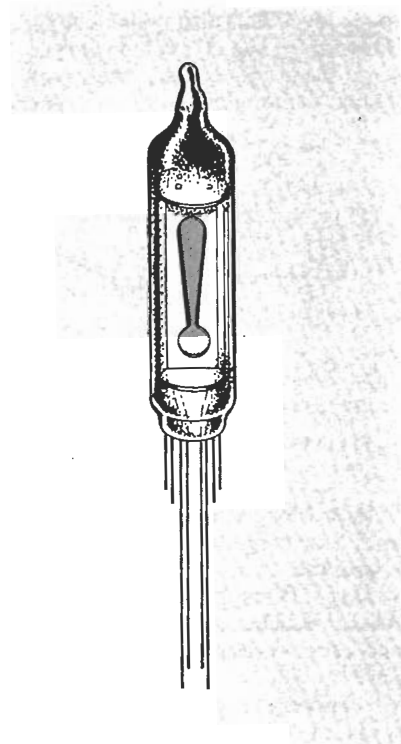
Signal and Voltage Indicators

Cut cost of experimental projects by using substitutes for expensive meters

By LEO G. SANDS

IN THE LONG-GONE AND OFTEN-lamented days right after World War II, inexpensive surplus equipment virtually flooded the parts market. Every experimenter worth his salt had a large and highly varied collection of voltmeters. Often selling for a couple of dollars or less, top-quality movements were available in almost any size, shape or range. Today, however, the well-mined mother lode of military voltmeters has pretty much played out, and the cost of a new one for the latest experimental project often can equal the combined cost of all other components.

Fortunately, there is a way around the dilemma. Many types of common indicator tubes and other indicating devices can be used for signal and voltage displays. Probably the most well known of these money-savers is the electron-ray indicator tube often called a "magic eye." Used in AM radio circuits as long ago as the late '30's, the indicator still is used in test instruments and in some FM tuners. It has several other possible uses as a voltage indicator as well.

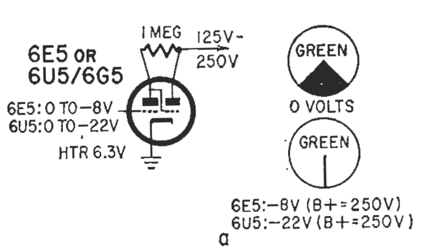


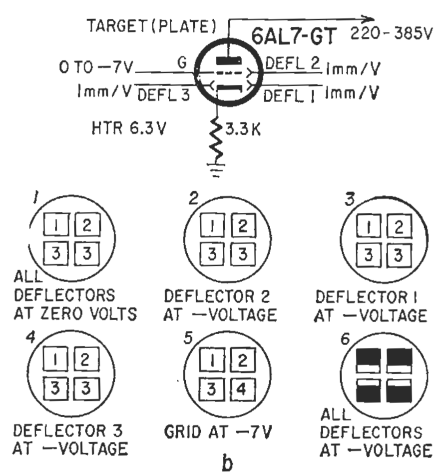
The original electron-ray indicator tube was the 2E5 with a 2.5-volt heater, and its 6.3-volt counterpart—the 6E5—shown in Fig. 1-a. The plate of one triode section (a dc amplifier) is connected internally to the ray-control electrode (grid). The plate of the second triode is known as the target.

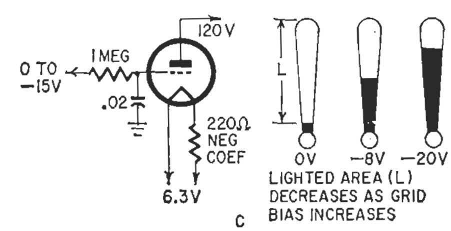
When the voltage at the amplifier-triode grid is zero, the circular target at the end of the tube glows a bright green, except for the shaded triangular wedge known as the shadow. As the grid is made negative, the shadow gets smaller. When grid voltage reaches approximately −6.5 to −8 (depending upon target voltage), the entire screen is green, and the shadow angle is zero. If the grid is made more negative, the edges of the illuminated area overlap. (The 6U5/6G5 is similar, but the grid voltage for zero shadow angle is about −22.)

Indicator bars

More novel is the type 6AL7GT indicator tube which displays two glowing rectangular bars divided into four







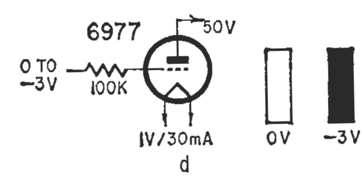


Fig. 1 (a-d)—"Magic eye" tubes provide a variety of these small signal display patterns. (1M3/DM70 is shown at c.)

segments. As shown in Fig. 1-b, this tube has a target (plate), a grid and three deflector electrodes. The grid varies the brilliance of the illuminated bars. Deflectors 1 and 2 control the size of the shadow on segments 1 and 2, and deflector 3 controls segments 3 and 4. The width of shadow area produced by each deflector is about 1 mm/volt.

The 1M3/DM70 tuning indicator displays an illuminated bar which is reduced in length through application of a negative grid voltage. As shown in Fig. 1-c, this tube employs a directly heated cathode which can be energized from 6.3 volts ac through a 220-ohm, negative-coefficient resistor.

The type 6977 indicator tube shown in Fig. 1-d also displays a glowing bar, the brilliance of which is reduced as the grid is made more negative. At a grid voltage of about −3, the glow is extinguished. This is also a filament-type tube drawing 30 mA at 1 volt ac or dc.

Then, of course, there are neon lamps which glow when a high enough voltage is applied initially (striking voltage) and continue to glow until voltage is reduced to a certain level (extinction voltage). Neon lamps are used as pilots, gates, oscillators, voltage regulators and excess-voltage indicators, to name a few.

Having reviewed briefly some basic types of voltage-indicating tubes, let's now see how they may be incorporated into some simple—and useful—circuits. In most cases, the full parts list is omitted, but no trouble should be had in duplicating any or all of them.

Type 6E5 and 6U5/6G5 tubes often are used as tuning indicators in AM receivers, connected directly to the avc bus as in Fig. 2. When the receiver is correctly tuned to a station, avc voltage is maximum, and the shadow angle is smallest. Use a 6E5 if avc measures from 0 to −8 volts maximum; a 6U5 can be used for voltages to −22.

Adding a pot (dotted lines) makes a simple S-meter. Use a dial scale with the pot and calibrate it in S-units or microvolts. Then, with a signal tuned in, adjust the pot for zero shadow angle and read the pot setting.

Another application for the 6E5 or 6U5/6G5 is as an FM-receiver tuning indicator. It can monitor limiter voltage using the same circuit as in Fig. 2, but with the input connected to the limiter grid-return circuit instead of the avc bus. A more meaningful indication is obtained by monitoring discriminator or ratio-detector dc voltage (Fig. 3). The cathode pot is adjusted for zero shadow angle when the receiver is correctly tuned to a station; off channel, the shadow angle increases.

The 6AL7-GT is a popular FM-receiver tuning indicator. In the typical circuit shown in Fig. 4, the grid and deflector 1 are biased negative by the cathode resistor. Deflector 3 is connected to the limiter grid return, and deflector 2 is connected to the discriminator or ratio detector as in Fig. 3. The illuminated bars are of equal length and shortest when the receiver is correctly tuned (deflector 2 at zero voltage and deflector 3 at maximum negative voltage).

The circuit of Fig. 2 can be used as

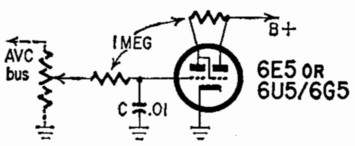


Fig. 2—Maximum avc voltage in AM receiver causes the smallest shadow angle.

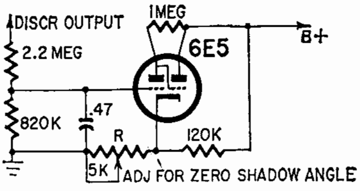


Fig. 3—FM discriminator or the ratio-detector voltage is monitored and pot R adjusted for zero shadow angle.

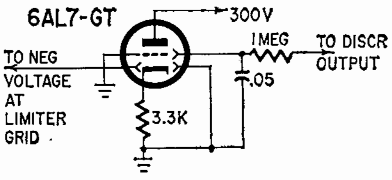


Fig. 4—6AL7 light bars are shortest when deflector 2 has zero voltage and deflector 3 has a maximum negative voltage.

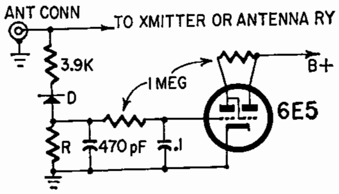


Fig. 5—Transmitter monitor: Output is rectified by the diode. Voltage across R controls 6E5 shadow width.

a dc vtvm by calibrating the pot dial scale in terms of voltage for zero shadow angle. It can be used as an ac vtvm by connecting a diode from the arm of the pot (anode) to ground (cathode) or in series with the hot end of the pot (cathode toward voltage being measured).

Electronic indicator tubes also can be used to monitor CB and ham transmitter circuits. Relative transmitter output can be monitored with a 6E5 using the circuit shown in Fig. 5.

The output signal is tapped at the antenna connector and rectified by a high-frequency diode; the resulting dc voltage appearing across R is monitored by the 6E5. Sensitivity is changed by altering the value of R. Signal strength determines the width of the shadow, and proper (upward) modulation is indicated by further reduction or overlapping of the shadow angle.

An 1M3/DM70 also can be used as a relative rf-output indicator. As shown in Fig. 6, rectified rf is fed to the indicator grid, causing the illuminated

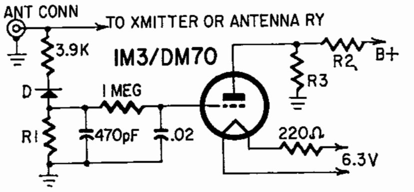


Fig. 6—Transmitter output varies the bar width in 1M3/DM70. Rectified rf signal appears on the indicator grid.

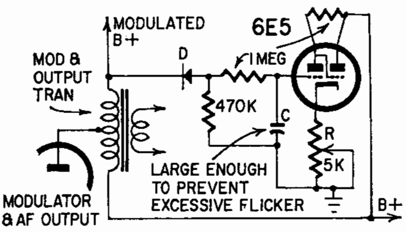


Fig. 7—Overmodulation indicator: The modulated B+ is rectified and fed to the grid of 6E5, varying the shadow angle.

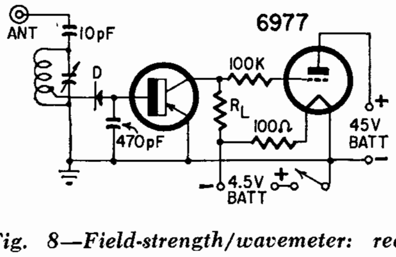


Fig. 8—Field-strength/wavemeter: rectified rf signal foward biases the transistor, lighting the 6977 indicator lamp.

bar to enlarge with increased output and upward modulation. The value of R1 is selected to provide the desired range. Values of R2 and R3 should be chosen to reduce B+ to 150–170 volts at the plate of the indicator.

Overmodulation indicator

A 6E5 can be used as a CB overmodulation indicator (Fig. 7). Here, modulated B+ voltage is tapped from the modulation transformer and fed to the 6E5 grid through diode D. Since modulated B+ voltage ordinarily is positive, the diode conducts only on negative overmodulation peaks, causing the shadow angle to flicker. Pot R is used to balance out diode leakage current in the circuit.

In Fig. 8 a 6977 tube is used as the indicator in a combination field-strength/wavemeter. Diode D rectifies the rf signal and forward-biases the transistor, causing the 6977 to glow. The tube glows when the tuned circuit is resonant and is dark at other times.

What else you can do with indicator tubes depends upon your imagination. Just keep in mind that they're simply vtvm's without a calibrated scale. Using the basic circuits of Fig. 1 and adapting the examples shown and described, you should be able to save the cost of an expensive meter in many of your experimental projects. **R-E**