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Atwater Kent Variometers, Variocouplers, and Related Devices

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This article is part four of a series on Atwater Kent by Thompson and Bassett. Parts 1, 2, and 3 appeared in the May, July, and October issues of Radio Age, *respectively.—Editor*

Introduction

In this section we discuss four Atwater Kent self-contained inductive tuners that were available to the hobbyist market, and used in factory-produced radios.

These devices all contain a rotatable coil (the rotor) mounted inside a fixed coil (the stator). The rotor is mounted on a split brass shaft held together by an insulating bushing so each end of the shaft serves as a separate electrical connection.

The Variometer

The single ubiquitous component in the early days of radio was the variometer. Produced by various

(Continued on page 3)

Figure 4-1 (Right). Unmounted variometers # 3488.

(Continued from page 1)
companies, this resonant circuit formed the heart of many different radio designs.

Variometers work on the principle of closely-coupled coils. In one position the rotor and stator coils are coaxial, and their magnetic fields add, resulting in maximum inductance. When the rotor is turned 90 degrees, coupling is at a minimum, and the inductance drops to the sum of the individual values. Turning the rotor another 90 degrees causes the fields to partially cancel, resulting in minimum inductance. The Variometer resonates with its own distributed capacitance plus the capacitance of the attached circuitry. By choosing proper dimensions, the frequency range of the resulting L-C resonant circuit can be made to lie within the broadcast band.

Here we introduce the Atwater Kent version of this device, for which Mr. Kent received patent #1,523,832, filed July 3rd, 1922, and issued January 20th, 1925. It is built with the rotor connected in series between the two halves of the stator.

Figure 4-1 shows two part number 3488 unmounted variometers lying on their sides. The round metal mounting feet are attached to the unit in the foreground, but missing from the other one. The rear unit is also missing one side of the outer housing and stator, so the rotor is visible. The unmounted variometers had no panel or dial. The # 3488 was sold to the hobbyist market with a long 3/16" diameter shaft, as shown in the front unit.

Figure 4-2 shows the rotor (right) and stator. The rotor has 66 turns, 33 on each side. The factory brochure says 64 turns, but every one author Thompson has examined has 66. Quite probably the sales literature was printed before the design was finalized. Each half of the stator was made with 33 turns of wire wound on

Figure 4-2. Variometer #3488 stator (left) and rotor.

Figure 4-3. Mounted variometer # 3714 (brown) or # 3838 (black).

the inside of the Bakelite form. This part is identical with the top of Coupled Circuit Tuners # 3715 and # 3752, and Type II Tuners # 4051 and # 4055. Both rotors and stators were wound with green or white # 22 AWG double-cotton covered (DCC) wire.

Atwater Kent's variometer was built with the rotor connected between the two stator windings. When the rotor is turned through a full 180 degrees, the inductance varies from ~1400 μH to ~200 μH, with a corresponding distributed capacitance of about 35 pF to 50 pF. The frequency range depends on the shunt capacitance presented by the external circuitry. For example, with a shunt capacitance of 30 pF, the variometer tunes down to ~530 kHz. The variometer exhibits some self-resonance and instability above

In This Issue

Figure 4-4. Mounted variocoupler # 3612 (black) or # 3734 (brown), left and right side views.

~1100 kHz. But when it was designed, broadcast stations did not populate the high end of the AM band.

The mounted variometer, # 3714 (brown panel and dial) or # 3838 (black panel and dial) is shown in Figure 4-3. This part includes a dial calibrated from 0 to 100 and a panel with a fiducial at top center. The numbers increase with clockwise rotation.

This device was never officially used on any of the factory models. But early sets # 3925 (our Model 1), 3945 (our Model 2), 3955 (our Model 3), and 3975 (our Model 4) all had provisions for mounting and connecting it, which converted them to regenerative sets. AK did not have a license for the Armstrong patent for regenerative receivers, so he could not legally install the variometer. However, customers could buy the part, and install it themselves or have it installed by a dealer or service shop.

The Variocoupler

The second type of self-contained tuner is the variocoupler (Figure 4-4). This is the first AK device to be designed for matching an antenna to a receiver input, for maximum signal transfer.

Both the unmounted variometer # 3488 and unmounted variocoupler # 3529, with long 3/16" diameter shafts for panel mounting, were originally sold only to the hobbyist market. The mounted units with integral panel and dial were introduced later as self-contained assemblies.

The variocoupler stators were wound on the outside of the Bakelite form to allow fixed taps to be installed for connection to switch contacts on the panel. Looking toward the device from the operator viewpoint, the left side was wired as the fine adjustment (one winding turn per tap), and the right side as the coarse adjustment (six turns per tap).

A disassembled variocoupler is shown in Figure 4-5. The wires going to the tap switch are visible on the stator at the upper right. The split rotor shaft with its insulator is shown in the lower right, with the rear section still mounted on the rotor at the upper left. The

Figure 4-5. Disassembled early variocoupler.

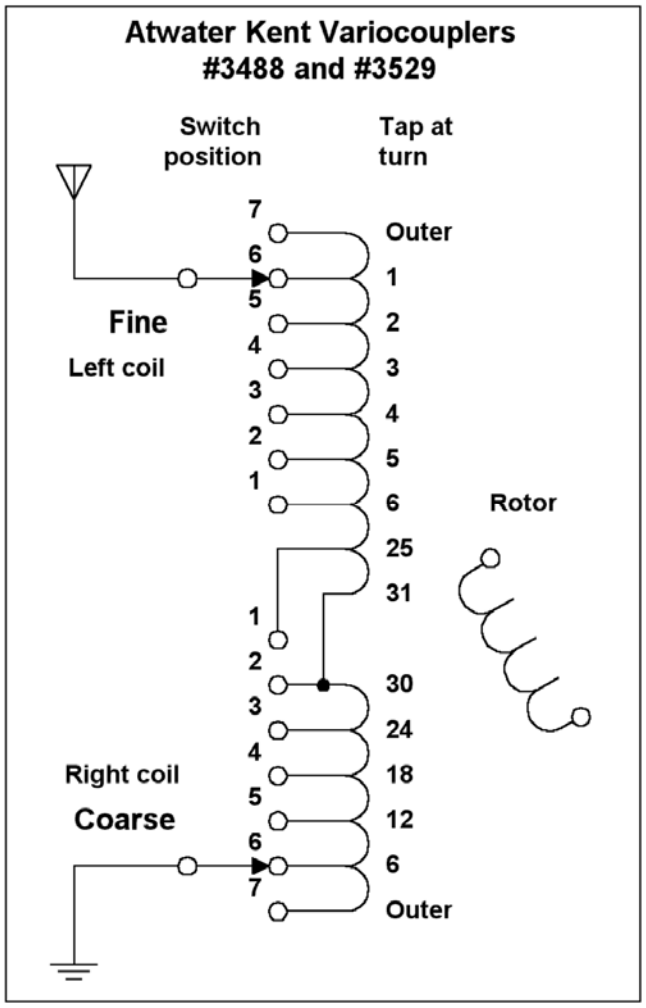

Figure 4-6. Schematic of variocoupler.

part shown is an early version or possibly a prototype. The switch wiring is routed through the inside of the Bakelite form and exits through holes in the perimeter. (See details in Fig. 4-7.)

The external connections went to the two switch wipers, ANT on the left, GND on the right as viewed from the operator position. The fixed switch contacts were connected to various points on the two stator windings, with position # 7 corresponding to the outer end of each winding. The switch positions and tap points are shown in Figure 4-6. Slight variations on the total number of turns on each half have been found with the examination of several units.

Two different rotors were used. The earlier style had 14 turns on each half (28 turns total). On some of these a string-like material was wound between adjacent turns to fill the Bakelite form, as can be seen on the right hand unit in Fig. 4-8. On others, a larger diameter wire was used.

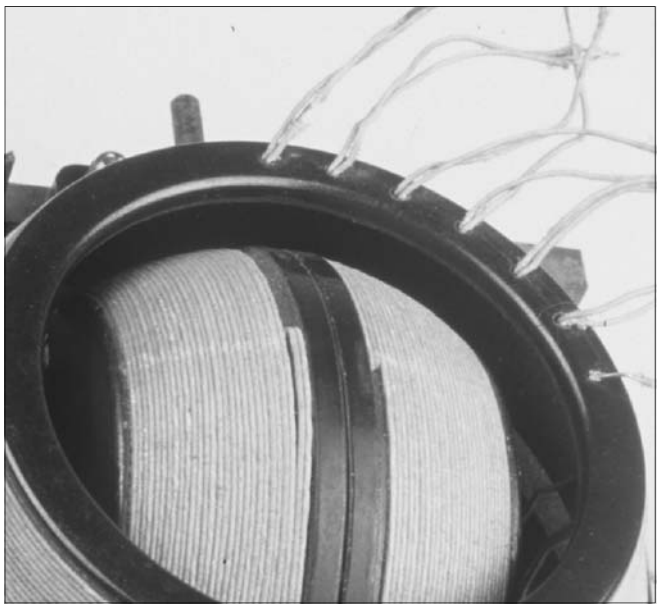

Figure 4-7. Detail of early variocoupler switch wiring and bifilar rotor.

The later rotors had 28 turns on each side, for a total of 56. Early AK factory pamphlets advertise 64 turns on the varicoupler rotor, but author Thompson has found none of these. As shown in Figure 4-8, the rotor ball is smaller than that used on the variometers, coupled circuit tuners, and Type II tuners. The rotors on these other tuners do have 64 turns on average.

Three versions of mounted variocouplers exist: 1) Part # 3612 has a black panel, knobs, and pointer, and nickel-plated contacts. 2) One version of part # 3731 has a brown panel, knobs, and pointer, and brass contacts. 3) The other # 3731 has a brown panel, black

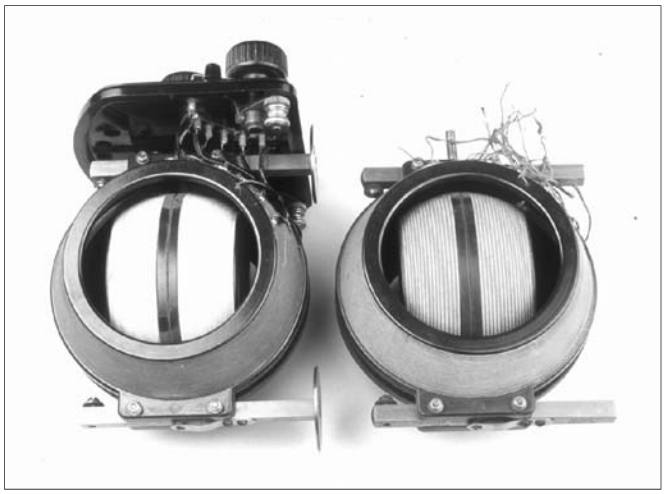

Figure 4-8. Left: mounted variocoupler # 3612 (black) or # 3731 (brown); Right: unmounted variocoupler # 3529 with string spacer in the rotor winding.

Figure 4-9. Mounted coupled circuit tuner # 3752 (brown only) early (left), and late (right).

knobs and pointer, and brass contacts.

The Coupled Circuit Tuner

Possibly the most widely used tuner was the coupled circuit tuner (CCT). It was originally sold unmounted as part # 3715 for home radio builders and experimenters. It was also available mounted, designated part # 3752, as shown in Figure 4-9.

This is the most sophisticated of the four tuners. It not only has rotor and stator windings for tuning, but also a separate outside coil to couple the antenna to the tuner proper. It is a cruder method than that used on the varicoupler, as the early CCT has only three taps on the antenna winding, and only one on the later versions.

The CCT is actually a variometer laid on its side. The top piece is interchangeable with the variometer. The bottom uses the same winding as the variometer, but the Bakelite housing has an outside skirt to support the antenna winding (with taps).

The earliest units typically have 64 turns on the rotor (32 each half), 68 on the stator (34 each half), and 34 turns (tapped at the 6th and 12th turns) on the antenna winding. This version was used by the factory on the # 3925 (our Model 1), # 3945 (our Model 2), and # 3955 (our Model 3) open sets. This early CCT was mounted to the board with two screws, one on each side. A few of the last of the earliest units had five mounting holes.

The second version of the CCT was modified to tune the higher frequencies that were added to the broadcast band during the 1920s. The 64-turn rotor and 68-turn stator remained unchanged. The big change was the antenna winding. It had only 21 turns and no taps. One of the connection terminals was eliminated—the A3 terminal. The winding was now connected between the A1 and A2 terminals. Both versions are shown in Figure 4-10.

All later version CCTs were made with five mounting holes. The second version was used exclusively on the factory Model 9 (# 4445) open set. By this time the factory had introduced the dial plate with vernier (Figure 4-9 right), and all Model 9's used this version. The later style CCT, with vernier, was also sold as a component for hobbyists.

A third version of the CCT had no thumbscrews for the

Figure 4-10. Coupled circuit tuners, first version (left), and second version (right).

Figure 4-11. The coupled circuit tuner, third version, mounted on a Model 9A # 4445A open set, rear view.

external connections. Wires came down from the device through the mounting board and were soldered on the bottom. This version, shown in Figure 4-11, was used on the Model 9A (# 4445A).

The Type II Tuner

The fourth and final inductive tuner was the Type II tuner, part # 4051 (mounted, with brown vernier dial)

Figure 4-12. Type II tuner # 4051.

or # 4055 (unmounted). The Type II tuner is electrically identical to the variometer. But while the variometer was used as a tuned circuit, the Type II was used to match the antenna to the radio input. Figure 4-12 shows a side view of the Type II tuner.

The two parts differ only mechanically, in that the Type II tuner is laid on its side as compared with the upright mounting of the variometer. The bottom portion of the Type II is a redesign of the coupled circuit tuner base with the outside winding removed and the A2 and A3 terminals eliminated. A metal identification plate was attached to the left side of the base, in the area occupied by the antenna winding in the CCT, and the Atwater Kent ID tag was removed from the upper

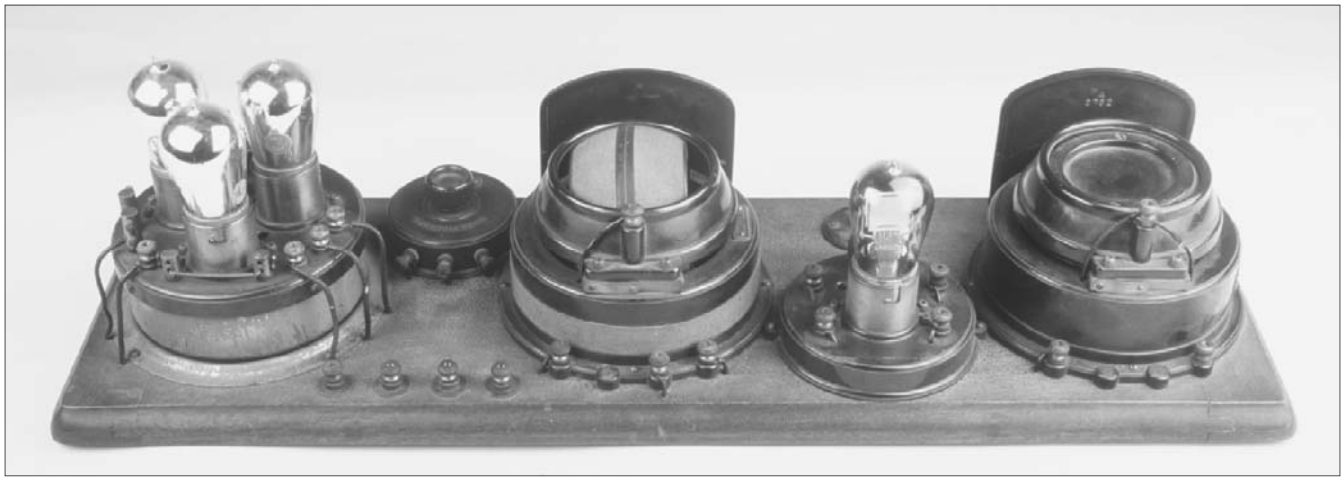

Figure 4-13. Type II tuner (right) on Model 9 # 4445 open set, rear view.

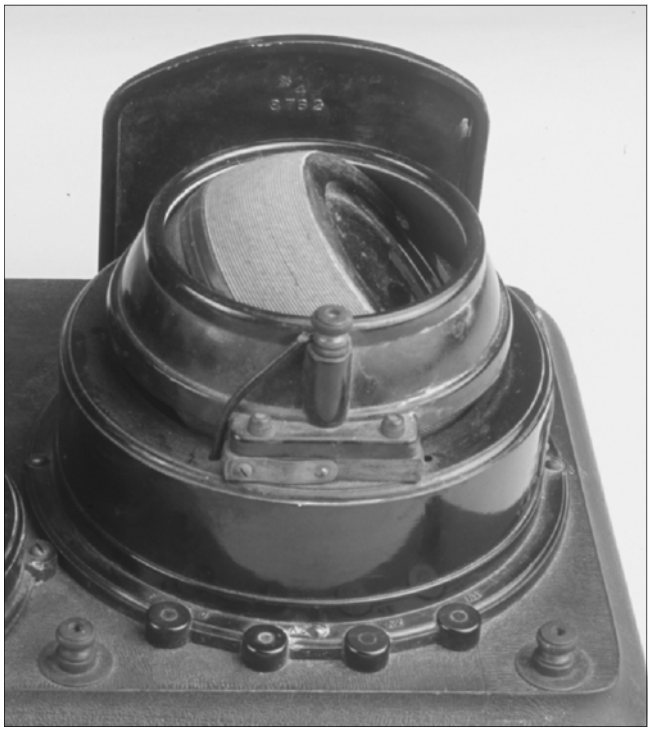

Figure 4-14. Type II tuner, third version, on Model 9A # 4445A, rear view.

surface of the base.

The early production Type II tuners had only two mounting holes in the base, one on each side. This version was used by the factory on the early 1-amp # 4052 (our Model 6), the early 1-amp # 4066 (our Model 7), the Model 8 (# 4325), and the (early?) Model 5 # 4333 open sets. All had an internal 50-pF capacitor between the antenna connection terminal and the stator winding. This capacitor is shown in the foreground of Figure 4-12. [*Atwater Kent called them condensers, of course, but in* Radio Age *we say capacitor. - Editor*]

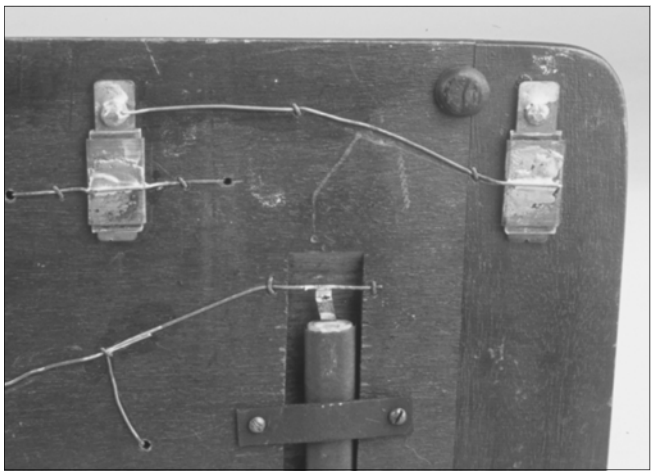

Figure 4-15. Antenna capacitors, bottom view.

A second Type II tuner was used that had five mounting holes rather than two. This unit was installed on the ¼-amp # 4275 (our Model 6), the ¼-amp # 4205 (our Model 7), and the green Model 9 # 4445 with power terminals on the board (Figure 4-13). The first two versions were also sold to the public as components.

A third version, not sold separately, was used on the Model 9A # 4445A, as shown in Figure 4-14. This version was modified from earlier versions by eliminating the terminals. The wires were run through holes in the mounting board, the same as for the coupled circuit tuner. Two terminals were added to the board for the antenna and ground connections.

The 50-pF capacitor was not used in the third version. Instead, capacitors were mounted under the board as shown in Figure 4-15. The attached screws projecting through the board with thumb nuts were labeled for long and short antennas. A bottom view of the third version of the Type II tuner is shown in Figure 4-16.

Numerous examples of each tuner from the Ray Thompson collection have been examined, and a couple of observations can be made. There were two different types of wire used, either white or green double-cotton covered (DCC). Both colors were #22 AWG.

The number of turns on a given winding varies slightly from one example to another. Why should this be?

Figure 4-16. Type II tuner # 4051, third version, bottom view.

Since all the stations operating during this period of radio development occupied a narrow range of frequencies, the number of turns and the resulting total tuning range were not critical for the parts to cover all available programming. The uniformity of the DCC wire varied somewhat. The personnel winding the coils put enough turns on the Bakelite forms to make the winding fit snugly. This was probably to ensure that the turns would not shift with use.

Conclusion

It is interesting to follow the evolution of a simple component over time. Components were adapted to new needs and varied applications. Experimentation and innovation were the essence of early radio development.

In the next installment in this series, we'll discuss the Atwater Kent tuning capacitors.

Errata

In Chapter 2 (July 2005): In Figure 2-3, the catalog number should be 3978, not 3987.

Links

Email: Ray at AKRadio@aol.com or Leigh at Leigh@AtwaterKent.Info

This series is available online after publication, along with additional drawings, photos, and schematics, at http://www.AtwaterKent.Info on the Articles page.■