RADIO AGE

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THE 1932 RCA FIELD TEST TV RECEIVER

by Jeff Lendaro

My interest in early TV began when I stumbled upon a 1939 *RCA Red Book* while in high school. There it was, a picture and service notes for the TRK-12 prewar television set! I had been collecting radios from the '20s and '30s for a couple of years, but postwar electronics had never really charmed me. I had never seen any pre-1946 televisions. Aunt Hattie had always said they had a television in 1940 while living in Jackson Heights, NY. I guess I had always thought that she had remembered incorrectly.

While in college in the early 1980s, I started a concentrated search for all the RCA/NBC engineers from that earlier era who were still alive. I was especially looking for a surviving 1936 RCA field test television receiver. While I never did find a receiver that summer, I did meet plenty of nice people, heard many interesting stories, and collected lots of literature and old parts. I especially remember one visit, with my brother, to Robert Morris. Robert was a development engineer with NBC in the 1930s. We talked for hours. I remember his wife making all of us lunch. She served a delicious drink made from iced tea, lemonade, and ginger ale. I also remember his showing me some pictures of the RCA 1932 field test television receiver. He had been involved with the field test and informed me that I would never see one.

Figure 1. The 1932 RCA field test TV receiver. (Compartment for sound chassis on the right.)

Because of my conversation with Morris, I had assumed that all of these early receivers had been destroyed. I was wrong. In November 1984 the receiver shown in Figs. 1 - 3 still existed, but was heading for the scrap pile, presumably after 52 years in RCA's possession. It took someone cleaning an Indianapolis warehouse less than a minute to place a one-foot-long piece of masking tape on the top and write the word "SCRAP." I was lucky enough to have joined RCA as a design engineer eleven months earlier. Not long after I arrived it became well known that I collected early RCA radios and televisions. When someone told me that a warehouse was being cleaned out on the other side of the Indianapolis complex, I really did not expect to see much.

When I arrived at the warehouse and turned the corner I immediately spotted the 1932 test set, 100 yards away. This is certainly my record for the 100-yard dash. There it was, lying on its side because one of its legs had been broken off. When I met with the person who was doing the cleaning and told him of the significance of this set, he just ignored me. I went over his head with the story about my collection and just how historically significant this set was. I told him that RCA should either keep it or give it to me. Finally, about three weeks later, it was in my possession.

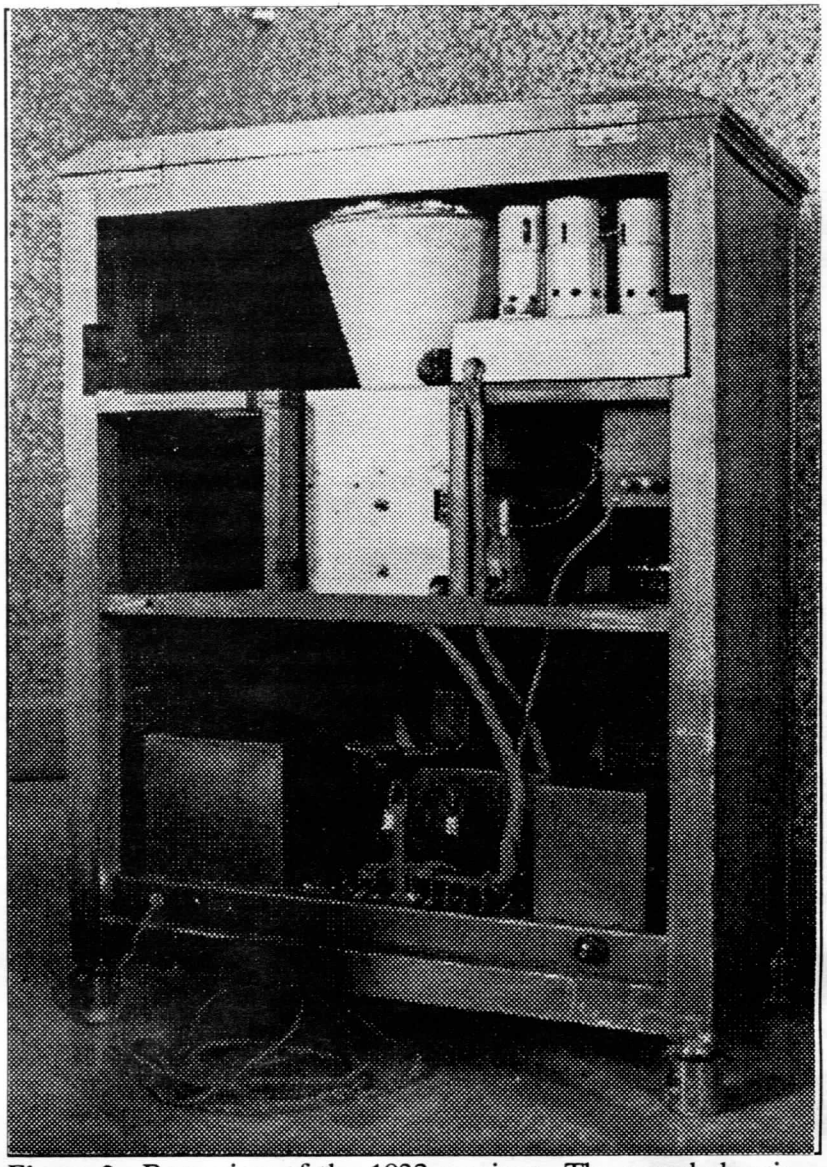

Figure 2. Rear view of the 1932 receiver. The sound chassis slipped into the empty top left compartment. The power supply chassis is at the bottom of the cabinet.

Looking at this set, one cannot help but reflect on the rapidly changing technology of television in the early 1930s. The likes of Baird and Jenkins were promoting various forms of mechanical television here in the US and in Europe. A few experimental mechanical (scanning disc) TV stations were springing up across the country in all sorts of places — from universities to department stores. Perhaps the department stores imagined that television might be a way to increase sales. (And we thought that home shopping networks weren't conceived until the 1980s!) Although TV receivers of that era were not very expensive, picture quality was poor, their entertainment value was small, and, consequently, not many were sold.

In 1927 Dr. Ernst Alexanderson was experimenting with a 48-line mechanical system at General Electric. A small field test was conducted in Schenectady, NY, using the famous GE scanner with the octagon case and a modified Radiola 51. In 1928 an RCA television laboratory was estab-

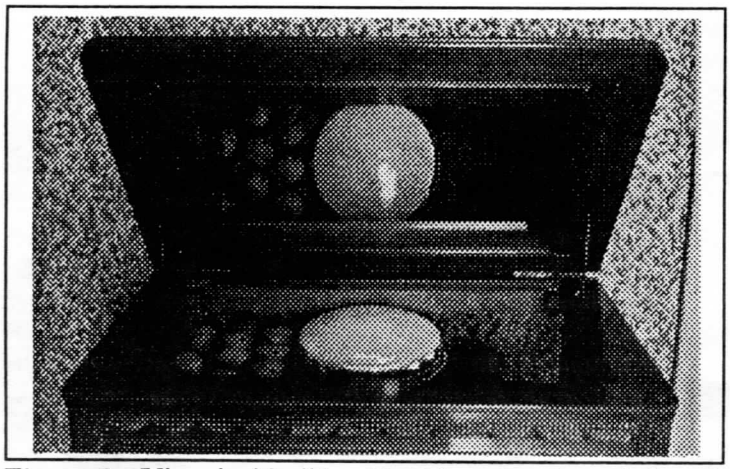

Figure 3. View inside lid, with video chassis on left and picture tube in center. Missing sound chassis would have been on the right.

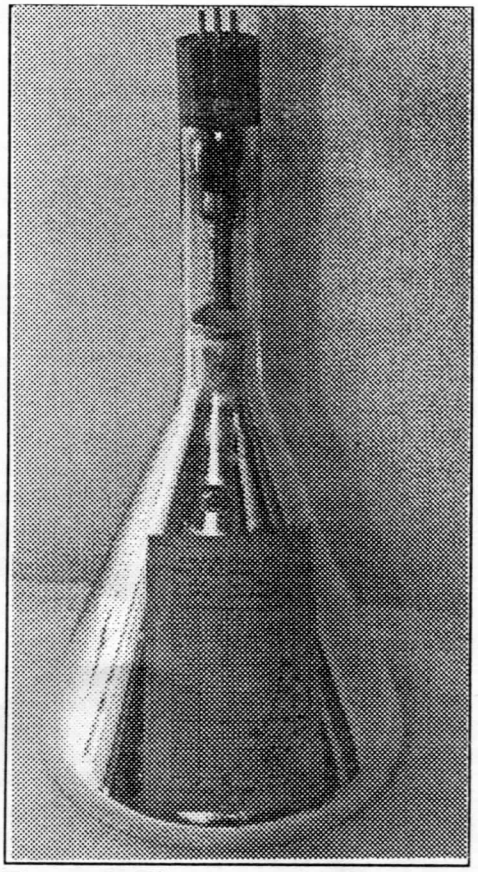

Figure 4. Kinescope with graph label noted in text.

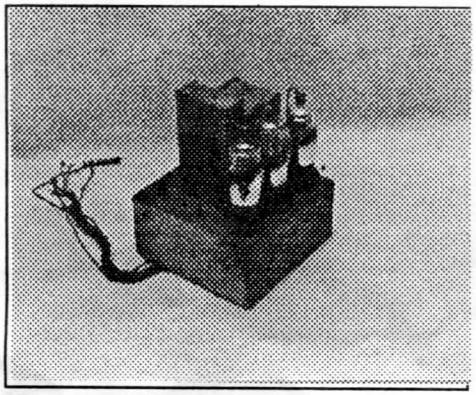

Figure 6. Vertical chassis with tube shields removed.

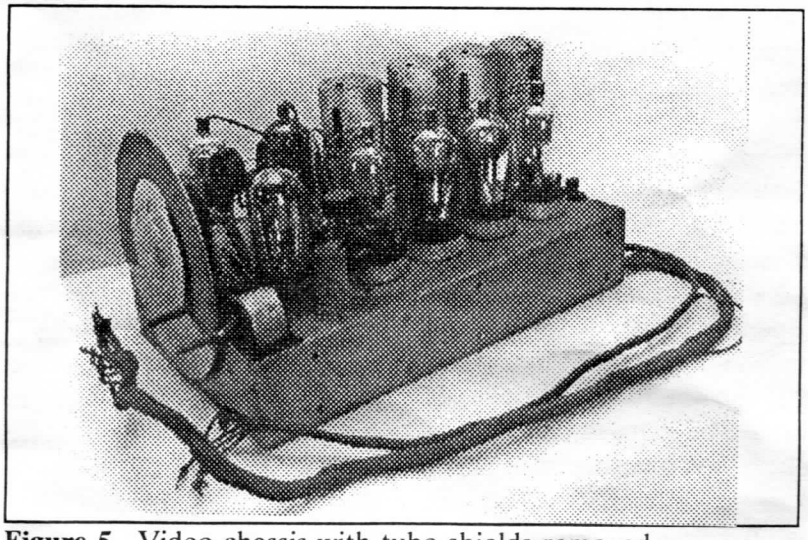

Figure 5. Video chassis with tube shields removed.

lished in New York, and was coordinating television research with NBC. RCA built some mechanical televisions in RE-45 radio cabinets. Station W2XBS was broadcasting with 250 watts, mostly pictures of Felix the Cat. But, by 1930, most major radio manufacturers realized the shortfalls of mechanical TV and abandoned their efforts.

In the 1920s Vladimir Zworykin was also experimenting with television at Westinghouse. Although Zworykin's boss was not too impressed with the progress made on his "all electronic" television system and suggested he find something useful to work on, Zworykin still managed to work on projects closely related to his passion, electronic television.

RCA Vice President David Sarnoff, seeing a demonstration early in 1929, granted funding for Zworykin's television research. By November 1929 a motion picture projector had been rebuilt to make video signals, along with scanning circuits, wideband amplifiers, and power supplies. Six receivers with the newly developed "Kinescope" cathode-ray tube were also completed. One set was placed in Zworykin's home. Progress had also been made on the "Iconoscope" camera tube. Late in 1929 Zworykin left Westinghouse and joined the newly formed RCA Victor company as Director of the Electronic Research Group.

Early in 1931 RCA decided to hold a field test. By the beginning of 1932 a handful of receivers, a transmitter and a primitive studio were ready. The transmitter and studio were located on the 85th floor of the Empire State Building — the same location used later by Armstrong for his FM demonstrations. It was not until the 1936 field test that a more sophisticated studio designed specifically for television was built in Radio City.

Because the iconoscope was not ready at the beginning of the 1932 tests, a flying spot scanner was used. This consisted of a large rotating disc with 120 holes in a spiral arrangement in front of the brightest arc lamp available. A lens in front of the disc produced a sharply focused beam of light that scanned the subject to be televised. Banks of sensitive cesium oxide photoelectric tubes were placed around the subject. The reflected light received at the phototubes produced the video signal.

Still, the light available at the banks of phototubes was small. Even at 120 lines, the signal-to-noise ratio would be only a little better than 20 dB. More lines in the picture would mean even smaller holes in the disc and even less light at the phototubes. While 120 lines was pushing the state of the art at the time, RCA knew even before the tests began that more lines would likely be needed to obtain a picture of sufficient quality to win widespread consumer acceptance of electronic television. The disc contained an additional hole pattern, which together with an additional light source and phototube generated both the horizontal and vertical synchronization pulses.

Since film was likely to be the major source of program material, the frame rate was chosen to be 24 frames per second. A movie projector was modified to generate the video signals. Because of the inefficiency of the flying spot scanner for direct pickups, most of the actual transmissions were from film. Current newsreels and the Disney cartoon "Steam Boat Willie" were shown over and over.

The two transmitters at the Empire State Building used precision quartz crystal-controlled oscillators along with doublers and triplers to put the picture carrier on 44 MHz and the audio carrier on 61 MHz. The output power was 2 kW and 1 kW respectively. A video bandwidth of 225 kHz was required for the 120-line picture.

The television receiver was housed in a very attractive cabinet with the kinescope mounted vertically. The rear view in Fig. 3 shows how the chassis were arranged. Fig. 4 is a closeup of the kinescope. There were four major chassis plus a small chassis containing six wet electrolytics. On the left side (facing the front) was an 11-tube superhet, having a tuning range of 35 to 55 MHz for the picture channel. Fig. 5 shows this chassis. A similar 10-tube superhet with a tuning range of 55 to 75 MHz for the sound was on the right. The wide separation in the sound and picture channels was chosen to eliminate any possible interference from the incoming carriers and local oscillators.

The horizontal and vertical sweep circuits, the deflection yoke, and the kinescope were in the center of the cabinet. Fig. 7 shows the deflection and kinescope subassembly. The vertical chassis, shown in close-up in Fig. 6, is at the top, and the horizontal chassis is on the bottom right. The power supply occupied the entire bottom of the cabinet. Brought out to the front of the receiver were the tuning and gain controls for each signal chassis and the contrast and brightness controls from the deflection/ kinescope chassis.

The vertically mounted kinescope proved to be a good design for several reasons. First, this was a simple way to mount and protect the kinescope. The picture was viewed through a mirror mounted in the lid. The mirror eliminated distortion due to the curvature of the face plate. This also made the receiver look more like an ordinary 1930s radio when closed.

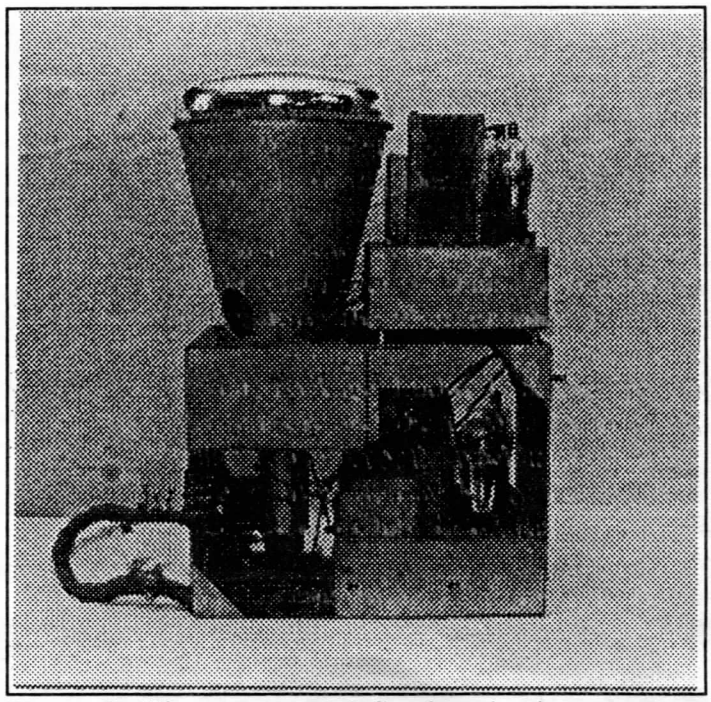

Figure 7. Kinescope and deflection circuit subassembly.

Robert Morris had one of these receivers in his home early in 1932. Because the project was not public knowledge, he was not allowed to show the television to anyone. He recalled one evening when Loren Jones, an RCA television engineer, traveled from Camden, NJ, to Morris's home outside New York to conduct some tests. By the time Jones arrived, Robert and his wife had some unexpected guests drop by, so the tests had to be scrubbed for that evening. Loren was to return the next evening. But, the next night, Robert's brother dropped by unexpectedly. Frustrated by the delays, the two engineers swore the brother to secrecy and went ahead with their tests.

The receiver tube complement is as follows: The picture chassis has a UY-224 first detector (mixer) and UY-227 oscillator, followed by three picture IF stages. I am not certain whether the IF tubes were UY-224s, RCA-235s, or special developmental tubes. A special tube with a high transconductance and low capacitance may have been required to handle the higher video bandwidth. Unfortunately, all the original tubes are missing from our set.

It is interesting that all the tube types are documented in the published literature except for the IFs and the power supply. The IF center frequency is six MHz and the gain from the grid of the first detector to the grid of the second detector is 7,000. A '24 is used for the second detector followed by a '24 video amplifier. Here the signal path is split, to a '24 sync amplifier and a '24 picture amplifier.

The sound chassis also uses a UY-224 first detector and a UY-227 oscillator. The sound IF consists of two amplifiers, and again a '24 is used for the second detector. The sound IF center frequency is about four MHz, with a gain of 8,000. The two stages of audio amplifier use a UY-227 and a UX-210. The '10 was chosen because it could operate using the same high-voltage supply as the deflection. It is less likely that special tubes were used in the sound IF. The sound channel bandwidth was chosen to be 50 kHz, larger than necessary, to desensitize the tuning and minimize the effects of local oscillator drift.

The sweep chassis is really two chassis; a smaller chassis is mounted on top for the vertical deflection. The vertical chassis contains a '24 for the dynatron oscillator, a '24 for the discharge tube, and a '24 for the vertical output.

The horizontal deflection also uses '24s for the oscillator and the discharge tubes but uses a UX-210 for the horizontal output. No video processing is done on this chassis.

The power supply chassis contains three tubes. I do not know what tubes were used here, but they were likely all of the same type. The three tubes are small base 4-prong tubes, have a 2.5-volt filament, and a 3/8" plate cap. The RCA-879 tube works fine here, but I do not know if production RCA-879s were available in 1931. Perhaps developmental type tubes were used.

The power supply design is interesting in that two of the 879 tubes are configured as a full-wave 1-kV dc supply. This supply is used for the entire receiver. The picture and sound IFs, oscillators, etc., are tapped off large resistor dividers. Only the two discharge circuits, three output circuits, and focus grid of the kinescope directly use the 1-kV supply. The third 879 is a half-wave 6-kV supply for the anode. This exceeds the ratings for an 879, but it's only a field test receiver, so long-term reliability was probably not a concern. Also, specifications were pretty conservative in those days.

Figure 8. Edna Wilson, secretary to Chief Engineer O. B. Hansen, with Felix the Cat and the 1932 television. Is her hand covering the missing sound chassis?

The field test did prove that high frequency electronic television was workable. The effects of interference on television pictures were observed. The tests also confirmed that 120-line pictures were not good enough, and that a 24-frame-per-second frame rate caused objectionable flicker. It also proved that the kinescope could provide a good picture in reasonable room light and was much more desirable than any mechanical contraption, even though the light from those first kinescopes peaked at 5230 Angstroms (pea green!). The tests were concluded in about a year, and then the demonstration sets were obsolete.

As you might expect with an experimental prototype, our receiver does not carry any make or model markings anywhere. The only place "RCA" appears is on a paper label on the kinescope. The label contains a grid voltage vs. candlepower graph dated October 1931, as shown in Fig. 4. (The kinescope looks rather fragile compared to modern CRTs.) It is likely that only six or eight receivers of this type were made. Ours has the number 2 stamped on all removable parts of the wood cabinet. If you examine closely the RCA/NBC publicity photo of Edna Wilson and Felix the Cat in Fig. 8, you will see that the veneer grain patterns match our set exactly.

When I acquired the set, the audio chassis was missing. The two knobs on the right are mounted on screws. It is clear from the RCA/NBC photograph that Edna is awkwardly holding her left hand over this area. She is apparently covering the fact that the audio chassis was missing then, too!

I will always remember vividly Robert Morris showing me pictures of this model and telling me that I would never see one of them. I always think

it sad to know that something of historical significance just no longer exists. I think fate stepped in on this occasion to save this small but tangible part of history.

References:

Television, Collected Addresses and Papers, RCA, 1936.

Personal correspondence with Robert Morris, NBC engineer

Personal correspondence with Harley Iams, RCA Victor engineer

Note from the editor:

MAARC member Ludwell Sibley happened to learn that we were about to publish this article by Jeff Lendaro. By coincidence, at a recent New Jersey Antique Radio Club auction, Ludwell bid successfully on a package of papers from the George Beers estate. Beers was one of the engineers who worked on the 1932 television field test project. In fact, Beers published a paper about testing the receivers:

"Description of Experimental Television Receivers," G. L. Beers, *Proceedings of the Inst. of Radio Engineers*, Vol. 21, No. 12, Dec. 1933, p. 1692-1706.

In that same issue, Vladimir Zworykin published an additional paper on their television work with more details on the 9" green phosphor CRT used in the sets. Along with the other materials in the Beers estate package, Ludwell obtained photos of the video chassis and the control racks at the transmitter site. He recently submitted an article about the transmitter used in the tests to the New Jersey Antique Radio Club Newsletter.

One of the interesting comments in Beers' article is that prior to the tests, people had assumed that interference to the picture would be much more objectionable than noise in the sound channel, but the tests proved just the opposite. A bit of snow in the picture was tolerable, but noise in the sound was found to be quite objectionable. (A good reason to use FM for the sound!)