A Transistor Museum Interview with Ray Andrejasich

Recollections of Early Transistor Radio Technology at Zenith Radio Corporation

Curator's Introduction

Beginning with the introduction of the Royal "500" in 1955, the Zenith Radio Corporation of Chicago became the premier U.S. manufacturer of transistor radios, and maintained that role for over a decade until this market was completely dominated by the large quantity of less expensive radios imported from Far East countries such as Japan and Hong Kong. During the decade from 1955 to 1965, Zenith designed and manufactured some of the best performing and well remembered American transistor radios, including the Royal 500 series, the 700 Navigator series and the spectacular Trans-Oceanic series. During this time and into the mid 1970s, Raymond ("Ray") Andrejasich was an electrical engineer and technical manager with Zenith at the Radio Products group, and his personal recollections of the pioneering work at Zenith with early transistor radio technology are the basis for this Oral History. Ray's comments provide a very unique and "hands-on" perspective regarding this exciting time in early transistor history. This Oral History is based on recent Transistor Museum™ communications with Ray and also on excerpts from a 1996 speech by Ray at the Indiana Historical Radio Society – this latter material is a very comprehensive review of Zenith transistor history, and you'll find a link to this information in the reference section of the Oral History.

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Curator's Introduction

Here is a brief summary of Ray Andrejasich's Zenith career positions and accomplishments:

- Ray graduated from the University of Notre Dame in 1957 with a BSEE degree and started working in May for the Zenith Radio Corporation in the Transistor Radio Group.

- From 1957 to 1967, Ray worked on component analysis, started transistorized RF and IF circuit design work, was on a two year military leave of absence, and designed portable radios for domestic manufacturing.

- From 1967 to 1971, Ray was the Group Leader for five engineers designing portable radios for Zenith Hong Kong manufacturing facilities. This position required extensive travel to Hong Kong.

- In 1971 and 1972, Ray was the Department Head for Electrical Engineering for Portable Radios and was responsible for the overseas manufacture of portable radios.

- From 1972 to 1977, Ray was the Section Manager for Electrical Engineering for Radio Products, with complete responsibility of product from conception to start of production.

- Ray left Zenith in 1977, after a 20 year career working closely with all aspects of transistor radio design and production.

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Oral History – Ray Andrejasich

Ray, please recount your first experience with transistors.

First of all, my interest in electronics (we said "radio" in those days) started at age 10. I was given a crystal radio by my older brother Frank. He was attending a military high school at the time and built a set so he could listen to night time radio after "lights out." It had a galena crystal probed by a copper cats-whisker and a beautiful set of high impedance Bell earphones. That was in 1945 when the "bug" bit me. After that, I became a frequent visitor of Army surplus electronic stores. Following the latest technologies at the time, I "souped up" my crystal set by using the Army surplus 1N34 diodes to replace my cantankerous galena crystal. Around three years later (1948) the transistor became commercially available, a product of Bell Laboratories. In 1951, I saved up my allowance and purchased a Raytheon CK716 point contact transistor from Allied Radio in downtown Chicago. At that time, $23.00 was a lot of money and my folks thought I was crazy. But then again, the CK716 was a crazy transistor! It came in a brass cylinder with two pins at one end. The metal case was the base contact and the pins were the collector and emitter contacts. I had to contact Cinch Corporation for a special socket (which thankfully they sent at no charge). The CK716 was a combination detector/amplifier. In my radio, it knocked the boots off the magnetic speaker and gave comfortable room volume on ALL the Chicago stations.

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Oral History – Ray Andrejasich

TRANSISTORS

ALLIED offers for the first time, the recently developed point-contact transistors. Primarily they are voltage amplifiers but may be used in all types of circuits including oscillator and switching circuits. Extremely rugged and very small, they offer distinct advantages over the vacuum tube: provide greater flexibility since there is no filament supply to consider; consume 1/1,000 as much power for the same amount of work; have much longer life—estimated at 70,000 to 90,000 hours or approximately ten years.

NEW RAYTHEON TRANSISTOR

Type CK716. New Raytheon point-contact transistor in brass case only 13/20" by ¼" in diameter. Maximum ratings: collector current, 4 ma; collector voltage, 40 volts; collector dissipation, 100 milliwatts; emitter current, 10 ma. Operating characteristics with grounded base: collector current, 1.5 ma; collector voltage, 10 volts; emitter current, .5 ma. Average power output is 3 mw and gain is 18 db. Minimum frequency response, 100 kc. Operates efficiently up to 40° C. Shpg. wt., 2 oz.
5-721. NET.....18.00

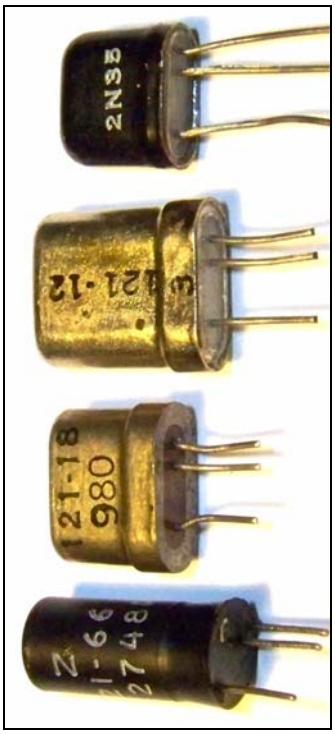
ALLIED RADIO CATALOG #131, 1953, pg 55

Shown above top is a photo of two Raytheon CK716 point contact transistors, which became available commercially in 1951. Note the unique pin-out at the bottom of the rightmost CK716. As mentioned by Ray, a special socket was required for these early transistors, as shown with the CK716 at top left. Shown also is a section of the 1953 Allied Radio Catalog, listing the remarkable CK716 for $18. Ray had bought his CK716 in 1951, and the price then had been $23 – that's almost $200 in today's dollars. Ray's first-hand experience with transistors began only three years after the public announcement of the transistor in 1948.

A Transistor Museum Interview with Ray Andrejasich

Recollections of Early Transistor Radio Technology at Zenith Radio Corporation

Photo Courtesy of Bob McGarrah. Used with permission. See Bob's excellent Zenith R500 website for more information.



Zenith began production of its first transistor radios in 1955, with the famous and well remembered Royal 500 series. Shown above are photos of the front views of two 1955 era R500s, as well as a photo of the top view of the circuit board. These first R500s contained seven transistors, all mounted in plug-in sockets, to allow for fast repair of failing transistors. Many of these transistors were individually tested at Zenith to determine performance and then color coded to facilitate circuit placement; you can see the blue and orange paint swatches on the transistors in the chassis above. Zenith used transistors from four different manufacturers for the early Royal 500 series of radios: RCA (black case at bottom of left photo), Texas Instruments (silver), Raytheon (silver case 3rd from bottom), and Sylvania (black unit at top of left photo). Zenith stamped these transistors with its own unique identification sequence, of the form 121-XXX, with the last three digits identifying the actual type of transistor. Note the RCA is marked 121-66, TI unit is marked 121-18, and Raytheon is 121-12. The Sylvania is marked 121-7 on the opposite side of the case. Most all of these early transistors used in R500 radios carried both the original manufacturer's stamp and the Zenith 121 Number. Ray started at Zenith in May of 1957, so the R500 was in full production at that time and he had the opportunity to work directly with these early and truly historic transistors.

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Recollections of Early Transistor Radio Technology at Zenith Radio Corporation

Oral History – Ray Andrejasich

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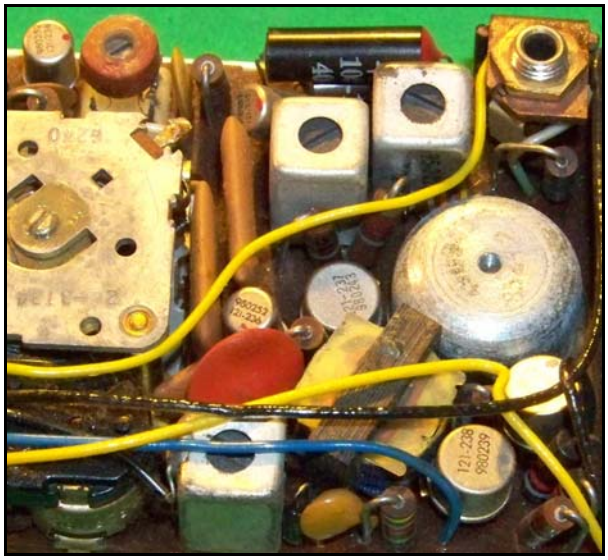

During his time at Zenith, Ray worked on the design of a number of different portable radios, including these model numbers: R40, R50, R60, R100, R125, R130, R265, R285 and R555. These radios spanned a timeframe from approximately the late 1950s to the mid 1960s. The photos on this page show different views of the R50 radio, which was introduced in 1960 as Zenith's shirt-pocket sized radio. There were several colors available, including the subtle "avocado" green shown above left. At this time Zenith was in fierce competition with Japanese imported radios, which were much less expensive. As shown above, Zenith used American made transistors (Texas Instruments, in this case) and also made a point of advertising a commitment to the American worker (the label at left was attached to the back of the radio). The battle with the Far East imports was ultimately lost by Zenith, but not without years of competition. In the late 1960s, Ray was involved in a corporate effort to reduce cost, first by using a Hong Kong based Zenith manufacturing facility, and then with direct import of Japanese made Zenith radios.

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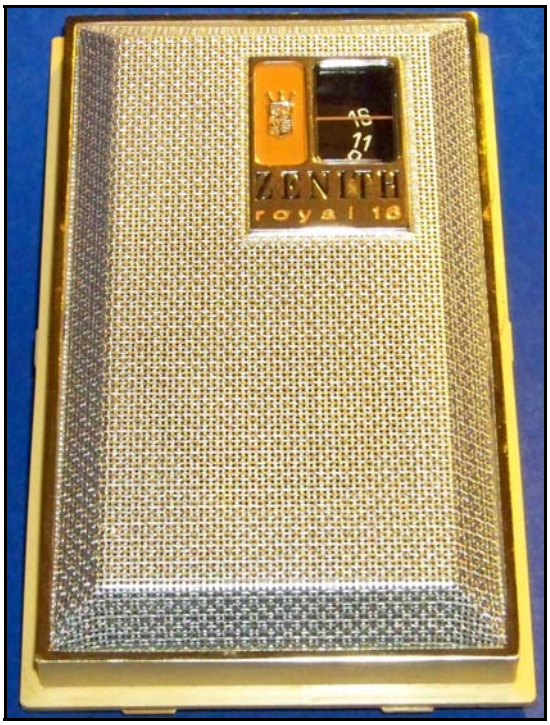
Recollections of Early Transistor Radio Technology at Zenith Radio Corporation



ZENITH / THE GIFT OF QUALITY!

Text on the Original Packaging of the Royal 16 case.

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Oral History – Ray Andrejasich

By the early 1970s, Zenith was not able to compete successfully with manufacturers from the Far East, and began importing radios from Japan. These radios were Zenith-designed and Zenith-labeled. During this time, Ray managed the Electrical Engineering for Radio Products group, with complete responsibility for product from conception to start of production. The Zenith Royal 16, as shown on this page, provides an interesting example of a radio from this period. Above left is a photo of the front of the R16. The radio came in several colors, and was housed in a closeable billfold flap (not shown). Shown above is the inside view of the radio – of note is the very high quality of the manufacture and the design. Only six transistors were used in the circuit, but the performance excelled that of most other imported radios of the time. Zenith had established a reputation for high quality since the introduction of the Royal 500 radio in 1955, and maintained that approach to product development into the 1970s, even with foreign manufactured products. Also of note with this radio is the use of Japanese transistors, with no Zenith part numbers. Shown at left is a closeup of the R16 circuit, showing a black plastic NEC silicon RF transistor (2SC839) and a Toshiba germanium audio transistor (2SB56). Forty years after this radio was manufactured, it still has exceptional performance, pulling in multiple distant stations with excellent audio quality!

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The 1965 Royal 555 line of Zenith radios was manufactured in the U.S., but used a number of components manufactured in Japan. For example, as shown in the chassis closeup photo above, Hitachi germanium transistors were used in the circuit. Although these transistors were stamped with the "Hitachi" name, the type numbers were based on the Zenith 421-XXX numbering scheme.

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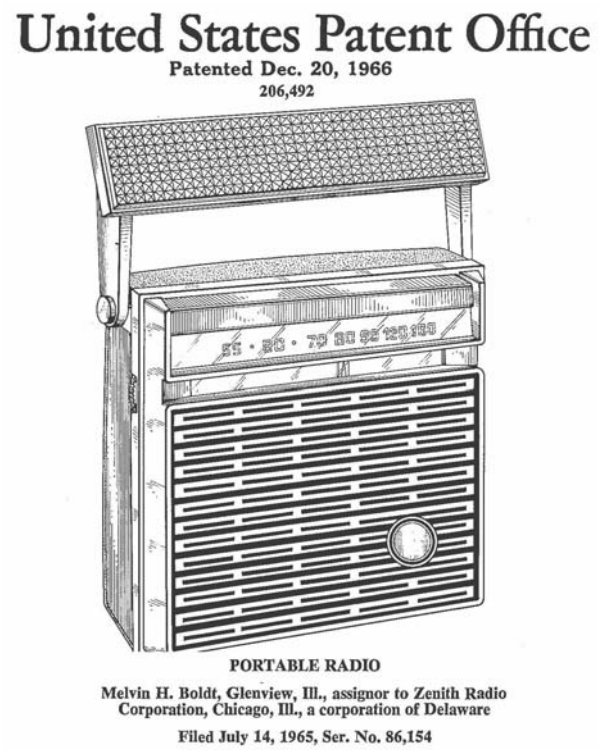
Oral History – Ray Andrejasich



United States Patent Office

Patented Dec. 20, 1966

206,492

PORTABLE RADIO

Melvin H. Boldt, Glenview, Ill., assignor to Zenith Radio Corporation, Chicago, Ill., a corporation of Delaware

Filed July 14, 1965, Ser. No. 86,154

While working as an electrical engineer for component analysis with the Zenith Transistor Radio group, Ray was involved with several highly innovative radio designs. An example is the 1965 Royal 555 model lineup, which included the unique "solar-powered" Royal 555-G shown above left. The horizontal case style and the use of the handle to house the solar battery array for the 555-G was based on a Melvin Boldt patent, granted to Zenith (section shown above). According to Ray, Mel was responsible for many Zenith radio industrial designs. Ray also remembers that the rechargeable batteries (NiCad) used in the radio were fairly new to this country. The evaluation samples came from Germany, and he evaluated them to determine how many charge cycles they could survive. He also had to redesign the chassis for 5 volt operation, as the voltage of the NiCad was 1.25V.

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Shown above is a mid 1970s Zenith "Circle of Sound" clock radio. This device uses 21 plastic silicon transistors, a single clock integrated circuit and large red LEDs. Ray worked on the design of this radio, and it was one of the last projects he worked on for Zenith. Here are his comments: "I designed the first 'Electronic Clock' for our line of transistor clock radios that were using mechanical clocks. I chose LEDs over vacuum fluorescent displays because of product life. The clock IC was a 40 pin package from National Semiconductor. It had separate output pins for each display segment.

Working in the midwest winter at the time, I found myself destroying our prototype clock modules by handling them! That's when I was first introduced to Electrostatic Discharge (ESD).

The LED segments, the 'Snooze' input and the clock-settting controls were all direct wired to pins on the IC. Won't go into details of how we protected these inputs, but we had technicians (volunteer) standing on an insulated platform, one hand placed on the top of a Van de Graaf generator and the other hand throwing bolts of ESD!

Shortly after we had our clock properly protected, the winter Consumer Electronics show came to one of the Chicago hotels. Manufactures had individual suites for displaying their new products for distributors to place orders. Imagine the plush carpeting and low humidity heat in the suites!

I went to the show wearing my best pair of leather-soled dress shoes. When visiting the manufacturer's suites, I made sure to shuffle around before examining the displays of electronic clocks. The casualty rate was quite high! The positive side of my actions was that the vendors with problems had an opportunity to go back to the drawing boards before shipping product from overseas."

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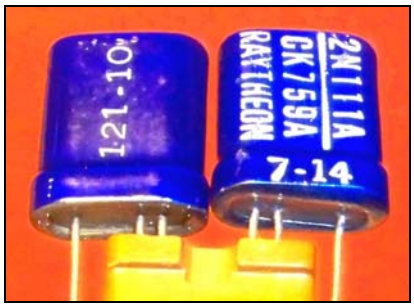
Recollections of Early Transistor Radio Technology at Zenith Radio Corporation



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Zenith #	EIA
121-426	2N3588
121-427	2N990
121-429	2N3588
121-413	2N3588
121-414	2N3588
121-415	2N3588
121-309	2N2429
121-310	2N2428
121-425	2N2431

Zenith radios used transistors from many different manufacturers, and developed a unique numbering system to identify the many different types of transistors used in Zenith radios. As shown below left, the Raytheon 2N111A/CK759A transistor used in the Royal 500 was also stamped by Zenith with the type identifier "121-10". Zenith used the "121-xxx" system for many years, through the 1960s, to identify hundreds of different transistors used in various models of Zenith radios. Shown above is a cross-reference list recently developed by Ray to identify the more standard "2N" EIA types that correspond to the "121" numbers of the transistors in his Zenith Royal 94/990 Inter-Oceanic radio, which recently failed to function after 40+ years of frequent use. He was able to repair the radio by replacing a failed AM/FM oscillator transistor with an Amperex 2N3588. In addition to the "121" numbering scheme, Zenith also began using "421" in the 1960s. Zenith sold replacement transistors to dealers for repair purposes – for example, the Raytheon 121-10 shown at left was sold as a 1950s Zenith replacement part in packaging shown at middle left. In 1973, the Zenith Components and Accessories Division initiated the Cross Reference Sales Program (CSRP) which made a broad range of replacement transistors available. These were identified by the "ZEN XXX" numbering scheme. Shown above left is an example of a CRSP ZEN302 germanium replacement transistor, which can be cross-referenced to the Raytheon 2N111A transistor shown at left.

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Conclusion

For 20 years, from 1957 to 1977, Ray was involved with transistor radio technology at Zentih Radio Corporation, the premier American consumer electronics company of the time. His tenure there saw many transitions:

- **Transistor technology evolved dramatically from the early germanium alloy junction devices used in the first Royal 500 radios of the mid 1950s to the sophisticated silicon transistors and integrated circuits used in 1970s products.**
- **The America radio industry, and Zenith specifically, fought a long and ultimately losing battle to compete against the low cost imports from such Far East countries as Hong Kong and Japan. As a senior technical manager at Zenith during the 60s/70s, Ray was directly involved in this historic business and technology struggle.**
- **On a personal note, Ray's 20 year career at Zenith reflected an ever increasing range of professional and technical growth, from a newly graduated electrical engineer in 1957 to the senior technical manager with complete responsibility of product from production to start of production.**

The Transistor Museum™ is indebted to Ray for his support during the development of this Oral History. Ray's detailed and personal recollections about the Zenith transistor radio story will add greatly to the understanding of an important chapter in transistor history.

Ray worked in the electronics industry for an additional 18 years after leaving Zenith Radio Corporation. You can find specifics of this important work, including 13 patents, at this link:

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Oral History – Ray Andrejasich

Additional References for Zenith Transistor History

1) Smith, N.R. 1998. "Zenith Transistor Radios - Evolution of a Classic". Atgen Pa. Schiffer Publishing Ltd.
This is the definitive text on Zenith transistor radio history. Norm had access to Zenith historical records and interviewed Zenith employees to get first-hand information in writing this book. You'll also find numerous photos and a lucid writing style.

2) Bob McGarrah Zenith R500 Webpage
http://transistorhistory.50webs.com/royal500.html
Bob's website on transistor history is highly regarded and is lauded as one of the best on the net. He has documented a unique photographic and factual story of the famed Royal 500. While at Bob's site, be sure to see his spectacular photography for other aspects of transistor history. Highly recommended!

3) Zenith Transistor Radio Repair Website
http://www.transistor-repairs.com/
Jim Barnard, W4BRX, has developed a terrific website with the stated purpose: ***A WEBSITE DEVOTED TO COLLECTORS AND RESTORERS OF ZENITH TRANSISTOR RADIOS.*** **There are some great photos, Zenith repair information and a really helpful cross reference list for those inscrutable Zenith "121" numbers. In addition, Jim has uploaded a complete slideset of Ray's 1996 presentation on Zenith transistor history. Thanks, Jim, for your efforts on preserving Zenith history.**

4) Link to Ray's Zenith History Presentation at 1996 Quarterly Meeting of the Indiana Historical Radio Society (Webpages hosted by Jim Barnard)
http://www.transistor-repairs.com/talk1.html
Here is a direct link to Ray's presentation hosted on Jim's website.

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Ray's Career After Leaving Zenith Radio Corporation in 1977.

After leaving Zenith in May 1977, Ray became an Associate Editor for Electronic Packaging and Production Magazine, Milton S. Kiver Publications, Inc. There he researched and wrote articles on developments in hybrid microelectronics, microprocessors, component packaging, interconnections, as well as manufacturing processes related to these areas. He also attended conferences, symposiums, and exhibitions, such as NEPCON. An example of Ray's work at this magazine is his article "PC Board Profiling Systems", which was published in the June 1978 edition.

Beginning in 1978, Ray joined the Emhart Electrical/Electronic Group, Pollulert Systems, P.R. Mallory Co. Inc. in Indianapolis IN. He was a New Product Engineer with this company, and worked extensively with underground monitoring systems to detect hydrocarbon fluids leaking out of gasoline tanks, such as at gasoline stations. Ray was very active technically during this timeframe, and was granted 13 patents (shown at right) related to this technology. He retired from Mallory in 1995.

Oral History – Ray Andrejasich

Patents Granted to Ray Andrejasich

1) **4,361,031** Granted: Nov 30, 1982. "Sensing Device"
2) **4,414,441** Granted: Nov 8, 1983. "Hydrocarbon Responsive Switch"
3) **4,434,650** Granted: Mar 6, 1984. "Hydrocarbon Sensor Float"
4) **4,442,405** Granted: Apr 10, 1984. "Float Assembly for a Sensor"
5) **4,586,033** Granted: Apr 29, 1986. "Fluid Detection System"
6) **4,646,069** Granted: Feb 24, 1987. "Fluid Detection System"
7) **4,721,950** Granted: Jan 26, 1988. "Fluid Detector"
8) **4,728,941** Granted: Mar 1, 1988. "Fluid Detection System"
9) **4,835,521** Granted: May 30, 1989. "Fluid Status Detector"
10) **4,835,522** Granted: May 30, 1989. "Tank Inventory/Leak Detection System"
11) **4,890,492** Granted: Jan 2, 1990. "Differential Pressure Level Sensor with Temperature Sensing Elements"
12) **5,008,653** Granted: Apr 16, 1991. "Fluid Detector with Overfill Probe"
13) **5,375,454** Granted: Dec 27, 1994. "Programmable Pump Controller"