

ELEMENTS OF REFERENCE FOR IDENTIFYING AND DATING WESTERN ELECTRIC ELECTRON TUBES

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In this essay a series of elements of reference has been compiled and organized to assist the reader in identifying and assessing the manufacturing date of most Western Electric electron tubes. While essentially based on information available for general-purpose (receiving) tubes, these notes can also be extrapolated and used with transmitting tubes or other electron-tube types manufactured by the Western Electric Company [1]. The paper will successively review the chronology of the different tube types (codes) manufactured, the changes in external tube construction (bulb and base) which took place over time, and finally the evolution of factory markings (code numbers, patent markings, and manufacturing date codes).

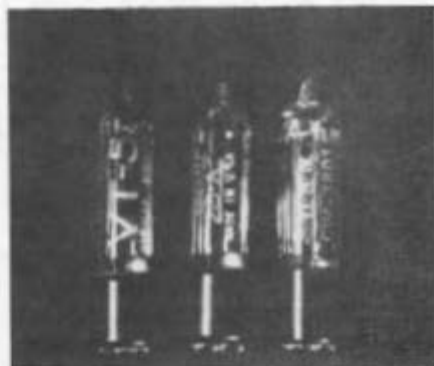
I. TUBE TYPE I.1. WEC_o TYPES

During a period of sixty years (from 1914-15 to the mid-1970s), Bell Telephone Laboratories and the Western Electric Co. issued specifications for more than 500 different electron-tube codes in order to cover an ever-expanding range of applications. Emphasizing this change in scope, tube terminology itself evolved over that period of time: the oldest documents referred first to "telephone repeater elements," then to "repeater bulbs," and finally to "vacuum tubes" (beginning in 1917 for commercial tubes). The latter name was changed to "electron tubes" in 1955. All the following tube types fall under the definition of "electron tubes": general-purpose ("receiving"), transmitting, cathode-ray, magnetron, klystron (reflex oscillator), cold-cathode, spark-gap (radar T-R and lightning protector), Picturephone, photoelectric, traveling-wave and "special" tubes [2].

Alphabetic at the very beginning, then numeric, the individual tube codes were assigned sequentially in the majority of cases, irrespective of tube type. Sometimes codes were reserved for prototypes but never put into production, accounting for several gaps existing in the WEC_o tube coding sequence. There were five three-digit numeric series specifically used by Western Electric: 100, 200, 300, 400 and 700 [3]. The 100-series was reserved for telephone repeaters (101s, 102s, 104s). The 700-series was for military applications, mainly radar, early in WW II; few of those codes outlived the war [4]. Consequently, the general-purpose tube codes were assigned in the 200-, 300- and 400-series. As a first approximation, the code number itself will help define the first design and manufacturing dates of a given tube. Sometimes it will be helpful in dating



The Navy CW-931 of WW I, equivalent to the Army VT-2.



The same tube three ways: an Army VT-5, a civilian 215-A, and a Navy CW-38015.



A 203-D triode, with patent dates on the bulb.



The 231-D triode, in "T" bulb; early tipped version.



The 239-A, in "T" bulb but without tip (1928-29).



A 216A with paper-strip license marking.



The 245A tetrode, first WE tube with a UY five-pin base.

tubes, other times not really, as in the case of "long runners" which were manufactured over decades. Table A indicates a few relevant code dates which may be used as guidelines.

TABLE A
BENCHMARK CODE DATES FOR WEC_o TUBES

YEAR	CODE	DATE	DATE MFG.	NOTES
		CODE RESERVED	INFO. ISSUED	
1915	101A	Oct. 1915	Jan. 1916	Triode, First 3-Digit Code
1920	211A	Apr. 1920	Nov. 1921	Transmitting Triode
1925	225A	N/A	May 1925	Transmitting Triode
1930	251A	July 1929	Mar. 1930	Transmitting Triode
1935	305A	May 1934	July 1935	Transmitting Tetrode
1940	359A	Oct. 1939	Jan. 1940	Cold-Cathode Tube
1945	396A	Nov. 1945	June 1948	Twin Triode, Min. 9-Pin
1950	431A	Jan. 1950	May 1950	Reflex Oscillator
1955	444A	Oct. 1955	Apr. 1958	Traveling-Wave Tube
1960	448B	Oct. 1959	Mar. 1960	Tetrode
1965	462A	June 1964	N/A	Traveling-Wave Tube
1976	473A	N/A	Ca. 1976	TWT, Last Code Issued

WEC_o also manufactured quite a few tubes with a code of the form D-xxxxx or D-xxxxxx. Those were typically assigned by Bell Labs and generally were prototype production indicating the interim improvement or the modification of an existing tube or the introduction of a new model pending wider use. Almost by definition, they were not produced in large quantity. Practically all of them were designed before 1940; they covered a wide range of applications: ionization gauge (D-79510), transmitting triode (D-80039), telephone repeater (D-86326), UHF triode (D-156548), etc. [5]. Bell Labs did not limit this coding scheme to electron tubes, but applied it to other equipment as well. For instance, D-70837 was a condenser microphone [6].

12. COMMERCIAL TYPES

In addition, other code schemes have been used by WEC_o, generally in connection with tubes manufactured for "commercial" (non-AT&T) applications. The most important instance was the production of electron tubes for the U. S. armed forces (Army and Navy). Each corps had its own specifications and coding system until about the end of 1942 when the JAN (Joint Army-Navy) specifications and RMA/EIA (Radio Manufacturers Association, later the Electronic Industries Association) coding scheme for special-purpose tubes was issued. The latter had largely faded from use by about 1950 in favor of a simpler four-digit code. Table B cross-references Army and Navy codes manufactured by WEC_o with their WEC_o equivalents (if any).

TABLE B
ARMY AND NAVY CODES MADE BY WEC_o

<u>ARMY</u>	<u>NAVY</u>	<u>WEC_o</u>	<u>COMMENTS</u>
-	CW-186	201A	Globular Triode
VT-1	CW-933	203A	Tubular Triode
VT-2	CW-931	205B	Globular Triode
VT-3	-	-	Prototype Only
VT-4	CW-1818	211A	Transmitting Triode
VT-4B	CW-1818A	211D	Transmitting Triode
VT-5	CW-1344	215A	Small Triode
VT-6	CW-1819	212A	Transmitting Triode
VT-6A	CW-1819A	212D	Transmitting Triode
VT-14	CW-1162	-	Transmitting Triode
-	CW-1887	220B	Transmitting Triode
-	CW-2354	225A	Transmitting Triode
-	CW-38015	215A	Small Triode
-	CW-38112	212E	Transmitting Triode
-	CW-38120	220B	Transmitting Triode
VT-52	CW-38142	-	Triode, 45 Special
-	CW-38282	282B	Transmitting Tetrode
-	CW-38412	312A	Transmitting Pentode
VT-106	-	322A	Transmitting Pentode
VT-142	-	39DY1	Doorknob Triode
VT-143	-	331A	Transmitting Triode
VT-166	-	371A	Vacuum Rectifier
VT-191	-	316A	Transmitting Triode
VT-225	-	307A	Transmitting Pentode
VT-230	-	350A	Beam Tetrode
VT-240	-	710A	Transmitting Triode
VT-255	-	705A	Rectifier, WE 378A
VT-269	-	717A	Receiving Pentode
VT-279	-	D-161831	Thyratron

I.3. OVERSEAS TYPES

Quite a few tube codes manufactured by WEC_o, used for the most part in telephone systems, have also been made overseas by corporations which originally were founded by the Bell System (dating back as early as 1882). In Europe those subsidiaries were placed under a holding company named International Western Electric Company (IWEC), based in Antwerp, Belgium. In 1925, due to pressures from the U. S. Justice Department to divest, AT&T sold IWEC to International Telephone and Telegraph, at that time a startup company (much of what ITT became later can be traced back to the purchase of IWEC). IWEC was then renamed International Standard Electric Company (ISEC). The sale agreement provided for an interchange of technological information and patents and for ISEC to act as selling agent of WEC_o telephone equipment abroad. Under this provision WEC_o tube designs were subsequently manufactured over-

seas. Two of the largest of those one-time overseas subsidiaries were Standard Telephones and Cables Limited (STC) in Great Britain (today still a part of ITT) and Nippon Electric Company (NEC) in Japan. Table C cross-references WECOs designs with STC and NEC code numbers [7, 8].

II. TUBE CONSTRUCTION

II.1. TUBE ENVELOPE

Since vacuum-tube manufacturing was originally based on the technology developed for electric lamp production, standard dimensions and specifications for existing glass bulbs were carried over to the new field. The basic shapes available in the early days were globular or "G" (familiarily known as "tennis ball" shape), tubular or "T," and straight-sided tapered or "S" (also known as "pear" shape). Associated with those letters were two digits indicating the maximum bulb diameter in eighths of an inch. For instance, G-19 meant a globe-shaped bulb approximately 2-3/8" in diameter.

The glass bulb associated with all WE telephone repeater tubes from 1914 to 1939 was globular (type G-19). The corresponding codes were in the 100-series. In the 200-series the main "G" types were the 205B/205D (1917-42) and the 216A-217A (1922-44). All the globular shapes were exhausted via a tubulation at the top of the bulb.

The tubular shape was first used by WECOs for military and transmitting tubes, like VT-1 (1917), VT-4 and VT-5 (1919-20). By 1925-26, it was also used for receiving tubes (230D, which is identical to the UV-199; 231D, identical to the UX-199). Originally exhausting tubes via a tubulation located at the top of the bulb, WECOs switched to a bottom location for the exhaust, probably in 1929.

WECOs did not use the straight-sided tapered shape, which was the industry standard during most of the 1920s (with the S-14 bulb used by the ubiquitous UX-201 and UX-201A) until 1929. The instance was the introduction of its first indirectly heated tubes, the 244A triode and 245A tetrode.

In 1931 a new industry standard was introduced with the "ST" shape, a combination of the "S" and "T" forms which WECOs also called "dome" shape. It was characterized by an upper section having a smaller diameter than the main section of the bulb. This configuration made a much more rigid positioning of the tube electrodes possible, by giving a second securing point: an upper mica spacer anchored against the glass bulb. It quickly replaced the earlier styles. Among the first WECOs tubes to use it was the 274A, a rectifier developed in 1931. The telephone repeater tubes themselves (100-series) were finally converted to the "ST" shape by 1939.

The drive toward VHF-UHF applications brought tube design back to more compact glass bulbs in conjunction with the down-sizing of the internal elements. First there was the so-called "doorknob" shape in 1935-36 with the 316A, which reduced to a "mushroom" size a couple of years later with the 380A and 381A. Then came the tubular shape of the miniature tubes of the 1940s and 1950s, which ultimately supplanted the "ST" shape in almost every low-power application. Interestingly enough, the exhaust tip of the miniature tubes was again located at the top of the bulb.

The last evolution in bulb shape was a short tubular bulb (T-9) with a stiff-lead

TABLE C
WEC_o DESIGNS MANUFACTURED IN GREAT BRITAIN AND JAPAN

<u>WEC_o</u>	<u>STC (1)</u>	<u>STC (2)</u>	<u>NEC (1)</u>	<u>NEC (2)</u>
101D/F/G	4101D/F/G	3A/141A	101D/F/G	TB-600A
102D/F/G	4102D/F/G	3A/142A	102D/F/G	TB-601A
104D/F/G	4104D/F/G	3A/144A	104D/F/G	TB-602A
205D	4205D	3B/151A		
211D/E	4211D/E			
215A	4215A			
228A	4228A			
242A/C	4242C	3B/850A		UV-211A
251A	4251A			TC-517A
260A				UX-860
271A				TB-627A
274A/B	4274A/B			
279A	4279A			TC-522A
282B	4282B			
284D	4284D			
300A/B	4300A/B			
304B	4304B			
305D	4305D			
307A	4307A			
310A	4310A	5A/150A	310A	
311A	4311A		311A	
313C				KB-758B
316A	4316A			
319A				4H72
328A	4328A			
329A	4329A			
336A	4336A			
345A	4345A			
349A	4349A			
350A	4350A	5B/250A		UY-807
351A	4351A			
356A				5T33
369A				5H69A
371B				2K71
378A	4378A			
393A				4G93
408A				6028
409A				6R-R8
417A				6R-H2
418A				6B-P16
435A				6R-R21
448A				6B-R22
705A				1K75
715C		P552/10E		
723A/B				2K25
725A			725A	
726B/C			726B/C	
730A			730A	

(1) Direct WEC_o design.

(2) Listed by the manufacturer as equivalent, not necessarily a WEC_o design.

stem, like a chubby miniature tube (the same basic shape as the "Compactron" design of the General Electric Co.). WECO first used it with the 418A power tetrode (1948), but the bulb probably will remain best associated with the 435A, 436A, and 437A tubes which arguably represented the ultimate in design of conventional electron tubes.

II.2. TUBE BASE

By 1914 the electron tubes produced by WECO were fitted with a machined brass base having four studs mounted on an insulated insert at the bottom and having on the side a bayonet locking pin which was equidistant from the grid and the plate studs. This was eventually adopted by the tube industry as a standard: the so-called "UV" base.

In late 1917 the machined brass base was replaced with a formed casing of sheet nickel. The contact studs were mounted on an insulated cruciform member and the bottom filled with wax (telephone repeaters) or covered by a phenolic insert (VT-2). The VT-2 also introduced an alternative location for the bayonet locking pin, the pin being now in line with the grid stud, in order to prevent accidental insertion of a receiving tube into a transmitting socket.

In late 1925 the metal base was replaced with a phenolic base which eliminated the problems associated with filling the bottom of the metal base with wax: poor mechanical and heat resistance. At the same time, the contact studs were changed according to what became the new "UX" standard: they were made longer in order to permit contact to be made to the sides of the studs (not only to the tip) and the filament studs were made thicker than the other two in order to assure correct insertion of the tube into a socket. The "wafer" sockets then coming into use no longer had a slotted collar by which the bayonet locking pin could "key in" and position the studs properly [10].

As the need for more pins arose with multi-grid tubes, additional pins were set into the molded base according to tube industry standards at the time: five ("UY") with the 244A and 245A in 1929, six ("UZ") with the 286A RF pentode in 1932. In 1935 the industry got a new eight-pin base, a totally original design by the General Electric Co. intended for the new all-metal tube. The octal base quickly became the standard of choice because of its convenience in the field (ease of insertion of a tube in its socket, thanks to the central spigot providing positive positioning). Apparently WECO first used it in 1938 with the 347A, an AF-RF triode.

Miniature tubes brought an altogether different standard, with no base or pins as such, the stiff lead-in wires serving directly as pins. They fell roughly into the following two categories: WW II period (seven pins, starting with the 6AJ5 and 6AK5 sharp cutoff RF pentodes) and post-WW II era (nine pins, starting with the 396A/2C51 dual triode in 1945).

III. TUBE MARKINGS

III.1. CODE MARKINGS

The very early telephone repeater tubes had their code markings steel-stamped on the brass base. When the latter was changed to sheet-metal (1917), for a while the code markings were only stamped in raised letters in the wax filling at



The 274A rectifier, probably the first WECO tube with an ST bulb.



The 286A pentode, first WECO tube with UZ 6-pin base. Mid-30s Hawthorne sample.



"Doorknob" UHF tubes: 388A, 316A, and 703A. All are marked in red ink.



D-91143, with "S" bulb and hot-branded markings dating from 1929 to the early Thirties.



D-91143, later version with "ST" shape and stamped identification.

the bottom of the base, but by 1918 they were again steel-stamped on the base shell.

Until 1923, all repeater tubes were marked "Property of the American Tel. & Tel. Company" since they were leased to the operating companies with the corresponding repeater equipment. At that time a change of corporate policy took place at AT&T and the tubes began to be sold to the operating companies with the marking: "Western Electric - Made in U. S. A."

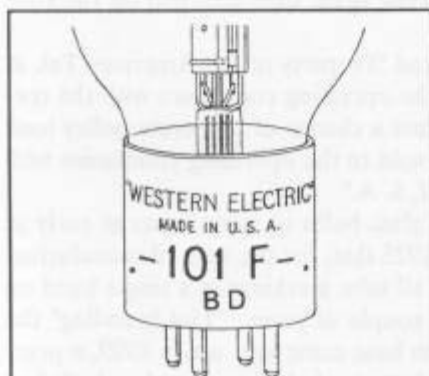
Code markings had been etched on the glass bulbs of some tubes as early as 1920-21 (VT-5/215A) but it was not until 1925 that, for the sake of manufacturing economy, WECO systematically etched all tube markings in a single band on the glass bulbs. The practice lasted for a couple of years. "Hot branding" the code markings into the molded composition base came into use in 1929, a practice followed until the mid-1940s. Enamel lettering baked on the glass bulb had been used by WECO for some transmitting tube markings in the early 1920s but really became widespread with the advent of miniature tubes at the end of WW II. Black (sometimes white) enamel was originally used with transmitting tubes but certainly the most common enamel color was bright yellow, used with all miniature tubes. (Red markings have been used with VHF-UHF power tubes, for instance the 316A and 388A, and the 705A.) Baked enamel was a feature unique to WECO, excellent in terms of legibility and durability.

During the second quarter of 1947, WECO adopted a system of tube markings consistent with the recommendations of JETEC (the Joint Electron Tube Engineering Council). Three types of marking were then in use: base, bulb side, and bulb top. The type was dictated by the manufacturing methods employed, the size of the bulb and base, the quantity manufactured, etc. Base markings and bulb-top markings were hot-branded and rubber-stamped respectively, while the side markings were usually enameled. Until that time, the code markings on Western Electric tubes had been inscribed using a Gothic letter style, which is a fine, straight typeface. The Western Electric logo, designed with the bold, distinctive "Electric Flash" typeface proprietary to WECO, was used infrequently and only on bulb side markings. From 1947 on, the logo was systematically used to print the Western Electric name on the base or the bulb side. All markings on the bulb top, the code numbers themselves and other factory codes continued to be set in Gothic typeface. The base and bulb side markings were done with yellow ink or yellow enamel, the bulb top markings with silver ink.

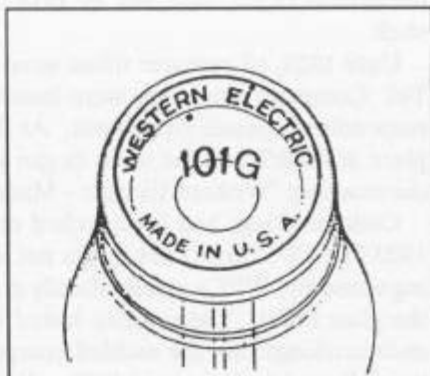
III.2. PATENT MARKINGS

The issuance dates of the patents under which a tube was manufactured were originally steel-stamped on the metal base or, starting in 1925, etched on the glass bulb. In 1928, to conform to a change in patent law, this information was modified from date of issuance to patent number. Especially in the early years, the patent information was often updated. This fact may be used as an additional clue for determining the earliest possible production date.

With the advent of hot-branding the code markings on the composition tube base (1929), the patent markings were removed from the base and printed on a paper strip which was used to seal the tube packing box. Later, those patent numbers, when indicated at all, were simply printed on one of the box flaps (as most manufacturers did).



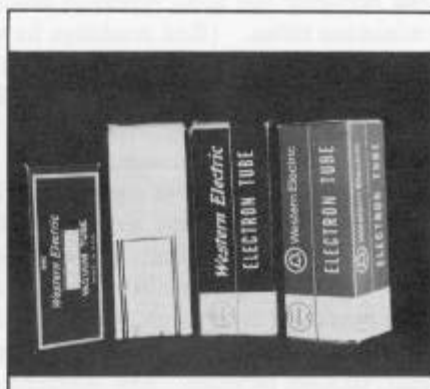
Typical base marking for date:
"BD" implies April 1937.



Typical top marking for date:
"RL" designates September 1943.



Molded marking on the base of a
203A/VT-1.



WECo tube boxes from the
Twenties through the Sixties.



A telephone repeater tube, mili-
tary version.



Two items of a style predating the
GE Compactron.

III.3. MANUFACTURING CODES

All the early telephone repeater tubes had a serial number etched on the bulb for maintenance records. To distinguish between the vacuum tubes made at the tube shop in Manhattan (first located at 463 West Street, then moved to 350 Hudson Street in 1924) and those made at the Hawthorne plant in the suburbs of Chicago (which began tube manufacturing in late 1919), the letter "H" (later "A") was added to the beginning of the serial numbers of the tubes made at Hawthorne. It is not known precisely when, before the institution of a manufacturing date code in 1936, the serializing of telephone repeaters was discontinued [11].

Originally, a clear distinction was made between vacuum tubes used for telephone repeaters and those used for other purposes ("commercial" or "non-associate" uses). Even with identical electrical characteristics, the latter tubes had a different code number:

<u>TELEPHONE</u>	<u>COMMERCIAL</u>
101B	208A
102A	209A
104A	210A
104D	223A

Then, from late 1922 until mid-1923 when the distinction between telephone and commercial uses was abandoned, commercial tubes used the same code numbers as their telephone counterparts, but with the letter "W" appended, e. g., 101DW, 102DW, 104DW. The "W" append was used for other "non-associate" equipment as well. For instance, the 387 telephone transmitter (microphone) was sold to the outside market as the 387W [12].

Beginning about July 1936, a manufacturing date code was added to the markings on the base of some telephone repeater tubes of the "G" type, namely 101F, 102F, 102D, D-86326, and D-86327 [13]. It was an alphabetical code of two capital letters. The system was as shown in Table D.

TABLE D
SIGNIFICANCE OF DATE LETTERS - FIRST SYSTEM

<u>LETTER</u>	<u>FIRST POSITION</u>	<u>SECOND POSITION</u>
A	Year 1936	January
B	Year 1937	February
C	Year 1938	March
D		April
E		May
H		June
K		July
L		August
M		September
N		October
P		November
S		December

Thus a code "AP" indicated a tube manufactured in November 1936. With the advent of the "ST" type tubes, the code and other markings were sometimes placed on the top end of the bulb. A system of two indices (a radial line or a dot on top of a letter and a dot below another letter) applied to the letters of the name "WESTERN ELECTRIC" was then devised to mark the two letters needed for indicating the manufacturing date code, as shown in Table E.

TABLE E
SIGNIFICANCE OF DATE LETTERS - SECOND SYSTEM

<u>LETTER</u>	<u>INDEX BELOW LETTER: YEAR</u>	<u>INDEX ABOVE LETTER: MONTH</u>
W	1938	January
E	1939	February
S	1940	March
T	1941	April
E	1942	May
R	1943	June
N	1944	July
E	1945	August
L	1946	September
E	1947	October
C	1948	November
T	1949	December

In the second quarter of 1947 the manufacturing date code was changed from alphabetical to numerical. It used a three-digit system. The first digit indicated the year of manufacture according to the following scheme: 6 through 0 indicated 1946 through 1950 respectively, while 1 through 5 indicated 1951 through 1955. The next digits gave the quarter of manufacture, expressed in number of weeks in the calendar year, as follows:

- 13: weeks 1-13, or January to March inclusive;
- 26: weeks 14-26, or April to June inclusive;
- 39: weeks 27-39, or July to September inclusive;
- 52: weeks 40-52, or October to December inclusive.

Thus the number 652 on a tube indicates that it was made in the period from October to December 1946.

In the first quarter of 1956 the manufacturing date code was modified slightly to use a four-digit system wherein the first two digits indicated the year of manufacture, 56 meaning 1956, etc. The next two digits indicated the quarter of manufacture as seen previously. Accordingly, the number 6526 marked on a tube indicated that it was manufactured in the period from April to June 1956. This latter coding system was used until the discontinuation of electron-tube manufacturing at AT&T. After WW II tube manufacture took place in Allentown, Pennsylvania, and Kansas City, Missouri (beginning in 1958 for the latter). To

distinguish the several codes produced simultaneously at both plants, the corresponding output of the KC Works was marked with a small diamond sign. Electron-tube manufacturing ceased at Allentown in 1972 and finally at Kansas City in 1988.

NOTES

1. Unfortunately, they cannot be considered definitive since a few issues have eluded the author and remain unsolved for the moment. Any input from readers having additional information on the subject is most welcome.

2. The major project of producing a complete listing of all electron tubes known to have been manufactured by WECO is being undertaken by B. D. Magers, Senior Production Engineer at the AT&T Kansas City tube plant, now retired. It is anticipated that this work will be published by AWA. It should become a major reference tool for the WE tube enthusiast.

3. Of course, an exception comes to mind: WECO manufactured an ionization gauge tube with the code number 507! RCA made an equivalent tube, the 1949.

4. An article on the 700-series is planned for a forthcoming AWA publication.

5. More information on the D-spec tubes will be given in the October 1990 OTB.

6. This microphone is pictured in Fig. 41 of Bob Paquette's very informative paper "Early Microphone History" in the AWA Review, Vol. 4.

7. The author will attempt to compile and publish a more complete listing of tubes designed by WECO and manufactured overseas, as more information becomes available.

8. Finally, not all tubes bearing typical WECO markings were manufactured by WECO; likewise those labeled "Made for Western Electric." A typical instance would be a WECO tube design shared with another manufacturer for enhancing production capacity via second-sourcing. Wartime designs like the 717A or the 723A/B come readily to mind. Another case would be WECO writing specifications for tubes produced for it by other manufacturers. This was probably the case with the VT-52, a medium-power triode also known as the "45 Special," which, while not listed in any WECO tube literature, showed up quite frequently on the surplus market.

9. WECO rarely used octal all-metal tube envelopes, the only examples being the 723A/B klystrons and their successors.

10. From here on the author will follow the accepted practice of calling the studs "pins."

11. The large (and expensive . . .) transmitting tubes continued to be serialized.

12. This double-button carbon microphone is pictured as Fig. 38 of Bob Paquette's paper (*op. cit.*).

13. Consequently, it appears that, until the 1940s, no manufacturing-date coding system was systematically applied to all electron tubes produced by WECO. This is in sharp contrast with RCA, which printed manufacturing code dates as early as 1929. See Bro. Patrick Dowd's monograph "Dating RCA (Cunningham) Composition Base Tubes."

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BIBLIOGRAPHICAL REFERENCES

AT&T Co., Electron Tube Data Sheets, miscellaneous years.

Bell System Technical Journal, various issues, 1923-75.

Bell Laboratories Record, miscellaneous issues, 1925-75.

Pilkenton, W. H., 100 Years of Excellence: A Chronology of Important Events in the History of the Western Electric Company, Inc., 1869-1969 (New York: Western Electric Co., 1969).

Stokes, J. W., 70 Years of Radio Tubes and Valves (Vestal, NY: The Vestal Press Ltd., 1982).

Tyne, G. F. J., Saga of the Vacuum Tube (Indianapolis: Howard W. Sams Co., Inc., 1977).

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A lifelong enthusiast for high-quality sound reproduction, Attila R. Balaton acquired an early appreciation for vacuum tubes by scratch-building audio amplifiers. Since his academic background (U. of Paris, UCLA) and work experience are in a different field of endeavor, he considers himself a dedicated amateur. An interest in researching, documenting, and preserving the early era of electrical sound reproduction (1920-1950) brought him into contact with several members of AWA who encouraged him to join. His particular area of interest is the research done at Bell Laboratories on high-quality sound reproduction and the resulting products manufactured by WE during those 30 years. He welcomes correspondence from any AWA member who can help him locate or document tubes or other artifacts for future publications on the subject.

