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technical SECTION

MEASUREMENT CIRCUITS FOR SYLVANIA TRANSISTORS

By Irving Shapiro, Engineer-in-Charge,
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Since an ever-increasing amount of transistorized equipment is being marketed, it is obvious that service centers must equip themselves with proper test equipment and also have available trained personnel.

The average service center does not have the economic resources at its disposal to secure all types of equipment. Therefore this article will present in semi-technical form a number of tests which can be performed on transistors, and also show the equipment needed for such tests.

These tests have been selected so that the technician will get enough information about each transistor to determine its usefulness in a given circuit. Each of these tests, along with many others, is performed on almost all of Sylvania's transistors.

Sylvania, as well as most other transistor manufacturers, conducts many AC small signal tests as well as the so called large signal or DC tests. Because these tests are sometimes complicated and involved, this article will be concerned only with a few of the more important ones. These tests are listed below:

1. Current Gain
2. Collector and/or Emitter Reverse Bias Characteristics.
3. Frequency Response
4. Input Resistance and Saturation Voltage
5. Application tests
6. Thermal Characteristic Rating

1. Current Gain

The current gain of a transistor is always expressed as a ratio of output current to input current. In the common emitter circuit configuration the current gain, sometimes called Beta or h_{FE}, is expressed as a ratio of collector current to base current. The circuit used for this measurement is shown in Figure I.

$$h_{FE} \text{ or Beta } = \frac{I_C}{I_B} = \text{ Current Gain}$$

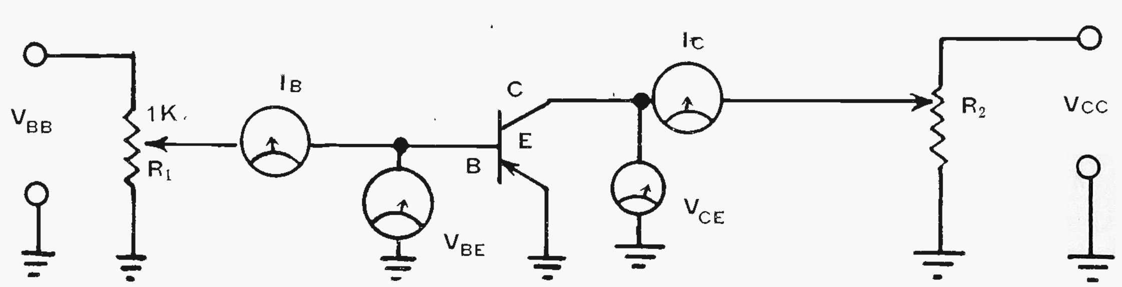
Beta is usually measured at a specified collector current and collector-emitter voltage. The measurement is made by adjusting R_1 until the specified I_C is obtained. The V_{CE} is maintained constant at the specified value by adjusting R_2. Beta can then easily be calculated.

A typical curve of common emitter current gain versus collector current is shown below. Values have been omitted since they will vary with transistor types. (Figure II)

Values of Beta will almost always

(*Continued on page 6*)

Figure I



For PNP transistors V_{BE} and V_{CE} are negative.
For NPN transistors V_{BE} and V_{CE} are positive.

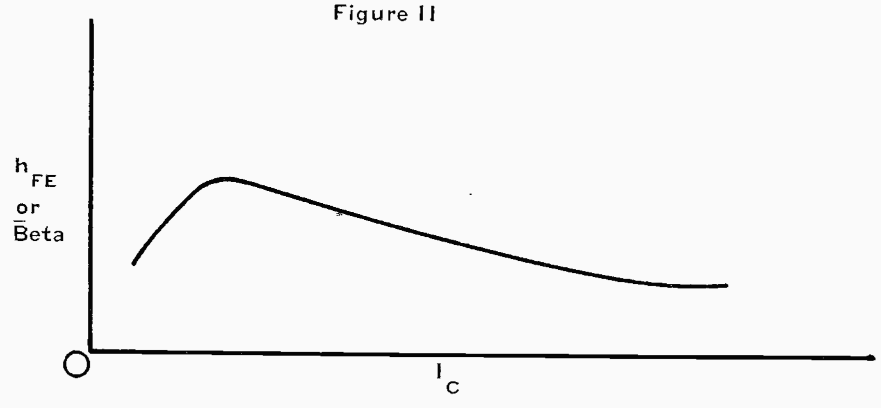
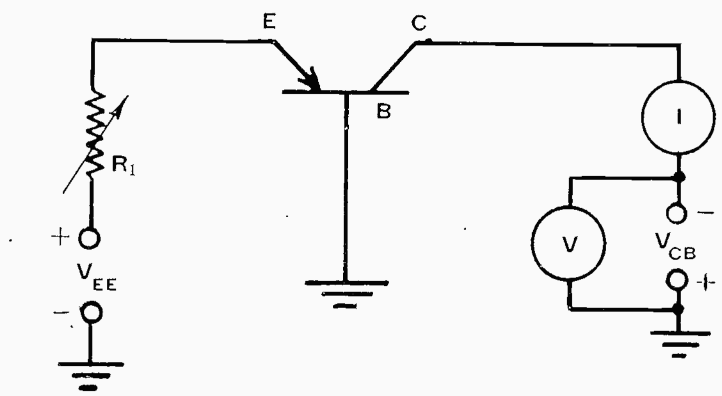


Figure II

Figure III



Circuit shown is for PNP devices.
Reverse polarities must be used for NPN devices.

(*Continued from page 5*)

be much greater than one. Depending on the device and the collector current range, Beta's of 50-200 are common. The values are generally specified on the data sheets.

The common base current gain (alpha, hFB) is also expressed as a ratio of output current to input current. The base lead is the common element during this measurement. The circuit used for this measurement is shown in Figure III.

Alpha will always be less than one (1) for the conventional type of alloy junction transistors.

The circuits described above are shown only for DC testing. Very often AC measurements are specified. Current gains are measured exactly the same way except small ac signal currents are used. A typical ac beta circuit is shown in Figure IV.

The transistor is biased to the specified DC conditions. A small AC signal is fed to the base and the amplified output signal is read across RL. The AC signals must be small compared to the DC bias in order to minimize distortion. Generally the ac signal is set at a value which is one per cent of the DC value. The ac current gain can easily be calculated.

$$h_{fe} \text{ or AC Beta } = \frac{I_c \text{ (AC)}}{I_b \text{ (AC)}}$$

2. Collector and/or Emitter Reverse Bias Characteristics

The reverse voltage bias characteristics are important device parameters. The maximum reverse voltage of a collector or emitter junction can be directly compared with maximum inverse voltage rating in a tube. Above this voltage the device may be permanently damaged.

A number of reverse bias tests are performed on transistors. These tests are sometimes called I_{CO} tests, cutoff current tests, collector leakage tests etc. They all relate to a test condition which imposes a reverse bias between two elements and then measures a current.

Two typical circuits are shown in Figure V.

Circuit A depicts a conventional I_{CO} test where the V_{CB} is adjusted and the I_C measured. I_{EO} can be measured if the collector and emitter leads are interchanged. In circuit B the collector current is again read at some collector voltage; however, in this circuit the emitter is the common element and the base is returned to the emitter or ground thru a resistor R_1. This circuit is intended to approximate a typical transistor circuit that might be encountered in the field. The resistance R_1 is generally low to approximate a low impedance drive source. This "idling current" is an intermediate value of collector current between the I_{CO} current and the current that would flow if the base was open circuited.

Figure VI displays a curve of collector voltage versus collector current for these reverse bias conditions.

3. Frequency Response

The terms Frequency Alpha Cutoff (grounded base configuration), f_{ab}, and Frequency Beta Cutoff (grounded emitter), f_{ae}, refer to the frequency at which the device output has dropped to 0.707 (3 db) of its low frequency output. The circuit used for the beta frequency cutoff measurement is shown in Figure IV. A low frequency output measurement is made and then the frequency is increased until the output drops 3 db. The input AC signal is kept at a constant amplitude throughout the measurement. The frequency alpha cutoff measurement is made the same way except that the grounded base circuit is used.

As a first order approximation the beta frequency cutoff can be expressed as the ratio $\frac{fab}{h_{FE}}$ of the device. This will only hold however, if all measurements are made at the same DC bias level.

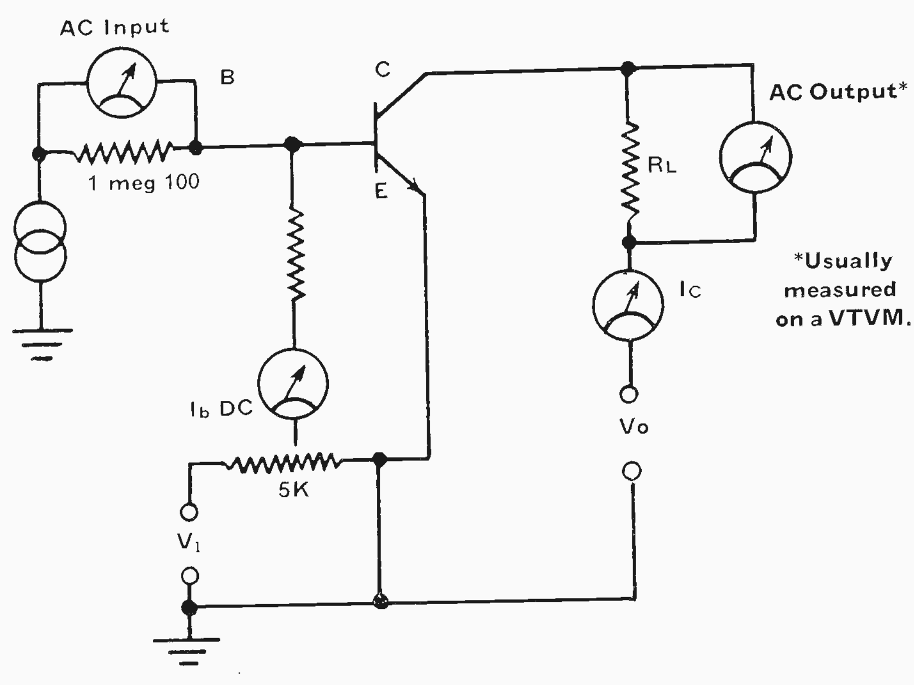
4. Input Resistance and Saturation Voltage

The input resistance measurement as well as the saturation voltage (V_s) test can be performed in the circuit shown in Figure I. As I_B is varied, V_{BE} will also vary and only a simple calculation is necessary in order to determine the input resistance.

$$R_{in} = \frac{V_{BE}}{I_B}$$

The collector to emitter saturation voltage V_s is defined as the voltage between the collector and emitter under given I_B and I_C conditions. V_s is read directly on the V_{CE} meter once the required current conditions have been reached.

Figure IV



*Usually measured on a VTVM.

Figure V

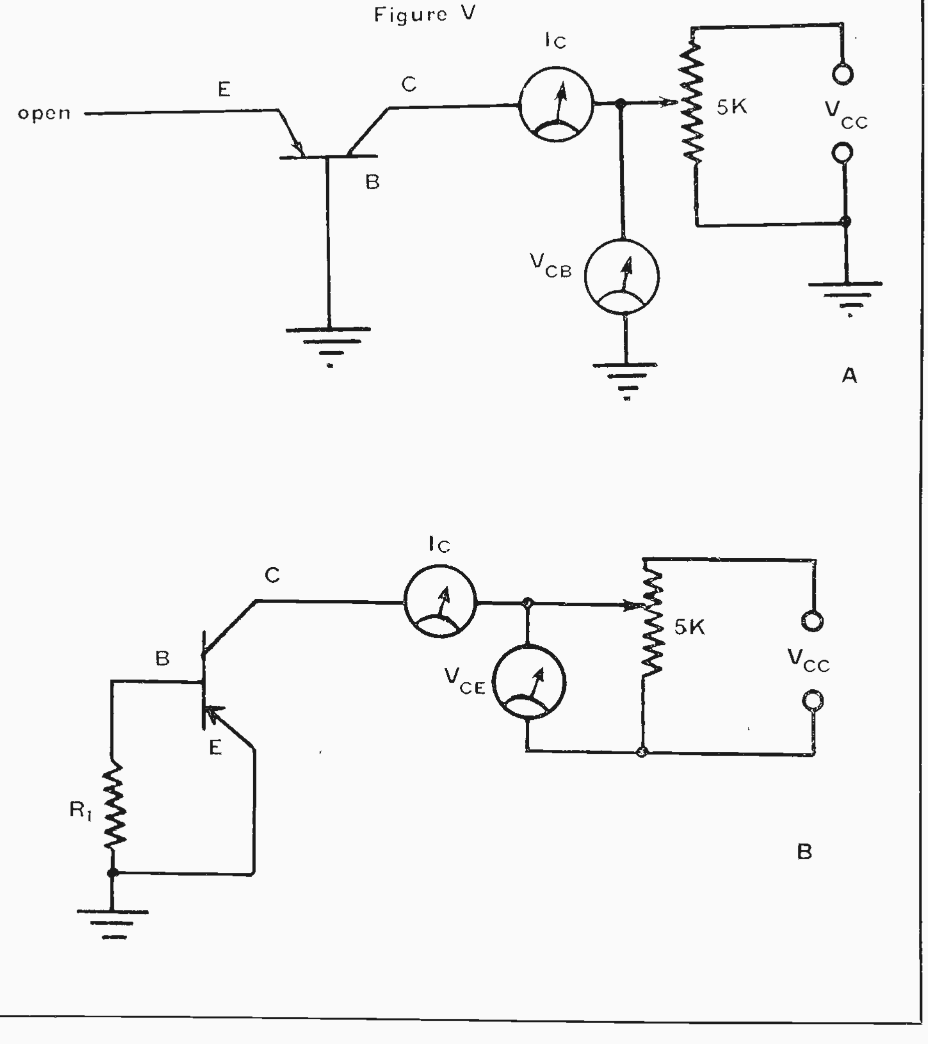
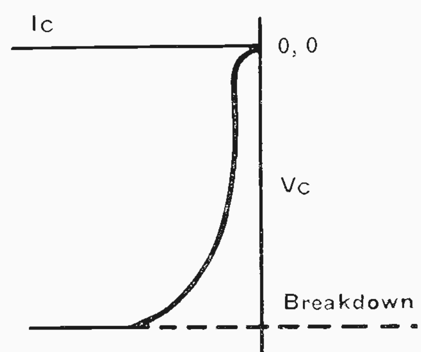


Figure VI



(Maximum Collector Voltage)

5. Application Tests

A significant number of application tests are made by the manufacturer in his laboratory. Some of these are power gain measurements, distortion and switching time tests. These will be the subjects of future articles.

6. Thermal Characteristic and Thermal Dissipation Ratings

The internal power dissipation rating of a transistor is an ambiguous term since it will depend almost entirely on the ability of the cooling structure to carry off the heat generated within the device. For a given

(*Continued on page 8*)

(*Continued from page 7*)

cooling structure the maximum allowable dissipation of the device will be determined by the power required to raise the junction temperature to its maximum rated temperature.

When running a transistor at high power levels, the danger always exists that the maximum junction temperature may be exceeded unless an appropriate cooling structure is provided. The specifications for transistors generally contain some sort of derating information. Usually this information is given by means of a °C/watt rating. By measuring the temperature of the transistor case at the dissipating surface, knowing the power dissipated and referring to the °C/watt rating, the junction temperature can be calculated.

The following formula may be used to calculate the junction temperature.

$$T_j = T_{case} + (°C/_w)(PC)$$

(Where, PC = Power Dissipation)

The thermal resistance ($°C/_w$ or K) is the temperature gradient which will exist between the case and the junction. For every watt of power dissipated in the collector the case will be cooler than the junction by the $°C/_w$ rating. As long as the maximum junction temperature (T_j) is not exceeded the device can be operated safely.

The equipment described above is such that it will permit the service man to determine whether marked changes have occurred within the transistors. This will also tell him if replacement is necessary in approximately 75% of the cases. The equipment is inexpensive to construct and easy to maintain.

ERRATA
Sylvania Technical Manual
10th Edition, 3rd Printing

It has been called to our attention that the page containing data on the Types 6SQ7GT and 6T4 is in error. It should be noted that the bulb and basing diagrams for these two types are interchanged. To avoid confusion, we suggest marking the Manual to this effect.

Supplements Issued To 10th Edition Tech. Manual

Listed below are the inserts which have been issued to the 10th Edition, 1st, 2nd, and 3rd Printings. It should be noted that data for tube types covered by inserts 1-10 through 20-10 are incorporated in the body of the 10th Edition, 3rd Printing and need not be obtained in supplement form. Likewise, data for tube types covered by inserts 1-10 through 10-10 are incorporated in the 2nd Printing.

Additional copies of the inserts listed may be obtained by writing directly to Sylvania Electric Products Inc., Central Advertising Distribution Department, 1100 Main Street, Buffalo 9, New York.

Purchasers of new Technical Manuals should be sure to return the self-addressed card contained in the front of the Manual. This automatically places your name on our mailing list for future supplements.

Insert Number	Types	Date
	1st PRINTING	
1-10	6BA8; 5AXP4	May-June 1955
2-10	4CB8; 6CB8	September 1955
3-10	6BE8, 5BE8; 24YP4	October 1955
4-10	6CS7; 12AVP4A	November 1955
5-10	6DN6, 25DN6; 21ALP4B	December 1955
6-10	12BV7; 21AUP4B	January 1956
7-10	12BR7; 21AVP4B	February 1956
8-10	6AU8; 21ATP4A	March 1956
9-10	6AX8; 8CP1, 8CP4	April 1956
10-10	6DQ6, 12DQ6, 25DQ6; 8XP4	May-June 1956
	2nd PRINTING	
11-10	*6CN7; 14QP4/14QP4A	July-August 1956
12-10	12AD7; 14SP4	September 1956
13-10	6CN7, 8CN7; 14XP4/14XP4A	October 1956
14-10	6CU5, 12CU5, 17CU5; 17ATP4A/17AVP4A	November-December 1956
15-10	6CM7, 8CM7; 16RP4A	January 1957
16-10	6BH8, 8BH8; 21ACP4A/21AMP4A/21BSP4	February 1957
17-10	12AB5; 17BVP4	March 1957
18-10	12AE6; 24CP4A/24VP4A/24ADP4	April 1957
19-10	12AD6; 14RP4, 14RP4A	May 1957
20-10	12AF6; 21BTP4	June 1957
	3rd PRINTING	
21-10	12AC6; 12F8	July-August 1957
22-10	21AXP22, 21AXP22A	July-August 1957
23-10	12J8; 5CP1A, 7A, 11A, 12	September 1957
24-10	12AJ6; 21CQP4	October 1957
25-10	6/10/13DE7; 21CEP4	November-December 1957
26-10	6BN8, 8BN8; 17BJP4	January 1958

**6CN7 superseded by 6CN7, 8CN7 data issued with Insert No. 13-10.*

SYLVANIA NEWS

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R. A. Humphreys, Technical Editor

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technical
SECTION

THINGS TO REMEMBER WHEN SERVICING TRANSISTORIZED RADIOS

by John N. McCaul
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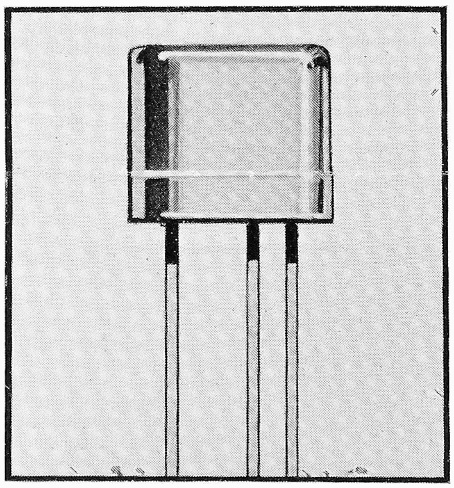
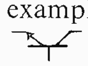
Electronic Tubes Division

The transistor is here—and it is becoming a greater factor in electronics as each year goes by. It is estimated that a total of 60 million transistors will be manufactured in 1958 for use in home radios as well as industrial and military applications. About half of these will fit the first category, home entertainment, and this is the business of the Radio-TV serviceman. Therefore, in order to get your fair share of this expanding servicing market you must become thoroughly familiar with transistors and their associated components.

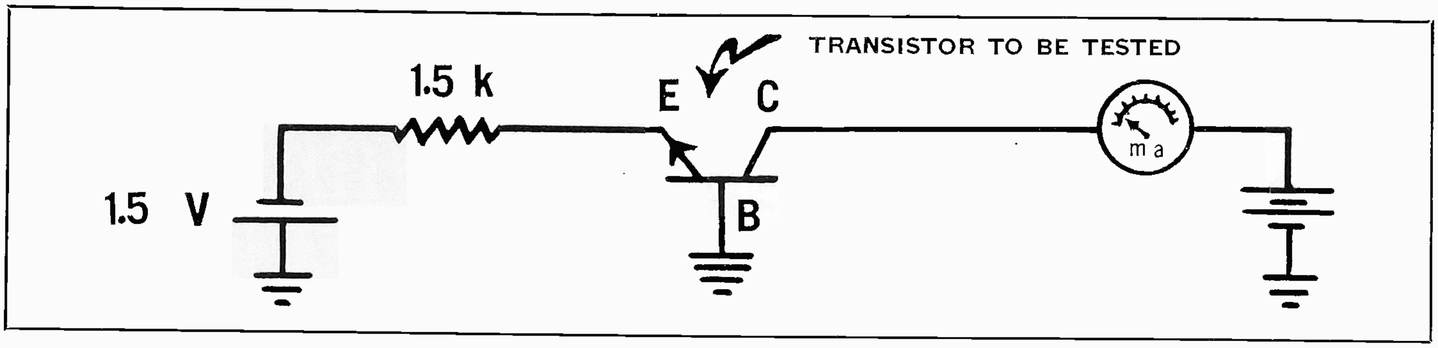
The transistor is extremely durable in some ways and equally as fragile in others. It can take shock and vibration in the order of thousands of times what the ordinary receiving tube can bear. But, and this is important, the transistor is extremely sensitive *to heat* or *to the application of the wrong polarity* D.C. biasing voltages. Both can destroy the ability to get what is called "transistor action." Too much voltage, an improperly used soldering iron or a poor connection to a heat sink as well as ambient temperature can create heat at the junction. And heat is one factor that must be carefully avoided at all times.

In order to avoid these two ways of causing destruction to the transistor,



we first must become familiar with the two main types we run into. This familiarity includes not only an understanding of the two opposite types, but also the symbols that describe them. The two types are the NPN and the PNP. What is the correct collector polarity? Just look at the center letter or, as some put it, the "ham in the sandwich." Take the NPN. "P" is the center, the ham, and plus is the polarity of the large voltage that is applied to the collector. The same for the PNP. "N" is the center, negative is the correct collector voltage. Suppose you do not know from the schematic whether you have a PNP or an NPN. Look at the symbol—it will tell you very easily. If, for example, the symbol looks like this , you have an NPN. How can you remember this? In an NPN transistor the outsides are "N", and this indicates electrons are the carriers. Current flows opposite to electrons. The carriers, however, always go from the emitter to the collector. The arrow coming out from the emitter indicates to you that this is an NPN transistor. In like fashion, should the arrow be pointing towards the emitter , you have a PNP transistor and "hole" carriers, as they are called. "Hole" carriers go in the same direction as the current, and the arrow points the direction of the current.

Thus, by looking either at the symbol () or the type (NPN), you know the correct polarity to apply to the collector. Always determine this first, for the large reverse collector bias, if applied to the collector incorrectly, will cause so much current to flow across the collector-base junction that it will quickly heat up and be destroyed. It is a simple matter then to connect the emitter. Apply to it the opposite polarity to that applied to the collector. Every Sylvania transistor carton carries a basing diagram to help you.



Before doing any actual servicing in a transistorized radio, it is wise to give all components and wiring an intense visual check. Look for such things as broken antenna leads, cracks or breaks in the circuitry, poor solder joints, corroded or bent battery terminals, solder or dirt between leads, poor grounds and and other similar items. Test your battery. It is desirable to do this under load for, among other things, many circuits are extremely sensitive to their voltage supply. Check your on-off switch if your battery is weak or dead. The tiny switches used can become worn more rapidly than the larger units you are used to. Then they do not turn off the power supply, thereby draining the battery.

When measuring a transistor circuit, the serviceman should know his instruments. An ohmmeter check is inadvisable unless the voltage of the ohmmeter is known, and it is also known that this voltage does not exceed the ratings of the transistor; or, and this is often forgotten, the ratings of the miniature capacitors. In the case of the transistor, the ratings of the emitter-base junction, which is forward biased, are extremely low and cannot be exceeded without permanent injury. The collector-base junction, which is reverse biased, has a much higher rating but even this, if exceeded, will cause destruction due to a breaking of the covalent bonds. This is sometimes called Zener breakdown. In the case of the capacitors, they generally carry ratings of somewhere between 2 and 10 volts and, in addition, the capacitors have a polarity which must be observed.

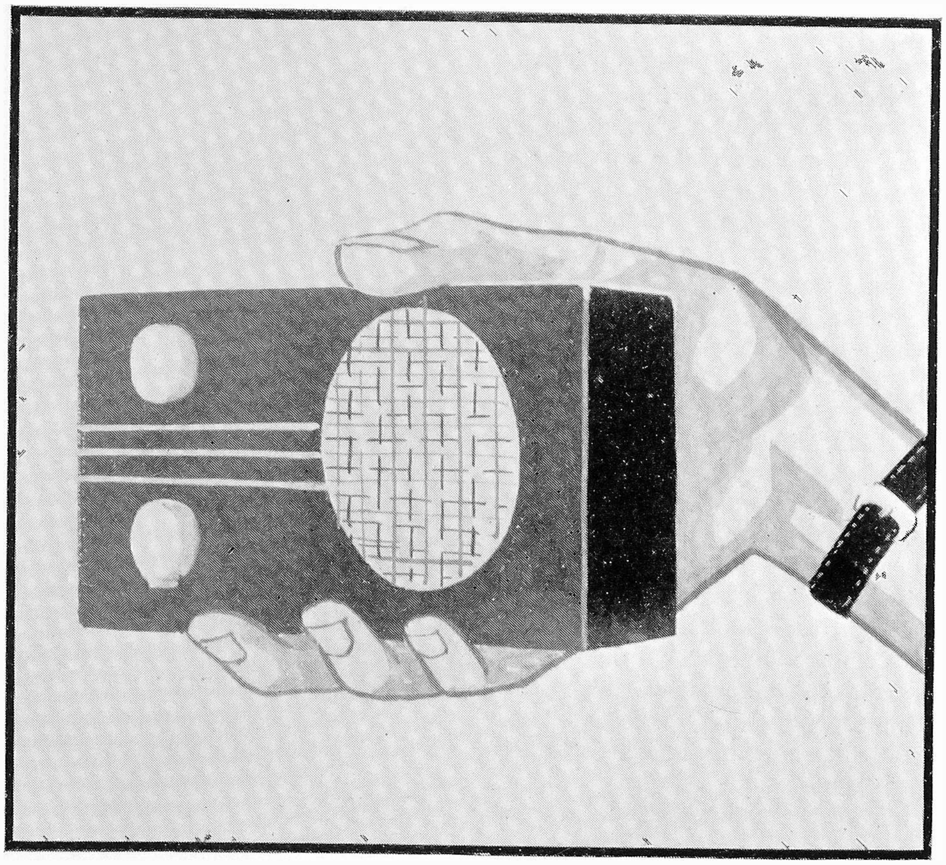
To quickly check whether a transistor is good or possesses "transistor action," you can use a simple circuit such as shown below using a milliammeter. As shown, the polarities are set up for an NPN transistor as is indicated by the symbol with the arrow leaving the emitter. For a PNP type, just reverse polarities.

Selection of 1.5 volts and a resistance 1.5 K in the emitter circuit provides a current flow of 1 mil across the emitter-base junction. We know the ratio of our collector current to emitter current (α) should be something around .95 to .97. If our meter indicates .95 to .97 mils, then we can safely assume that our transistor possesses transistor action. The collector bias, of course, should be chosen so that it does not exceed the collector rating of the unit tested.

When replacing a defective transistor or component to avoid damaging current surges, make sure the power supply is off. If working on a hybrid auto radio, make sure the speaker is connected before applying power.

Avoid excessive heat by using long-nosed pliers between the transistor or component and the joint to be soldered. The pliers will draw off the iron's heat. If the set you are working on has plug-in transistors, then remove them if you are going to solder and any surrounding circuitry.

Remember your two types of transistors and their symbols so that correct polarity is observed. Avoid heat in every way possible, and take extreme care to note the value of the voltages applied. Applying these rules with your knowledge should greatly simplify transistor servicing.



NEW SETTINGS BRING ROLL CHARTS UP-TO-DATE

Note these important additions to the roll charts you have for Sylvania tube tester models 139, 140, 219, 220 and 620. Make sure your charts are completely accurate and up-to-date by adding these important facts, now.

New roll charts will be available for the nominal charge of $1.50 each in a short time. A special notice in *Sylvania News* will announce the new roll charts, which may be ordered directly from the company's Williamsport, Pa. installation.

ADDITIONS TO SETTINGS ON YOUR 139 and 140 ROLL CHARTS

TYPE	A	B	C	D	E	F	G	TEST
1G3	1.4	0	2457	0	8	—	37	V
3CY5	3.3	0	4	0	4	36	41	U
	3.3	0	2	0	4	36	41	U
4AU6	5.0	0	—	0	4	36	32	W
4DT6	5.0	0	—	0	4	36	61	T
6AN6	6.3	2	48	4	0	—	49	T
	6.3	2	48	4	1	—	49	T
	6.3	2	48	4	4	—	49	T
	6.3	2	48	4	7	—	49	T
6BK4	6.3	0	—	0	3	—	55	T
6CY5	6.3	0	4	0	4	36	40	U
	6.3	0	2	0	4	36	40	U
8CN7	7.5	0	5	0	8	7	47	T
	3.3	7	15	3	1	—	46	T
	7.5	0	5	0	1	—	46	T
	7.5	0	5	0	2	—	46	T
8SN7GTB	7.5	0	678	1	7	5	36	W
	7.5	0	278	1	3	3	36	W

TYPE	A	B	C	D	E	F	G	TEST
12CN5	12.6	0	5	0	3	26	51	T
	12.6	0	2	0	3	56	51	T
12CS7	12.6	0	—	0	1	6	21	W
	12.6	0	—	0	3	7	59	Y
12DW8	12.6	0	—	0	1	3	47	T
	12.6	0	—	0	3	7	47	T
	12.6	0	—	0	4	—	47	T
12EL6	12.6	0	—	0	1	3	55	X
	12.6	0	—	0	4	—	55	T
	12.6	0	—	0	5	—	55	T
12U7	12.6	0	5	0	1	3	48	T
	12.6	0	5	0	3	7	48	T
	6.3	0	6	3	3	7	48	T
17BY7	12.6	0	45	0	6	39	35	Y
	12.6	0	45	4	6	39	34	Y
25AV5GT/GA	25	0	—	0	3	57	20	Y
25CA5	25	0	5	0	3	26	26	Y
	25	0	2	0	3	56	26	Y

ADDITIONS TO SETTINGS ON YOUR 219 and 220 ROLL CHARTS

TYPE	A	B	C	D	E	F	G	K
1G3	1.25	2	13578	26	7	U	9	
3CY5	3.3	3	47	60	4	16SV	5	2
	3.3	3	24	60	4	16SV	5	7
4AU6	5.0	3	4	23	4	16Y	5	7
4DT6	5.0	3	4S	41	4	16T	5	2
6AN6	6.3	1	7	35	7	T	2*	6
	6.3	1	7	35	7	T	3*	6
	6.3	1	7	35	7	T	4*	6
	6.3	1	7	35	7	T	5*	6
6BK4	6.3	2	367	37	7	T	5	1
6CY5	6.3	3	47	65	4	16SV	5	2
	6.3	3	24	65	4	16SV	5	7
8CN7	7.5	4	359S	40	5	7T	8	6
	7.5	5	569	34	5	T	1*	3
	7.5	4	569	34	5	T	2*	3
8SN7GTB	7.5	7	68	38	8	1V	2	3
	7.5	7	38	39	8	4V	5	6

TYPE	A	B	C	D	E	F	G	K
12CN5	12.6	3	45	8	4	26SU	7	1
	12.6	3	24	8	4	56SU	7	1
12DW8	12.6	4	58	34	5	2T	1	3
	12.6	4	35	34	5	7T	6	8
	12.6	4	35	34	5	T	9	8
12CS7	12.6	4	59S	34	5	7Y	6	8
	12.6	4	58S	29	5	3Z	1	9
12EL6	12.6	3	4	48	4	1V	2	7
	12.6	3	4	41	4	T	5	7
	12.6	3	4	41	4	T	6	7
12U7	12.6	4	589S	36	5	2T	1	3
	12.6	4	359S	36	5	7T	6	8
	6.3	9	359S	36	5	7T	6	8
17BY7	19	4	569S	27	5	28Z	7	1
	12.6	4	569S	27	6	28Z	7	1
25AV5GT/GA	25	2	7	29	7	18SZ	5	3
25CA5	25	3	45	19	4	26Z	7	1
	25	3	24	19	4	56Z	7	1

ADDITIONS TO SETTINGS ON YOUR 620 ROLL CHART

TYPE	A	B	C	D	E	F	G	K
1G3	1.25	2	13578	24	7	T	0	
3CY5	5.0A*	3	47	66	4	16RU	5	2
	5.0A*	3	24	66	4	16RU	5	7
4AU6	5.0A*	3	4	24	4	16X	5	7
4DT6	5.0A*	3	4R	46	4	16S	5	2
6AN6	6.3	1	7	37	7	S	2	6
	6.3	1	7	37	7	S	3	6
	6.3	1	7	37	7	S	4	6
	6.3	1	7	37	7	S	5	6
6BK4	6.3	2	367	47	7	05TZ	0	1
6CY5	6.3	3	47	65	4	16RU	5	2
	6.3	3	24	65	4	16RU	5	7
8CN7	7.5A*	4	359R	42	5	7S	8	6
	5.0	4	569	35	9	S	1	3
	7.5A*	4	569	35	5	S	2	3
8SN7GTB	12.6A*	7	68	39	8	1U	2	3
	12.6A*	7	38	39	8	4U	5	6

TYPE	A	B	C	D	E	F	G	K
12CS7	12.6	4	59R	34	5	7X	6	8
	12.6	4	58R	29	5	3Y	1	9
12CN5	12.6	3	45	9	4	26RT	7	1
	12.6	3	24	9	4	56RT	7	1
12DW8	12.6	4	58	37	5	2S	1	3
	12.6	4	35	37	5	7S	6	8
	12.6	4	35	38	5	S	9	8
12EL6	12.6	3	4	48	4	1U	2	7
	12.6	3	4	41	4	S	5	7
	12.6	3	4	41	4	S	6	7
12U7	12.6	4	589R	38	5	2S	6	3
	12.6	4	359R	38	5	7S	6	8
	6.3	9	359R	38	5	7S	6	8
17BY7	19.0	4	569R	28	5	28Y	7	1
	12.6	4	569R	29	6	28Y	7	1
25CA5	25A**	3	45	15	4	26Y	7	1
	25A**	3	24	15	4	56Y	7	1
25AV5GT/GA	25A**	2	7	29	7	18RY	5	3

Important Additions To Sylvania Picture Tube Chart

To help service-dealers keep up-to-date with the latest picture tube information, Sylvania provides this special supplemental listing to its popular picture tube comparison chart and pocket-sized "ABC" guide. Although these publications are constantly revised by the company, the listings here are for picture tubes registered after the last picture tube chart issue went to press.

These listings are primarily intended for use by dealers as a "data service" and because a particular picture tube type is included does not necessarily mean that it is in demand, or even available, for replacement sales, now.

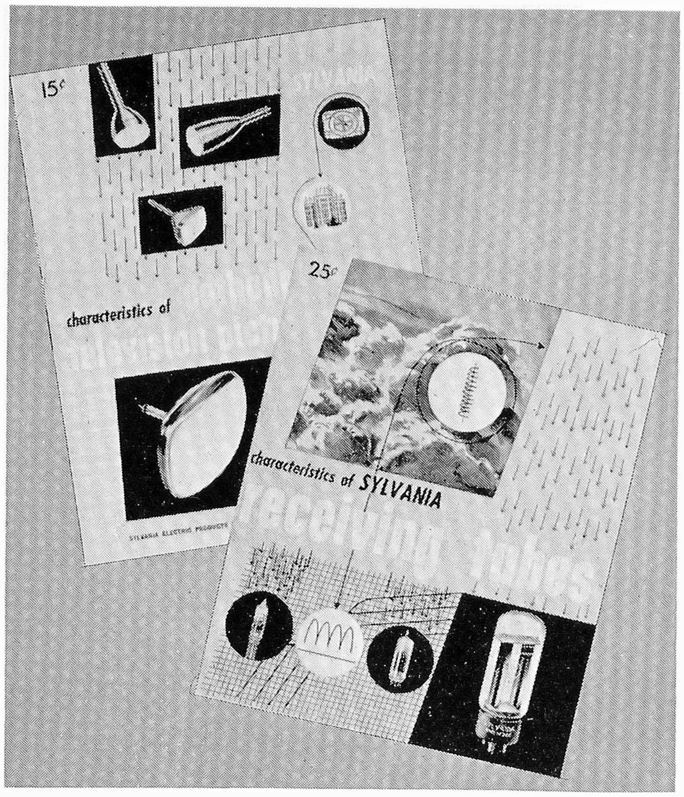
Up-to-the-minute modifications in the technical characteristics of several picture tubes already listed on the latest Sylvania picture tube wall chart and "ABC" guide are also included here.

The supplemental listing is arranged so that you may actually cut the page from this issue of *Sylvania News* and attach it to your present picture tube comparison chart which dealers find ideal for use in their shops. The "ABC" pocket guide has achieved its popularity because it not only fits compactly into jacket and trouser pockets but can be easily included in a tube caddy or tool kit. To get your free copy of both Sylvania's picture tube comparison chart and "ABC" guide, contact your local authorized Sylvania distributor or write to: CADD, Sylvania Electric Products, Inc., 1100 Main Street, Buffalo, New York.

MODIFICATIONS TO PRESENTLY INCLUDED TYPES:

Type	Shape	Ext. Cond. Coating	Anode Volts
17AVP4	....	1000/1500	....
17AVP4A	....	1000/1500	....
17BJP4	....	1000/1500	....
17BUP4	....	1000/1500	....
17CBP4	....	1000/1500	....
21CBP4	....	....	19.8
21KP4	c	....	....

Characteristic Booklets Valuable Dealer Service Helps



Sylvania's up-to-date characteristics booklets on cathode ray-TV picture tubes and receiving tubes can be valuable reference guides for the busy radio-television service-dealer.

Both the receiving tube characteristic booklet and the cathode ray-picture tube booklet are available at a nominal charge from your Sylvania distributor or directly from Sylvania. The receiving tube booklet costs only twenty-five cents per copy, while the cathode ray-television picture tube booklet can be yours for only fifteen cents per copy. When ordering from Sylvania, address your requests to: Central Advertising Distributor Department, Sylvania Electric Products Inc., 1100 Main Street, Buffalo 9, New York.

NEW TYPES:

Type	Ef Volts If Amps	Face-Plate	Shape	Metal or Glass	Ext. Cond. Coating	Focus	Defl. and Neck Diam.	Anode Volts	Basing	Ion Trap Mag.	Nominal Length
14AUP4	6.3/.45	TA	□	G	1000/1500	LoEs**	90	16.5	12L	N	13 3/16
17CLP4	6.3/.60	TA	□	G	1800/2300	LoEs	90	17.6	12L	S	15 5/8
17CRP4	6.3/.45	TA	□	G	1800/2300	LoEs**	90	17.6	12L	N	14 5/8
SS 17CSP4	6.3/.60	TA	□	LWG	900/1400	LoEs	110	17.6	7FA	N	12 5/16
SS 17CTP4	6.3/.45	TA	□	LWG	1000/1500	LoEs	110	17.6	8HR	N	12 9/16
21DFP4	6.3/.60	TA	□	G	1500/2200	LoEs	110	19.8	8HR	N	14 7/16
SS 21DHP4	6.3/.45	TA	□	LWG	1700/2500	LoEs	110	19.8	8HR	N	14 11/16
24ALP4	6.3/.60	TA	□	LWG	2000/2500	LoEs	110	22	8HR	N	15 7/8
SS 24AMP4	6.3/.60	TA	□	LWG	2000/2500	LoEs	110	22	7FA	N	15 5/8
SS 24ANP4	6.3/.60	TA	□	G	1700/2500	LoEs	90	22	12L	S	20 1/8
SS 24ASP4	6.3/.30	TA	□	G	1700/2500	LoEs	90	22	12L	N	19 1/8
27VP4	6.3/.60	TA	□	G	2000/2500	LoEs	90	19.8	12L	N	21 1/16

**Low grid No. 2 voltage.

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R. A. Humphreys, Technical Editor

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technical
SECTION

FILAMENT VOLTAGE TEST UNIT FOR HIGH VOLTAGE RECTIFIERS

by M. A. Stamberger, Field Engineer
Receiving Tube Division

Probably one of the most sought after instruments in the TV servicing field today is a unit which would enable a technician to measure the operating filament voltage of high-voltage rectifiers, such as the Types 1B3GT, 1X2B and 2B3, which supply the picture tube anode voltage.

Published data, for example, states that the Type 1B3GT should under no circumstances be operated with an applied filament voltage of less than 1.05 Volts or more than 1.45 Volts, Table I. Thus, there is only 0.4 Volts difference between the minimum and maximum recommended operating conditions which will insure normal tube life. Yet, there are many controlling factors, including improper adjustment of horizontal drive and variation in line voltage, that can result in a filament voltage which is well outside the recommended limits.

High line voltage —Any increase in line voltage will naturally step-up the plate and screen voltages and drive-voltage applied to the horizontal deflection amplifier. Increased output from this stage will cause an increase in the filament and plate voltages of the high-voltage rectifier. Depending upon the actual line voltage and the particular receiver,

(Continued on page 6)

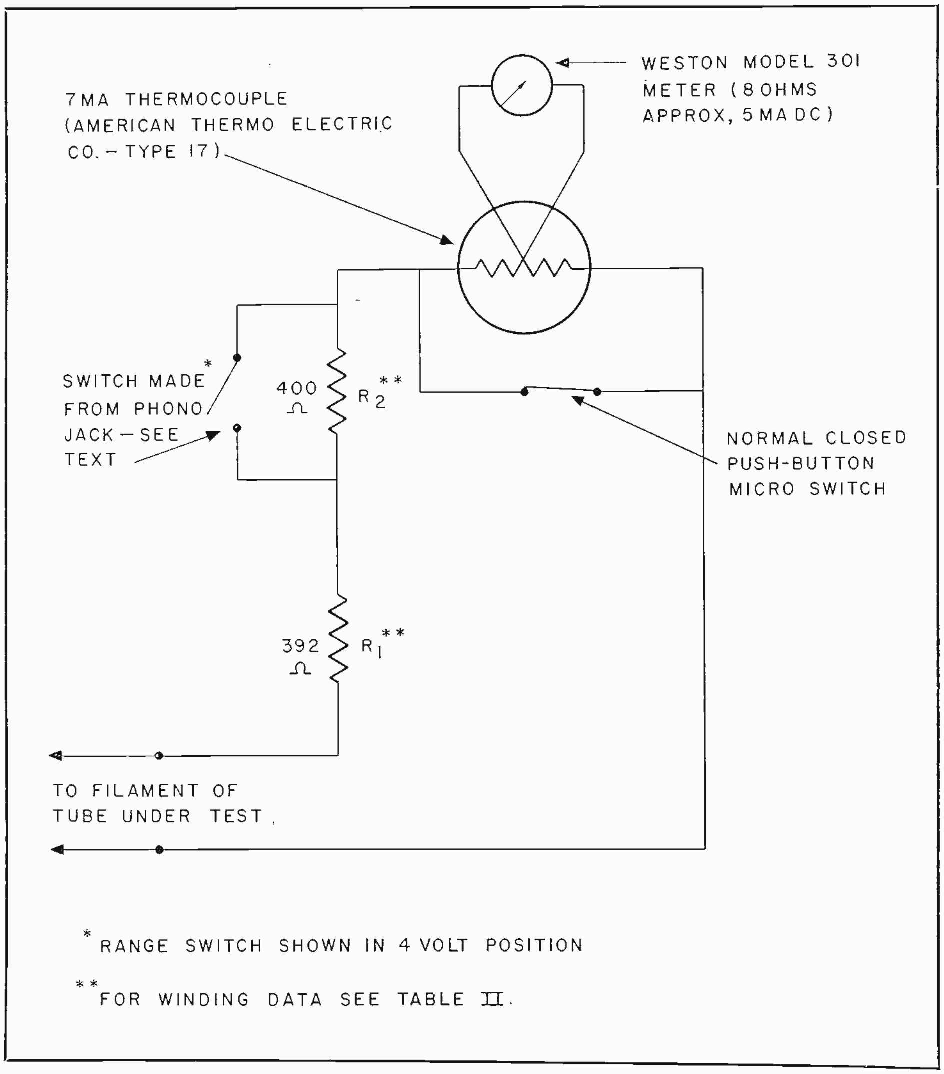

Figure 1.—Circuit diagram of high-voltage rectifier filament-voltmeter.

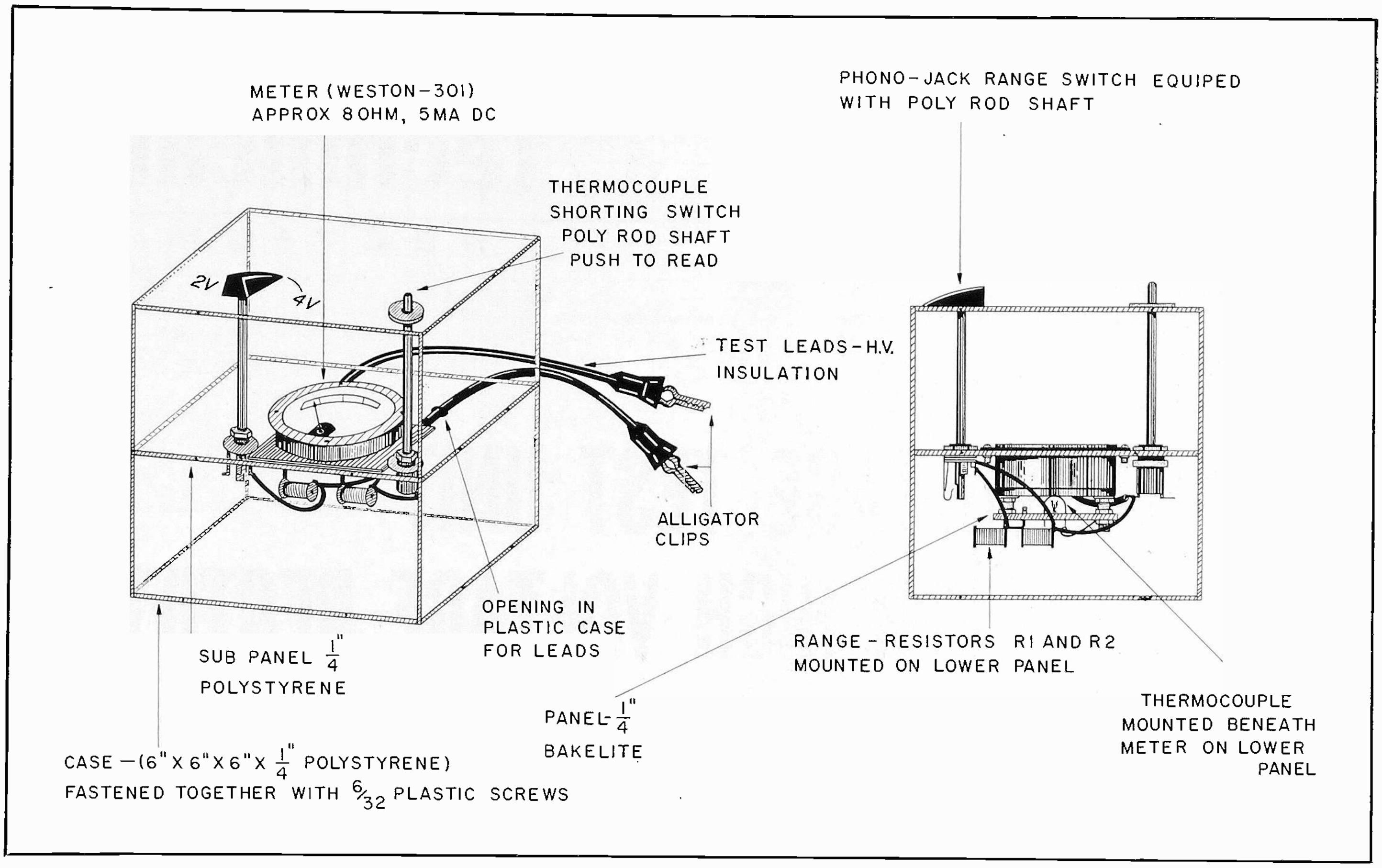

Figure 2.—Construction details of test instrument.

the high-voltage rectifier may be found to be operating with heater and plate voltages which are well above the maximum rated values for the type. The natural result, in many instances, will be relatively short tube life.

The usual failures from this condition are either open filaments (burnouts) or arc-overs and shorts. The abnormally high voltages applied to the filament and plate under conditions of high line voltage causes a very strong electrostatic-field to build up between these two elements. This field actually tends to distort and/or pull the filament coil toward the plate. As the filament coil bows, the coating sometimes cracks and breaks off causing hot-spots along the filament wire. The hot-spots tend to weaken the filament wire at the points where they occur. In addition, flexing of the filament, due to the build-up and collapse of the electrostatic field when the receiver is turned on and off, gradually weakens the filament wire to the point where it may break.

Low line voltage—Low line voltage does not cause damage to the high-voltage rectifier in quite the same sense that high line voltage does. The overall effect, however, is much the same in that a call-back may result due to poor set performance.

Low voltages on the horizontal output stage caused by insufficient line voltage may result in lower than normal filament power being coupled to the high-voltage rectifier. Low filament voltage and/or power may cause insufficient emission. This will usually be evidenced by blooming, poor focus, low picture tube anode voltage, insufficient scan and inadequate brightness.

Faulty operation of the Horizontal Output Stage—It goes without saying that probably one of the greatest factors affecting the life expectancy of the high voltage rectifier is the adjustment and/or operating conditions of the horizontal deflection circuit. There are many instances where a set has been adjusted so that the picture tube is being severely overscanned, the high voltage is exceeding the maximum rated value of the rectifier by 2 KV or more and the filament is operating well above the recommended filament voltage. In most cases the 1B3GT or 1X2B will be an early life failure in this circuit whether the problem lies in improper adjustment, faulty components or in replacement parts.

With respect to problems caused by replacement parts, let's consider a receiver in which we have replaced the flyback transformer. In a number of cases the high-voltage rectifier filament voltage has been found to be excessive with the new transformer installed. The reason for this is simply that, due to progress in transformer design, the replacement flyback transformer is more efficient than the one originally employed in the receiver. Thus, the new transformer as well as the horizontal deflection amplifier tube can be operated more conservatively and still supply the power required for normal operation of the picture tube and high-voltage rectifier filament.

Maladjustment of the drive, width and linearity controls may cause the high-voltage rectifier tube to operate outside its maximum rated operating conditions. Any changes in the value of a component can have the same effect.

Methods of measuring heater voltage—Due to the ever present high voltage on and around the horizontal output circuit, the only method a technician has been able to use in the past to "check" the filament voltage of the high voltage rectifier is to observe the brightness of the light given off by the glowing filament coil. This test method, although better than none, leaves a lot to the imagination and is of little value at all when it comes to pinning down the actual filament voltage. Thus, the need for a direct reading voltmeter capable of measuring the filament voltage of high-voltage rectifier tubes is readily apparent.

HV RECTIFIER FILAMENT-VOLTMETER

Referring to the circuit diagram and accompanying photographs, the unit is composed of a Weston Type 301 D.C. milliameter (approximately 8 ohm — 5 ma); two non-inductive resistances of 392 ohms and 400 ohms, two switches and a 7 ma vacuum thermocouple (American Thermo Electric Company Type 17). The voltmeter has two ranges; 2 volts for such tubes as Types 1B3GT and 1X2B; and 4 volt range for Types 2B3, 3B2 and other color TV high-voltage rectifiers. The complete unit is housed in a 6 inch x 6 inch plastic case, to prevent meter-to-ground shorts and to reduce the shock hazard.

Construction—The only circuit components which must be constructed are the resistors employed in the range-switch voltage-divider network, R1 and R2. The resistors are wound on ¼ inch diameter fiber forms using insulated resistance wire: No. 32 (7.4 ohms/ft.) or No. 34 (11.8 ohms/ft.). Due to the frequency involved (15,750 cps) these two resistances must be non-inductive. This is accomplished in the conventional manner by first doubling the wire to form a loop. The loop of wire is then wound on the form as a single strand, Figure 4. Since the accuracy of the meter is somewhat dependent upon the values of R1 and R2, they should be carefully constructed and accurately checked to insure that they have the proper ohmic value. The conventional ohmmeter would not be accurate enough for measuring these resistances. A resistance bridge must be used.

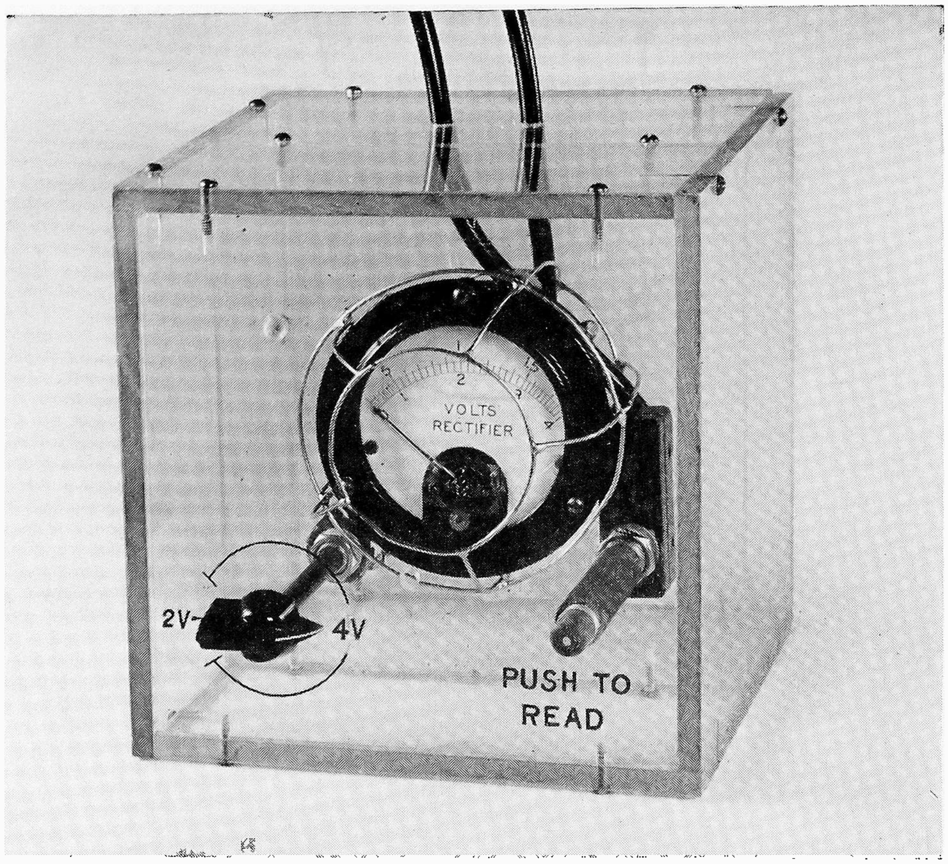

Figure 3.—Photograph of completed laboratory model. Note construction of electrostatic meter-cage.

The range switch consists of a phone-jack equipped with a set of normally-closed contacts. The switch is actuated by a fiber rod which is filed half-flat on one end. The filed end of the rod is inserted in the phone-jack. When rotated, the rod opens and closes the switch contacts. When the switch is open, resistances R1 and R2 are connected in series to form the 4 volt range. Closing the switch shorts out R1 to form the 2 volt range.

A normally-closed switch is connected in shunt with the thermocouple to protect it from high surge currents caused by arc-overs or a short circuit. This switch is also actuated by a fiber rod. The switch employed in the unit shown is a standard micro-switch. The fiber rod is ½ inch in diameter and is drilled out on one end to receive the switch button. The opposite end of the rod is cut down to ⅜ inch and allowed to protrude through the case about ½ inch.

As previously mentioned, the unit is constructed in an all plastic case to protect the user from possible shock. Figures 2, 3 and 4 are intended to aid the builder when constructing the plastic box and to show the approximate parts layout. The meter, range-switch and thermocouple shorting switch are mounted on a plastic sub-plate which is anchored to two walls of the case. It should be noted that these components are at high potential with respect to ground during operation of the unit. Do not surface mount these components and be sure to use fiber rods to trigger the switches —not metal.

The thermocouple and voltage-divider resistors R1 and R2 are mounted on a small plastic plate which is attached to the back of the meter. The mounting plate is at-

(*Continued on page 8*)

(*Concluded from page 7*)
tached to the meter via the meter terminal lugs.

The test leads are made from high-voltage insulated (30 KV) wire and are equipped with alligator clips which are shielded with insulating hoods.

Finally, it should be noted that the meter is enclosed in a shield-cage constructed of No. 14 wire. The cage is essential to protect against possible erroneous readings caused by electrostatic pickups.

Calibration—Calibration of the unit can be accomplished with a low voltage dc source and an accurate DC voltmeter. If the voltage-divider resistors are accurately constructed it should not be necessary to plot the 4 volt scale. A multiplier of 2 can simply be applied to the 2 volt scale. If a check of the instrument reveals that the 4 volt scale is not an exact multiple of the two volt scale, it will be necessary to write-in both scales on the meter face.

A word of caution—The thermocouple is very sensitive and surge currents due to arc-overs or capacitor discharge will burn it out. Make absolutely sure the high voltage circuit is completely discharged before attempting to connect the test leads to the receiver. The alligator clips should be securely fastened to the socket terminals of the rectifier tube. Should one of the test leads become disconnected and contact the receiver chassis—the thermocouple will be permanently damaged.

The normally closed switch in shunt with the thermocouple must be depressed to read the voltage under test. This switch protects the thermocouple to a certain extent but does not provide complete protection. A direct short will still burn out the thermocouple even though the switch is closed. The receiver should be turned off and the high voltage circuit discharged before the test leads are disconnected.

In conclusion, this unit was designed primarily for shop usage although it can be used on home calls. Cost wise, the construction of the instrument does not involve any tremendous expenditure and should more than pay for itself within a short period of time.

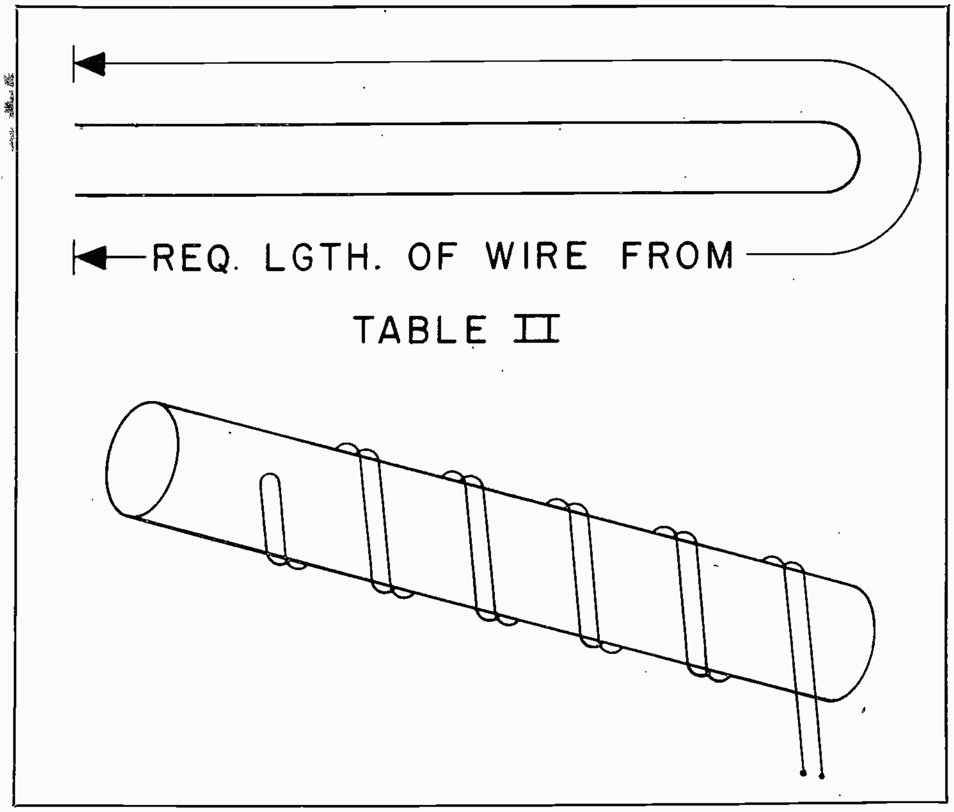

Figure 4.—Method used to wind the non-inductive resistances R1 and R2. The wire may be wound in scramble fashion.

TABLE I

Recommended Filament Voltage Operating Conditions for Popular High Voltage Rectifiers

Type		FILAMENT VOLTAGE IN VOLTS Min.	Avg.	Max.
1AX2		1.19	1.40	1.61
1B3GT 1G3 1J3 1K3 1X2 1X2A 1X2B		1.05	1.25	1.45
2B3		1.50	1.75	2.00
3A2 3A3 3B2		2.70	3.15	3.60
3C2	Parallel	1.40	1.58	1.80
	Series	2.70	3.15	3.60

TABLE II

WINDING DATA FOR RANGE RESISTORS

	Res. in Ohms	Resistance Wire No.	Res. in Ohms/ft.	Total Length * of Wire in Feet
R1 **	392	32	7.4	53 ft.
		or 34	11.8	33 ft. 2½ inches
R2 **	400	32	7.4	54 ft.
		or 34	11.8	33 ft. 11 inches

*Approximate calculated length—approx. 3″ additional should be added to allow for trimming to specified value with resistance bridge.
** Must be non-inductive—see text.

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R. A. Humphreys, Technical Editor

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technical SECTION

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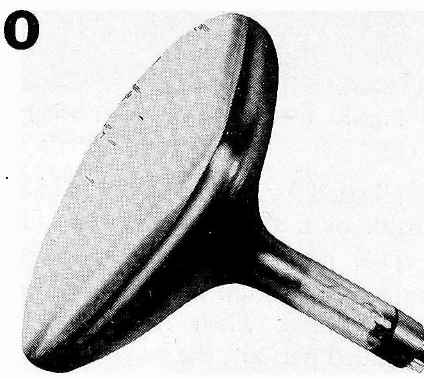
USING THE 8YP4 110° TEST PICTURE TUBE



Information On A New Check Tube Developed As An Aid In Servicing 110° Receivers

Miniature check tubes such as the 5AXP4 and 8XP4 have proved to be of invaluable aid to the TV technician, enabling him to check CRT performance by substitution, and to perform bench service without the necessity of pulling cabinet-mounted CRT's. The introduction of wider-angle deflection circuits, however, has necessitated changes in CRT design, making the aforementioned 53° and 90° check tubes incompatible. The service technician's need for a 110° tube has been fulfilled with the development of the 8YP4.

As you may know, two different base styles currently are being used on 110° tubes. A conventional shell base is employed on the 8YP4 because of its proven ability to stand up under repeated socket connections. However, since some 110° tubes are equipped with the rigid-pin base, an adaptor is supplied with each 8YP4 to permit its use in either application. In Fig. 1, a rigid-pin socket is being installed on the base adaptor, which is shown in place on the 8YP4 base. Fig. 2 shows the removable, plastic cross-hatch screen and two-color imprinted carrying and storage carton supplied with the new check tube. The plastic screen is designed to serve as a reference during the checking and adjusting of picture size and linearity. For temporary use, it is merely slipped over the face of the tube like a cover; but if the technician desires to leave it mounted permanently in place, it may be secured with tape. The imprinted carton is constructed of heavy-gauge, corrugated cardboard, thus serving either as a handy portable case for transporting the tube in the service vehicle, or as a storage box in the shop. The adaptor and plastic screen may also be kept in the box when they aren't needed.

As with previous check tubes, the 8YP4 is designed to operate satisfactorily within a wide variety of voltage ranges, and is thus applicable for all 110° receivers—from the small portable to the 24″ console.

For the sake of safety and to make the 8YP4 universally applicable in all 110° circuits, no external conductive coating is employed. This eliminates the need for "discharging" the tube each time it is used, a time-saving feature in a busy service shop. Should the normal picture-tube capacitance be needed for proper high-voltage filtering, it can be

Electrical specifications are as follows:

Maximum anode voltage	22,000 volts dc
Grid 2 and Grid 4 voltage	550 volts dc max.
Grid 1 voltage	
Negative bias value	150 volts dc
Negative peak value	220 volts
Positive bias value	0 volts dc
Positive peak value	2 volts
Peak heater-to-cathode voltage	
Heater negative with respect to cathode during warm-up period not to exceed 15 seconds	450 volts
After warm-up period	200 volts
Heater positive with respect to cathode	200 volts

Some typical operating characteristics are:

Anode voltage	16 KV
Grid 2 and Grid 4	300 volts dc
Grid 1 voltage required for cutoff (visual extinction of raster)	−35 to −72 volts dc
Grid 1 resistance	1.5 megohm max.

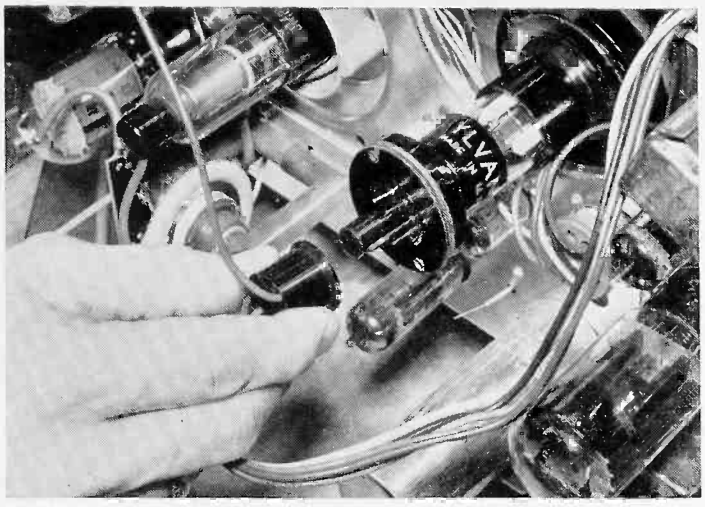


Figure 1.—Rigid-pin socket being installed on adaptor-equipped 8YP4 base.

Figure 2.—8YP4 Universal 110° test picture tube kit.

duplicated by the temporary installation of a suitable filter capacitor.

This tube is not made for continuous operation at high brightness levels; thus, when it is used for extended periods, the brightness level should be kept at the minimum usable value. The straight electron—gun design eliminates the need for a beam bender, and a slight ion burn may therefore be noted after the tube has been in use for some time. This in no way affects the usefulness of the tube, nor does it indicate that the tube is approaching the end of its useful life.

Other notable electrical features include electrostatic self-focusing (internal connection between grids 2 and 4), light transmission of approximately 80%, and a white P4 phosphor which has short to medium persistence. Because 110° tubes are employed in both 450-ma and 600-ma filament strings, the 8YP4 is designed to operate from a filament supply of 6.3 volts at 600 ma, 6.3 volts at 450 ma, or 8.4 volts at 450 ma, making the tube useful in any of the 110° sets now in existence. Physically, the 8YP4 is about 9″ long, 8″ wide, 6″ tall and weighs 2 pounds. The neck itself has a 1⅛″ outside diameter with a length of 5 $\frac{3}{16} \pm \frac{3}{16}$″.

USING THE 8YP4

To use the 8YP4 on the service bench, the technician must utilize some reasonable method of holding vertically-mounted type chassis in an upright position. The check tube can then be slipped through the yoke and propped in place as shown in Fig. 3. A piece of ½″ or ¾″ plywood about 18″ by 24″ makes a good base to which a vertical-type chassis may be secured. In this example, short wood screws were used in fastening the chassis-mounting lips to the plywood. Screws alone may not provide the necessary stability for some chassis designs, in which case they may be further secured with wire as shown in Fig. 4. If the necessary chassis holes are not available, they can be easily made with a drill. In some cases, it may be desirable to drill a hole through the plywood and secure the chassis with bolts and nuts rather than wood screws.

The wooden bracket on which the 8YP4 is shown resting is one which was originally made for use with the 8XP4. A small piece of 1″ pine was needed for additional height, placing the check tube in a plane that would give maximum security, while keeping the yoke firmly seated in its normal forward position. It takes

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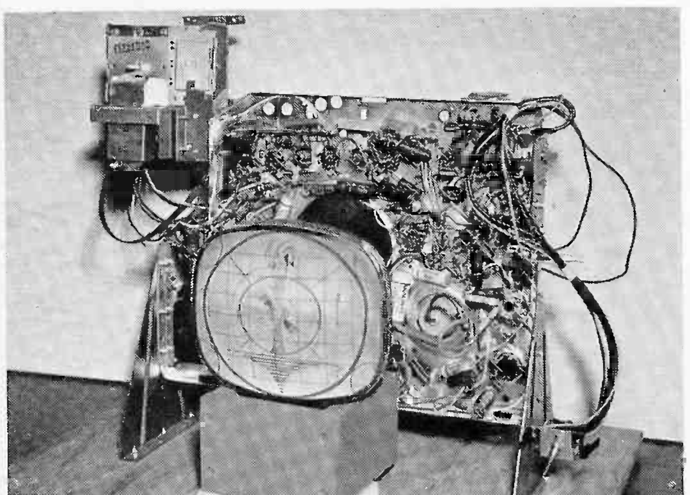


Figure 3.—8YP4 being used to check operation of a vertical-type chassis.

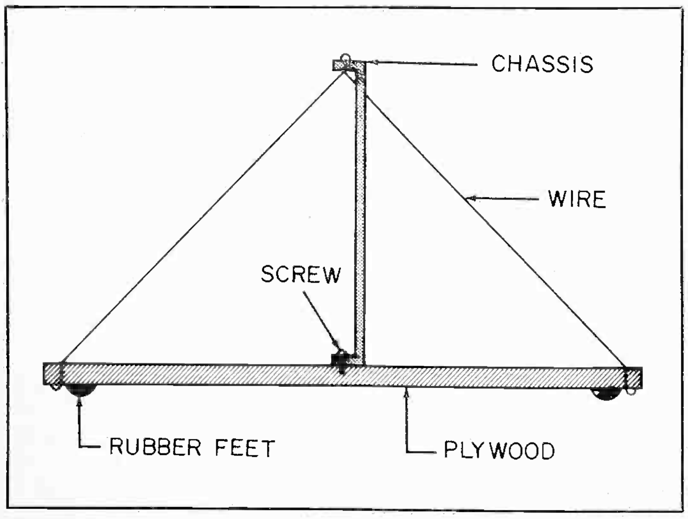


Figure 4.—Drawing to illustrate vertical chassis mounted on plywood base.

only a minute or two to make a setup such as this.

The plywood base can be improved further by the addition of four rubber feet, small holes at the four corners for support wires, a couple of holes in the center through which the chassis can be bolted, and a coat of durable paint. If you are doing very much servicing on receivers that employ vertical chassis and 110° picture tubes, you may want to have several of these bases available.

A better method of supporting the 8YP4 is illustrated in Fig. 5. This setup consists of a felt-padded metal band around the bulb of the 8YP4, and a metal bracket to suspend the tube from the chassis. Most of the necessary materials should be available in your "junk box." A piece of malleable iron or ST type aluminum ⅛" x 1" x 14" is satisfactory for the two bracket pieces and a short piece of stainless steel or galvanized antenna-mounting strap should suffice for the metal band around the tube. Small angle brackets riveted to the ends of the metal strap secure the band around the bulb. The remaining details are clearly outlined in Fig. 5.

NOTE particularly that three methods of attaching the bracket to the chassis have been considered: 1). Chassis lip turned forward and sufficient clearance between it and circuit components to clear the small turned-down end on the bracket. 2). Lip turned toward the rear. 3). Lip turned forward but no clearance for bracket tip. If this is the case, lay bracket over the chassis, drill a hole through the lip of chassis to match the unthreaded bracket hole and secure with bolt and nut.

The small amount of time spent in preparing the test fixtures just outlined will be returned to you many times. Other advantages are increased safety for yourself, reduced danger of breaking the check tube, and added accessibility to the circuit components behind the bell of the tube.

As a further timesaver, larger shops will want to have several of the 8YP4 check tubes available. Even a small shop will find a use for at least two—one to keep in the service truck and one for the shop.

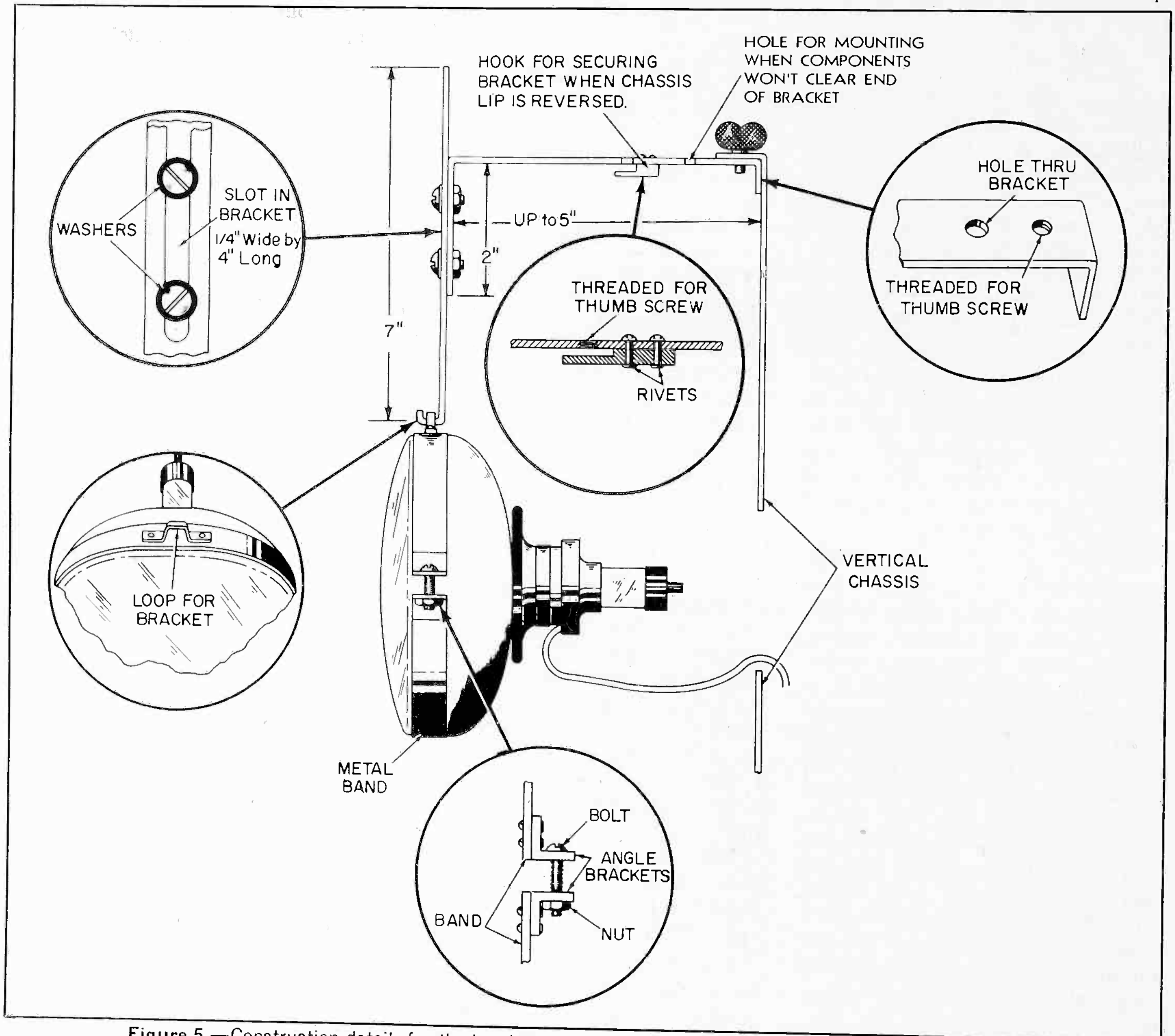


Figure 5.—Construction details for the bracket and band assembly for use in supporting the check tube.

MORE TRANSISTOR FACTS AND TESTS

John N. McCaul, Supervisor, Sales Engineering Service, Electronic Tubes Division

Let's look at the transistors we find in the radios serviced today. The majority of these transistors are of the junction variety, for a number of reasons. Stability of operation and close control of transistor action are among the more important factors governing their use.

However, in junction transistors we never have a current gain within the transistor. The current gain is always less than one, somewhere in the order of .95 to .98. Now, this would seem odd in an amplifying device, especially in view of the fact that transistors are current operated devices, whereas our vacuum tubes are voltage operated devices. The transistor's gain is dependent upon $\Delta I_C/\Delta I_E$ and this is called α (Alpha), whereas in tubes our mu or amplification is $\Delta E_{PF}/\Delta E_G$. Here would appear to lie a mystery, for how, with our ratio figure less than one, can we hope to gain any amplification within the transistor.

The answer lies within the great resistance ratio between our input and output. Remember, our voltage gain is equal to our current gain (which is always less than one) times our resistance gain (which may be of the order of 1000) or $V_G = I_G \times R_G$. Thus, despite the fact that I_G or α is less than one, we get a great voltage gain as a result of our large resistance ratio.

We have been discussing, so far, the grounded or common base configuration. Going a step further, let's look at the common emitter hookup which is the most widely used today. Let us see why it is so popular. If the α of a transistor is, let us say, .97, this means that for every 100 carriers that leave the emitter, 97 pass thru the collector and 3 drop thru the base circuit. Now, if we impress our input signal on the 3 carriers traveling thru the base circuit (keeping our emitter common) we affect the 97 carriers passing thru the collector or the output. Thus, although the transistor itself exhibits no current gain, we can effectively utilize the large difference in current between the base and the collector. Then, as far as our input and output carriers are concerned, we have a gain of 97/3 or 32.3. This ratio, namely the collector current to the base current, is called β (Beta). The output to input resistance ratio is not as large in the common emitter hookup, but the voltage gain (V_G) which we want, is now the product of $\beta \times R_G$, and this product is greater since β is so much larger than α. It may be commonly assumed that the approximate relationship between the two ratios is $\beta = \alpha / 1 - \alpha$. One drawback to the common emitter configuration, with its better voltage gain, is that our I_{CO} (to be covered in the next *Sylvania News* transistor article) or leakage current is a much more important factor, and, therefore, any increases in I_{CO} must be avoided. In the grounded emitter circuit, I_{CO} is multiplied by β which, as we know, is so much larger than α. This means that it will have a greater effect on the signal we are amplifying. This greater effect of I_{CO} may either result in poorer frequency response or increased distortion. As we know, any increase in temperature will increase our I_{CO}, and, therefore, in the common emitter circuits so predominant today, we must watch our temperature. To overcome the increase in I_{CO}, caused by slight temperature changes or drift, we employ what is called a stabilizing resistor in the emitter circuit. This resistor creates a negative feedback which overcomes any change in current due to temperature drift. It is usually by-passed or paralleled by a capacitor to avoid any AC in the negative feedback. (Fig. 1.)

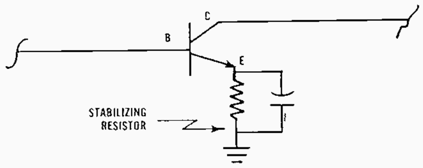
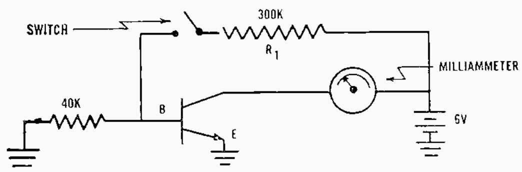


Figure 1

This is just one of many ways currently employed to avoid the problems developed by ambient temperature changes or drift. This action is very similar to that of the cathode resistor used in vacuum tube circuitry.

Since, as has been said earlier, the common emitter is the predominant circuit that you will find in radios today, then the transistor parameter that is most pertinent is β. This is a measure not only of transistor action, but actually of how good or how efficient the transistor action really is. It is a measure of the relative quantity between the output carriers at the collector and the input carriers at the base. What we need to determine β is, simply, a circuit which will put a known current, upon the closing of a switch, into the base circuit. A milliammeter in the collector circuit will then give us a direct reading of how good our transistor under test is, or, in other words, its β. Below is such a simple test circuit.



The polarity observed here is for an NPN unit.

Selection of our voltage and R_1 values are actually somewhat arbitrary. What is important is that you know the amount of current that you are putting into the base circuit when you close the switch. As it is set-up in the figure above, when the switch is closed, .02 MA is the current in the base. The milliammeter should have a scale of 0-3 mils. Remember to have the switch open before starting your test. Now, if the transistor we are testing should have a β of ten, then with the switch closed the meter should read .2 MA. If the transistor should possess a β of 100, then the reading on the meter should be 2.0 MA, and so on. Remember that such a type of test will give you an indication only of how good your transistor may be. The values of the battery and resistor may change thereby giving you different results than you may expect. However, as with all equipment, if you know your tester and use it as an indicator only, it can greatly help you in your work in servicing transistorized equipment and radios.

SYLVANIA NEWS
MAY 1958 VOL. 25, NO. 5
R. A. Humphreys, Technical Editor
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technical
SECTION

PRINTED CIRCUIT SERVICE HINTS

(PART I)

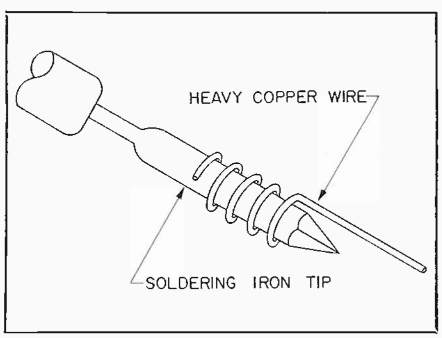


FIGURE 1.—Method of using a high wattage iron in place of a low wattage iron.

Printed Circuits have replaced conventionally wired circuits in many applications including television receivers, portable radios, and in many pieces of equipment where size and weight are of main interest. They have many advantages over hand wired units in that error-free wiring as well as compactness and uniformity are experienced. The printed circuit is easy to troubleshoot, since all its leads can easily be seen, and capacitors and resistors as well as all major components are easily accessible. In addition, voltage readings can be taken directly at the tube socket pins and most major components on either the top or bottom sides of the panel.

The replacement of components in printed circuit chassis is also relatively simple. However, the printed circuit board can be permanently damaged by excessive heat during the soldering of components, or in the process of attempting to pry a defective component loose. Any overheating may cause the bond between the laminated phenolic board and the copper foil to break. A brief discussion of the basic construction of printed circuit boards prior to discussing actual servicing techniques will help us understand why certain precautions must be observed.

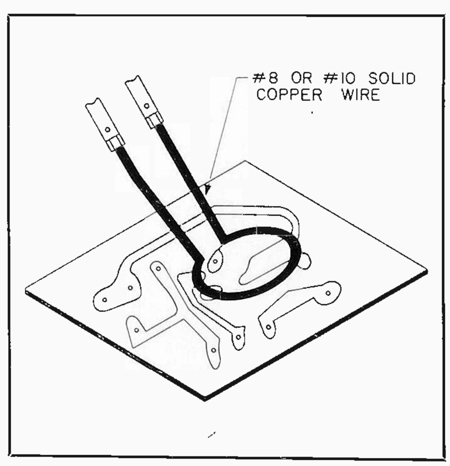


FIGURE 2.—Special soldering-gun tip.

PRINTED CIRCUIT BOARD CONSTRUCTION

Paper base phenolic is the material used for most printed boards; a laminated product comprised of several layers of a good grade of rag paper with heavy phenolic coating. Rolled copper foil in the order of a few thousandths thickness is then added to form the conducting part of the base material. Next the printed circuit pattern is imprinted on the copper with a special resistant which protects the circuit design as the etching solution removes the remaining exposed areas.

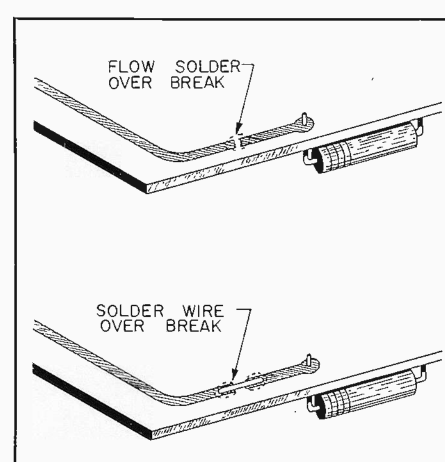


FIGURE 3.—Two methods of repairing breaks in foil.

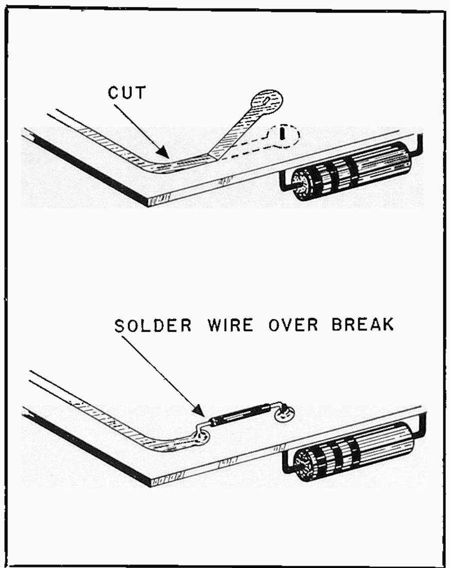


FIGURE 4.—Method of repairing raised section of foil.

Actually, there are several methods of imprinting the circuit design in the copper foil. The Photo-etch process is probably the most popular commercial method. In this process the copper foil is made light-sensitive by coating it with an emulsion similar to that used on photographic plates. By exposing the emulsion to a light source through a negative of the circuit pattern, the desired areas of the emulsion will be activated. After being washed and rinsed only the desired circuit pattern remains. Thus, it can readily be seen that printed circuit boards are in some respects quite delicate and can, unless proper precautions are taken, be easily damaged during servicing.

AVOID EXCESSIVE HEAT

The first precaution to be observed in the servicing of printed circuit boards is to guard against subjecting the board to any excessive heat during the installation or removal of components. This problem is best overcome by using a low wattage soldering iron and/or gun. If the number of repairs does not warrant the purchase of a low wattage iron, a large iron may be used with proper precautions. One method is to wrap a piece of heavy copper wire around the tip of the iron as shown in Figure 1. This will conduct enough heat to solder but not enough to damage the printed board. Another method would be to connect an incandescent lamp in series with the high wattage iron.

SPECIAL TOOLS

Circular Soldering Iron Tip — Terminals on tube sockets, transformers, coils, and potentiometers are usually arranged in a circle. Therefore, by revamping the soldering-gun tip to form such a circle, the above mentioned parts can be repaired with a minimum of time and effort. The circular tip can be constructed with a piece of No. 8 or No. 10 copper solid wire. Figure 2 shows how this special tip is placed over a group of terminals enabling the part to be removed without breaking the board or damaging the copper bond.

A number of other semi-special tools which may not be found in the shop, but which are invaluable when repairing printed circuits include:

1. 1½″ diameter solder pot (optional)
2. Silicone resin and solvent
3. Masking tape
4. Toothbrush (fairly firm bristle)
5. 60% tin, 40% lead low temperature rosin solder (normal solder, 40% tin 60% lead)

The use of these items in conjunction with the servicing of printed-circuit-boards will be discussed throughout the remainder of the article.

REPAIR AND REPLACEMENT TECHNIQUES

Repair of Foil—If the foil has been damaged, there are two methods of repair to use depending on the size of the break, Figure 3. If the break is small (1/32″ or less) tin both sides of the break, then flow solder across the gap. If the break is larger, tin both sides of the break, lay a piece of solid hook-up wire across the gap (allowing at least 1/16″ overlap on each side) and solder it to each side of the break. Bare wire may be used if the break is not too large; insulated wire should be used if the break is

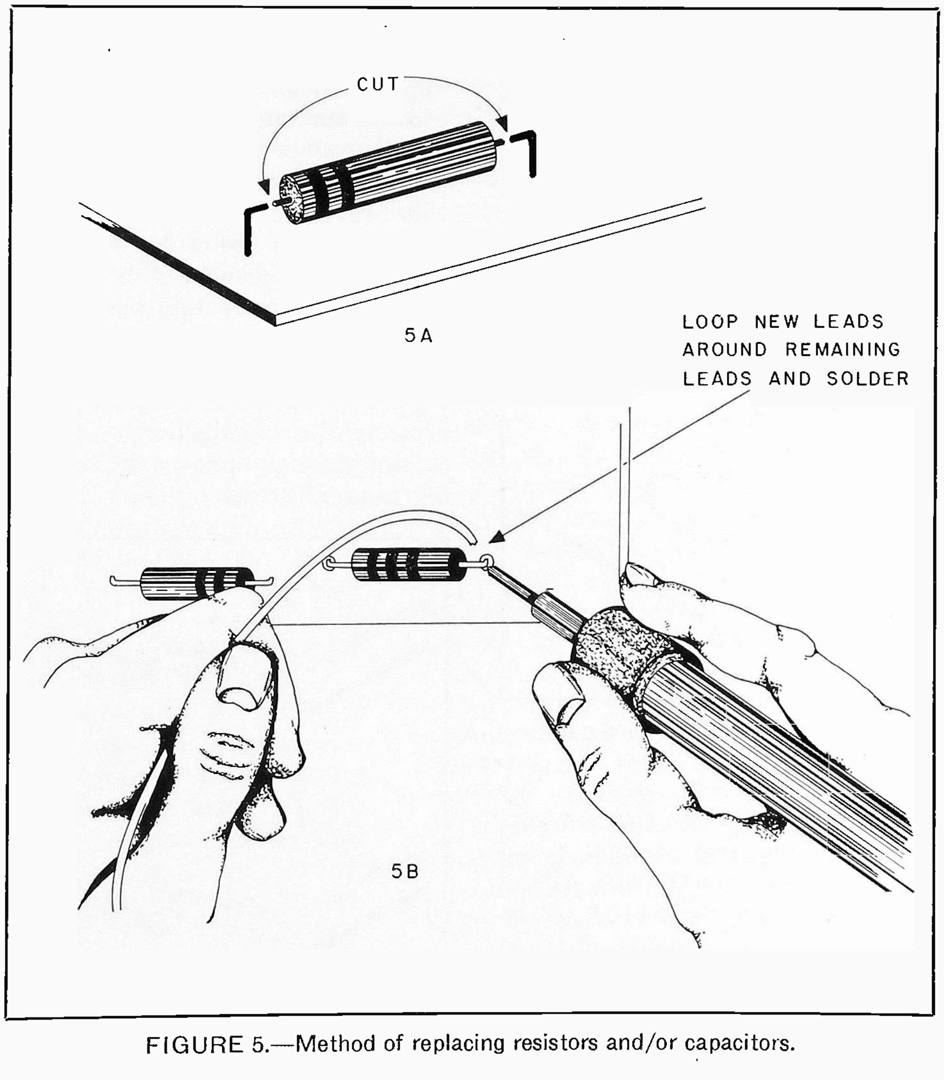


FIGURE 5.—Method of replacing resistors and/or capacitors.

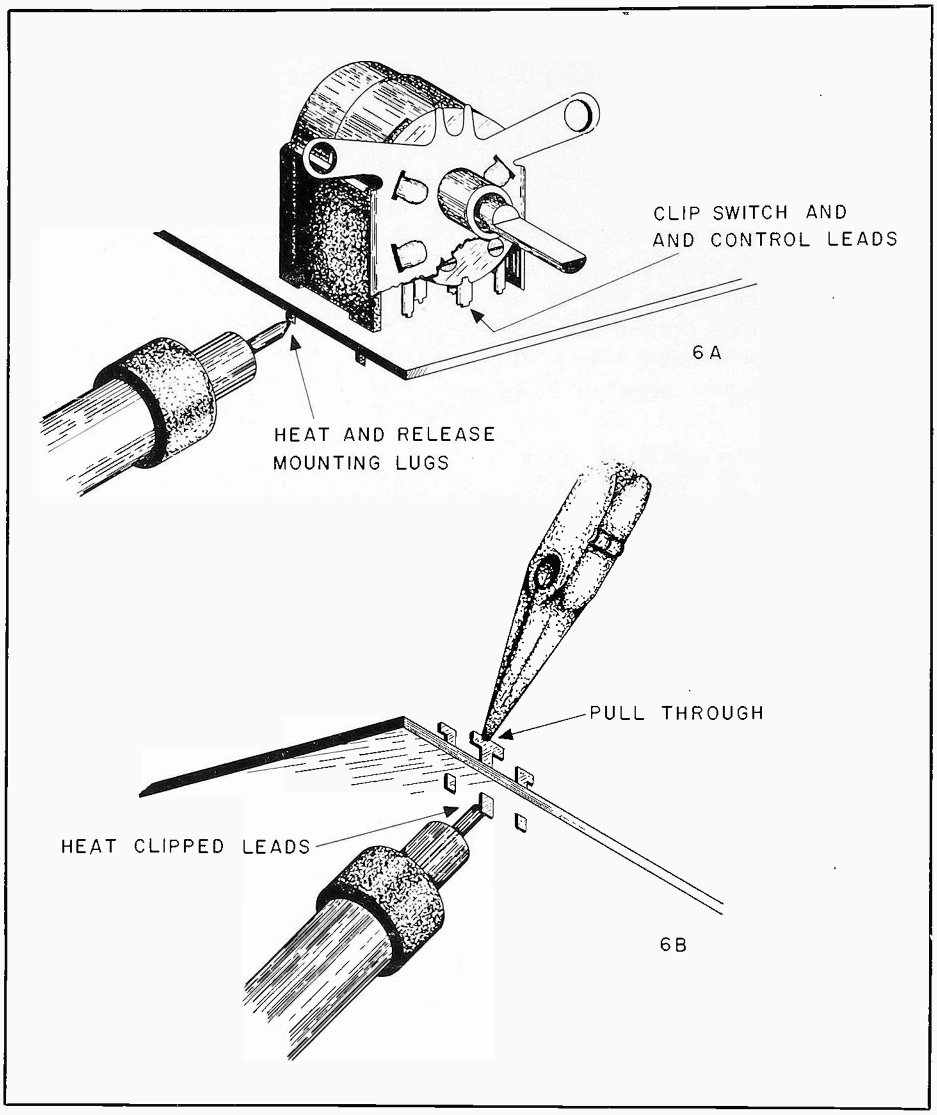


FIGURE 6.—Method of replacing a control assembly.

large enough to cause a possibility of a short.

Raised Foil—If the printed circuit foil becomes raised from the panel, clip off the raised section and replace it with a section of wire in the same manner as given for breaks, Figure 4.

Resistors and Capacitors—the following two methods are recommended for the replacement of resistors and capacitors (except "can" type capacitors):

Cut the leads on the original units as close as possible to the body of the unit. Straighten the old leads from the panel so that they are perpendicular to the panel and loop the leads from the new unit around the old leads; solder the leads together and trim the excess old leads if necessary, Figure 5.

To completely remove the component, cut the leads on the original unit as close as possible to the chassis. Heat the joint at the bottom of the chassis and pull each original lead through the hole from the bottom of the panel. Clean the holes and insert the new component. Bend the leads over on the bottom of the panel, clip any excess lead, and solder in the new component.

Oscillator Coil, IF Transformer, Can-Type Electrolytic Capacitor, Variable Capacitor—To replace these items it is convenient to make use of the circular formed tip previously mentioned. However, if this item is not used then apply a low wattage soldering iron to each individual lug and brush off any molten solder with the small brush (toothbrush). When removing solder by heating and brushing, exercise caution to prevent spreading solder. This can cause possible leakages and shorts. When clean, bend each lug to the center of the hole (while the solder is melted) to free the lug from the copper strip. With all the lugs free, lift the component from the panel.

When replacing an IF transformer, care must be taken to note the position of the lug bearing the color dot. This lug should be used as a "guide" lug when inserting the new component. Do not use the manufacturer's number on the side of the can as a guide because the position of these numbers may vary.

Another precaution must be taken when a new IF transformer is installed. If a lug is overheated, solder may flow into the transformer causing a short.

Controls—To replace controls mounted directly on the printed circuit board, cut the leads to the control assembly about 1/4" above the chassis. Free the mounting bracket by heating the lugs one at a time and brushing away the solder until each lug is free; then, lift the assembly from the panel, Figure 6. (If the lugs are bent, straighten them before attempting to remove the bracket.) Remove the leads that were previously clipped by gently pulling each one from the component side of the panel while applying heat

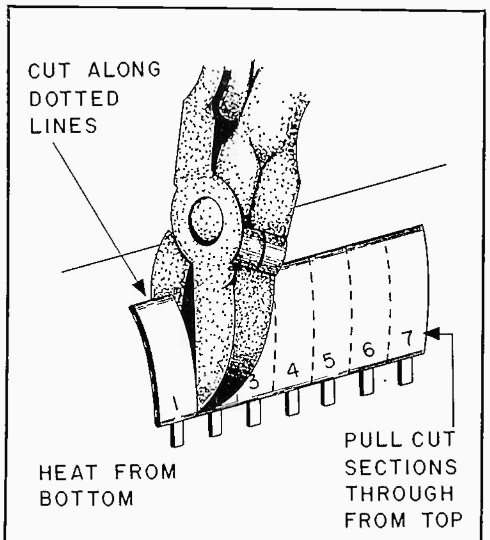


FIGURE 7.—Remove printed circuit plate a section at a time.

to the point at which it is soldered on the bottom of the panel. Clean all of the holes for the control leads and bracket, insert the new control, and solder all connections.

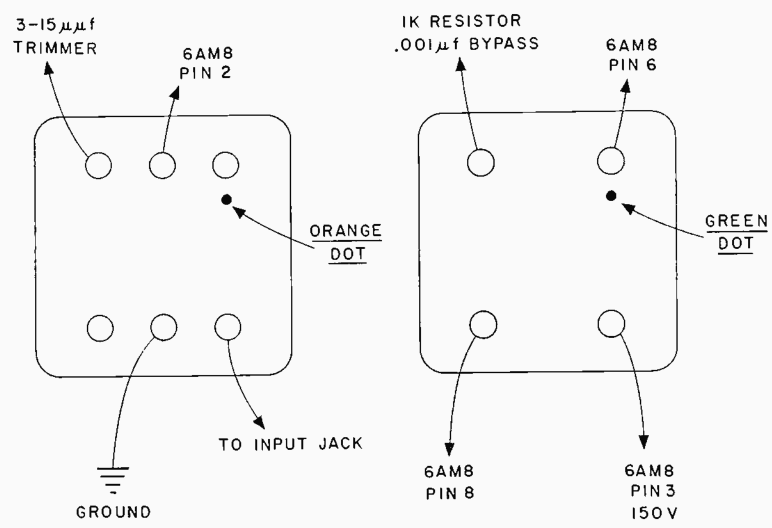
Printed Circuit Plate—A printed circuit plate is a sub-printed circuit consisting mainly of resistors and capacitors. Usually these plates are used as RC networks, but in some cases they have been used for complete amplifiers. The plate may be removed by heating each lug and brushing it to free it from the panel. If it is definitely determined that the plate is defective, it may be more easily removed if it is first cut into small pieces with a pair of diagonal cutters in such a manner that the individual lugs of the plate will not be joined together by the remaining sections of the plate, Figure 7. Heat each lug on the wiring side of the panel while gently pulling the same lug from the component side of the panel. Thoroughly clean all holes, insert the new plate and carefully solder all the connections.

Additional information concerning the repair and/or replacement of tube sockets, solder-pot techniques, final inspection and troubleshooting of printed circuit boards will appear in the June 1958, issue of Sylvania News.

Additional Information On Practical Chroma-Tracer

We have received a number of inquiries asking for additional information on the Chroma-Tracer as described in the article "Compatibility in Color Receiver Servicing" which appeared in the September 1957 issue of *Sylvania News*. The figure below, identifies the terminal connections for transformer T1 and T2. Additional power supply information is also included.

I TRANSFORMER TERMINALS, T1 AND T2



T1 (SYLVANIA 120-0014)

T2 (SYLVANIA 120-0013)

II POWER SUPPLY

POWER TRANS. : MERIT P-3045 (OR EQUIVALENT)

PRI - 117 V, 60 CPS

SEC - 117 V, 50 MA* (HALF WAVE) 6.3 V, 2 AMP.

RECTIFIER : 6X4 OR SUITABLE SELENIUM RECTIFIER

*CURRENT RATING OF SECONDARY (hv WINDING) MAY BE AS LOW AS 25 MA.

ERRATA

The following corrections apply to the article "Measurement Circuits for Sylvania Transistors" as published in the January 1958 issue of *Sylvania News*.

1. **FIGURE III** — There should be a drawing of a current-meter in the line leading from the variable resistor R_1 to E of the transistor.

2. **FIGURE IV** — The arrowhead has been omitted from the center-arm connecting the I_b DC meter to the variable 5K resistor.

3. **FIGURE V** — The lower lead connecting the V_{CE} meter, the 5K resistor and the V_{CC} supply should be returned to ground.

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R. A. Humphreys, Technical Editor

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technical

SECTION

PRINTED CIRCUIT SERVICE HINTS

(PART II)

In Part I, we discussed the basic construction of printed circuit boards, some necessary precautions and the use of a few special tools before going into the techniques of repairing and replacing defective components.

When it is necessary to replace a tube socket, crush the bakelite of the socket with a pair of diagonal cutters a small section at a time and separate from the contacts. Use care not to put any pressure on the loose pin contacts as this will cause the copper foil to be pulled away from the panel. It is suggested that small sections of the bakelite be cut at a time. The pins can now be removed by applying heat to the lugs on the printed side of the panel and gently pulling them through the hole from the component side. Remove the center post by applying heat at its soldered point and pushing it through from the component side. Be sure that all holes are clean before attempting to insert the new socket. Insert the new socket and solder the lugs and center post.

A convenient method of replacing the common wafer type socket shown in Figure 1 is to remove the top wafer of the defective socket (exposing the individual contacts) and insert a Sylvania type printed board socket in the appropriate lug openings and solder. Be sure to remove all broken socket clips from the old socket before mounting the Sylvania socket.

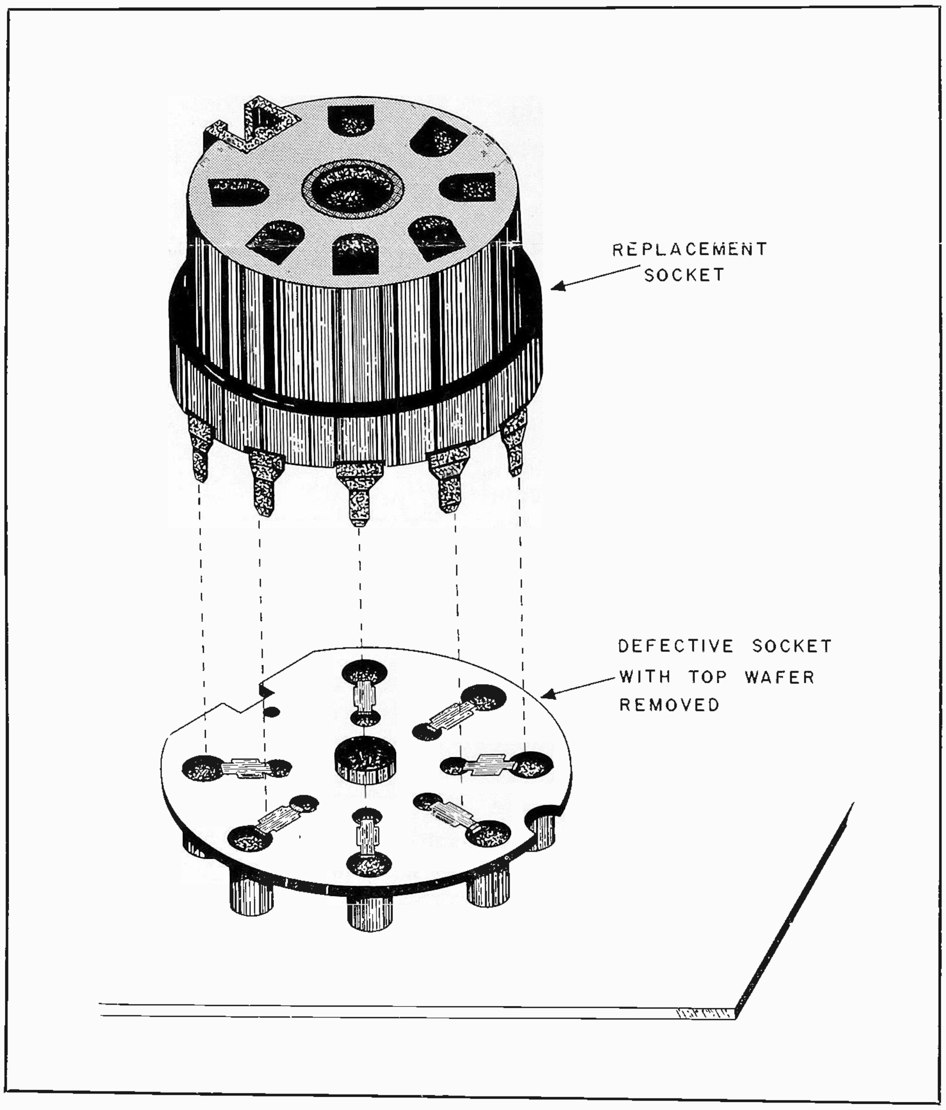

FIGURE 1.—Repair without removal of defective socket by insertion of Sylvania type printed circuit socket.

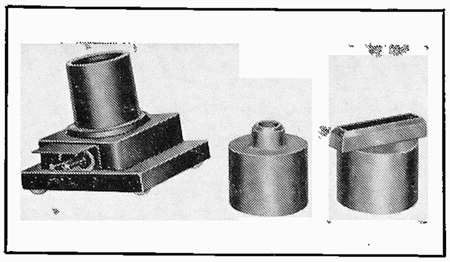

FIGURE 2. — Drake "Three-in-One" Solder-dip pots (from left, Models 100, 100A, 100B) for printed circuit servicing. (Courtesy of Drake Electric Works Inc. of Chicago, Illinois.)

The Sylvania printed circuit socket part numbers for T-5½ and T-6½ tube types are 7470-0102 and 7490-0080 respectively. In some cases the socket can be replaced without removing the chassis from the cabinet and without subjecting the printed board to an excessive amount of heat.

COMPONENT REPLACEMENT WITH SOLDER POT

Now that we have become familiar with some of the problems connected with servicing printed circuit boards, it can be seen how a solder pot (approximately 1½″ diameter) could speed up and simplify component replacement. A solder-dip-pot of the type just described is shown in Figure 2. The two accessory pots No. 100A and No. 100B are placed over the No. 100 pot when only small sections of the printed circuit board require servicing. A thermostat temperature control capable of varying the solder temperature from 300 to 600 degrees is shown in Figure 3. This control is extremely handy when components of various sizes are mounted on the printed circuit board.

To remove a component, its soldered connections are placed over the solder pot so that they make contact with the molten solder. The component is then pulled up through its mounting holes. (The chassis area must not be left in the molten solder too long or damage will result to the printed circuit.)

Installation of the new component is accomplished by placing the component area on the foil side of the panel over the solder pot so that it makes contact with the molten solder, then gently push the new component into place. The joints should then be touched up with a light heat soldering iron to correct any spot missed and to remove excess solder.

The advantage of this method is that the holes need not be cleaned before replacing a component, or components need not be broken for removal. The only component that requires special care is a tube socket. Its center lug must first be cut as close to the panel as possible with a pair of diagonal cutters. This is necessary because of the flange on the center post which would ordinarily make removal difficult. It then can be removed by the same method as given for other component replacements with the solder pot.

FINAL INSPECTION

Upon replacing a defective part with a new part, the board should be checked for shorts caused by excess or overrun solder and also for open foil. If the foil becomes open, solder can be run from one end of the open foil to the other. If the break is large,

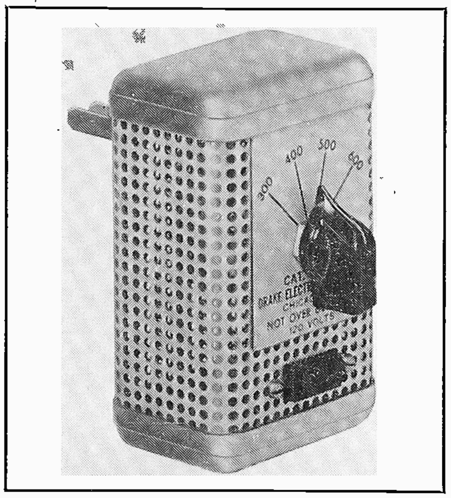

FIGURE 3.—Temperature control used in conjunction with "Three - in - One" solder-dip pots. (Courtesy of Drake Electric Works Inc. of Chicago, Illinois.)

a piece of insulated wire connected between solder points can be used to complete the circuit, Figure 4. Always check where the foil and metal frame or tie point meet to make the ground connection since this will open with the slightest jar and is difficult to see.

After the repair area has been carefully checked and any repairs made the area should be cleaned with a solvent and a rag or stiff brush. Denatured alcohol makes a good solvent. If carbon tetrachloride is used, avoid over exposure to the fumes. These fumes are extremely poisonous and can cause serious illness.

Leave sufficient time for the cleaner to evaporate and then coat the foil side of the printed board with a silicone spray. Use the masking tape to protect the parts on the other side of the board.

TROUBLE SHOOTING

The general techniques of trouble-shooting receivers employing printed circuit boards are essentially the same as those used in servicing conventionally wired chassis. Circuit tracing on the top side of the printed circuit board can be simplified by placing an incandescent lamp (40-75 watts) beneath the board. Since most circuit boards are translucent, the printed wiring will be clearly visible.

In conclusion, we might add that voltage readings should be taken only at soldered points on the foil. It should be noted that this precaution applies to the connection of all other types of test equipment to the printed circuit board. It is advisable to use these soldered points in order to prevent damaging the foil. When taking measurements be sure to use a sharp-pointed probe since the printed circuit panel is covered with a protective coating of resin which prevents moisture and dirt from causing leakage or shorts.

This concludes the series of two articles entitled "Printed Circuit Service Hints;" the first part of which appears in the May 1958 issue of *Sylvania News*.

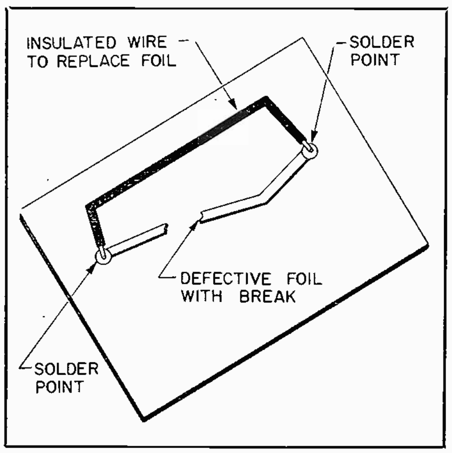

FIGURE 4.—Repair break in foil by connecting insulated wire between solder points.

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AUGUST · SEPTEMBER 1958 VOL. 25, NO. 7
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technical SECTION

STEREO IN THE HOME

(PART 1)

by J. L. Erhard Advanced Application Engineer Radio Tube Division

High quality sound reproduction, more popularly known as "Hi-Fi," has been available to the consumer for the past decade. Stereophonic sound, although a reality for 25 years, has just recently entered the home entertainment field. Because of the increasing popularity of stereophonic sound for home use, the enterprizing service technician now has an additional source of revenue. Future servicing can be seen to concern a great deal more home music system maintainance than in previous years. As noted in Figure 1, sales of home music systems have been increasing rapidly and steadily in the past several years.

Stereophonic sound, like 3-D motion pictures, adds "depth" to sound. When an orchestra is playing, locations of individual instruments can be easily visualized, almost as though the orchestra itself were playing in front of the listener.

In 3-D motion pictures, two cameras, two films and two projectors are used to place two pictures on the screen to give "depth" to the picture.

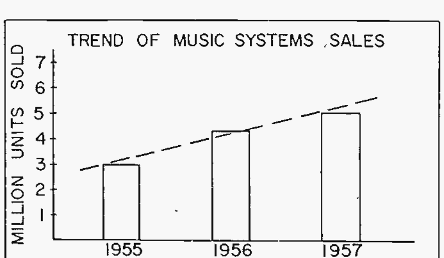


FIGURE 1—Sales of home music systems have been climbing rapidly in the past several years.

Similarly, as shown in Figure 2, stereo-sound uses two microphones, two amplifiers and two speakers to give the feeling of "depth" to sound.

MONO AND STEREO SOUND SYSTEMS

Stereo sound employs what is known as a "two channel" system (having two separate audio channels) as compared to regular, or Monophonic, sound which uses only one. In order to obtain a thorough understanding of stereo, let's compare the mono and stereo systems using an orchestra as

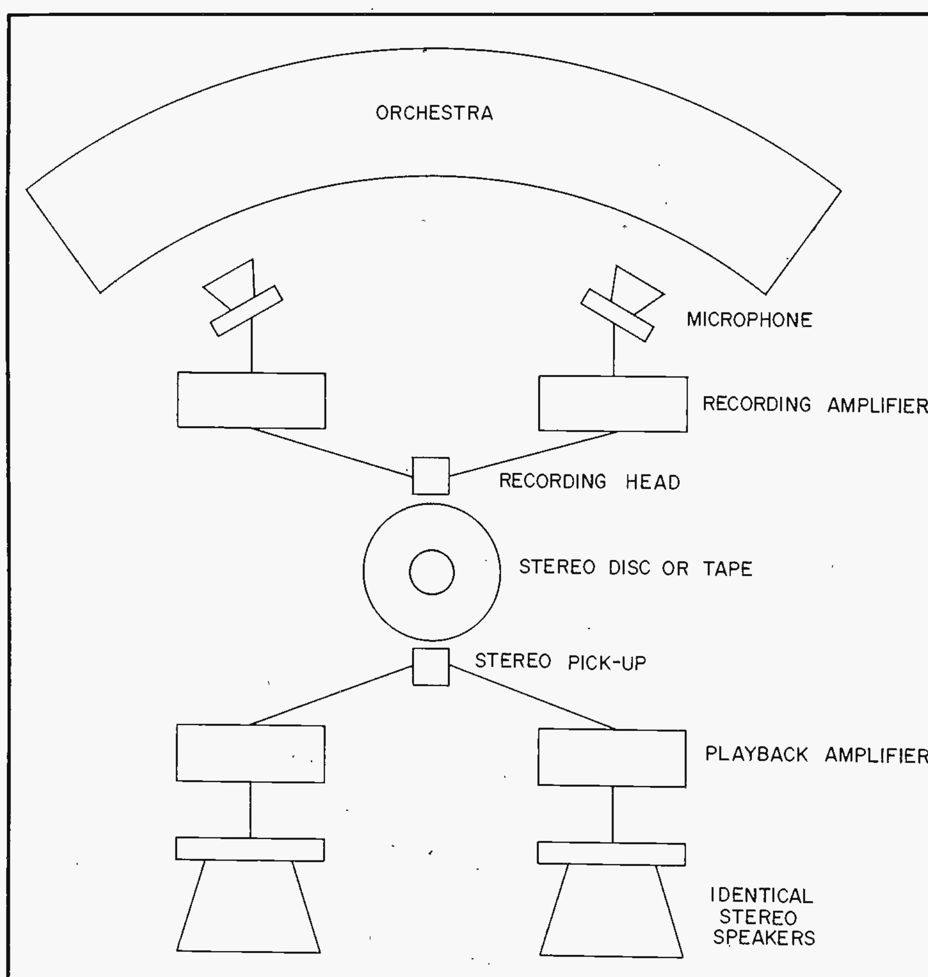


FIGURE 2—A stereo "two channel" sound system.

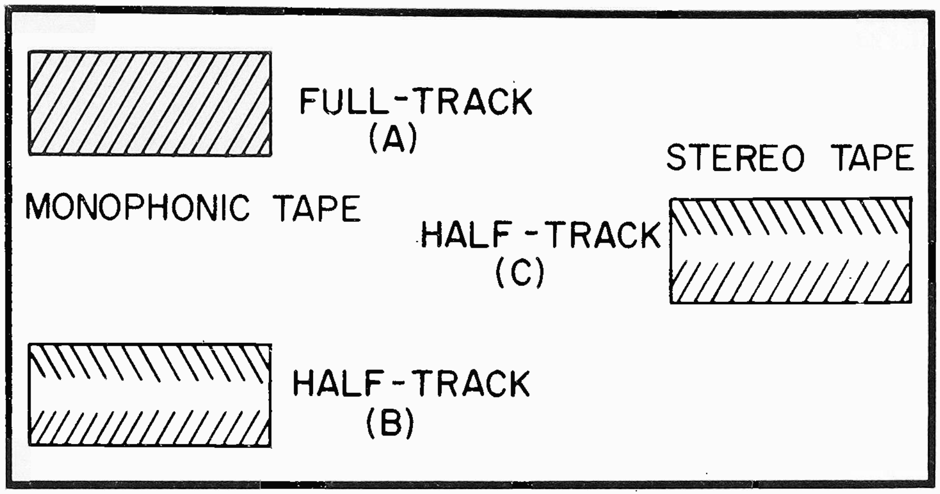


FIGURE 3—Three methods of recording sound on tape. 3A—Monophonic full-track—entire width of tape used for a single recording. 3B—Monophonic half-track—each half of tape contains a different monophonic recording. 3C—Stereo half-track—upper half carries information contained in channel 1, lower half information contained in channel 2.

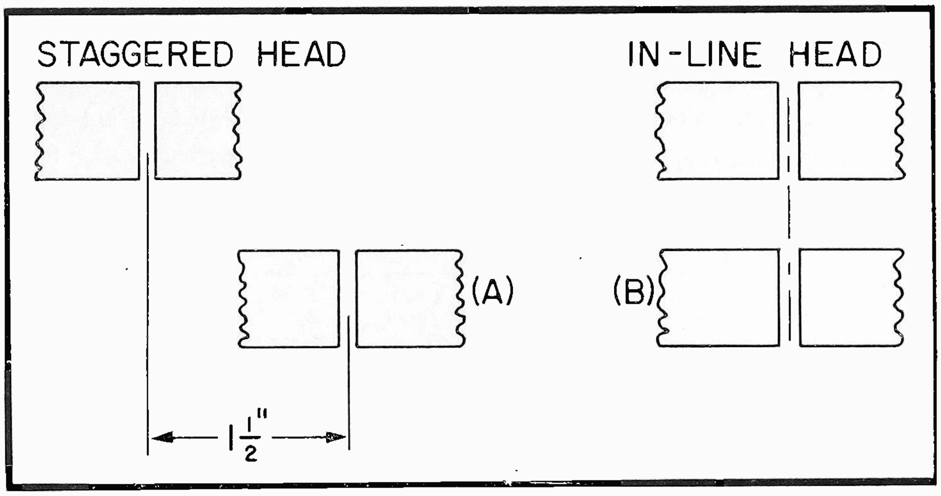


FIGURE 4—Early stereo systems utilized "staggered" recording and playback heads whereas modern systems utilize "in-line" heads eliminating synchronization problems.

our source of music.

Recording—The sound waves from the orchestra are, of course, picked up by microphones. One accepted method for monophonic use is to place a single microphone approximately 15 feet above the conductor's podium. In this location, the microphone receives an excellent mixture of sounds from the various instruments of the orchestra.

For stereo recording, two microphones are placed approximately seven to ten feet apart directly in front of the orchestra. (The exact placement depends upon the individual recording engineer and the effects he wishes to achieve.) One microphone receives sound from predominantly one side of the orchestra while the second microphone receives sound from the other side.

Record Processing—As soon as the orchestra starts to play, processing commences. This step consists of recording the music on tape (often more than once since someone might have hit the wrong note or perhaps sneezed half way through) and then editing the tape to remove all errors before arranging the musical selections in the desired order. A disc master is then made from the tape and processed until a record is finally produced for home use.

Stereo-sound is processed in exactly the same way as mono-sound except both channels are kept separate throughout the processing steps. As before, the final product is a stereo record or a stereo tape recording.

Playback—The mono - record is then placed on a phonograph and played back through a single speaker system. The stereo record (or stereo tape) is placed on a stereo system and played back through two separate identical speakers. These speakers are generally spaced about seven to ten feet apart in the average living room. It must be realized that each speaker radiates different audio sounds — both together produce stereo.

STEREO TAPE

Actually there are two methods of recording sound on tape. Most professional recorders use the "full" track method which records over the entire width of the tape, Figure 3A. Full-track mono-recording is used for slightly better signal-to-noise ratio and for editing ease. Home tape machines use the "half" track method whereby sound is recorded on only one half of the tape, Figure 3B. Thus it can be seen that by using the latter method the amount of sound that can be placed on a single tape is increased by 100 per cent. Stereo tape, with its required two channels, consists of simply two half track recordings on one tape, as shown in Figure 3C.

Early stereo tapes used what was known as "staggered" heads, Figure 4A, whereby recordings were placed 1½ inches apart on the respective tracks. These staggered heads required spacing adjustments to synchronize the tracks as well as azimuth adjustments for frequency response.

Modern stereo tapes use what is known as "in-line" heads whereby both signals are recorded on the same vertical axis, Figure 4B. The modern "in-line" heads are much easier to adjust than the staggered heads since they are aligned during manufacture so that only azimuth adjustments are necessary.

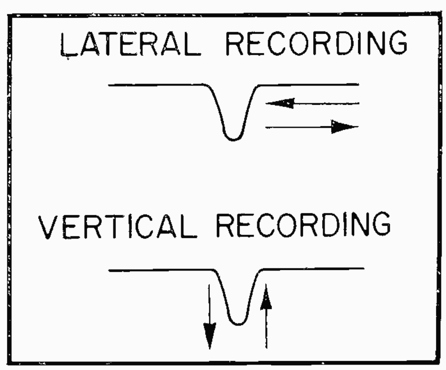


FIGURE 5—Methods used for mono-disc recording.

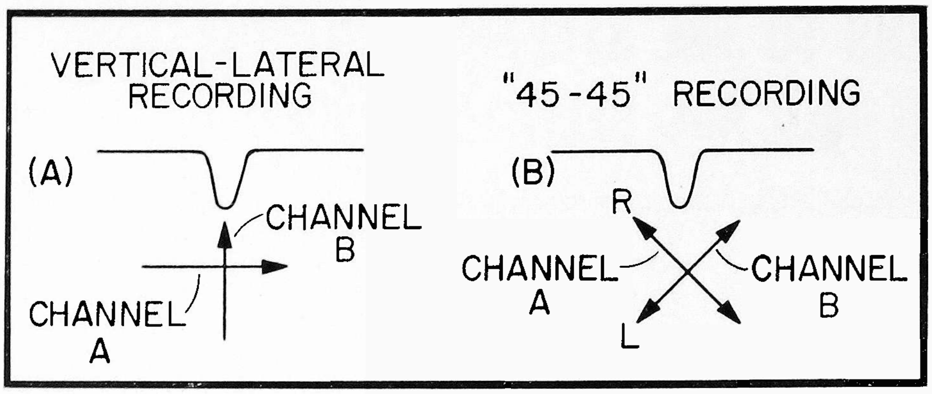
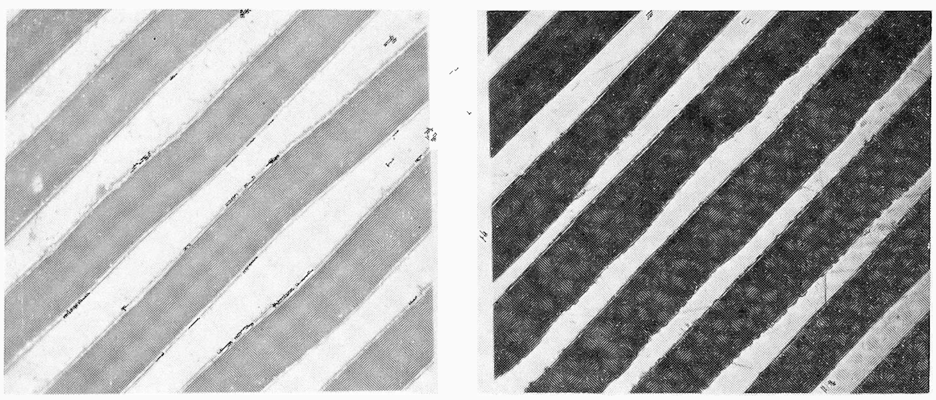


FIGURE 6—Methods used for stereo-disc recording. Note that each channel in the "45-45" system contains both horizontal and vertical components.



A B

FIGURE 7—Microphotography of a mono-disc compared to that of a stereo-disc.

STEREO DISCS

Stereo discs utilize a combination of recording techniques that have been used in monophonic disc recording for many years. The techniques or methods used for mono-recording are illustrated in Figure 5. The most common method is that of lateral recording where the record groove varies sideways in displacement to carry the sound information. With the vertical method of recording, which is seldom used, the record groove varies in depth to carry the sound information.

In stereo, both of the above methods are combined to record information from the separate channels in a single groove. Early single groove stereo records used vertical recording for one channel and lateral recording for the other as illustrated in Figure 6A. However, the latest method of processing stereo discs employs the "45-45" or Westrex system, the principle of which is shown in Figure 6B. Here both channels are recorded at 90° to each other in the same groove but the axes of modulation are placed at an angle of 45° to both the horizontal and vertical planes.

Microphotography of the record groove illustrates the difference between mono and stereo recording. Figure 7A is a photograph of a monophonic disc. Notice that the groove moves only from side to side to convey the information. The stereo groove, photograph 7B, not only moves from side to side but varies in width also. The variation in width of the groove is caused by the triangular shaped cutting needle moving in a vertical direction.

SOURCE FOR THERMOCOUPLES

Thermocouples used in conjunction with the Filament Voltage Test Unit for High Voltage Rectifiers described in the March issue of SYLVANIA NEWS Technical Section may be obtained by writing to the American Thermo Electric Company located at 7269 Santa Monica Blvd., Los Angeles 46, California.

The "45-45" system is preferred over the vertical-lateral method for the following reasons:

1. The vertical lateral system of recording results in one channel having much high distortion than the other. The "45-45" system, because both channels have a vertical component, splits the distortion between both channels and results in a more balanced system distortion wise.

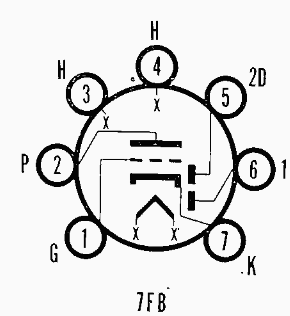
2. Dust in the record groove appears as extraneous vertical modulation (noise) while having almost no effect on the horizontal motion of the needle. Vertical-lateral stereo recording would result in record noise being reproduced in the vertical channel while the lateral channel would appear noise-free.

The "45-45" system, since both channels have a vertical component, divides the noise between both channels and again results in a balanced system.

3. A mono-record, when played on a vertical-lateral stereo system, would result in all the sound coming from the lateral channel while all the record noise would come from the vertical channel. The "45-45" system would reproduce the mono-record equally on both channels since the lateral movement of the mono-groove would be split into the two 45° axes. Again the "45-45" system results in more balanced reproduction.

ERRATUM
12EL6 MANUAL INSERT

The Basing Diagram for the Type 12EL6 is incorrectly shown on the recently issued Technical Manual Insert. The correct Basing Diagram for the 12EL6 is shown below. A replacement for this insert will be mailed to registered Technical Manual owners shortly.



IMPORTANT ADDITIONS TO THE SYLVANIA PICTURE TUBE WALL CHART AND ABC SELECTOR GUIDE

To help service-dealers keep up to date with the latest picture tube information, Sylvania provides this special supplemental listing to its popular Picture Tube Comparison Chart and pocket-sized "ABC" Guide. The listings here are for picture tubes registered since the last picture tube chart was issued.

These listings are primarily intended for use by dealers as a "data service" and because a particular picture tube type is included does not necessarily mean that it is in demand, or even available, for replacement sales now. To get your free copy of both Sylvania's Picture Tube Comparison Chart and "ABC" Guide, contact your local authorized Sylvania distributor, or write to: CADD, Sylvania Electric Products Inc., 1100 Main Street, Buffalo 9, New York.

Type	Ef Volts If Amps	Face-Plate	Shape	Metal or Glass	Ext. Cond. Coating	Focus	Defl. Angle	Anode Volts KV-Abs. Max.	Basing	Ion Trap Mag.	Nominal Length
8FP4	6.3/.6	TA	▭	G	—	MAG	90	19.8	12D	S	11 7/16
8JP4*	6.3/.6	TA	▭	G	—	Auto	110	22	8JL	N	8 15/16
8YP4*	6.3/.6	T	▭	G	—	Auto	110	22	7FG	N	8 11/16
9QP4A	4.7/.3	T	▭	G	—	Lo Es	70	7.5	12AD	S	12 3/4
14AUP4	6.3/.45	TA	▭	G	1000–1500	Lo Es**	90	16.5	12L	N	13 3/16
14AVP4	6.3/.6	TA	▭	G	450-700	Lo Es	110	15.4	8HR	N	11 3/8
14AWP4	6.3/.45	TA	▭	G	800–1200	Lo Es**	90	15.4	12L	N	13 3/16
17CLP4	6.3/.6	TA	▭	G	1800–2300	Lo Es	90	17.6	12L	S	15 5/8
17CRP4	6.3/.45	TA	▭	G	1800–2300	Lo Es**	90	17.6	12L	N	14 5/8
17CSP4	6.3/.6	TA	▭	G	900–1400	Lo Es	110	17.6	7FA	N	12 5/16
17CTP4	6.3/.45	TA	▭	G	1000–1500	Lo Es	110	17.6	8HR	N	12 9/16
17CUP4	6.3/.3	TA	▭	LWG	1200–1500	Lo Es	90	17.6	12L	N	15
17CVP4	6.3/.3	TA	▭	G	1000–1500	Lo Es	110	17.6	8HR	N	12 9/16
17CWP4	6.3/.6	TA	▭	G	1000–1500	Lo Es	110	17.6	8HR	N	11 5/8
17CXP4	6.3/.45	TA	▭	G	1000–1500	Lo Es**	90	17.6	12L	N	14 5/8
17CZP4	6.3/.6	TA	▭	G	1000–1500	Lo Es	90	17.6	12L	N	13 5/8
17DAP4	2.68/.45	TA	▭	G	900–1400	Lo Es	110	17.6	8JK	N	10 11/16
17DBP4	6.3/.3	TA	▭	G	750–1500	Lo Es	70	17.6	12L	S	19 3/16
21CBP4B	21CBP4A with B6-203 base										
21DEP4A	6.3/.6	TA	▭	LWG	2000–2500	Lo Es	110	22	8HR	N	14 11/16
21DFP4	6.3/.6	TA	▭	G	1500–2200	Lo Es	110	19.8	8HR	N	14 7/16
21DHP4	6.3/.45	TA	▭	LWG	1700–2500	Lo Es	110	19.8	8HR	N	14 11/16
21DJP4	6.3/.3	TA	▭	G	2000–2500	Lo Es	90	22	12L	N	18
21DKP4	6.3/.3	TA	▭	LWG	1700–2500	Lo Es	110	19.8	8 HR	N	14 11/16
21DLP4	6.3/.6	TA	▭	G	2000–2500	Lo Es	90	22	12L	N	17
21DMP4	6.3/.6	TA	▭	LWG	2000–2500	Lo Es	110	22	8HR	N	13 3/4
21DNP4	6.3/.6	TA	▭	G	1200–1500	Lo Es	90	22	12L	S	19
21DQP4	6.3/.6	TA	▭	G	2000–2500	Lo Es	90	20	12L	N	17 1/2
21DRP4	6.3/.6	TA	▭	LWG	2000–2500	Lo Es	90	22	12L	N	18 1/4
21DSP4	6.3/.6	TA	▭	G	2000–2500	Lo Es**	90	22	12L	N	18
21DVP4	6.3/.3	TA	▭	G	500–750	Lo Es	90	22	12L	S	20
21EAP4	2.34/.6	TA	▭	LWG	2000–2500	Lo Es	110	20	8JK	N	12 15/16
24ALP4	6.3/.6	TA	▭	G	2000–2500	Lo Es	110	22	8HR	N	15 7/8
24AMP4	6.3/.6	TA	▭	G	2000–2500	Lo Es	110	22	7FA	N	15 5/8
24ANP4	6.3/.6	TA	▭	G	1700–2500	Lo Es	90	22	12L	S	20 1/8
24AQP4	6.3/.45	TA	▭	G	1700–2500	Lo Es	110	22	8HR	N	15 7/8
24ASP4	6.3/.3	TA	▭	G	1700–2500	Lo Es	90	22	12L	N	19 1/8
24ATP4	6.3/.6	TA	▭	G	2000–2500	Lo Es**	90	22	12L	N	19 1/8
24AUP4	6.3/.6	TA	▭	G	1700–2500	Lo Es	90	22	12L	N	18 1/8
24AVP4	2.35/.6	TA	▭	G	1700–2500	Lo Es	110	20	8JK	N	14 13/16
24AWP4	6.3/.6	TA	▭	G	2000–2500	Lo Es	110	22	8HR	N	14 7/8
27VP4	6.3/.6	TA	▭	G	2000–2500	Lo Es	90	19.8	12L	N	21 1/16

*Television Receiver Check Tube. **Low Grid No. 2 Voltage.

SYLVANIA NEWS

technical SECTION

OCTOBER 1958 VOL. 25, NO. 8

R. A. Humphreys, Technical Editor

This information in Sylvania News is furnished without assuming any obligations.

STEREO IN THE HOME

(PART II)

By J. L. Erhard, Advanced Application Engineer Receiving Tube Operations

STEREO PHONOGRAPH PICK-UPS VERSUS MONOPHONIC PICK-UPS

Stereophonic pick-ups operate on the same basic principles as their monophonic equivalents except they contain more components to obtain the two channels. There are two major types of pick-ups in use today; the crystal or ceramic type and the magnetic type.

Ceramic, as used in phonograph pick-ups, is known as piezoelectric material. A piezoelectric material, usually a crystal, is one which generates a voltage when it is placed under mechanical stress. For example, suppose we have a bar of ceramic material rigidly fastened at one end as shown in Figure 1. Now let us push it toward the left. Since the left side of the crystal is now under compression, it will have a negative voltage present on it while the right side which is in tension will have a positive voltage thereupon. The actual magnitude of voltage depends upon the particular material from which the crystal was formed and how far it is displaced from its natural "rest" position.

Should the crystal be bent to the right, the negative voltage would appear on the right and the positive voltage on the left. Likewise, should the crystal be bent toward the reader, a negative voltage would appear in the front and a positive voltage on the rear. A similar but opposite effect would occur should the crystal be bent away from the reader.

Ceramic Monophonic Pick-ups—Let us see how the piezoelectric principle is utilized in a mono-lateral ceramic pick-up. Figure 2 features a simplified lateral ceramic pick-up. A needle is fastened to one end of a ceramic rod which is held at the other end by the case and the pick-up arm. Two metal foil strips are placed along the sides of the rod. As the lateral movements of the groove and needle bend the rod from side to side, voltages are generated on the two metal foil strips. This voltage is then used to operate an amplifier for sound reproduction.

A vertical ceramic pick-up is constructed much like a lateral pick-up except the metal foil strips are placed on the top and bottom of the rod. Then, when played on a mono-vertical record, voltages are generated on the upper and lower faces of the rod. What happens when a mono-lateral ceramic pick-up is placed on a mono-vertical type record? The groove and needle bend the ceramic rod in a vertical direction. However,

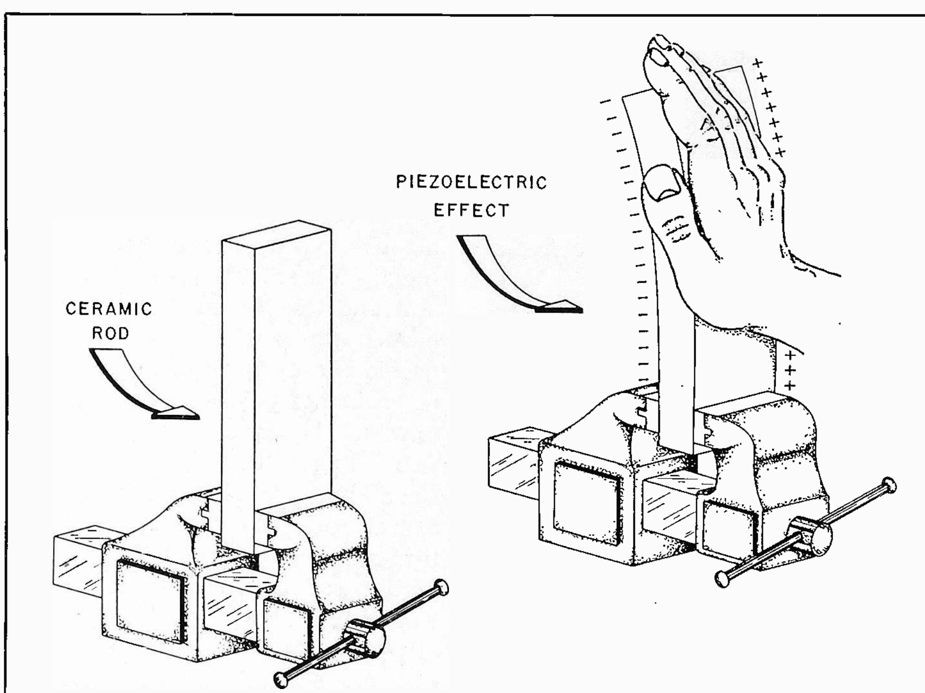


FIGURE 1—A piezoelectric material generates a voltage when placed under mechanical stress.

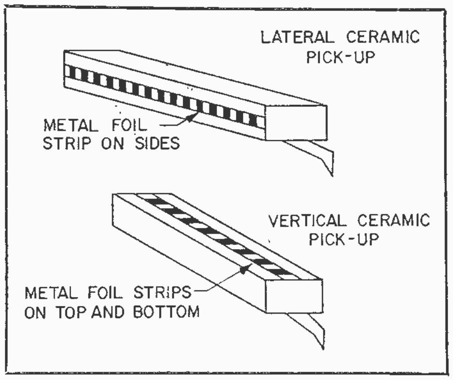


FIGURE 2—Note the placement of the metal foil strips on both the lateral and vertical ceramic pick-ups.

the voltages generated on the upper and lower faces will not be amplified since there are no metal foil strips on the upper and lower faces of a lateral rod. Thus, it can be seen how ceramic pick-ups can be built that will separate the horizontal and vertical motions of the groove.

Ceramic Stereo Pick-ups—A stereo pick-up as illustrated in Figure 3, is simply two monophonic pick-ups operated on one needle and inside one case. Thus, as the stereo groove moves the needle in direction No. 1, voltage is generated between the foil strips on ceramic rod No. 1. Movement of the needle in direction No. 2 results in voltage generated on the foil strips on ceramic rod No. 2. The respective sets of foil strips then feed the proper amplifier producing stereo sound.

Ceramic pick-up manufacturers now have not only a simpler stereo pick-up but one that is universal. This pick-up is designed such that only one ceramic rod with metal foil strips on all four sides is used with one needle fastened as shown in Figure 4. When the needle bends the rod in direction No. 1, voltage is generated in foil strips No. 1; likewise, when the needle moves in direction No. 2, voltage is generated in strips No. 2. Voltage from each pair of strips is then fed to separate amplifiers for stereo reproduction.

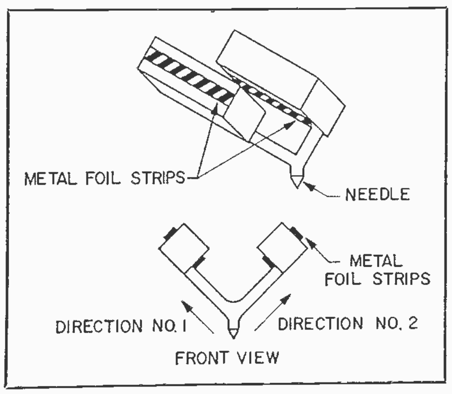


FIGURE 3—Early stereo pick-ups were simply two mono-pick-up heads operated by one needle.

This ceramic stereo pick-up is universal in that it may effectively be used as a monophonic pick-up too. Remember that a good mono-pick-up should reproduce the lateral motion of the needle while suppressing the vertical motion (noise, rumble, etc.). This is accomplished with a stereo pick-up in the following manner:

Figure 5 shows the schematic of a stereo pick-up when normally used for stereo. For monophonic use, the right and left terminals are connected together and used as the "hot" lead.

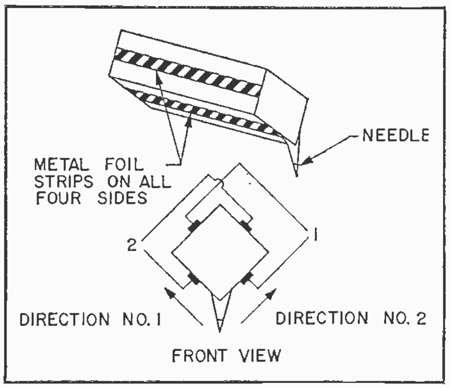


FIGURE 4—Modern stereo pick-ups utilize one head with metal foil strips on all four sides.

With the stereo pick-up wired in this manner, the following occurs. When the needle is bent to the right, the left and right terminals have a positive voltage impressed upon them. These two positive voltages add and the lateral motions of the needle are reproduced. When the needle is bent upward, the left terminal becomes positive while the right terminal becomes negative. These two voltages "buck" each other and, since they are of equal amplitude, cancel each other out. Therefore, the pick-up reproduces lateral motions of the needle while suppressing output from vertical movements of the needle.

Variable Reluctance Pick-ups—Since stereo magnetic pick-ups are appearing on the market, we will discuss the most popular type—the variable reluctance pick-up. The simple monolateral pick-up shown in Figure 6A will illustrate the principles of operation behind this type of pick-up.

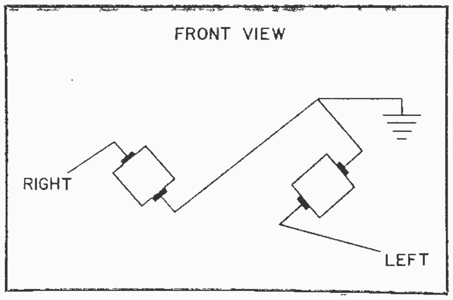


FIGURE 5—For monophonic use, the right and left terminals of a stereo pick-up are connected and used as the "hot" lead.

In this case, the magnetic flux leaves the permanent magnet, travels through the core (and coil around it), across the air gap, through the shank of the needle and back to the permenent magnet. The air gap controls the amount of magnetic flux in the core due to the high magnetic reluctance of air. (Reluctance is comparable to resistance in Electrical Circuits. The higher the reluctance, the less magnetic flux is present with a fixed permanent magnet.) The voltage generated corresponds to the movement of the needle, thereby reproducing the recorded sound. Vertical motion of the needle, however, does not change the air gap thereby reducing the noise effects.

Figure 6B illustrates a variable reluctance pick-up for mono-vertical records. Notice that the vertical movement of the needle varies the air gap, thereby producing an output voltage. Horizontal movement produces no output voltage since the air gap does not vary.

Modern lateral variable reluctance pick-up feature two air gaps as shown in Figure 6C. Here as the needle moves from side to side the flux in one core is increased while the flux in the other core is decreased. The two coils are phased so that both voltages add. The two air gaps result in much less distortion and decrease hum field effects in the vicinity of the pick-up. Vertical pick-ups do not use two air gaps because of the difficulty in placing magnetic core material below the record.

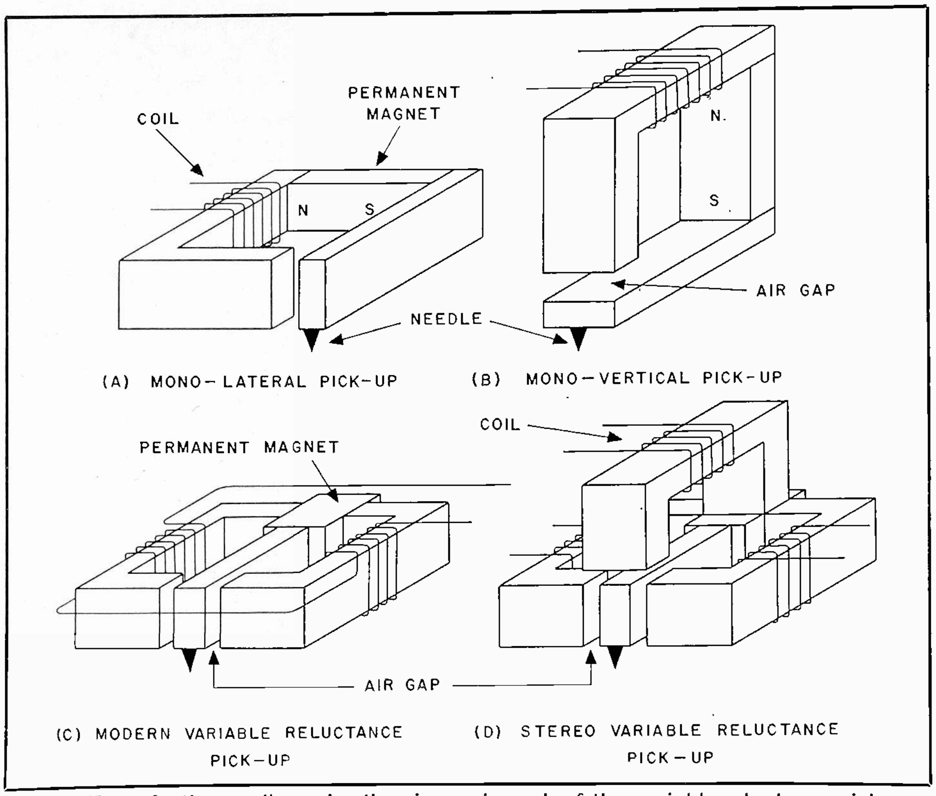


FIGURE 6—As the needle varies the air gap in each of the variable reluctance pick-ups, there is a corresponding change in magnetic flux that governs the voltage generated in the coils. This voltage is then fed to the playback amplifiers reproducing the recorded sound.

Stereo Variable Reluctance Pick-up— A stereo variable reluctance pick-up can be illustrated as shown in Figure 6D. As before, the flux would proceed from cores 1, 2 and 3 across the respective air gaps and down the needle shank. Horizontal motion of the needle would result in flux changes in cores 1 and 2 while vertical motion of the needle would result in flux changes in core 3. Coils placed around the three cores result in voltages generated proportional to the horizontal and vertical movements of the groove. The individual horizontal pick-up coils will generate a signal proportional to the sum of the channels while the vertical coil will generate a signal proportional to the difference between the channels. The sum and difference voltage outputs can be easily obtained by using a circuit similar to that shown in Figure 7. For mono-lateral recordings, the left and right terminals could be connected as before for cancellation of the vertical pick-up.

It should be noted that no commercially available variable reluctance type of pick-up uses the exact method explained. Enough similarity exists, however, for easy understanding of the principles of operation.

CONTROLS FOR STEREO

Stereo requires slightly different controls than monophonic systems. Stereo systems have two amplifiers which require gain and tone controls. The gain and tone controls are "ganged" which means both adjustments are made simultaneously with two identical "pots" on one shaft. The only unfamiliar control present will be the balance control.

When the balance control is adjusted, the gain of one channel is increased while at the same time the gain of the other channel is decreased. Balancing results in equal channel gain or "balanced sound" coming from the speakers. In other words, both speakers have equal loudness.

Balance can be adjusted by ear only but it is rather annoying and time consuming having to leave your chair and make as high as three to five different adjustments. Although present stereo equipment does not feature balancing monitors, future stereo systems will be easily balanced with the aid of such devices.

BALANCE MONITOR

The Advanced Application Lab at Sylvania, Emporium, has developed a simple "balance monitor" for use with stereo sound systems. The serviceman who is bound to encounter more and more stereo servicing might find this device very useful.

As mentioned earlier in the article, an assumption is made that both left and right speakers are identical for almost all stereo sound systems. Thus, when a stereo system is properly balanced, a single or monophonic sound will appear with equal loudness from both speakers. It should be noted that equal loudness is obtained by the presence of identical voltages at the voice coils of the speakers.

In this device, the input voltages are fed to separate identical audio transformers. The transformer secondaries are connected such that the developed voltages cancel each other out. Any unbalance will result in a signal being fed to the grid of the 6U5 tuning-eye tube, causing the "eye" or shadow to flutter.

In practice, the sensitivity control is adjusted for a reasonable indication on the tuning-eye tube. Purposely unbalance the system when making this adjustment. The system is then balanced by adjusting the amplifier balance control until the tuning-eye tube registers a null or no audio indication. If a null cannot be obtained in this manner, the transformer secondaries are aiding instead of cancelling. Reverse one pair of speaker leads and balance the system again.

The audio transformers may be of any variety provided they are designed to operate between the plate of an audio output tube and a

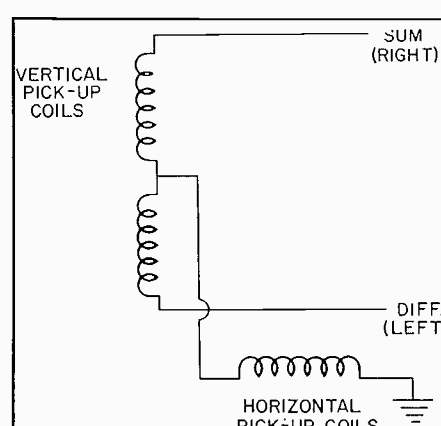


FIGURE 7—Circuit diagram illustrating method used to obtain the sum and difference voltage outputs.

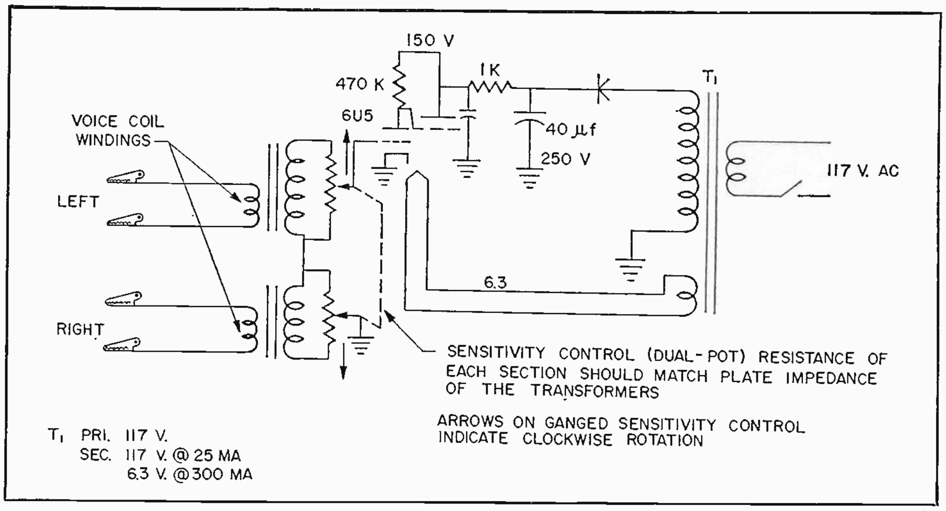


FIGURE 8—Circuit diagram of balance monitor developed by the Sylvania Advanced Application Laboratory.

speaker. However, the transformers must be identical. Also the sensitivity control should "match" the plate impedance of the transformer.

The rest of the circuit, as shown in Figure 8, is straight forward and should present no problems to the builder.

The builder may be tempted to do away with the power transformer. If this is done in favor of a line-connected circuit, be absolutely sure that no exposed grounds are present.

A good percentage of home music systems feature AC-DC amplifiers (hot chassis) or they are grounded through water pipes for hum reduction. Little imagination is required to see the hazards involved in operating without a power transformer.

Further information on stereo sound is available in many trade magazines and should prove of interest to the enterprising service technician.

This concludes the series of two articles entitled "Stereo in the Home;" the first part of which appeared in the August-September 1958 issue of SYLVANIA NEWS.

Testing the Hybrid Auto Tube Types on the Models 137, 138, 139, and 140 Tube Testers

The Sylvania tube tester models 137, 138, 139, and 140 do not have a selection of plate, screen and signal voltages as do the other Sylvania models. Therefore, to check the hybrid auto type tubes, it is necessary to lower the plate and screen supply voltages so that the dissipation ratings of those elements will not be exceeded. A suggested method for lowering the voltages, requires the use of a double pole double throw toggle switch mounted on the panel, so that the circuitry can be switched from "Normal" to the "Special Test" positions, Figure 1.

Briefly, when the special test switch is thrown the 110 volt secondary winding of the transformer is removed from the circuit, a divider made up of a NC5 selenium rectifier, a 1000 ohm resistor and a 2000 ohm resistor, is placed across the winding and the plate and screen voltages taken from the divider. In the "Normal" position of the switch the screen of the tube under test is fed through resistor R-116 and the plate through R-110. In the "Special Test" position the screen is fed through both R-110 and R-116 and the plate voltage applied directly to the meter shunt network.

To install the divider, locate the red 110 volt secondary lead from the transformer that connects to the two 5 watt resistors in the center of the terminal board. There are four 5 watt resistors on the board and the two in the center, a 2000 ohm and a 1500 ohm, are tied together at one end. Remove the red 100 volt transformer lead from the junction of these two resistors and connect it to the arm of SW1-A as shown in the diagram. The "Normal" side of SW1-A connects to the junction of the 1500 ohm and 2000 ohm resistors. The "Special Test" side of SW1-A is connected through the NC5 to the 1000 ohm and 2000 ohm resistors to ground in that order. Ground can be picked up at the center arm of "D" switch or at the center lug of the lockin test socket. Connect the center arm of SW1-B to the junction of the 1000 ohm and 2000 ohm resistors. Connect the "Special Test" side of SW1-B to the positive terminal of the meter. This completes the installation.

To test the hybrid types, set up switches A, B, C, and D and place the switch just installed in its "Normal" position. Plug the tube in its test socket and after sufficient warmup check it for shorts. The switch is then placed in its "Special Test" position and the remainder of the test carried out as in the regular testing procedure. It will be noted that the meter pointer will drop to about one quarter scale when the switch is placed in the "Special Test" position. This can be ignored as it has no bearing on the meter reading when the final test lever is thrown.

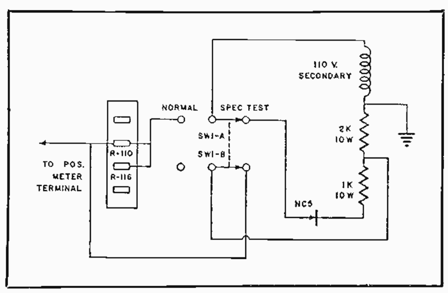


Figure 1—Conversion circuit for testing hybrid auto tube types.

SYLVANIA NEWS

technical SECTION

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R. A. Humphreys, Technical Editor
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LIFE TESTING OF TUBES IN TELEVISION RECEIVERS* (Part I)

In just over ten years, television receivers have grown from an oddity to one of the most common furnishings of the American home. The average householder regards his TV set as a necessity on a par with his telephone or the finned monster in his garage.

We of the electronics industry, associated with the problems of producing and servicing this item of standard living room furniture, know that the behind-the-scenes problems have been far from commonplace. Since the early days, set reliability, which depends upon circuit design, tube and component reliability, has been one of the most troublesome problems besetting us. Yet many of us tend to overlook the steady growth in component reliability which has taken place in these few years.

Since 1950, the Radio Tube Division of Sylvania Electric Products at Emporium, Pennsylvania, has been conducting life performance tests on Sylvania tubes in various makes and models of television receivers. The year-to-year operation of this life test program has proved most valuable in the maintenance and improvement of tube life performance. As a result of this program, a serviceman can make tube replacements with Sylvania tubes in any make of television receiver with the knowledge that Sylvania has already proven-in their tubes in the same or a similar model receiver.

During the first few years of the program, various test conditions and procedures were studied to find that combination which would provide the maximum information in a minimum length of time. There has now been sufficient data collected to reveal trends in tube life performance. These trends are based on life test data collected in the last three years resulting from the testing of 15,089 tubes in television receivers for a total of 1.4 million hours of receiver operation. All data are known to be statistically accurate to the extent that there is only one chance in twenty that the observed results are not true. This means there is only one chance in twenty that some "freak accident" might have occurred

*Based on a paper authored by E. H. Boden, Advanced Applications Engineer, Receiving Tube Operations.

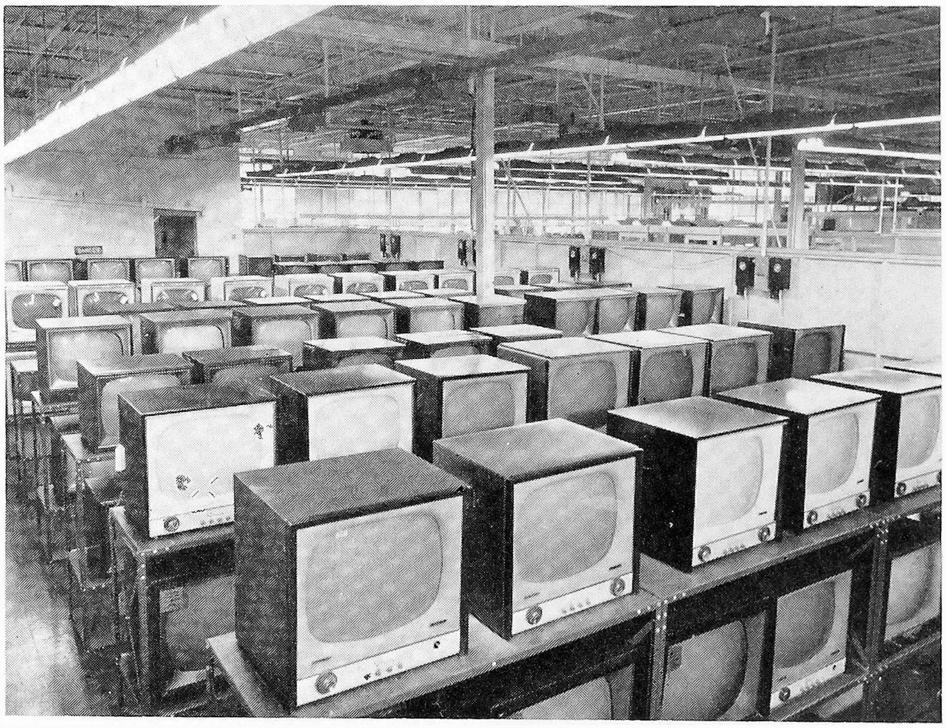

FIGURE 1—TV Life Test Area at Emporium.

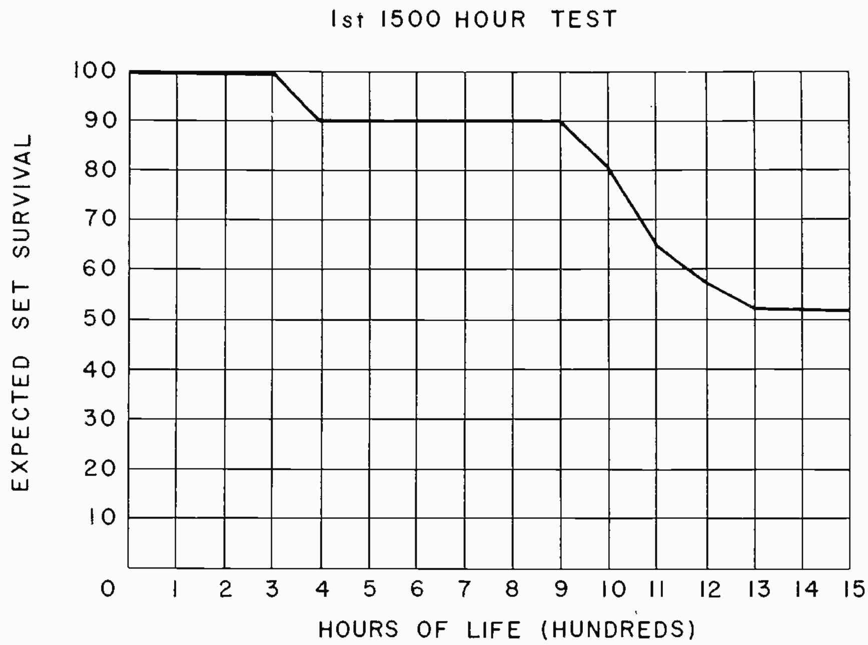

FIGURE 2
Expected number of sets surviving per 100 sets tested at accelerated life conditions.

which would cause the data to be erroneous.

TEST CONDITIONS AND PROCEDURES

Shown in Figure 1 is a portion of the area being used for set life-testing tubes. Here the sets are run for a period of 1500 hours during which time the sets are automatically cycled on 50 minutes and off ten minutes of each hour, with two additional manual cycles of one hour off during each 24-hour period. Fifteen-hundred hours approximates one year of operation. Brightness and contrast controls are adjusted for normal viewing.

A LINE VOLTAGE OF 130 VOLTS was selected to produce an accelerated life condition. The degree of acceleration using 130 volts had to be determined from experimental data. For this purpose a representative group of receivers was selected and run for 1500 hours. Half of the receivers were operated at 130-volts line and half of the receivers were operated at 117-volts line. At the completion of the run, sets operating at 130 volts had *2.4* times as many failures as the sets operating at 117 volts. This would seem to say that one year at 130 volts was approximately equivalent to *2.4* years at 117 volts. Actually, this means the serviceman can expect many more call-backs in areas where high line conditions prevail as compared to areas having normal line voltage. This same test is repeated each year with current models of receivers to determine if any change might have occurred in this acceleration constant. As yet there has been no significant difference in this constant.

OPERATION OF RECEIVERS

From time to time, new television receivers are obtained in groups of 10 to 20 sets of each model. One hundred eighty to two hundred fifty sets are under test at all times with upwards of 11 different set manufacturers being represented.

Each group of receivers is first run 1500 hours as tubed when received. At the completion of the first run and each additional run, the receivers are completely re-tubed with Sylvania tubes and then run for another 1500 hour period. This is repeated until the sets are replaced by new models. Each group of sets is used for as few as four runs or as many as seven runs.

When a tube fails during a test run, the tube is removed from the receiver and a replacement is inserted to serve the set for the remainder of the run. Failure of the replacement tube is not included in the data but is noted to detect the existence of a critical application in a particular socket. Although important picture tube information and other circuit component data has been obtained, this article covers only receiving tubes.

All tube failures are carefully studied to determine if any other component failure might have caused the tube to fail. The tubes are visually and electrically analyzed to determine the cause of the failure. A failure is regarded as that level of performance that would cause a set owner to call a serviceman.

CALCULATION OF SET SURVIVAL

Each time a tube fails, the receiver must be regarded as a failure. But what happens when two or more tubes in one receiver show a failure *tendency* even though the failures did not occur in the same set during these tests? There is a probability that such combinations of failures could occur in one of the sets being tested. Since this had to be taken into account, statistical formulas were utilized to calculate this probability. Hence the expected set survival data is computed rather than a mere record of test data.

Upon the completion of each 1500-hour run, data representing tube failures (at the accelerated life condition of 130 volts line) are collected and analyzed. An important part of each analysis is a curve showing expected set survival vs. hours. One such curve is shown in Figure 2. This curve is computed from the tube failures occurring in ten or more receivers and is a prediction of the number of sets surviving, by hours, with each tube failure regarded as a complete set failure.

REDUCTION IN TUBE FAILURES

Of first interest to both tube manufacturers and TV repairmen is how the tube failure figures have varied in the past three years. Table I shows the percent of the tubes which failed from July to July of the years indicated. The differences in the figures shown are significant and it may be correctly concluded that in the past three years there has been an improvement in television sets and/or tube designs. To remove the "and/or" question, Table II represents a compilation of data obtained by using the *same* group of sets to accumulate failure rates of tubes from three different production years. In this way the question of receiver design has been removed and the comparison becomes strictly tubes. In the table obtained it is seen that in 1954-1955, under the accelerated life conditions, 7.7 percent of the tubes tested in a certain group of 12 receivers failed, while in the following year these same 12 receivers, complemented with tubes manufactured one year later, showed only 6.2 percent of the tubes tested failing. The 1.5 percent difference is a significant difference, and, therefore, it may be concluded that tubes did improve that year. An improvement in tube life performance of 3.4 percent is noted with a second group of 4 receivers tested under the same accelerated life conditions, sample II.

Since a 3.4 percent reduction in tube failures at high line conditions would represent approximately a 10 percent reduction at normal line condition the serviceman at the same time would expect to notice an equal reduction in the number of call backs. This is where we often fail to consider the question—How do tube failure rates vary among sets made by different manufacturers?

Additional information concerning variations in set survival, reduction in failure causes, and VHF versus VHF-UHF receivers will appear in the January 1959, issue of SYLVANIA NEWS.

TABLE I

Tubes Tested and Failures by Years Under Sylvania's Accelerated Life Test Program

YEARS TESTED	NUMBER TUBES TESTED	NUMBER FAILURES	PER CENT FAILED
1954 – 55	4250	328	7.7
			△ 1.2
1955 – 56	5953	387	6.5
			△ 2.3
1956 – 57	4886	203	4.2

TABLE II

Overall Tube Improvement by Years at the Accelerated Life Condition of 130 Volts Line

YEARS TESTED	NUMBER TUBES TESTED	NUMBER FAILURES	PER CENT FAILED
SAMPLE I (12 MODELS – 7 MFRS.)			
1954 – 55	4250	328	7.7
1955 – 56	4309	268	6.2
		DIFFERENCE	1.5
SAMPLE II (4 MODELS – 4 MFRS.)			
1955 – 56	1621	118	7.3
1956 – 57	1251	49	3.9
		DIFFERENCE	3.4

TESTING SF PICTURE TUBES

Recently, a series of picture tubes has been introduced to the industry, that employ an ordinary appearing base but has the normal G1 and G2 basing connections reversed. Also, the series utilizes either a 2.35 or 2.68 volt filament. These tubes are known as the "SF" series, which is an abbreviation for "semiflat", and to date they have been employed only in Philco receivers.

It can easily be seen then that adequate precautions must be taken when testing these tubes, so that they are not permanently damaged or burned out by being subjected to excessive heater voltages, or the application of G2 voltage to the number one grid.

There are presently three of these "SF" tube types in use, as follows:

TYPE	FILAMENT
17DAP4/SF17	2.68 V.—450 ma.
21EAP4/SF21	2.35 V.—600 ma.
24AVP4/SF24	2.35 V.—600 ma.

Present indications are that this problem will continue to be encountered with a number of tube types that will be on the market in the near future.

Tenth Edition 4th Printing Technical Manual —Answers To Owners' Questions

A number of letters have been received concerning recently purchased 10th Edition, 4th Printing Technical Manuals and/or the accompanying supplement service. The questions that have been asked are answered in this article for the benefit of those who have not had the opportunity to write.

- Data for tube types issued as supplements 1-10 through 28-10 were incorporated in the 10th Edition, 4th Printing as an integral part of the Manual. Therefore, it is not necessary to obtain these data in supplement form.

- The insert service provided via SYLVANIA NEWS was replaced last July with a more flexible packet mailing program. Two packets, containing data for 78 types total, have been issued to date. (This figure is more than three times the number of types published in insert form in a year's time previous to beginning periodic packet mailings).

- Inserts that are missing from your manual can be obtained from Central Advertising Distribution Department, 1100 Main Street, Buffalo 9, New York. For your convenience, an accompanying table lists the tube types issued as inserts to the 10th Edition, 4th Printing through December 1958.

- Should your mailing address change—write immediately to the above Buffalo, New York department of Sylvania stating both your old and new address.

Data In Insert Form Applicable To 10th Edition, 4th Printing

29-10	21CBP4A, 6BW8	April 1958
30-10	21CXP4, 6CL5	May 1958
31-10	21DQP4, 6EB8	June-July 1958

Packet I

RT	RT	PT	CRT
1G3GT	6BY8	17BRP4	3JP__
2B3	6BZ8, 4	17BWP4	3RP__
3B2	6CE5, 3, 4	17BZP4	5AHP__
6AZ8	6CG8, 5, 8A	17CAP4	5BNP16
6BJ8	6CH8	17CLP4	5UP__
6BN4, 3, 2	6CL8, A, 5, A, 9	21CMP4	7ABP__
6BQ5	6CM8, 5	21DAP4	
6BR8, 5	6CR6, 12	21DEP4	
6BS8, 4, 5	6CY5, 2, 3, 4	24AEP4	
6BT8, 5	6DE6, 4		
6BU8, 4, 3	12BL6		
6BW4, 12	12CN5		

Packet II

RT	RT	PT	CRT
5AU4	10C8	10ABP4, A, B, C	2AP__
5V3	12BZ7	17CNP4	3AP__
6AS8, 5	12CT8	21CUP4	3BP__
6CQ8	12EG6	21CWP4	3KP__
6CU8	12EL6	24AHP4	3MP__
6CX8, 8	12EM6		5ADP__
6CZ5	12K5		5AQP__
6DB5, 12	12R5, 17		5BP__
6DG6GT	12U7		5ZP__
6DK6, 3, 4	17H3		10NP11
6DS5	18A5		10SP4
6DT6, 4, 3			

YOUR SERVICE HINTS WANTED

Attention—Service Dealer readers of SYLVANIA NEWS! What has happened to the Service Hints column the past year? This column, supported by YOU, should include all technical hints believed useful to your fellow Service Dealer.

For each hint accepted, you will receive a certificate worth $10.00 that can be applied against any item listed in Sylvania's Advertising-Merchandising Aids Booklet. These include: tools, tube caddies, technical manuals, display signs, etc. If you are not familiar with this booklet, get a copy at your Sylvania Distributor or write to our Central Advertising Distribution Department, 1100 Main Street, Buffalo 9, New York.

Perhaps you are not quite sure just what comprises a Service Hint. It should be nothing more than a simple method or device used to solve irritating or time-consuming service problems. It could be that you have devised a simple but unique method for servicing a remote section of a chassis without removing it from the cabinet; maybe you've solved an electrical problem peculiar to a particular chassis—such as a remote component responsible for difficulty in the section being serviced.

Today, you are certainly not hampered field-wise. Many areas such as TV servicing, Hybrid auto servicing, Home radios, and the up-and-coming Stereo systems should produce many different Service Hints. Another area which is wide open to a variety of service hints is the numerous techniques involved in Printed circuit servicing. Also, tuner techniques, electrical or mechanical, are always welcomed by the serviceman.

Any service hint which you feel might be of value to you and your fellow service dealer should be mailed to Sylvania Electric Products Inc., Receiving Tube Operations, in care of the Technical Publications Section, Emporium, Pa.

Sylvania is not obligated to return any material submitted for publication, whether or not published.