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Atwater Kent: The Two-Tube Detector / Amplifiers

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[This is part 6B of a multi-part series on Atwater Kent by these authors. Previous installments have appeared from time to time in issues of Radio Age *beginning with May 2005. - Editor]*

Introduction

In this chapter we will discuss the two-tube Detector/ Amplifier (**D/A**), part # 3676, and its redesigned successor, part # 4940. These **D/A**s contain a detector and one audio amplifier. The # 3676 is shown on price lists dated February and October 1923.

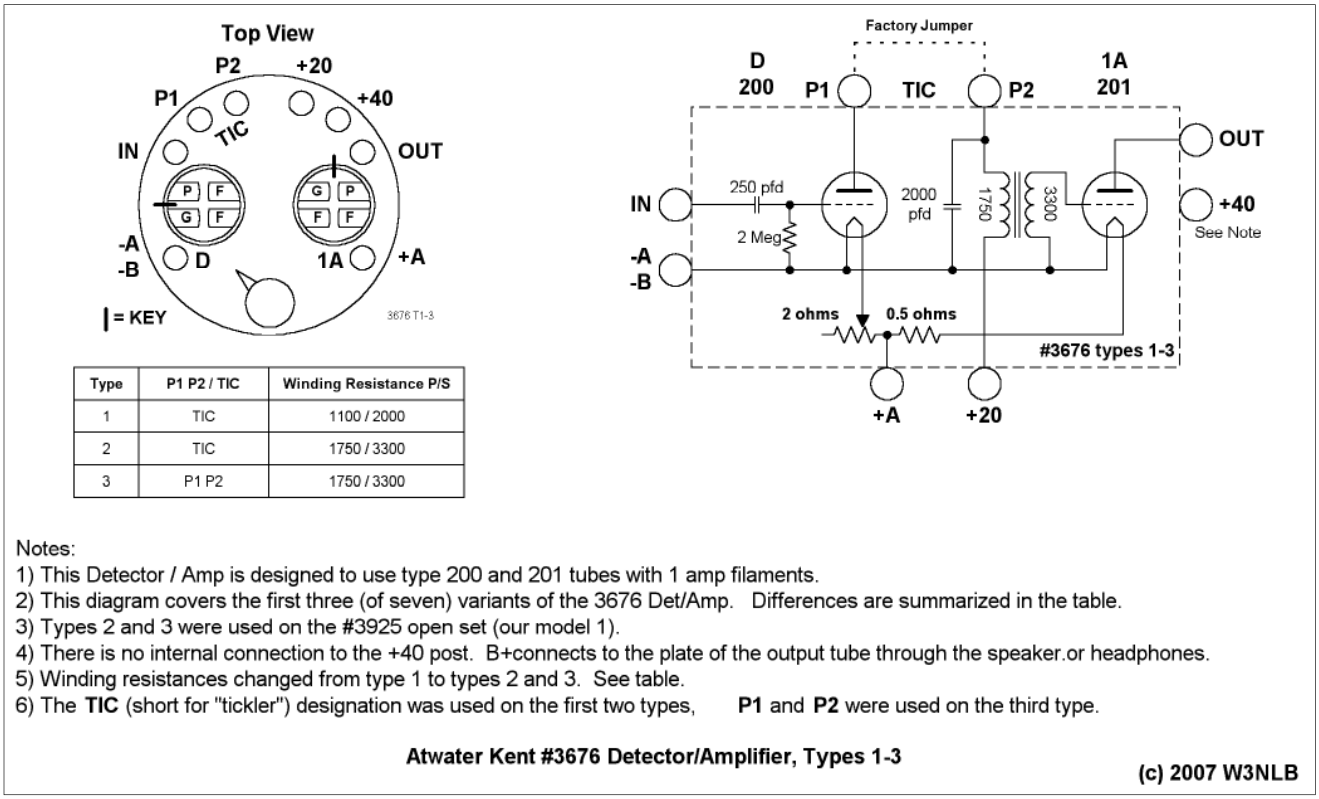
All **D/A**s contain several common components: A 250-pF condenser and a 2-megohm resistor in the detector grid circuit, a 2000-pF "phone" condenser in the detector plate circuit, and a transformer between the detector output tube plate and the audio amplifier tube grid. The # 3676 **D/A** (all seven variants) is distinguished by having a single transformer, while the # 4940 has two transformers. All **D/A**s also have a filament rheostat, the configuration of which varies considerably, as will be discussed separately for each type.

The # 3676 and # 4940 **D/A**s were assembled in the manner of the one-tube AF amplifier previously described. The metal can base has a flange with screw holes for mounting it to the breadboard. Some components are mounted in the base, potted in tar, which served as a waterproofing material.

The tube sockets, the filament rheostat, and some additional components are mounted on the Bakelite top. All external connections are made to terminals on the top, and legends for these are molded into the Bakelite. These legends changed over time, and are not always indicative of the actual function, as will be shown later in this chapter. Connector legends presented in the text appear in **boldface**.

In the first chapter of research information on the TA units, we thought that the most convenient method of study was to focus on differences by noting the colors

(Continued on page 3)



Type	P1 P2 / TIC	Winding Resistance P/S
1	TIC	1100 / 2000
2	TIC	1750 / 3300
3	P1 P2	1750 / 3300

Notes:
1) This Detector / Amp is designed to use type 200 and 201 tubes with 1 amp filaments.
2) This diagram covers the first three (of seven) variants of the 3676 Det/Amp. Differences are summarized in the table.
3) Types 2 and 3 were used on the #3925 open set (our model 1).
4) There is no internal connection to the +40 post. B+connects to the plate of the output tube through the speaker.or headphones.
5) Winding resistances changed from type 1 to types 2 and 3. See table.
6) The **TIC** (short for "tickler") designation was used on the first two types, **P1** and **P2** were used on the third type.

Atwater Kent #3676 Detector/Amplifier, Types 1-3

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(Continued from page 1)
of the painted cans. The AK factory started with green, then black, and finally brown. But in the course of this analysis, we discovered that this method did not clearly show the evolution of the design changes. Therefore, the format for this chapter has been changed to better reflect the chronological order of production.

A Note Regarding Tubes

The # 3676 **D/A** was originally designed to use a UV-200 detector and a UV-201 amplifier tube, both with 1-amp filaments, since that was the only option at the time. These tubes had been available since December 1920[1]. When the UV-201A was introduced in December 1922, [2] its ¼-amp filament required a redesign of the filament rheostat, as will be discussed later.

The UX 201A tube base was not introduced until August 1925 [3]. All open set and component production had ceased in the early months of 1925, so this tube was not available for the initial sales. But the UX 201A tubes could be used as replacements with the proper filament voltage since the UX base was designed to enable this interchangeability.

Atwater Kent's Model 12C, # 4910 with its # 4940 **D/A** and # 4925 two-stage amplifier, was the only open set still in production when the UX base was introduced. All other open sets and components had been discontinued by this time, but they could use UX tubes as replacements.

Later low-filament-current versions of the 201, specifically the 01B (125 mA) and 01C (60 mA) [4], would not work correctly in any of the **D/A**s since the filament rheostat was not designed for such low current.

The ¼-amp UX-200A detector tube did not become available until April 1926 [5], long after production ceased on all open set products. The three later versions of the # 3676 could use either a 1-amp type 200 tube or a ¼-amp 201A as the detector, as noted on the schematics. There was never a ¼-amp UV-200A detector. The UV base was discontinued a year before the UX-200A was developed.

A table summarizing the possible tube configurations along with other relevant data appears at the end of this article. Accompanying this article are four schematics, showing the different circuit arrangements used in the

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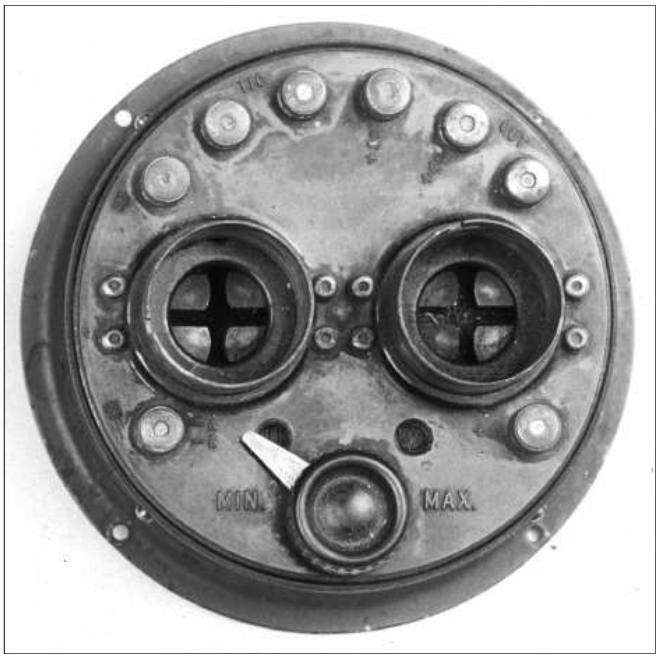


Figure 6B-1. Type 1 # 3676 Detector/Amplifier, top view.

3676 (the first of which is on this page), and the 4940.

Part # 3676 Type 1

The type 1 # 3676 **D/A** was designed to use a UV-200 detector and a UV-201 amplifier. Its phone condenser is attached to the transformer. One of its leads is connected to the transformer primary plate lead, and the other to the grid return, both at the transformer. Four wires are soldered to the transformer.

In addition, the detector grid condenser and resistor are installed with the audio transformer. One end of the condenser is tied to the resistor, with a wire coming out of the tar from this junction going to the detector grid. The other end of the condenser connects to the **IN** terminal on top via a second wire. The other lead of the grid resistor is tied to the grid return end of the audio transformer secondary.

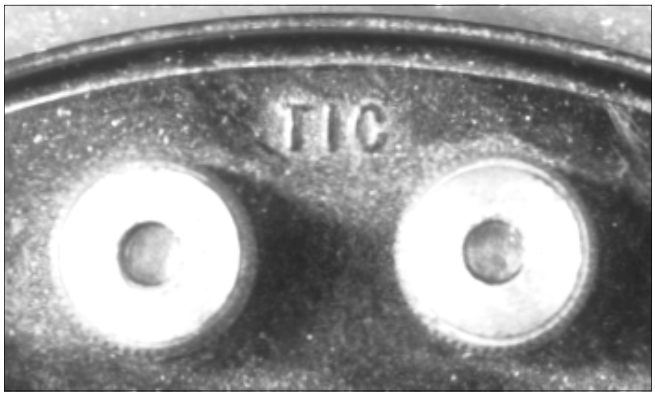


Figure 6B-2. Types 1 & 2 # 3676, detail showing TIC label.

Figure 6B-3. Part # 3676, front view.

Figure 6B-4. Type 1 # 3676, detail of blunt-end rheostat slider.

When this assembly was embedded in the tar, six wires were available for connection to points on the Bakelite upper housing (boldface indicates molded label on top): **IN**, **-A-B**, **P2**, **+20**, the detector grid, and the audio amplifier grid.

A fiber form supports the 2.5-ohm rheostat winding. The winding has a tap which divides it into a variable section of 2 ohms and a fixed section of 0.5 ohms. Only the detector filament voltage is variable. Amplifier filament voltage is derived from the fixed 0.5-ohm section, which yields an operating voltage of about 5.8 volts on a fully-charged 6.3-volt battery.

An interesting thing to note here is that the **-A-B**

Figure 6B-5. Type 1 # 3676, interior view.

terminal is connected directly to the tube filament pins and the returns from the audio and detector circuits. The **+A** voltage is connected through the rheostat. This is the opposite of the wiring for two-stage AF amplifier # 3634, where **+A** is hard-wired, and the rheostat is in the **-A** line. The **-A-B** line is circuit common for both configurations.

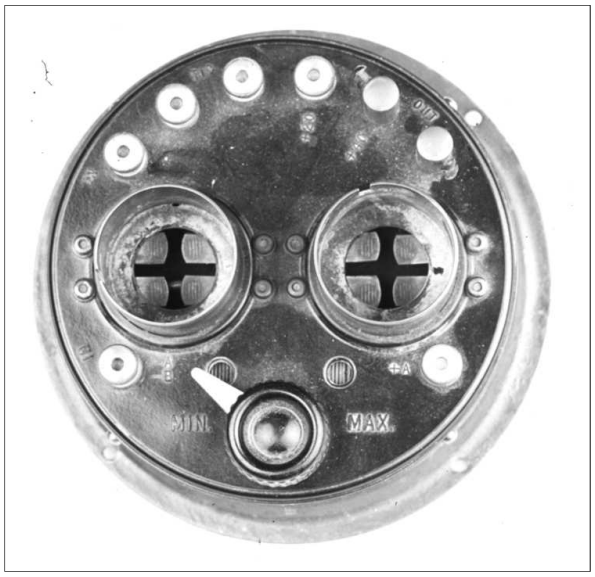


Figure 6B-6. Type 2 # 3676, top view showing added output posts.

The **-A-B** and **+A** terminals are located on top, toward the front, near the rheostat knob. There are two terminals marked **TIC** at the rear. These were connected by a wire jumper at the factory. Removing this jumper enabled the owner to connect a variometer in the detector tube plate circuit, which converts the radio to a regenerative configuration. The factory was not legally allowed to do the above, as Mr. Kent did not have a license for the Armstrong regenerative patent. But the unit was designed to allow the owner to make this modification.

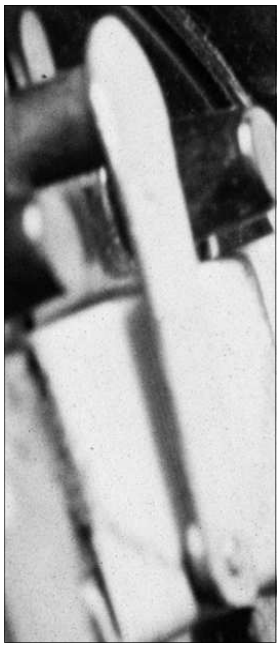


Figure 6B-7. Type 2 # 3676, detail of round rheostat slider.

The first type of part # 3676 does not have the familiar multi-hole output posts. Rather its output is via thumb nuts like those used for other connections. The rheostat slider has a blunt end that slides on the winding, just like in the Type 1 part # 3634 two-stage AF amplifier.

The cans are painted green. The color was called "Geronimo Grey" in early AK brochures. Both black and brown rheostat knobs are found on the Type 1. This unit was not used on any factory-produced radios. It was sold only as a component.

Part # 3676 Type 2

Type 2 of the # 3676 was used on the first factory-built Atwater Kent radio, # 3925 (our Model 1). This was

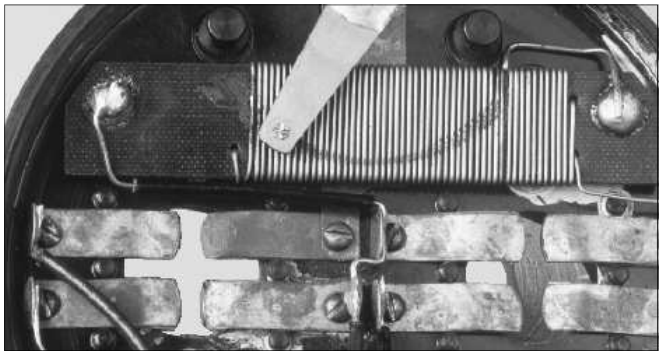


Figure 6B-8. Type 2 # 3676, wiring detail showing tapped rheostat winding.

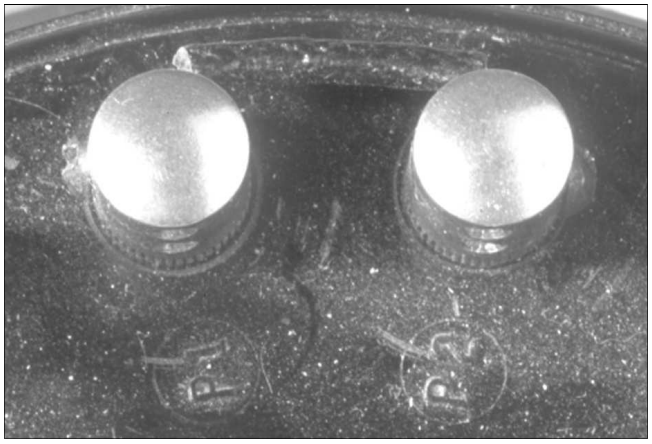


Figure 6B-9. Type 3 # 3676, detail of new P1-P2 posts.

the only factory radio to use the type 2 # 3676 Detector/Amplifier. Type 2 used the UV-200 and UV-201 tubes, like the type 1.

The Type 2 **D/A** incorporated several upgrades from the Type 1:

The rheostat slider was changed from a blunt end contact to a smoother rounded contact. This eliminated the tendency for the contact to snag the wires, and score the fiber form.

The familiar multi-hole output posts were added, which allow up to three sets of headphones to be attached, to accommodate multiple listeners.

The audio transformer was redesigned, with winding resistances of 1750 ohms primary, 3300 ohms secondary. (The Type 1 transformer had a primary resistance of 1100 ohms, and a 2000-ohm secondary.)

The housing was painted green. Type 2 was furnished with both black and brown knobs.

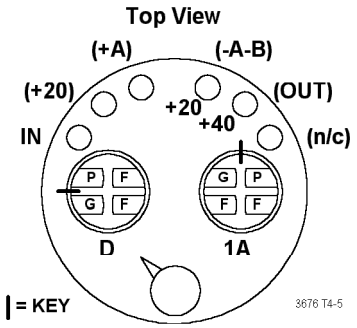
Part # 3676 Type 3

Type 3 of the # 3676 is almost identical to the Type 2 described above. There are only a couple of design changes, but they are sufficiently significant to warrant identifying this as a different type.

The word **TIC** on the Bakelite top was changed to **P1** and **P2**. This nomenclature identified the detector tube plate connections, where the owner could add a variometer to add regeneration to the set.

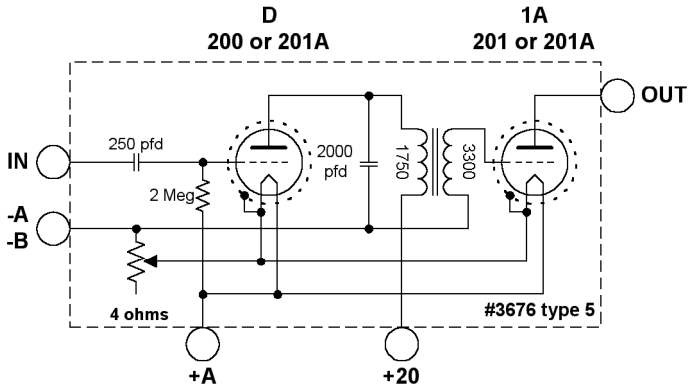
The detector circuit grid leak resistor return was separated from the audio transformer grid winding return previously connected in the tar. A seventh lead was added so the resistor could be connected to the **-A-B** terminal on the Bakelite top.

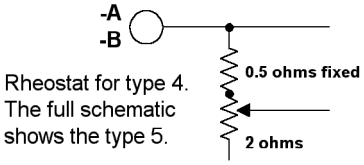
This detector/amp version has been found on at least



Usable tube combinations

Det	Amp	Type 4	Type 5
200	201	X	
200	201A	X	X
201A	201A		X





Rheostat for type 4.
The full schematic shows the type 5.

Notes:
1) This diagram covers types 4 and 5 (of seven) of p/n 3676 (brown). The two types differ in the rheostat value and configuration..
2) These two D/As were used on the Model 12B #4620 open set. They have labels molded into the Bakelite lid which are not correct. The proper connections are shown above in parenthesis. (n/c = no connection).
3) The rheostat for type 4 had a 0.5-ohm fixed section and a 2-ohm variable section as shown in the partial schematic.
4) On these **D/A**s the brass tube skirts are connected to **-A-B** (circuit common). The skirts are not connected on other 3676 types.

Atwater Kent #3676 Detector/Amplifier, Types 4 and 5

Figure 6B-10. Type 4 # 3676 (brown), internal view (from early 12B # 4620). Note the fixed rheostat section at the right-hand end.

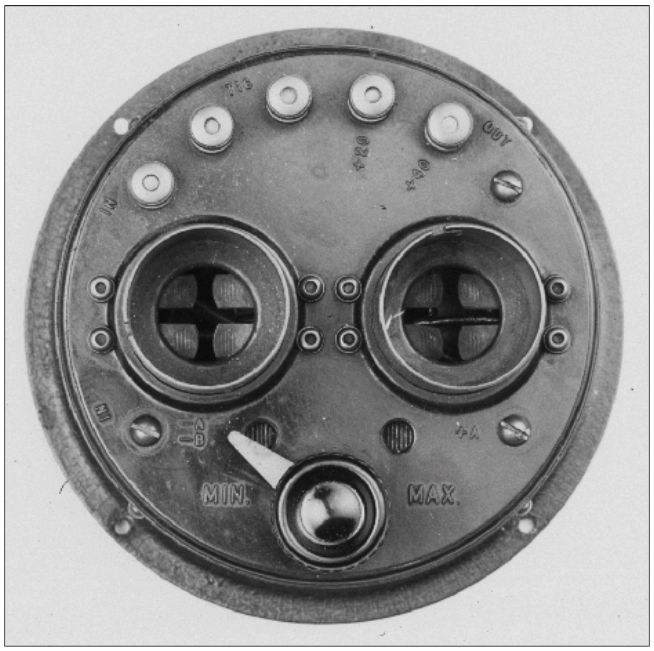


Figure 6B-11. Type 4 # 3676 (brown), top view (from early 12B # 4620). Note the TIC label at the upper left. The terminal labels do not indicate the actual function (see text).

one factory-built # 3925 radio (our Model 1) in 1922. The Model 3925 was still being sold in 1923 AK factory catalogs.

Part # 3676 Type 4

Type 4 of the # 3676 **D/A** had both electrical and mechanical changes. This is the first **D/A** to be painted with a brown crinkle finish. Oddly, type 4 has a black knob, which normally indicates a unit that uses 1-amp tubes, not ¼-amp tubes.

The type 4 was created from the type 2 by changing the wiring of the filament rheostat. The rheostat component itself is identical in both units. So why was this done?

When the Model 12B # 4620 open set, on which the type 4 was used, was introduced in March 1924, the ¼-amp 201A tubes had already been available for 15 months, so the modification wasn't occasioned by the appearance of a new tube.

We believe that type 4 was a post-production factory modification, required by excessive audio distortion in the 12B radio. The earlier # 3676 types ran the audio tube at full gain, in fact higher than normal, due to a filament voltage of 5.8 volts that could not be adjusted. The resulting high audio level could have over-driven the first stage of the # 3634 two-tube amp substantially, resulting in distortion of strong signals at all volume settings. The long-term solution to this problem was to install a new 4-ohm rheostat, which creates the type 5 described later.

The short-term solution was to modify the 2.5-ohm rheostat already installed in the **D/A** by changing the connections, creating the type 4. One wire was moved, one was removed, and the audio tube filament connection was changed. This created a 2-ohm rheostat in series with a 0.5-ohm fixed resistor. There was no longer a connection to this junction. The rheostat wiper controlled both tube filaments, thus providing reasonable adjustment of the amplifier stage volume. This explains why type 4 has a black knob, since it was built as a 1-amp unit, then modified.

Given that only 1520 of the Model 12B radios were produced, accounting for all of the type 4 and type 5 **D/A**s, it's likely that the type 4 was used only for three to four weeks, until production of the type 5 began.
Besides the electrical modification there were several mechanical changes.

The screw terminals for the **-A**-**B** and the **+A** connections near the rheostat knob are no longer used

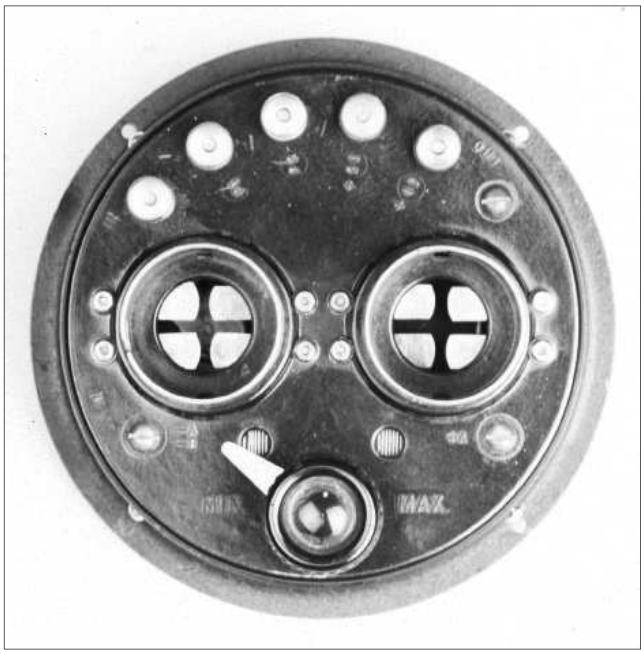


Figure 6B-12. Type 5 # 3676 (brown), top view (from early 12B # 4620). Note the P1-P2 labels at the upper left. The terminal labels do not indicate the actual function (see text).

for external connections. The screws are turned around, with the heads on the outside. Nuts on the inside hold the rheostat element in place. A lug under one of the

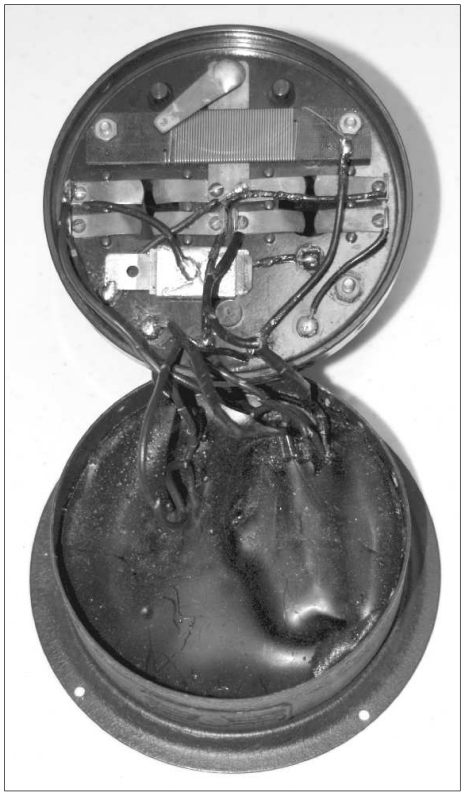


Figure 6B-13. Type 5 # 3676 Variant A (brown), internal view.

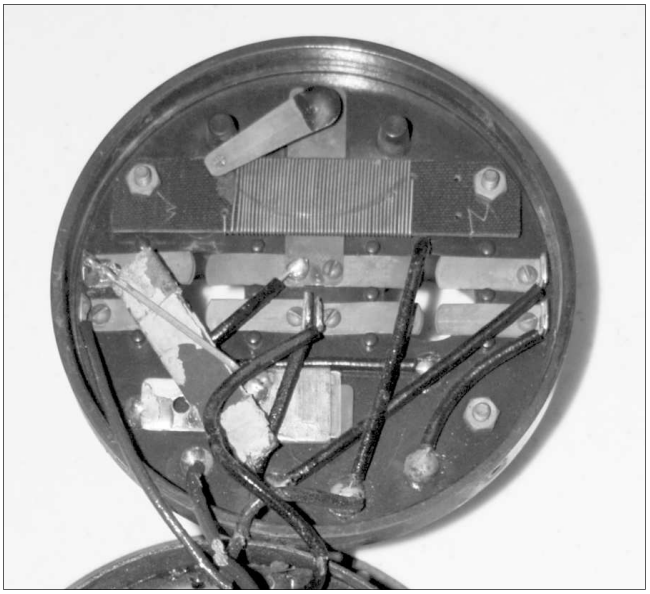


Figure 6B-14. Type 5 # 3676 Variant B (brown), interior view.

rheostat mounting nuts serves as a connection point for the **-A-B** wiring (see photo).

The **TIC** posts are replaced with thumb nuts which now provide connections for the **+20** detector plate supply and the **+A** filament line. The type 4 **D/A** may be found with **TIC** labels on the top. However, these do not identify the actual circuit function and should not be connected as earlier types were.

The output posts are eliminated. A screw with thumb nut is used for the second tube plate connection. The last hole on the right has no connection. A screw is installed here with the head exposed to fill the hole. The two brass tube socket sleeves are connected to the **-A-B** line, apparently to provide shielding against hum pickup. For example, touching the tube base could otherwise have induced hum.

The type 4 audio transformer has the phone condenser attached between the plate lead and the **-A-B** grid return line. All four transformer leads are brought out of the tar for connections to circuitry on top. The detector grid leak resistor and grid condenser are also in the tar, with three leads brought out for connection to **IN**, **+A**, and the audio grid.

The type 4 # 3676 was designed to be used on the Model 12B radio, part # 4620. Type 4 is interchangeable with type 5, but not with any other version of the # 3676, nor with the # 4940 (used on the Model 12C # 4910). It was never sold as a component, but only as a replacement part for repair purposes.

Figure 6B-15. Type 6 # 3676, top view.

Any reader who owns a brown **D/A** or a brown 2-stage audio amplifier is advised to consult the material in these articles to determine its type, before making any connections or attempting to use these parts.

Since there are so few Model 12B # 4620 radios to examine, it has been difficult to draw precise conclusions from the available data. It was recently determined that there are two versions of the 12B, one being a transitional version which has some parts used on the 12C # 4910 set. At first those who have studied Atwater Kent speculated that this was the result of collectors mixing parts, but enough sets have now been examined to determine that the transitional sets were genuine factory variants, possibly the result of the sets being produced at two different factory buildings or areas. The subject will be discussed further in the article about those radio models.

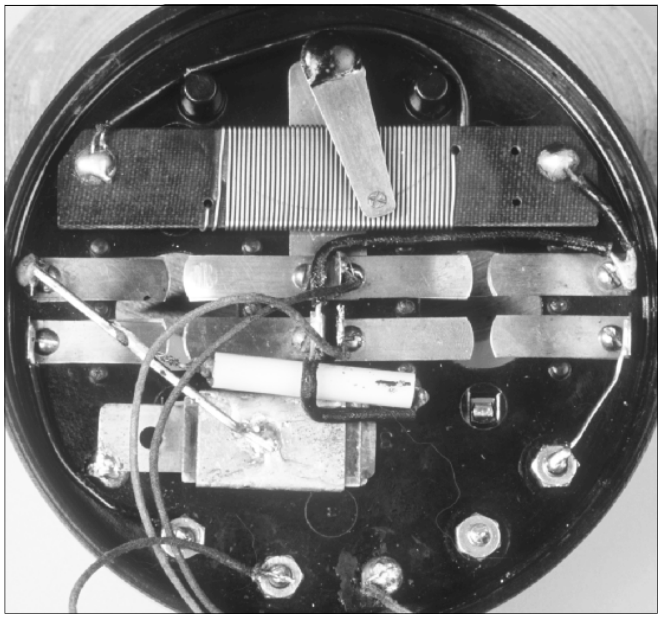


Figure 6B-16. Type 6 # 3676, wiring detail showing top-mounted condenser and grid leak resistor (white tube).

Part # 3676 Type 5

Externally, the type 5 is identical to the type 4, except that the letters **TIC** have been replaced by **P1 P2**. However, the device's interior is sufficiently different to warrant a separate type number and an explanation, as follows:

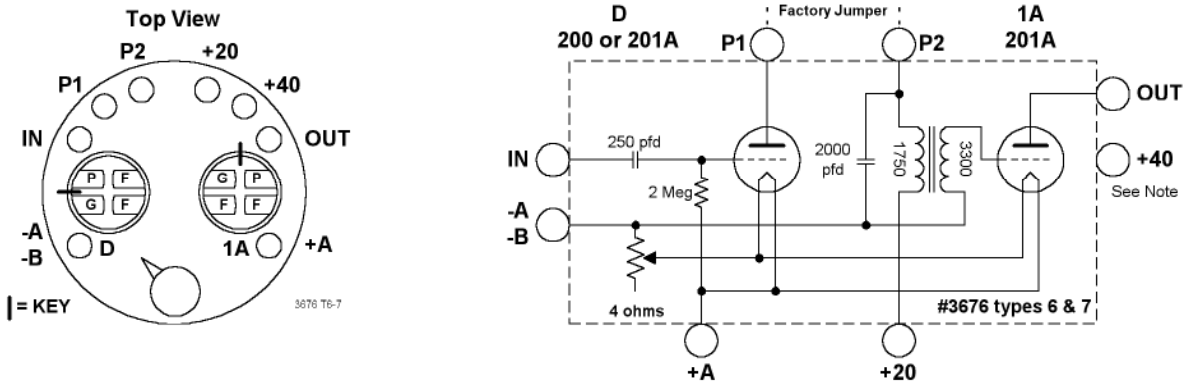
The type 4, discussed above, was a "stop gap" design which could use two one-amp filament tubes, or a one-amp detector and a ¼-amp 201A amplifier. Although the ¼-amp 201A had been available since December 1922, the ¼-amp 200A detector tube was not produced until April 1926, long after production of the open sets and their components ceased. So it was not considered in the 3676 design.

The type 5 could use two 201A ¼-amp filament tubes, based on the realization that the 201A could function satisfactorily as a detector in the contemporary receiving environment. Radio stations were becoming more numerous. Shorter receiving distances and higher power both minimized the advantage of the dedicated 200 detector tube as opposed to the general-purpose 201A in that function. Substituting the 201A for the 200 reduced the filament current by 60 percent, from 1.25 amps to 0.5 amps, which is quite a significant saving. For compatibility, the type 5 could also use the 1-amp 200 detector.

Two AK factory variations exist of the type 5. Each type employed a 4-ohm rheostat. This value would accommodate both the original 1.25-amp tube combination and the new 0.5-amp configuration.

The first version had also changed the 250-pF detector grid condenser to part # 4465, and relocated it from the base to the Bakelite top. The grid leak resistor remained embedded in the tar, resulting in six wires between the circuitry in the base and that on the Bakelite top.

In the second (later) variant, both the part # 4465 detector grid condenser and the grid leak resistor were installed under the Bakelite top. This left only the four wires emerging from the audio transformer, with the



Notes:
1) This Detector / Amp is designed to use a 1-amp 200 detector plus a ¼-amp 201A amplifier or two ¼-amp 201A tubes.
2) This diagram covers types 6 and 7 (of seven) of the 3676. The only difference between the two types is the color of the can. Type 6 is green. Type 7 is believed to be black., although no examples have been found.
3) There is no internal connection to the +40 post. B+ connects to the output tube plate through the speaker or headphones.

Atwater Kent #3676 Detector/Amplifier, Types 6 and 7

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phone condenser embedded in the tar. This was probably the most popular unit (version) used once the Model 12B, part # 4620 was in full production.

Type 5 was produced with brown crinkle paint, and was used only in the Model 12B # 4620 open set. It was not sold as a component nor used in other radio models.

Part # 3676 Type 6

The sixth type of the # 3676 is distinguished by several changes. As with the two-stage AF amplifier part # 3634, the introduction of the ¼-amp 201A tubes resulted in new designs for filament control. This was particularly true of the detector/amplifier unit.

Earlier versions of the # 3676 used a tapped 2.5-ohm filament rheostat. The type 6 used an untapped 4-ohm rheostat between the **-A-B** terminal and both tube filaments, connected in parallel. This was a major design change which enabled use of two ¼-amp tubes in the **D/A**.

The condenser and grid leak resistor were removed from the tar and mounted on the underside of the Bakelite top. The grid leak resistor return connects to the **+A** line, not to the **-A-B** line as in previous versions.

These changes left only the audio transformer and the phone condenser still encapsulated in tar. Only four wires were needed for connection to the circuitry above.

On the output connection posts, the new-style knurled thumb screws replaced the slotted round-head screws formerly used, making it easier to connect headphone leads. Three- and four-hole posts were used, as on previous versions.

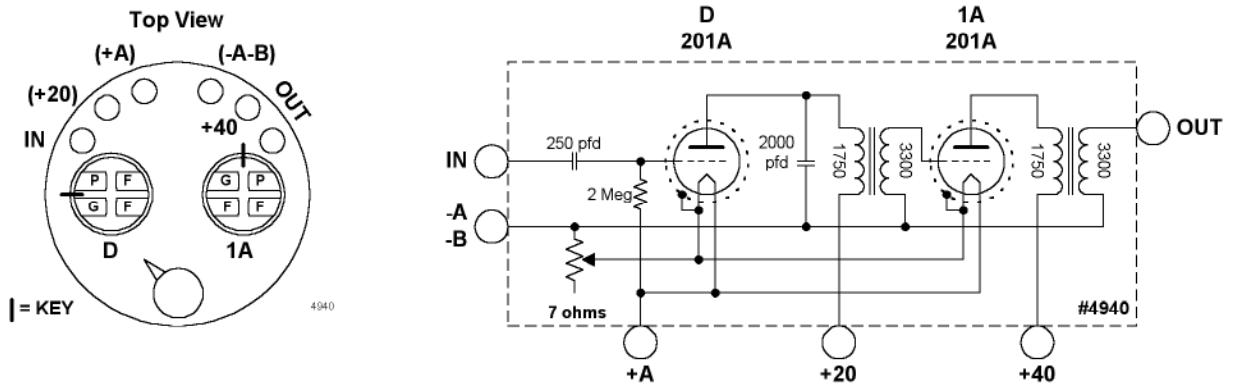
Short two-hole posts replaced the thumb nuts that had been used for the **P1** to **P2** jumper wire. Slotted round-head screws held the jumper wire in place in the posts.

Type 6 is the last of the green **D/A**s made. This version was sold as a component, to provide experimenters with the latest technology. It was not used in any factory-built radios.

Part # 3676 Type 7

Little is known about this last type of the # 3676 **D/A**. As of this writing, author Thompson has not seen this **D/A** unit, which is supposedly painted with a black crinkle finish. But because the companion black two-stage AF amplifier exists (rare in itself), there is reason to believe that the matching # 3676 was also produced. Why would the factory go to the trouble of marketing one unit in a different color without its companion?

Assuming that the black version is a reality, it would probably be basically the same as Type 6. It would have the same style output posts as the black two-stage AF amplifier, part # 3634. These would be different than the ones on # 3676 Type 6. The **P1 P2** posts would be the same as used with the # 3676 type 6.



Notes:
1) This diagram covers the #4940 D/A, which is a re-design of the #3676.
2) This Detector / Amp is designed to use type 201A tubes with ¼-amp filaments.
3) This D/A was only used on the Model 12C #4910 Open Set, mated with the #4925 two-stage amplifier.
4) The filament rheostat resistance is shown in factory parts lists as 7 ohms, but all units examined by Thompson measure 9 ohms. The reason for this discrepancy is not known.
5) The brass tube skirts are connected to -A-B (circuit common).

Atwater Kent #4940 Detector / Amplifier

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The rheostat would be four ohms, installed in the **-A-B** supply line, just like the Type 6.

The grid leak resistor and condenser would be mounted under the Bakelite top, with the grid resistor return tied to +A.

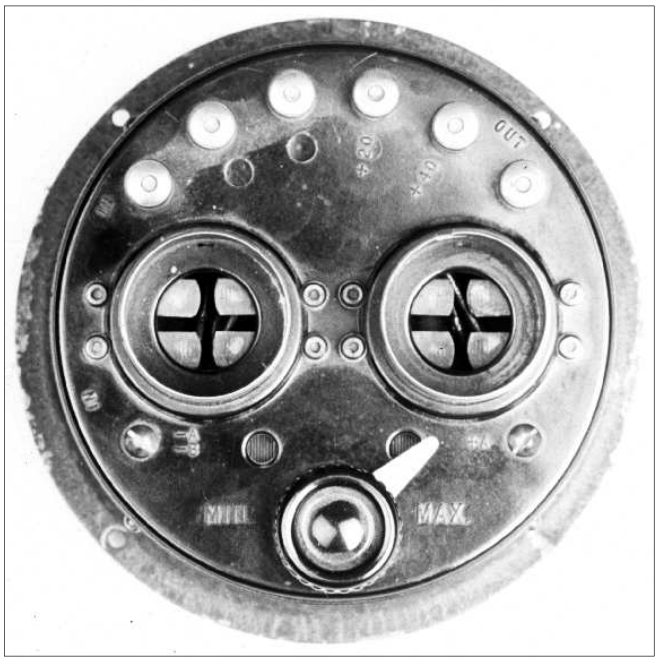

Figure 6B-17. Detector / Amplifer # 4940 (brown), top view. Note that the P1-P2 labels at the upper left have been replaced with black circles.

Figure 6B-18. Detector / Amplifier # 4940 (brown), internal view. Note the square bus bar wire used by the factory. Note also the first use of wire lug, on the right-hand rheostat screw.

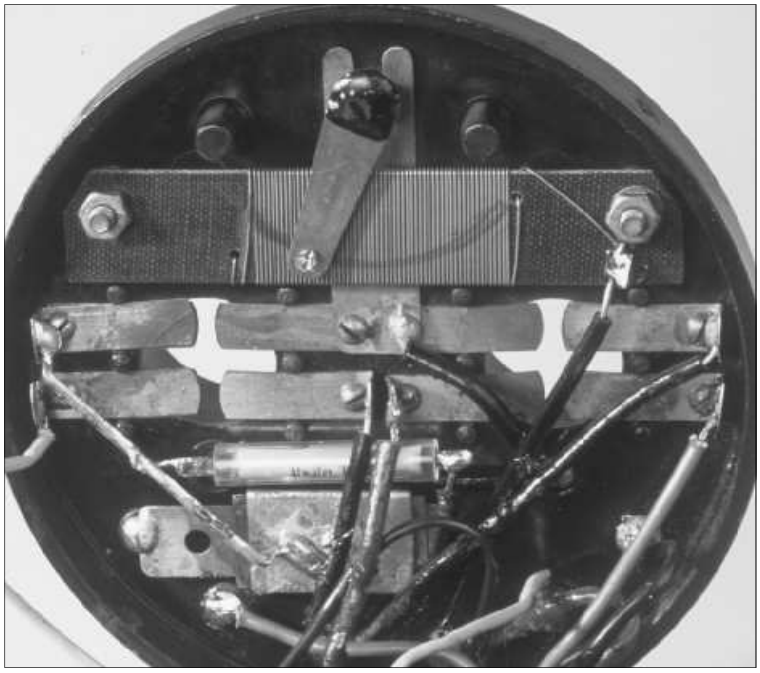

Figure 6B-19. Detector / Amplifier # 4940, late (brown), internal wiring detail.

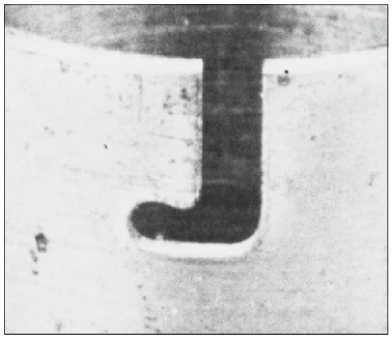

Figure 6B-20. Detector / Amplifier # 4940, detail of small tube key slot.

This type would have been available as a component, but was not used on any factory radios.

Part # 4940 Detector/Amplifier

As was discussed in an earlier chapter (*Radio Age*, Feb. 2007, p. 9) regarding the # 4925 2-

Table 1. Two-tube D/A Unit Tube Complement, Specifications, and Radio Model Usage

Part Nr	Type	Detector Tube	Amplifier Tube	Rheostat	Fixed R (Ω)	Current (A)	Open Set	Color	Note
3676	1	200	201	2	0.5	2	None	Green	1
3676	2	200	201	2	0.5	2	3925	Green	1
3676	3	200	201	2	0.5	2	3925	Green	1
3676	4	200 200	201 201A	2	0.5	2 1.25	12B 4620	Brown	2
3676	5	200 201A	201A 201A	4	0	1.25 0.5	12B 4620	Brown	3
3676	6	200 201A	201A 201A	4	0	1.25 0.5	None	Green	3
3676	7	200 201A	201A 201A	4	0	1.25 0.5	None	Black	3
4940		201A	201A	7	0	0.5	12C 4910	Brown	3

Notes:

1 The rheostat feeds only the Detector filament. The Amplifier filament is fed through the 0.5-ohm fixed resistor.

2 The rheostat feeds both tube filaments, connected in parallel. The 0.5-ohm fixed resistor sets the minimum circuit resistance.

3 The rheostat feeds both tube filaments, connected in parallel.

The column labeled "Open Set" shows which factory-built radios used a particular D/A, if any.

Where two rows of tube types appear, either combination can be used.

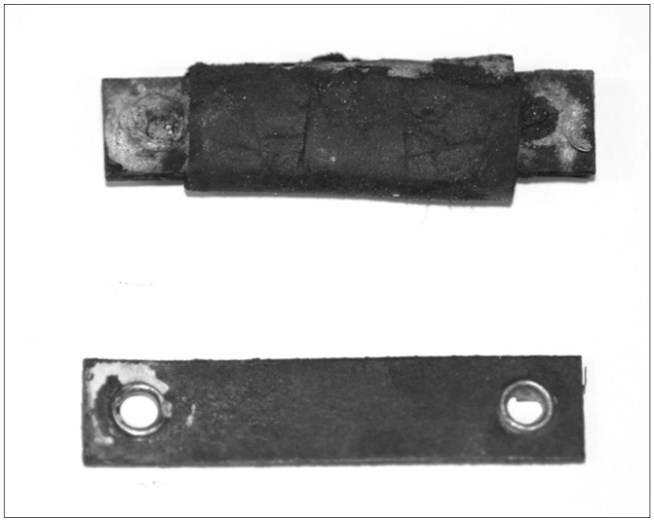

Figure 6B-21. Typical embedded components: phone condenser (top) and grid resistor.

stage amplifier, availability of the new ¼-amp tubes resulted in a complete redesign of the # 3676 detector/amplifier. This new version, part # 4940, differs substantially from its predecessors.

The value of the filament rheostat was increased from the 4 ohms used in the later # 3676 **D/A**s to 7 ohms (part # 4943) according to factory literature. However, all of the units examined by author Thompson measure 9 ohms. Whether this indicates an error in the factory documentation or a uniform aging characteristic of the components is not known.

The # 4940 has two identical audio transformers, with a primary resistance of 1,750 ohms and a secondary resistance of 3,300 ohms.

The first transformer is in the detector plate circuit, driving the amplifier grid. The second is an output transformer which connects to the grid of the first tube in the adjacent 2-stage amplifier, part # 4925. The phone condenser is the only component encapsulated with the transformers. It connects between the detector plate and the **-A-B** filament line (circuit common). Since both of its connections are on the transformer, no leads are brought out of the tar for it.

The 2-megohm grid leak resistor, part # 4814, and 250-pF grid condenser, part # 4465, are mounted on the underside of the Bakelite top. The resistor is protected by a glass tube, and has an AK label inside.

The can is painted brown with a crinkle finish. The socket skirts have the small key slots as described in the article on the # 4925 2-stage audio amplifier. The **P1** and **P2** labels have been removed from the Bakelite top, replaced with blank circles. However, some # 4940s have been seen with the **P1 P2** labels.

The second output screw, removed in the previous type, has been restored, and is used for the audio connection to the following 2-stage audio amplifier # 4925.

The # 4940 **D/A** was designed to be used exclusively on the Model 12C, part # 4910, along with its companion two-tube amplifier # 4925. It was not sold as a component for other uses.

Conclusion

The two-tube Detector/Amplifier launched Atwater Kent's radio receiver production with the # 3925 open set (our Model 1) in 1922 and ended the breadboard era with the Model 12 #4620 & # 4910 in 1924. Although this part was not used for any other factory receiver, it was used heavily by radio amateurs and experimenters, which accounts for so many of these devices still in existence.

Our next chapter will discuss the three-tube Detector/Amplifiers.

Links

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Visit the Articles page at http://www.AtwaterKent.Info for online copies of this series, additional drawings, photos, and schematics.

References

1. Gerald F. Tyne, *Saga of the Vacuum Tube* (Indianapolis: Howard W. Sams, 1977), ISBN 0-672-21470-9 [soft] or 0-672-21471-7 [hard], p. 308

2. Ibid, p. 314

3. Ibid, p. 315

4. Robert T. Millard, *The Collector's Vacuum Tube Handbook, Volume I* (Chandler, AZ: Sonoran Publishing, 2001), ISBN 1-886606-15-3 [soft], p. 6

5. Tyne, p. 316 ■