Repairing an Early Stromberg-Carlson AM-FM radio.

Gord Rabjohn

I friend of my wife has a Stromberg-Carlson model 7124 console radio phonograph, circa 1947, that he wanted fixed. The schematic from RCC indicated that it was an AM-FM-SW unit. I knew that this would be an interesting radio to work on.

I was quite excited when I saw this radio for the first time. It is a large12 tube console, with a pull-out record changer above the speaker. The dial had the usual AM and SW frequency markings on the slide-rule style dial, but it did not have the usual FM band frequency indication. Instead, it had 2 bands, one calibrated from 21 to 99, and the other from 201 to 299. (See figure 1) It turns out that these refer to the "Old" FM band from 42.1MHz to 49.9MHz, and the current FM band from 87.9 to 107.9MHz, respectively. This is the only radio I've ever seen that included both FM bands.

Edwin Armstrong, the father of FM radio, was instrumental in inventing, patenting, and commercializing FM radio. FM radio offered superior noise immunity and fidelity compared to the existing AM radio system. Broadcasting in the "Old" FM band started in 1937 (wikipedia), with equipment and receivers licensed under Edwin Armstrong's FM patent. This band extended from 42 to 50MHz and was divided into 79 channels at 100kHz spacing. The bottom channel, centered at 42.1MHz was channel 21, and the top channel, centered at 49.9MHz, was channel 99, with the channels at 100kHz spacing. The fact that there were unused channel numbers below 21 suggests that someone thought 40MHz to 42MHz might become available someday. Or, perhaps they wanted to avoid confusion with television channels. David Sarnoff, president of RCA, saw FM as a significant threat to his existing AM radio empire, and was able to use his influence with the FCC to have the FM band moved to its current frequency after WW2. This rendered the Armstrong radios immediately obsolete, Armstrong essentially bankrupt, and this type of radio very collectable and rare! The story of Armstrong, Sarnoff, and de Forest is

told in “Empire of the Air”, by Tom Lewis. I highly recommend this book (or the PBS TV program) if you have not seen it.

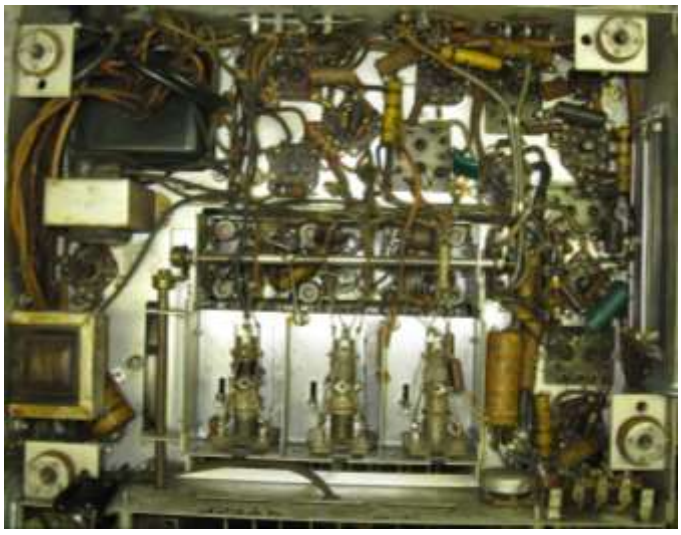
The current FM band (at least in North America) extends from 87.9MHz to 107.9MHz. It is divided into channels at 200kHz spacing. The lowest channel in the band, channel 200, is centered at 87.9MHz, and is 200MHz wide. The highest channel, channel 300, is centered at 107.9MHz. Channel 200 is almost never used because it overlaps with the audio carrier in television channel 6, so effectively channel 201 is the lowest FM channel. Note that all channels are centered at “odd” frequencies, you will never find a North American FM station with an even number in its last digit. The 200kHz spacing is used because the bandwidth of an FM signal is approximately 200kHz. These channel designations are no longer used by the public, but were the only calibration on this Stromberg-Carlson.

Channel #	Frequency
21	42.1 MHz
22	42.2 MHz
23	42.3 MHz
n	40+0.1*n
97	49.7 MHz
98	49.8 MHz
99	49.9 MHz

Channel #	Frequency
200	87.9 MHz
201	88.1 MHz
202	88.3 MHz
n	47.9+0.2*n
298	107.5 MHz
299	107.7 MHz
300	107.9 MHz

What is interesting to me is that this radio, which was built 2 years after the new FM band was introduced, still had the “old” band. I would have thought that the there would be little demand for this obsolete band, however this was a Canadian radio, so possibly the old band remained in service longer.

I brought the radio chassis home for service. I have chains that extend from the ceiling over my workbench that I use to suspend large chassis; this gives me unfettered access to both the top and bottom of the radio chassis. See figure 2. The radio had received some service in the past, but it appeared to be very neatly done. I was happy to see that replacement parts were nicely soldered and anchored down were necessary.



The designers of this radio treated the FM band as if it was just another shortwave band; the same pentagrid converter was switched between ~1MHz coils for AM and ~100MHz coils for FM. By 1950, two years later, the FM front-end would always be built as a separate module, which makes much more sense. It eliminates the need to

employ switches carrying 100MHz signals, allows a circuit topology and tube type more appropriate for that frequency, and allows for shorter leads. In this Stromberg, the variable capacitor, coils, and IF transformer are all different for the AM or FM band and are switched; only the tube is reused for both AM and FM. Because the wires need to be kept very short, and the switching is so complex, this part of the receiver is very cramped and difficult to work in, and definitely compromises FM performance.

Since the owner had been using the radio recently, I powered it up without the usual 100-watt bulb in series with the AC line. AM worked, but there was nothing on either FM band. I cleaned the switches and pots, still nothing on FM. I used a spectrum analyzer to look for the FM local oscillator; an LO signal that moved up and down as the radio was tuned was visible. I injected a 10.7MHz FM modulated signal into the IF; saw and heard nothing at all. I measured the gain of the IF strip at 10.7MHz with an oscilloscope, and it was less than unity. Since the IF strip had plenty of gain at 455kHz (AM worked), the tubes and DC must be OK. By adjusting the frequency of the IF signal into the IF transformer, I found that it was tuned low, so I adjusted the IF transformers back up. In the end, I discovered that all the 10.7MHz IF transformers had been mistuned! So much for the notion that this radio had been serviced by a skilled technician! Once I aligned the IF properly, I started receiving FM stations over part of the FM band, however I could not tune the whole band. It turned out that the dial cord had been installed improperly so the tuning capacitor physically could not rotate all the way around. Once that problem was fixed, I found that I still could tune only the low end of the FM band. Hmmm, maybe the 6SB7 converter was bad? I unplugged it, and discovered that a 6SA7 was in the socket intended for the 6SB7. A 6SB7 is similar to a 6SA7, but has improved high frequency performance, exactly for this application. The 6SB7 was introduced about 10 years after the 6SA7. The fact that the 6SA7 worked at all was quite surprising!

Once I found a 6SB7 and plugged it in, the radio started working. I gave the IF a proper tune using a sweep oscillator and the instructions in the service manual, and this brought it to life. The radio's performance is still quite touchy on the FM band, however. The primitive circuitry lacks any form of Automatic Frequency Control. In fact, each station can be tuned-in at 3 different locations, corresponding to the center frequency of the discriminator (which is correct), and the upper and lower edge of the discriminator curve. With AFC on, tuning to the two parasitic edges is not possible, because the AFC action acts to tune the radio away from the wrong responses.

Furthermore, the AFC limits the effect of drift, which is apparent until the set is fully stable.

I replaced the pilot lamps, some electrolytic capacitors, cleaned the switches and potentiometers and looked for other trouble, but generally the radio was in fairly good condition. The radio works fairly well, but there is still drift, and it needs retuning frequently. It has been returned to the elated owner.

References

RCC Circuit Manual, 1947-1948

Empire of the Air, Tom Lewis

Canadian Communications Foundation: Radio History
http://www.broadcasting-history.ca/index3.html?url=http%3A//www.broadcasting-history.ca/listings_and_histories/radio/histories.php%3Fid%3D419%26historyID%3D200

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