Vacuum Tube Testing

Topics on Vacuum Tubes, Hickok Testers and Researching the Past

> MAARC RadioActivity June 25-27, 2015

Presentation Organization

- A quest for methods of evaluating vacuum tubes
- Hickok's "genius circuit" its effect to the present
- Date coding does it matter?

> Sylvania/GE inquiry

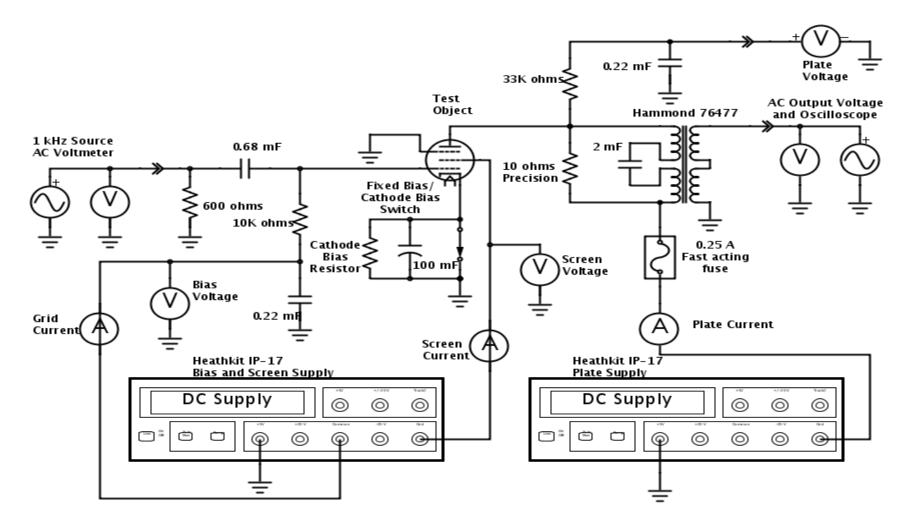
>A chart relating different manufacturers codes

Research on tube information
 RCA information releases

The Quest

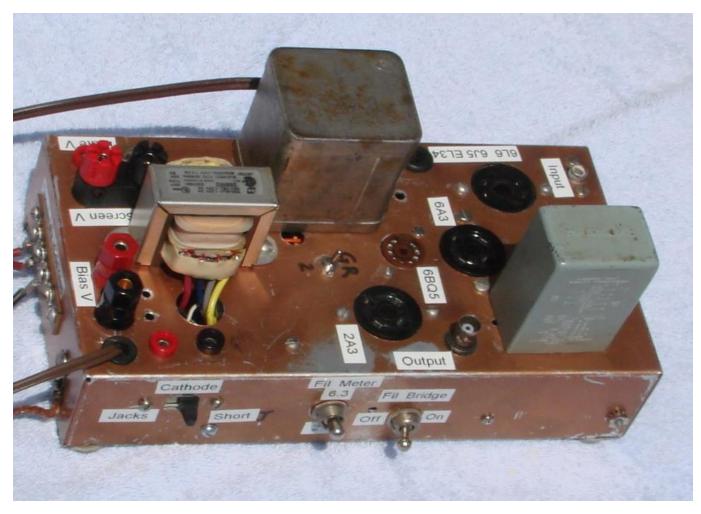
- Chaos about tube test results
- Research the literature and "prior art"
 >Engineering teaching texts
 - Industry practices, IRE 1950, General Radio, other elaborate testers
- Build a "no excuses" tester to verify performance as the manufacturer did
- Use that information as a basis for evaluation of other test methods

Schematic of Lab Tester



Jagundo Tester RadioActivity 2014

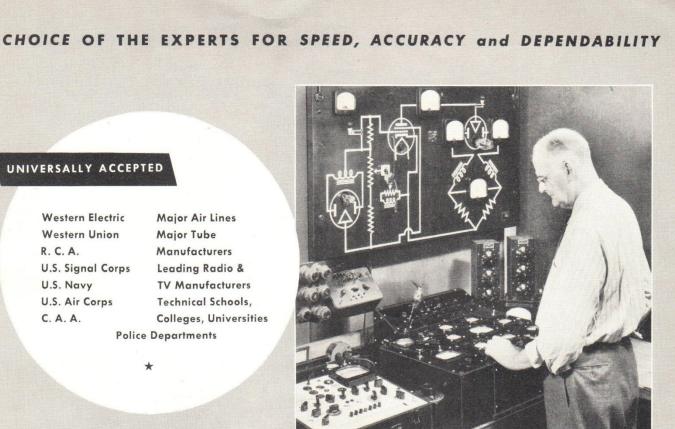




Tube Tester Chassis

Filament Transformers and Multiple Socket Detail not Shown on Schematic

The Hickok "Genius Circuit" and Legacy



Simplified TV-7 Gm Test Circuit From military manual, pg. 16

U.S Department of the Army, Technical Manual TM 11-6625-274-35 dated 30 June 1960 to Change 5, 30 March 1976.

For brief review and discussion.

Note provision for adjusting both sides of the bridge for calibration.

Filament arrangement not shown, but significant.

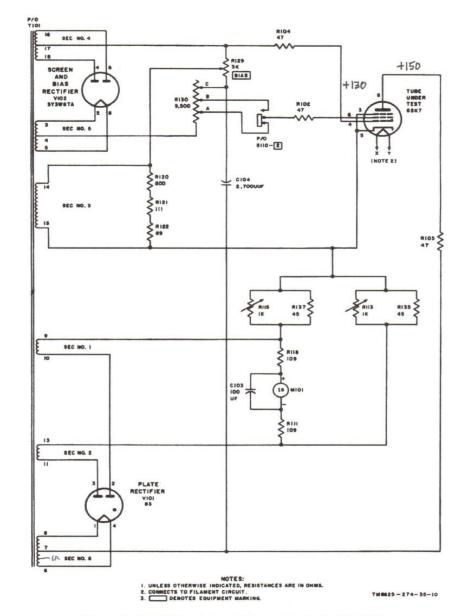


Figure 11. Simplified mutual conductance test circuit, TV-7D/U.

Perspectives on Calibration and the issue of Calibration Tubes

- Hickok has left many clues as to calibration techniques. They used calibration tubes.
 - >Adjustments provided in TV-7 series
 - Calibration instructions for 6000 and others using shunt pot for transconductance calibration
 - Schematic notations in other testers
- Use of AC surrogate technique does not require calibration tube, but is very coarse
 - Contrary conclusion: Calibration tubes are required

The Ubiquitous Calibration Tube The Metal 6L6

- ✓ A huge number were made – lots to choose from
- ✓ Durable
- ✓ Inexpensive
- ✓ Glass tubes are fine
- ✓ Many sources offer to sell you a calibration 6L6



Calibration Tube Dilemma

- Each type of tester is set up differently
- Hickok apparently closely guarded their standard test tubes

> Web information, Daniel Schoo

- Even if you could find one of the originals today, you couldn't trust it
- New calibration tubes must be created
- Many assumptions are required, increasing complexity and controversy
- A 6L6 is not all you need

Selection of a Calibration Tube

- Hickok testers use the same frequency signal and filament voltage
- 6L6s can exhibit different tendencies in leaking filament into the signal
 - Mike Higgins on Bogey Tubes Radio Age, January 2015 pgs. 13-14
 - > Daniel Schoo, others
- To separate the ones that do from those that don't, you need to switch the filament connections

Filament Connections on the TV-7 H-S Format 539B, C, 6000 series

F-R format applies to TV-3, TV-10, 539A, 600, 800, Western Electric To be sure, look up 6L6 on the roll chart of your tester.

Left Switch	Pin	Right Switch	Pin
Α	open	Р	open
В	1	R	1
С	2	S	2
D	3	т	3
E	4	U	4
F	5	V	5
G	6	W	6
Н	7	Х	7
J	8	Y	8
К	9	Z	open

Implications of Hickok Design

- The filament leakage issue for all tubes
 Do you have to check each tube twice and average?
 Affects all tubes being tested
- The tube being tested drives the meter directly
 Many tubes don't have the power to drive the meter without overdriving the tube
- Unique circuit and test conditions make it impossible to relate gm readings to actual transconductance

The Quest for the Ideal Tube Tester



Issues in Regard to Dating Tubes

• Enormous amount of information is available on tube dating.

Ludwell Sibley, Bro. Patrick Dowd – RCA Archives
 Lots published, Tube Lore, The Tube Collector
 Many varying locations, not easily accessible

- Gaps still exist in our knowledge
 - Currently addressing the gap in codes of non-RCA tubes from about 1935 to after WWII
 - Sylvania project because I was "seeing things"

Sylvania Coding System

- Sylvania had been using a manufacturing date code for many years
- Started in 1943 as two digits under the tube ID
- 1945-46 it was expanded to three
- A great help was that Sylvania made lots of tubes for resale by others
- This code continued far into the days of open coding adopted in 1946 (until about 1957)

1943 6F6G 1946 6U7G

6F6G L 3 CHS tube 12/1943

6U7G A6M Sylvania dated 9/1946



1952 Sylvania 2A3 Branded NU

NU branded 2A3 A2M January 1952 Early double plate NU branded 2A3 A2M Base with 1953 13th week warranty date



RCA Branded 7A8

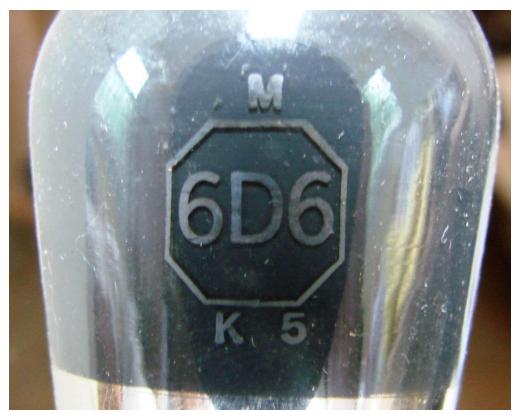
RCA 7A8 1951 9th week Dot = purchased type RCA 7A8 Sylvania L0B December 1950





Rare 6D6

A late 1945 Sylvania tube branded Silvertone. Sylvania had started adding the location, but soon went to "3 under".



Sylvania Inquiry

- Other than RCA, major gaps exist regarding date coding in this time period
- Looking at many manufacturers and resellers is extremely valuable
- Best examples are GE (before Ken-Rad acquisition), Philco, Raytheon, Zenith
- M-R program is a valuable tool
- A chart is needed for easy access to a broad look at tube coding practices in the industry

Researching the RCA Archives

- The following information is taken from the TCA Data Cache provided to TCA members in July 2011.
- They amount to about 7000 pages, from 37 product management binders from the RCA Archives, obtained by Bro. Patrick Dowd and donated to the Antique Wireless Association.

45-1

□ 1950 release

- reason unknown

Gives release date as 3/1/29

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45 changed to purchased type

Source: Sylvania

March 1955

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45-3

Type can nolonger bepurchased

June 25, 1957

End of an era

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□ Introduction date in 1947

 "Identical to the 12AU7 except for the grid"

□ (plate is not carbonized)

A May 1947

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: :	Temporary Tools .	Temporary	acilities are	aveilable fo	r testing.	
Ċ	femporary Equipment					
	Permaneat Too's	See ettach	d equipment a	urvey.		
9		and the second se				
ALULA	Cormanent Equipment	\$3375		4 months	W.L.	4/22/4
BACTULL	Vermanent Equipment	\$3375		4 months	W.L.	1/12/4
C C		\$3375	· · ·	1	W.L.	4/33/4
	?.lot Production	\$3375 5	· · ·	7/3/47	N.L.	<u>4/11/4</u>
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C C	Not Production, Dandy for Regular Prod. Tratative Cose of Tube Demarke Factory will or by September 15, 1947	5 roduce 500 tube 7. The A1522 *	ill share 12AU	7/1/47 10/1/47 1, and ship 7 facilities.	them to the	rarehouse
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12AX7A
 Superseded
 12AX7 in 1960

□ Cincinnati manufacture

PRODUCT	and the second se	COMMERCIAL TYPE	NO. 12AX7	
COLOR, Commercial: INITIAL(white); CODE: Developmental Type: (yellow)	CHANGE(blue); WITHDRAWN(plak)	DEVELOPMENTAL T	YPE NO. ALLOZE	
PRODUCT CLASSIFICATION DESCRIPTION High mu twin triode in S	RECEIVING ENTERTAINME			DATA SL10
SALES LIMITATIONS				FILE
MILITARY BRANDING		QUALIFICATION APPROVAL STATUS		
Supercedes 12AX7.	URCE: MFG. LOCATION Cin	FT FROM HAR	PACK	AGING DATA
Harrison	PURCHASED	California Para	APPROX. SHIPPING WEIG	нт
APPROVED PROGRAM CHART DA	EQUIPMEN TE 6/9/60	T DISTRIBUTOR	BULK	
PROPOSED ANNOUNCEMENT DAT	E 7/8/60	8/15/60	EN	CLOSURES
TYPE APPROVAL SAMPLES			INSERT	PK. LIS
INITIAL WHSE. NAT'L TOTAL (UNITS) 2,000 7/8/60		BULLETIN:	
RELEASE SHIPMENT DATE	7/8/60		REPO	RTING CODE
ESTIMATED SALES DEMAND	Will sur	ercede 12AX7	EIA ER	NEMA
EXCISE	ANTY CODE - Std. Rec		EPRA 7130	
SPECIAL ACTION				

 Interim construction at Harrison only

Mid 1960

 Appears that Harrison was making short cage tubes

Apparently marking issues for conversion to the A

Don't tell anybody!

	Encontainment Breatmen	Tubor	DEV. NO		40267C	
	PRODUCT LINE Entertainment-Receiving	Tubes			12AX7A	59
	NAME OR DESCRIPTION 9 pin miniatur triode	e, cwin			3-25-60	RECOR
	GIIOGE				3-30-60	REDON
	COMPETITIVE PRODUCTS		LEALLA	TROVED		AITH
	7025				-	DATA
	12AX7					31.20
	6EU7					
		COST			BY	DATE
	LIFE TEST			WITLETC		Unit
	GUIDANCE FACTORY COST (PER)	\$				
0	STDZG. NOTICES-MFG. DWG	SWILL ISSUE	3	29-60	R. Stiles	3-25-6
INGINEERING	DESIGN & DEV. } TEST SPECS. WILL ISSUE		Com	pleted	J. Dean	3-25-6
	TECH. DATA FOR PUBL WILL	BE SUPPLIED			J. Dean	3-25-6
Z	TYPE APPROVAL					1
	PERMANENT TOOLS & EQUIPMENT PILOT PRODUCTION WILL START		required	·		
	TEMPORARY TOOLS & EQUIPMENT					
		\$ None	required			[
	PILOT PRODUCTION WILL START					
10	the second the strikt	21-60				1
Z				A CONTRACTOR OF A CONTRACTOR OFTA CONT	MFG. LOC.	Harrison
S.	REMARKS A "one shot" deal only.	No producti	on beyon	đ	<u> </u>	
5	7-15-60.					
1	Shipping schedule as fol	lows:	-210		000 +6 +1+	
						s total
Z	*4-4-60 - 2,000 tube	5	1.1.1.1			
MANU	by 4-29-60 - 28,000 adds	tional tubes	, wi	11 have	been branded	1 12AX7,
MANU	by 4-29-60 - 28,000 addit by 5-31-60 - 48,000	tional tubes	wi pr	ll have ior to e	been branded	1 12AX7, ver.
MANU	by 4-29-60 - 28,000 addi by 5-31-60 - 48,000 " by 6-30-60 - 21,000 "	tional tubes	wi pr	ll have ior to e	been branded	1 12AX7, ver.
MANU	by $4-29-60 = 28,000$ add by $5-31-60 = 48,000$ by $6-30-60 = 21,000$ by $7-15-60 = 1,000$	tional tubes	wi pr	ll have ior to e	been branded	1 12AX7, ver.
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12AX7WA Release

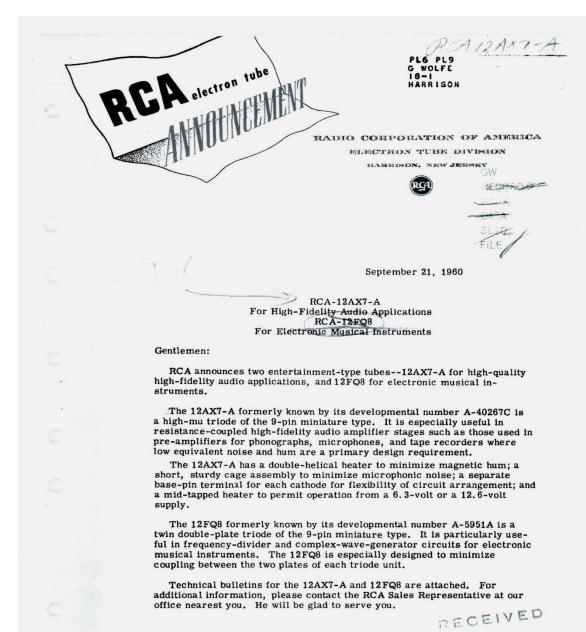
Early 1964

Ruggedized
 12AX7

Direct sale to government only

						NO				(1) COM	MERCIAL TY		124X 7WA	
ł						CHANGE (blue)			k)	(2) DEV	ELOPMENTAL		E NO.	
-		COLOR :			And and a second se	CHANGE(blue) (yellow)				(3) PRE	VIOUS ISSU			
1	(5)	PRODUC	T LINE	(NAME,	ABBREVIA	ATION, AND	CO	DE)		(4) CUR	RENT ISSUE	NO.		
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	(6)	DESCRI	FILON									-		
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ſ	(7)	SALES	LIMITATI	IONS									·+	
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		12AX7.												
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ł								NONE	1	L	BCDFI	50	the second se	0
	(15)	INITIA	ORIES	NAT	L TOTAL	S (UNITS)		26050	+		Indicate	Restri	iction Code a	bove
				BY	(DATE)		-	April '6	4		(20)	-	SE TAX	
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		2 10/62						W.	H.	CHALMERS		Ja	n. 29, 196	54

- Product announcement
- A has double helical heater to reduce hum
- Short cage assembly to reduce microphonics
- □ Has anybody ever seen a 12FQ8?



SEP 2 3 1960 G. WOLFE

 Internal WECo letter – testing 12AX7 on Cardmatics at -1V bias & 100V

Western: Tubes don't meet spec. by large amount

Manufacturers told them they had no complaints. Not going to fix it.

Iannicelli cc: To: C. Jones/Western Electric K. Lardie F. Ratino T. A. Hayden Trunk From: Subject: 12AX7 MEASUREMENTS ON KS CARDMATIC TUBE TESTERS The problems that have arisen are due to the fact that manufacturers are no longer holding their tubes to published specs. In the published specs two sets of conditions and resultant transconductance values are listed: .1. 250V Eb - 2V bias, 1600 µ mhos transconductance 100V Eb - 1V bias, 1250 µ mhos transconductance For various reasons we have selected Condition # 2 as a test condition to be used on the cardmatics. Now, it seems, most American manufacturers are only holding the transconductance at Condition #1; and as a matter of fact when measured under Condition #2 with lab standard equipment, tubes of recent manufacture (several different vendors) were found to have transconductance values of typically less than 50% of bogey. Since our cardmatic tube testers are set to reject tubes at 63% of bogoy, these recent tubes naturally will read "reject" on the cardmatic testers. Discussions with several vendors and the EIA Office in Washington have not resolved this difficulty. Essentially the manufacturers state that the published specs are only typical values and not guaranteed; and furthermore, the manufacturers plan to take no action since they have had no complaints from tube customers. Since our major difficulty with this tube have been with Western Electric customers, I forwarded the above information by telecon to: Mr. C. E. Jones Western Electric 50 Lawrence Springfield. - New Jersey (201) 467-7133

Wrap-up

- Hope you enjoyed the discussion
- More to come in the future if desired
- Thanks for your attention
- Next RadioAge article on tube behavior and testers
- For a copy of the slides with color <u>PKHartHAVE@aol.com</u>. Use "Timonium" in Subject line.