

VINTAGE AUDIO

Taking a Look at The Tuning Eye

BY JOHN VUOLO

“**T**uning eye” is the common name applied to the green-glow tubes used in radio equipment to visually assist the listener in tuning a radio station to the point of greatest signal strength. Officially known as electron-ray tubes, and differ from the cathode ray tubes used to produce images in television, although the two types share a common ancestry and fundamental architecture.

DuMont's Invention

The electron-ray tube was invented by Dr. Allen DuMont in 1930 as a result of his related work to develop the cathode ray tube for television. Dr. DuMont had just completed the transition from his engineering job with Westinghouse to become Chief Engineer for the De Forest Radio Company in Passaic, New Jersey. He most likely used the lab in the basement of his Upper Montclair home to carry out his experiments since he, and not the De Forest Radio Company, owned the patent for the electron ray tube he created. Dr. DuMont sold the patent to RCA in 1932. Prospects at the De Forest Radio Company at the time were not very bright, as the company was in severe financial difficulties. The company went into receivership in 1933, with RCA gobbling up most of the assets. The sale of the electron ray tube patent provided the seed money for Dr. DuMont to form his own company. Over the next 30 years, the company bearing Dr. DuMont's name pioneered early oscilloscopes, television sets, and television broadcasting, and it prospered greatly during and after World War II with the development and production of defense electronics.

RCA Markets' "Magic"

RCA registered its first electron ray tube, the 6E5, on June 27, 1935, and it appeared in the company's console model product line that same year. RCA, fearing a loss of market share to competitors' new lines of very small and midget radios, opted for a different marketing strategy. RCA promoted the "Magic Eye" as an elegant feature of its higher-end product line, where profit margins were greatest. Not surprisingly, the 6E5 wouldn't fit inside the competitors' smallest sets.



An example of a working eye tube

The name Magic Eye quickly gained acceptance by the public as the standard identity for the electron-ray tube and tuning eye feature in consumer radio sets, regardless of manufacturer. Alert to the appeal and success of RCA's Magic Eye, many radio manufacturers quickly purchased RCA's license agreement for the electron-ray tube and circuit designs. The difference in cost at the retail level of this extra feature was typically five to seven dollars. Arvin, Fairbanks-Morse, Lafayette, and Westinghouse, in particular, made early use of the tuning eye feature. Arvin was among the first to introduce it into table top sets with the company's "Phantom Junior" model 618. The tuning eye was popular also with the Sears Roebuck and Montgomery Ward brands, many of which were made by Arvin. It is not unusual to see different manufacturing runs of the same 1936 or 1937 model radio where the later version includes the addition of a tuning eye tube and associated circuitry.

Zenith Weighs In

Zenith featured visual tuning aids in their product lines more than most manufacturers did, but they avoided an exclusive engagement with the RCA product for two years. Zenith's 1936 sets featured a "Bullseye" variant of the Shadowmeter. This did not create much of a stir with the public as it was not nearly as visually appealing a display as the 6E5's. The Bullseye was dropped in 1937 in favor of the Raytheon 6T5. This unique tube appears in nearly all of Zenith's consoles for the 1937 model year as well as the seven-, nine-, and 12-tube "Walton's" tombstones and other non-console sets. Use of the 6T5 and the Shadowmeter eventually succeeded in pressuring RCA to reduce the price tag for licensing the tuning eye tube and related circuit designs. Finally, in 1938, Zenith adopted RCA's product with the same enthusiasm as they exhibited for other types of visual tuning aids. With the 6T5's principal user now switched to the 6U5_6G5, production of 6T5s was stopped by Raytheon and Sylvania in 1939.

Eye Tube Operation

The tuning eye tube was designed to visually indicate, by means of a fluorescent target,



Alexander Dumont

the effects of a change in controlling voltage. This was widely used for tuning indicators in radio receivers. The eye tube is comprised of two main parts: a triode that operates as a DC amplifier, and an electron ray indicator that's located in the bulb near the top (see **Figure 1**).

The target is operated at a positive voltage and, therefore, attracts electrons from



Typical 6E5 tubes

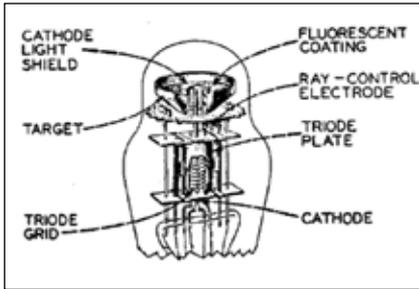


Figure 1.

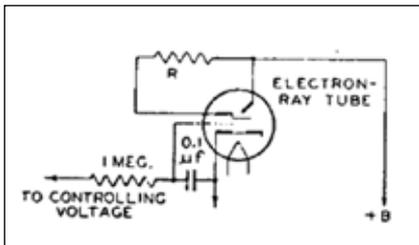


Figure 2.

the cathode. When electrons strike the target they produce a glow on the fluorescent coating of the target. Under these conditions the target appears as a ring of light. A ray control electrode is mounted between the cathode and the target. When the potential of this electrode is less positive than the target, electrons flowing to the target are repelled by the electrostatic field of the electrode, and do not reach that part of the target behind the electrode. Because the target does not glow where it is shielded from the electrons, the control electrode casts a shadow on the glowing target. The extent of this shadow varies from approximately 100 degrees of the target, when the control electrode is more negative than the target, to 0 degrees, when the control electrode is at approximately the same potential as the target.

In the application of the eye tube, the potential of the control electrode is determined by the voltage on the grid of the triode section, as can be seen in **Figure 2**. The flow of the triode plate current through resistor R produces a voltage drop that determines the potential of the control electrode. When the voltage of the triode grid changes in the positive direction, plate current increases, the potential of the

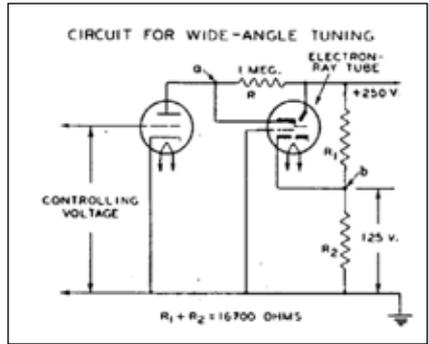


Figure 3.

control electrode goes down, because of the increased drop across R, and the shadow angle widens. When the potential of the triode grid changes in the negative direction, the shadow angle narrows.

In the design of radio receivers, the AVC voltage is applied to the grid of the DC amplifier. The AVC voltage will be at maximum when the set is tuned to give the maximum to a station; the shadow angle is at minimum when the receiver is tuned to resonance with the desired station. The choice between eye tubes depends upon the AVC characteristic of the receiver. Eye tubes like the 6E5 use a sharp cutoff triode that closes the shadow angle on a comparatively low value of AVC voltage. Other eye tubes, like the 6N5 and 6U5/6G5, have a remote cutoff triode that closes the shadow on a value of AVC voltage larger than the 6E5's.

The sensitivity indication of eye tubes can be increased by using a separate DC amplifier to control the action of the ray control electrode in the tuning indicator tube. This arrangement increases the shadow angle from the usual 100 degrees to approximately 180 degrees. An example of this circuit is shown in **Figure 3**.

Typical 6E5 Example

Figure 4 shows a typical tuning indicator circuit employing the 6E5. If the strongest carrier received produces sufficient AVC voltage to exceed the cutoff bias of -8 volts, the shadow area of the fluorescent target will overlap. To overcome this effect, Resistor R3 should be connected as shown, between the

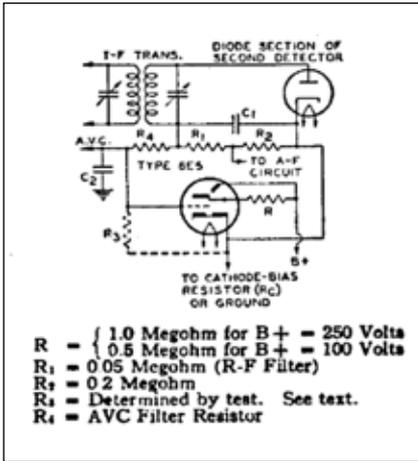


Figure 4.

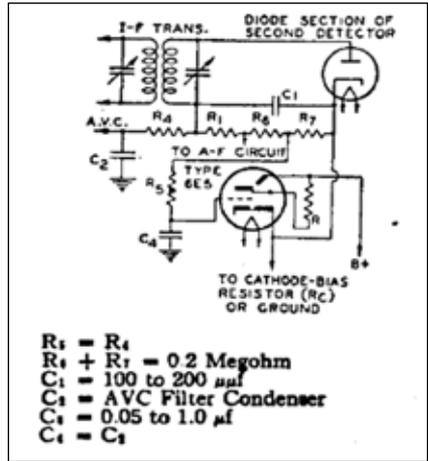


Figure 5.

triode unit grid and cathode, in order to reduce the control voltage. The value of R3 may be easily determined by applying a strong signal and adjusting R3 until the shadow angle is nearly zero. If the resultant value of R3 is so low as to reduce the AVC voltage appreciably, the DC controlling voltage for the 6E5 should be obtained from a tap on the diode load resistor as shown in **Figure 5**.

References

RCA Receiving Tube Manual

Fundamental of Vacuum Tubes, by Austin Vitruvius Eastman, McGraw-Hill Book Company, Inc.

The Forgotten Network: DuMont and the Birth of American Television, by David Weinstein, Temple University Press

Website: www.magiceyetubes.com

John Vuolo has been working in the telecommunications industry for 34 years. He has been restoring and collecting antique radios, tube amplifiers and receivers, TVs, phonographs, and reel-to-reel machines for 40 years.

Contact John at jvuolo9603@aol.com.



The RCA 6E5 tube in original packaging

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