of sheet molybdenum hold the tungsten against the heavier molybdenum support rods; when these clips are melted with an electric-arc torch (Figure 13, a firm bond is obtained. Inert gas is bled into the arc-welding chamber to prevent oxidation.

Fig. 15. Grid winder with mandrel

When the filament assembly is completed, it must be carburized. Thoriated tungsten requires this step to stabilize the rate at which the thorium contained in the tungsten is diffused toward the surface of the metal. Acetylene gas is bled into the glass vacuum chamber containing the filament, which is heated to a white heat by passing current through it. Changes in the electrical resistance of the filament indicate when the process is complete (Figure 14). The grid is fabricated on the mandrel shown in Figure 15. Molybdenum is used throughout the structure. Six relatively heavy supporting rods lie in slots along the mandrel, which is turned by hand. The thinner grid wires are fastened to each rod in turn by a spot-welding machine operated by a foot-pedal. Small spacers not visible here assure proper spacing of the turns of grid wire. Before the grid may be mounted on the base assembly as in Figure 16, it must be cleaned of all foreign matter. The operation is shown in Figure 17. The grid has been placed in one of the four bell jars in the machine. This is evacuated of all air, and high-frequency current is then applied to a coil that fits around the bell jar. By induction this causes currents to flow in the grid, which rapidly becomes white hot. All dirt is literally burned off the grid, and the same time, any gas trapped in the metal of the grid is driven out and carried off through the vacuum pump.

Briefly, the effect of any spots of dirt on the grid is that these spots tend to become much hotter than the rest of the grid, and may actually become hot enough to emit electrons. Naturally, this alters the electrical characteristics of the tube, lowers the efficiency, and may actually become serious enough to destroy the tube by melting the grid.

In the large glass lathe of Figure 18, the headstock and tailstock rotate at exactly the same speeds. The tailstock holds the base assembly and this is carefully aligned with the anode in the headstock. When the preheating is finished, the operator will perform the final seal of the two parts by using greater heat.

Fig. 16. Mounting the grid

The safety doors of the exhaust station have been temporarily opened to show the tube in position (Figure 19). With a progressive series of steps, power dissipation in the elements of the tube is increased to drive all gases in the metals out before sealing off the exhaust tube. Gas flames on the anode assist the heating.

Figure 20 shows a test set. The tube type F-5918 has been placed in a water jacket, and a complete series of tests is being made of the various electrical characteristics of the tube. The tube is connected in a self-exited-oscillator circuit, the almost-200-kilowatt output being dissipated in a dummy water load.

Figure 21 is a view of a corner of the shipping department. The clerk is checking the tag that accompanies each tube through the testing department to be sure that all requirements have been met. After checking

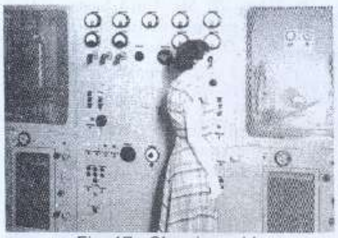


Fig. 17. Cleaning grids

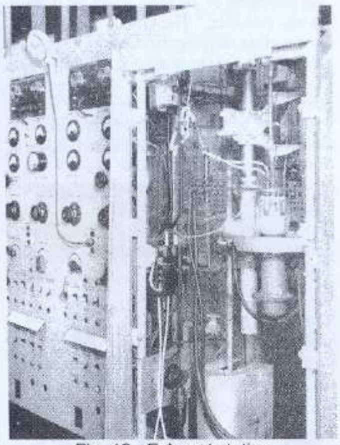


Fig. 19. Exhaust station

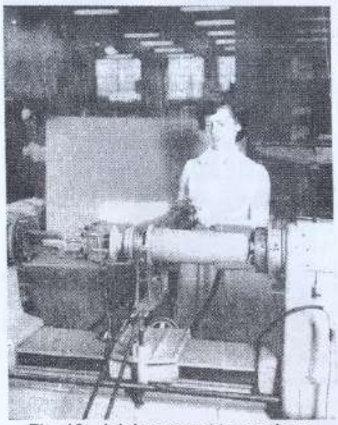


Fig. 18. Joining mount to anode assembly on glass lathe

Fig. 20. Test set

MORE ON THE 5918

In line with the postwar trend of reissuing pure-tungsten tubes with thoriated filaments, Federal Telephone and Radio registered the 5918 in 1950. It was a thoriated version of the Westinghouse 895 of 1941 (which had apparently been the first high-power tube to abandon use of a side arm for the grid connection). In place of triple Y-connected filaments (using 19 V @ 138 A each), the new version had a center-tapped filament taking 28 V @ 150 A. Typical of thoriated redesigns, this cut filament power about in half.

As a relatively radical change, Federal re-registered the tube in 1953 with a filament rated at 11 V @ 285 A. The starting current for the filament was 600 A.

The original tube was rated at 47 kW plate dissipation in Class C telephone use. A re-registration in 1951 raised the figure to 70 kW.

In 1953, also, they introduced a 5918A, with the new filament and (apparently) a slightly changed internal structure.

The 5918 was eventually marketed by GE, Westinghouse, Machlett and Eimac (the latter presumably as the final successor to Machlett).

Federal also made a thoriated version of the air-cooled 895R, the 5919. - Ed.

the packaging of the tube, it will be shipped to the customer. The tube is tied into the frame of the shipping container by a series of chains with springs at the ends. These insure that the tube will not strike the sides of the container if it should be dropped from any position. In shipping, a cardboard carton is slipped over the wooden framework shown in the picture.

In Figure 22, Mr. Floyd Lantzer, chief transmitter engineer of the station WLW, Cincinnati, Ohio, prepares to place an F-5918 tube in one of the 200-kilowatt short-wave broadcasting transmitters at the station.

Station WLW is an affiliate of the Crosley Broadcasting Corporation, and transmits some of the Department of State "Voice of America" programs to Europe.

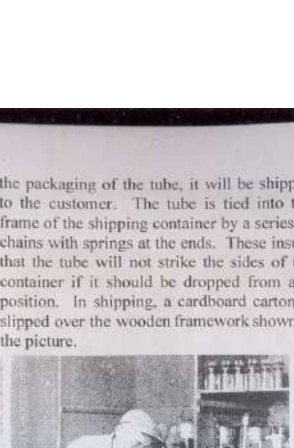


Fig. 21. Pre-shipment check of tests

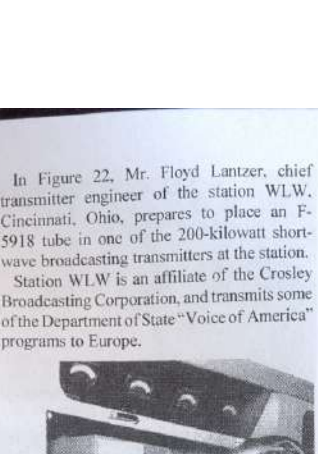


Fig. 22. Installing the finished tube

EXCESS EMISSION

From "A Few of the Tough Ones" by R. F. Shaughnessy, *Radio and Television Maintenance*, Feb. 1951

Cathode emission is next in importance to electrode insulation when checking tubes, both in the receiver and on the tube checker. Excessive emission can be detected very easily by observing the familiar glow inside the bulb which accompanies the phenomenon. It results from the deterioration of the vacuum which existed initially inside the envelope, and also from the bombarding, by the electron stream, of gas molecules in the electrode assembly. The bombardment causes the gas molecules to ionize, and the ions, carried along in the stream, add considerably to the plate current. They may, in some instances, completely ruin the tube.

An interesting test can be carried out in such an instance without removing the tube from its socket or recourse to specialized test apparatus. An ordinary bar magnet, brought close to the glass envelope, may or may not have an effect on the glow. If the field of the magnet causes the glow to be deflected, it shows it to be an electron glow, which is un- likely to have a detrimental effect. If, on the other hand, it is not deflected by the magnet, it is evident that the glow is the result of ionization, and the tube is no longer in good condition.

These are important points, to be kept in mind when confronted with apparently insoluble difficulties in the servicing of modern high gain radio and audio equipment.

HYTRON

Ludwell Sibley

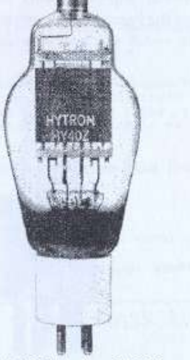
Hytron was an interesting medium-sized maker of tubes and, later on, solid-state devices. In its peak years (1954-55) it held a 9% share of the U. S. receiving-tube market [1], up from 6% in the late '40s. It produced a goodly number of innovations during its run.

Early logotype. On inspection of a good copy, the lines at the top represent a two-wire flattop antenna.

The company was founded in 1921 by Bruce A. and Lloyd H. Coffin in Salem, Massachusetts. In later years it persistently claimed to have begun tube manufacture then, but the company is not listed among the tube firms in the 1924-26 issues of the Radio Trade Directory. Tyne's Saga reports that that production began in 1926, at 19 Oakland St. As of 1938 the production facility and offices were in leased quarters at 76 Lafayette St. in Salem. By the time of WW II, the entire building belonged to the company.

Hytronic Labs logo.

The company got into making small glass power tubes in early 1938. These were mostly triodes with graphite anodes, porcelain bases, and "HY-" numbers. The power tubes were marketed by a subsidiary, Hytronic Laboratories, "the research and electronic division of the Hytron Corporation" at 25 Darby St. in Salem. The tube line grew to about 18 types by WW II. Their policy was "such tubes as we develop in the future will not include large, high-powered, expensive types, but instead will be limited to types with interesting possibilities for experimental work – with particular emphasis on a price low enough to encourage the experimentation from which we may later profit." Their largest tubes, the HY-51 family, had dissipation ratings of 65 watts. With the exception of professional mobile applications (see below), this line does not seem to have been a particular success in the amateur market. Hytron promoted its power tubes actively in *QST* in 1938 through early 1940, but then the program faltered. Scanning the tube-transmitters books [2] yields only four: the Electro-Mechanical VX-101-JR exciter (1946-47), with an HY-60; the Stancor Model 69 transmitter (1941-42), with an HY-69; the Stancor 112-T 2-½ meter transceiver (1941), with an HY-75; and the World Radio Labs 70 transmitter (1938) with a pair of 6L6GXs. There was, however, some success with the postwar 5514.



HY-40Z triode of 1938

Besides the usual receiving tubes (in all formats except "MG"), Hytron marketed a wide line of resistance tubes. In WW II it