Heathkit of the Month #125:
by Bob Eckweiler, AF6C

Heath IT-12 A (Quick) Refurbishment
Visual - Aural Signal Tracer

Introduction:

The club recently received a donation of ham related equipment. Among the donations was a Heathkit IT-12 Signal Tracer (**Figure 1**). Our club president passed it along to see about minor refurbishment for possible sale at the club auction or on eBay. There were only about two-weeks before the general meeting when I planned to return it.

The IT-12 was originally featured in HotM #9 (Oct 2008)[1].

External Inspection:

A visual inspection of the donated IT-12 showed it to be in fairly good shape, with only one small blemish on the front panel, and no dents on the panel or cabinet. The screw heads on the front and rear had lost their shine and the plating was discolored and powdery. The top of the cabinet was corroded, as if some chemical had dripped onto it, and the paint was flaking off. The exposed metal showed signs of rust, especially along the welded seam near the top rear (**Figure 2**). The bottom, back and sides of the cabinet were in good shape with only minor blemishes to the paint. The Heath series label was attached to the rear panel. It read (Model: IT-12; Series: 09545). One problem noticed was the tip was broken off the probe. These tips are used on numerous Heathkit probes and break easily. A few such probes are in-house awaiting a new tip which had, until while writing this article, no known source.

Figure 1: The refurbished IT-12 Showing the probe, bright 1629 eye-tube and later style knobs. The probe features an authentic #477-3 Solder less probe tip replacing the broken one on the unit as received.

Comparing this kit to the IT-12 featured in the 2008 HotM article, which was purchased in the summer of 1966 from the Heathkit Electronic Center in Redondo Beach CA, it was noticed the knobs were similar in style but different. The old knobs had a white

Here is a link to the index of Heathkit of the Month (HotM) articles:

http://www.w6ze.org/Heathkit/Heathkit_Index.html

1. Notes begin on page 7

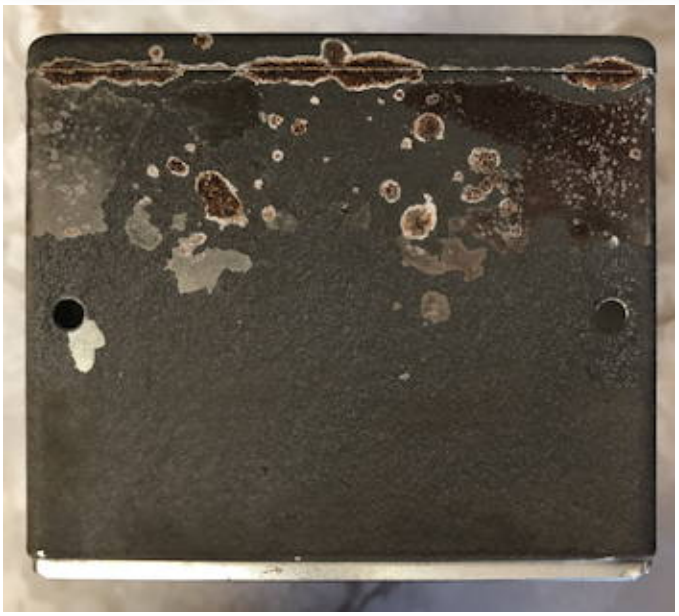

Figure 2: While most of the cabinet looked very good with no dents, the top suffered from some chemical damage and the paint started flaking and the bare steel began rusting.

pointer while the later knobs just had a black line on the silver disc. (**Figure 3**). Other than that, they looked identical externally.

Internal Inspection:

Upon completing the external inspection, the instrument was removed from its cabinet and examined. The kit was quite clean inside with minimal dust, which was brushed and vacuumed away. It was noticed, almost immediately, that the Sarkes Tarzian Model 50 (#57-13) selenium rectifier was missing, and in its mounting hole was bolted a vertical two terminal strip that held a 1N2071 (#57-27) silicon diode. Obviously, either this was a user modification or a Heath production change. Also noticed was the power transformer part number (#54-64-24). The transformer in the older IT-12 is just (54-64). In most cases the ending -24 identifies a transformer with a dual primary for 120/240 V; However this transformer, so marked, had only six leads; two primary (black), two filament (green) and two high voltage (red).

Figure 3: Left: a drawing shows the assembly of the knob (with setscrew in place) #462-139 and pointer #463-27 on early units. Right: Later units had a knob with a painted line #462-187 and no setscrew, which was supplied separately.

When someone refurbishes a Heathkit, or most any other older electronic device, one of the first things done is to replace electrolytic and tubular paper capacitors. The IT-12 has only one of each: A three-section electrolytic can capacitor (50/50 µF @ 150 V and 20 µF @ 25 volts), and a 0.01 µF 400 V capacitor. The latter was of the newer radial mylar type; again, whether this was a user modification or a Heath production change was still to be discovered. The three-section can capacitor needed to be evaluated. This part is now quite expensive, if even available; but it can be re-stuffed with a fair amount of effort or replaced with three separate capacitors.

With the instrument out of its cabinet, a series of resistance measurements were taken. Besides the values given on the schematic, safety checks of the primary and AC power cord to ground were taken. The IT-12 has no bypass capacitors between the AC line and ground. If it had, they would have been replaced with new safety capacitors of the same capacitance. All resistances were reasonable[2], and with time short, there appeared no need to replace resistors unless operation was affected.

Checking the Can Capacitor:

Using an empirical formula, given in the IT-11 manual - page 27, one can calculate max-

imum expected electrolytic leakage current as a function of rated voltage and capacitance. Using the formula, the maximum leakage for each of the 50 µF 150V sections is 1.3 mA. The 20 µF 25 volt section calculates to 0.55 mA.

The 50 µF 150 V Can Sections:

Using a Heathkit IP-32 HV power supply and a 3,500Ω 10 watt series resistor [3], voltage was applied to the two paralleled 150 V capacitors. The voltage was applied in approximately 25 volt increments. This was done in steps, always being sure the current remained below 2.6 mA. After reaching the next voltage plateau the capacitor was allowed to sit at that voltage until the current stabilized and then left at that voltage for several hours before going to the next voltage. This process reforms the electrolytic plates in the capacitor if it hasn't been used for a long period. When 150 volts was reached and the capacitor was allowed to stabilize, the current was under 1 mA for the paralleled capacitors – less than half the maximum allowed leakage rate. The capacitor was allowed to sit under full voltage for 24 hours. Current measurements during this process were made by measuring the voltage across the 3,500 Ω resistor (3.5 volts per mA).

The 20 µF 25 V Can Section:

Less emphasis was placed on this section as it could easily be replaced with a small modern electrolytic right at the socket of V2. It was checked for capacitance and leakage with an IT-11 Capacitor Checker.

Initial Power-On Evaluation:

Time to give it the smoke test! The IT-12 was plugged into a Heathkit IT-1 Isolation Transformer, which had been set to output 115 VAC. The tubes had been removed and checked on an EICO 667 tube tester. When the POWER switch was turned to ON, there was no smoke or report, and the fuse in the IT-1 remained happy! A small mechanical 60 Hz hum could be heard from the power transformer – a common occurrence [4]. A quick check showed 140, or so, volts across the two filter capacitors. Power was switched off, tubes were installed, and the unit was turned back on. The tube filaments lit up, and soon the 1629 eye tube lit up a bright green, a good sign as this WWII relic tube has become expensive. The speaker switch was tuned ON and a hum was heard from the speaker. Touching the broken tip of the probe caused the hum to increase significantly, Clipping the ground lead to the tip caused the hum to diminish, but not to the extent expected. Touching the metal probe housing caused the hum to increase, even with the tip grounded. Also, just handling the probe caused static and intermittent operation, especially around the probe's AUDIO – RF slide-switch. Evidently there were problems within the probe.

Probe Disassembly and Repair:

The black back of the probe was removed and slid up the RG-58 coax lead. There is supposed to be a short extension of the braid that gets pinched between the black plastic and the metal probe shield. It was missing. The probe shield was not grounded, and as such, it became more a hum antenna than a shield. A temporary jumper between the coax and the shield quieted down the hum, but the intermittency was still present.

The probe was totally disassembled. Removing the small circuit board and switch was difficult as the switch had not been seated fully into the board and passage through the shield required a lot of patience and difficult unsoldering. How it was installed is a mystery. Once free, the slide switch was disassembled,

cleaned and reassembled. (refer to HotM #M01)[5]. The probe was reassembled and a (slightly bent) probe-tip, from a Heath PK-3 scope probe awaiting repair, was temporarily installed in place of the broken tip. **Figure 7** [6] is an exploded view of the probe (**Page 7**).

An Updated IT-12 Manual Found:

Originally, the manual used for reference on this restoration was the one that came with the IT-12 discussed in the earlier HotM article. It was #595-570 with a date of 22 Feb., 1963, over 60 years ago. The last IT-12s were sold near the end of 1977, and between them at least five revisions of the manual and possibly the kit had occurred. A clue was a new crystal diode, used in many later Heathkits, was found in the probe. This set off a search for a later manual. Embarrassingly, one was found in my own folder of old Heath PDF manuals. It was not complete, but better than most partial manuals; it had construction and parts detail. The manual number was #595-570-06. A quick scan resolved a lot of questions between the early and later models:

1. The selenium rectifier (#57-13) was changed to a silicon diode (#57-27) and a 2-lug vertical terminal strip (#431-51) was added. It mounted in the existing hole of the selenium rectifier and provided tie points for the two silicon diode leads.

2. The crystal diode used in the probe was changed from a 60 volt Hughes HD2257 (#56-4) to a 90 volt 1N191 (#56-26).

3. The 0.01 µF 400 V tubular paper capacitor (#23-34) was replaced with a radial mylar capacitor (#27-36) of the same rating.

4. The 0.001 500 V ceramic capacitors were changed from class II Z5S ±22% to class II Z5P ±10% [7]. This change was probably done more for consolidation than design. The Z5S was marked (NLA) "no longer available", and Heath's price difference was about a tenth of one cent between the two.

5. The two knobs were changed from a knob (#462-139) with attachable white pointer (#463-27) to a knob (#462-187) with a line instead of pointer. Setscrews came with the early knobs, but separate 8-32 x ¼ setscrews (#250-43) were provided for the later knobs.

6. The body part of the 5 five-way binding posts (#427-2) were changed to one with a longer mounting stud (427-3) to allow an additional nut to be added to securely lock the binding posts in place.

7. The #22 solid copper vinyl insulated hookup wire (#344-1 - no color specified), supplied with most early kits became obsolete and was replaced in this kit with #22, solid copper, vinyl insulated, white, hookup wire (#344-59).

8. Various hardware were changed including the clamp that holds the eye-tube, and the 2-56 self-tapping screws used in assembling the probe. An additional 6-32 x ⅜ binder head machine screw was supplied to mount the terminal strip for the new silicon diode; as were five additional 6-32 nuts to use on the binding posts.

Obviously, there had been a fair amount of changes over the production life of the IT-12. The paper capacitor and selenium rectifier, items normally replaced in a basic refurbishing, were eliminated by Heathkit production changes. Older units should be updated.

When Heath replaced the selenium rectifier with a silicon diode all they did was to remove the rectifier, which mounted to the chassis with a #6-32 stud potted to the unit. The stud went

through the chassis and held a two-lug terminal strip on the other side. Heath removed the rectifier and used a #6-32 screw to hold a vertical 2-lug terminal strip **(Figure 4)** above the chassis in place of the rectifier, as well as to continue to hold the other two-lug terminal strip below the chassis. The silicon diode was wired between the lugs on the strip that replaced the rectifier and the wires now went to those lugs instead of the rectifier.

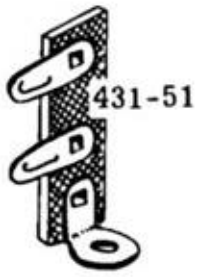

Figure 4: 2-lug vertical terminal strip

It is interesting to note that Heath didn't add a resistor to drop the voltage, like so many Heath enthusiasts claim is needed when they switched from selenium to silicon rectifiers in numerous kits.

Voltage Measurements:

After the probe was repaired, voltage measurements were made using a Heathkit IM-13 VTVM. The voltages for C7, and V1 through V3 are listed in **Table I.** The first of the two voltages shown is as marked on the schematic and the second voltage is the actual measured voltage. As the filaments all lit up normally, filament voltage was not measured. To improve hum reduction the filament circuit is not grounded except at the filament center-tap of V1. These measurements were taken at a line voltage of 119 V with the IT-12 connected directly to the AC outlet.

Operation:

A Heathkit IG-72 Audio Oscillator was connected to the IT-12 probe (switched to AUDIO) and set to 100 mV and 400 Hz. A clean tone was heard in the speaker and by varying the gain control on the IT-12 the volume was adjustable from undetectable up to beyond uncomfortable. There was plenty of gain, though Heath never specified gain or levels.

IT-12 Voltage Measurements

C7 A/B 50/50µF 150V		**V2 12CA5 Pentode**	
C7 A [square]	138/146V	V2 pin 1 (K)	6/6V
C7 B [triangle]	114/120V	V2 pin 2 (G)	0/-0.1V
C7 C 20 µF 25V		V2 pin 3 (fil)	
C7 C [*none*]	6/6V	V2 pin 4 (fil)	
		V2 pin 5 (nc)	
V1 -12AX7 Filaments		V2 pin 6 (S)	114/120V
V1 pin 4 (fil)		V2 pin 7 (P)	138/136V
V1 pin 5 (fil)			
V1 pin 9 (fil CT)	0/0V	**V3 1629 Eye Indicator**	
V1 - 12AX7 Section A		V3 pin 1 (nc)	
V1 pin 6 (P)	80/84V	V3 pin 2 (fil)	
V1 pin 7 (G)	-.1/-.06V	V3 pin 3 (P)	15/18V
V1 pin 8 (K)	0.6/0.54V	V3 pin 4 (T)	138/146V
V1 - 12AX7 Section B		V3 pin 5 (G)	-.4/-.45V
V1 pin 1 (P)	76/83V	V3 pin 6 (none)	
V1 pin 2 (G)	-.5/-.5V	V3 pin 7 (fil)	
V1 pin 3 (K)	0/0V	V3 pin 8 (K)	0/0V

Notes:

Filament voltages were not measured.	(S) = Screen Grid
[ ] = Capacitor terminal ID	(T) = Target
(G) = Control Grid	(fil) = Filament pin
(K) = Cathode	(fil CT) = Fil center-tap pin
(P) = Plate	(nc) no connection
	(none) = no pin

Table I

The probe was then switched to the RF position and connected to the 1st IF transistor of a Heathkit SW-717 receiver, tuned to a local broadcast station. The audio from the received program could be heard in the IT-12's speaker. Again the volume range was ample.

Replacing the Probe Tip:

After some research, the original Heathkit probe tip was found in a 1963 Arrow Electronics catalog. It is an H.H. Smith (Now Abbatron) #124 (See **Figure 5**). After two (not inexpensive) tries, more than a dozen of them were purchased at a decent price. **Figure 6** shows,

from left to right, four probe tips:

1. The broken IT-12 tip.
2. An equivalent tip that is press-fit instead of screw-in (one of the attempts at finding the correct probe tip). It is missing the knurled collar due to thread damage.
3. The bent tip originally from a Heath PK-3 probe.
4. The new H.H. Smith 124 probe tip.

Cabinet Paint:

The cabinet needed painting. Most of it was in good shape, but the top paint was badly damaged. The paint is textured to make it more difficult to match. The top was sanded and treated with Rust Reformer [8]. That was followed by a coat on the top with Krylon textured antique Bronze paint to restore the texture. The whole cabinet was then painted with London Fog paint [9]. This color is a close match for the "Pre-Classic" [10] style, but a browner gray than the existing paint.

Comments:

While this was a quick refurb job, the finished product should be serviceable for a lot more years. While no resistors were replaced, a couple were slightly out of their 10% tolerance range. They would have been in a full refurbishment, though it is most likely no one would

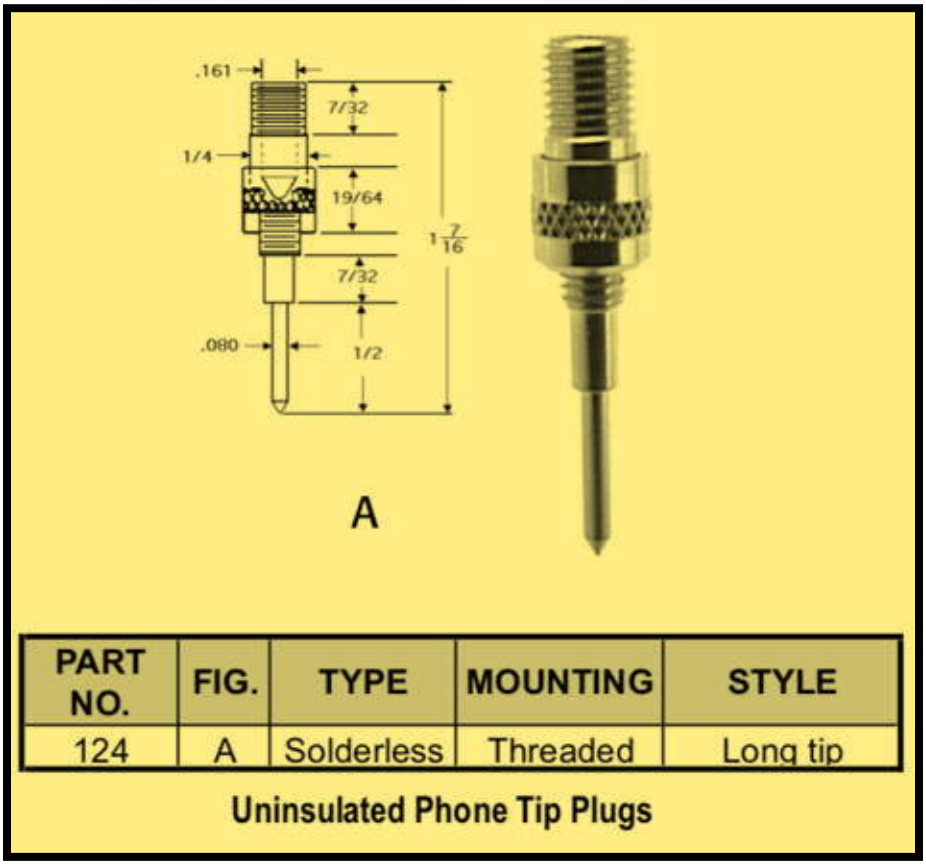

Figure 5: H.H. Smith (Abbatron) 124 Probe tip (Heath #477-3). No solder is necessary. The collar unscrews and the wire is wrapped around the probe body. Then the collar is screwed on and it clamps the wire tightly in contact with the probe body.

Figure 6: See Text

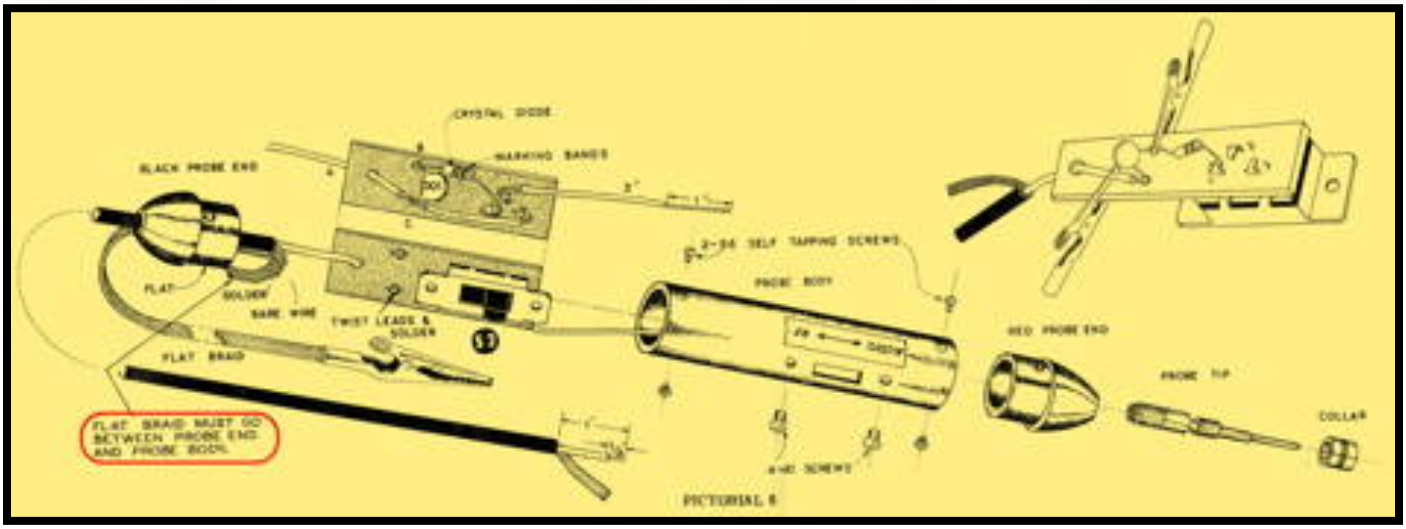

Figure 7: Probe drawing from the IT-12 Illustration booklet. A larger image can be found online [6]. The note in red shows the braid that was missing on the unit being restored.

notice a resulting effect. **Figures 8 & 9** are internal views of the IT-12.

The change from a selenium rectifier to a silicon diode was most likely the result of cost

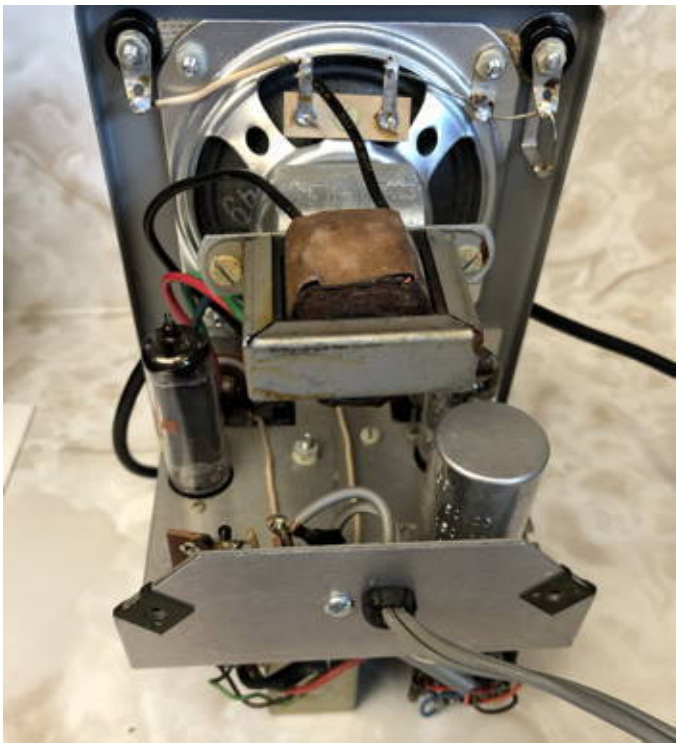

Figure 8: Upper rear view of uncased IT-12. Note audio output transformer behind speaker and tree section electrolytic can capacitor in foreground to the right.

Notes:

1. Heathkit of the Month #008 IT-12 Signal Tracer https://www.w6ze.org/Heathkit/Heathkit_008_IT12.pdf
2. Only resistances shown on the schematic were measured initially. Later resistors were checked as best they could while in circuit. None were significantly out of tolerance.
3. This resistor would limit the current to a safe level should the capacitor short.
4. This can often be cured by injecting a mixture of shellac thinned with denatured alcohol between the laminations and the frame and letting it dry. Usually, several applications are necessary.
5. https://www.w6ze.org/Heathkit/MiscArticles/Heathkit_Article_M01.pdf
6. A larger version of Figure 6 is available at https://www.w6ze.org/Heathkit/Sch/IT-12Fig7.jpg
7. See: Choosing Disc Capacitors: https://www.w6ze.org/btt/BTT048.pdf
8. Rust-o-leum Rust Reformer, available at most hardware stores such as ACE, Lowe's and Home Depot.
9. Rust-o-leum "2X", London Fog gray.
10. See *"Heathkit Test Equipment Products"* by Chuck Penson WA7ZZE, pages iv - vi, ISBN 9780615991337

Notes for HotM #125 (IT-12 Refurb) 8/2024

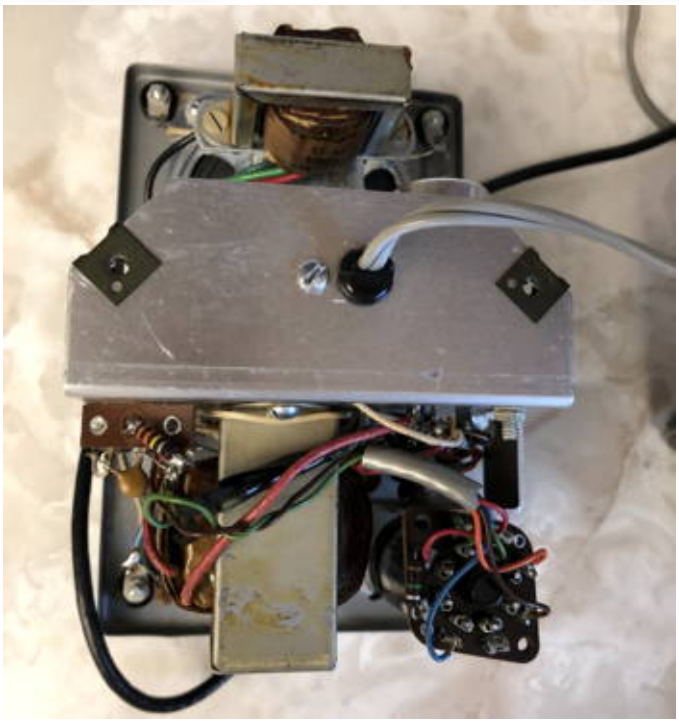

Figure 9: Lower rear view showing power transformer at lower center and 1629 eye-tube socket at lower right.

savings and/or availability of the selenium rectifier. This part, #57-13, was used in many kits including the V-7A and performs well if only supplying a few mA. In the IT-12, current draw can be high at high volume levels, so its replacement is warranted.

All nine external bolts were replaced with new #6-32 hardware of the same length (⅜") and slotted pan head design.

General:
There will probably not be an HotM article next month due to a busy schedule coming up. Look for the next article in October. Meanwhile, if there is a Heathkit you'd like to see featured, feel free to email me.

73, from Bob, AF6C

Remember if you are getting rid of any old Heathkit Manuals or Catalogs, please pass them along to me for my research.