

HOW THE COMMUNICATIONS RECEIVER BEGAN

The communications receiver appeared almost overnight it seemed, in late 1934. One month it didn't exist — and the next, there they were — the National HRO, Hallicrafters Super Skyrider, RME 9-D, RCA ACR-136 and the Patterson PR-12. Of course there were receivers for communications before this, but they were either the monstrous instruments of communications companies which occupied several relay racks or the inefficient regenerative receivers and superhets of amateurs. The small, self-contained, high-performance and versatile package we think of as a communications receiver simply did not exist.

Their sudden emergence in 1934 was only a surface appearance. It really began back in 1932. In June of that year, James Lamb, technical editor of *QST*, wrote an article entitled, "What's Wrong With Our CW Receivers?", in which he argued that the broad tuning and unstable receivers used by amateurs were not technically abreast of the contemporary crystal-controlled and well-filtered transmitters.

A second article (in the August *QST*), "Short-Wave Receiver Selectivity To Match Present Conditions" was subtitled, "Constructional and Operating Features of the Single-Signal Superhet." It described the use

of the crystal filter for single-signal CW reception and, because increased selectivity demanded better frequency stability, showed how to stabilize the high frequency oscillator. In order to overcome the common objection that superhets were insensitive and noisy, he also discussed the principles of quiet and electrically stable rf amplifiers.

Here was a receiver with the high performance of a communications receiver, and versions of it were built by many advanced amateurs. By 1933 the crystal filter was offered as an option by several companies. Before the manufacturers could produce a true communications receiver on the production lines however, many practical problems had to be overcome. They had to gang and track three or four tuned circuits for single control tuning. An order of frequency stability never before achieved on a production line basis was forced by the adoption of the crystal filter. Better tuning mechanisms were required. Plugging in three or four separate coils would be anachronistic with such advanced receivers, so efficient methods of band changing were developed. Direct calibration required more uniform tuning capacitors in order to use mass-produced dials.

At the same time the public's interest in shortwave broadcast reception was ap-

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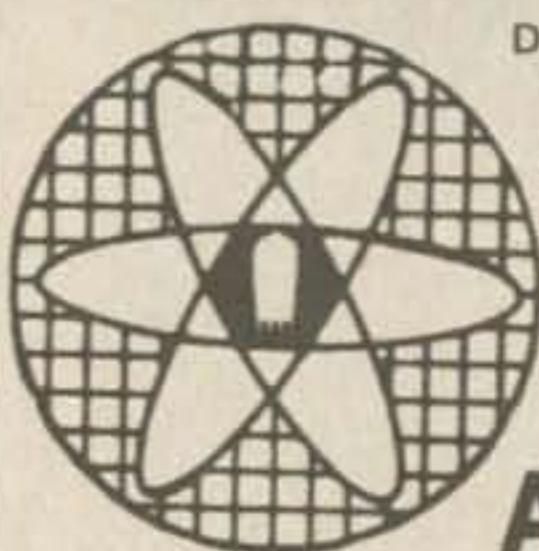
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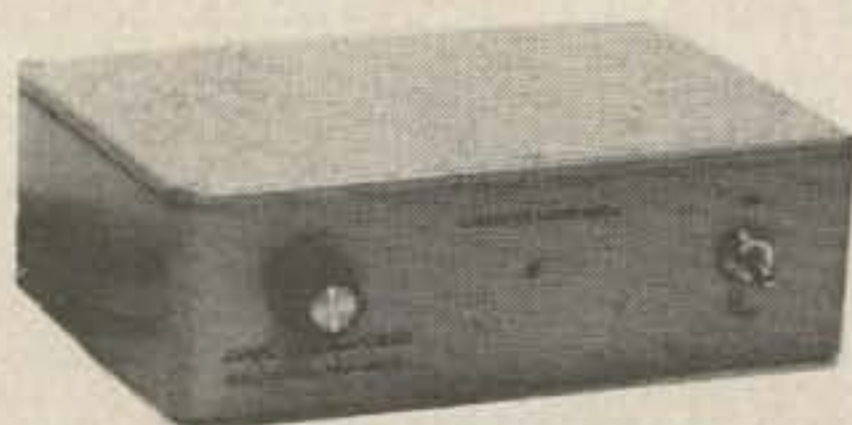
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proaching the proportions of a craze. Almost all broadcast receivers covered a portion of the shortwave bands. Indeed, the all wave broadcast receivers were ahead of communications receivers in many areas. Bandswitching, direct calibration, avc and rf amplification were all in common use before their adoption by communications receivers. Several broadcast receivers used double conversion in the early 1930's, fifteen years before it was first used in communications receivers.

The receivers of the point-to-point communications companies in early 1934 were advanced in performance and often custom built, with special components. The big labs like RCA and Bell produced these, and they could afford to use components and techniques too expensive for amateur and broadcast receivers. These receivers often used diversity receiving techniques, and they would soon install single sideband systems for their trans-oceanic routes.

As 1934 opened the average amateur still used the regenerative receiver with one or two stages of audio and perhaps a stage of tuned rf amplification. This was the same basic receiver he had been using for fifteen years. Some phone operators used the superhet, but it was generally conceded to be less sensitive than the regenerative set. Being quite simple, the regenerative receiver was often home-built, but several commercial models such as the National SW-3 and SW-5 and the Pilot Super Wasp were popular.

An occasional commercial superhet was found in the shacks of hams. Perhaps the most advanced of these receivers was the National AGC which included an rf amplifier among its nine tubes. It had single control tuning, avc and offered an optional crystal filter. The AGC was a well-built and engineered instrument for "... the fortunate amateur who can select his station equipment without regard to cost, as well as the commercial operator to whom nothing less than the best is adequate ..." Three separate coils had to be plugged into the front panel to change bands. Frequency was determined by charts on the front panel and there was a separate power supply.

The Hammarlund Comet Pro was another superhet used by some of the more affluent



The Hammarlund HQ-120, original receiver in the famous HQ-series which was manufactured for over thirty years.

hams. This eight tube set had no rf amplifier and required plugging in two coils in shield cans on the chassis in order to change bands; avc and a crystal filter were optional extras.

Thus there were three classes of high frequency receivers in early 1934. The all-wave broadcast sets had most of the conveniences of modern communications receivers — self-contained, small, bandswitching, avc, calibrated tuning dial — but they were deficient in performance. The communication company receivers utilized modern techniques such as diversity reception, single sideband, stabilized oscillators and crystal lattice filters but were very bulky and prohibitively expensive. The amateur receiver was still in the dark ages of receiver development, having neither the convenience of the all-wave broadcast set nor the performance of the commercial receivers.

Then in October, 1934, Hallicrafters announced the first of a long line of Super Skyrider receivers, a completely self-contained seven tube superhet. National announced their HRO for October delivery, and it was finally ready in December. By the end of the year the RCA ACR-136, RME 9-D, Patterson PR-12 and several others were on the market.

New developments came rapidly in 1935. Spurred on by the growing high frequency receiver market the components manufacturers developed improved insulation for bandswitches and coils, new metal tubes (6K7), acorn tubes to reduce input loadig and make amplification possible at higher

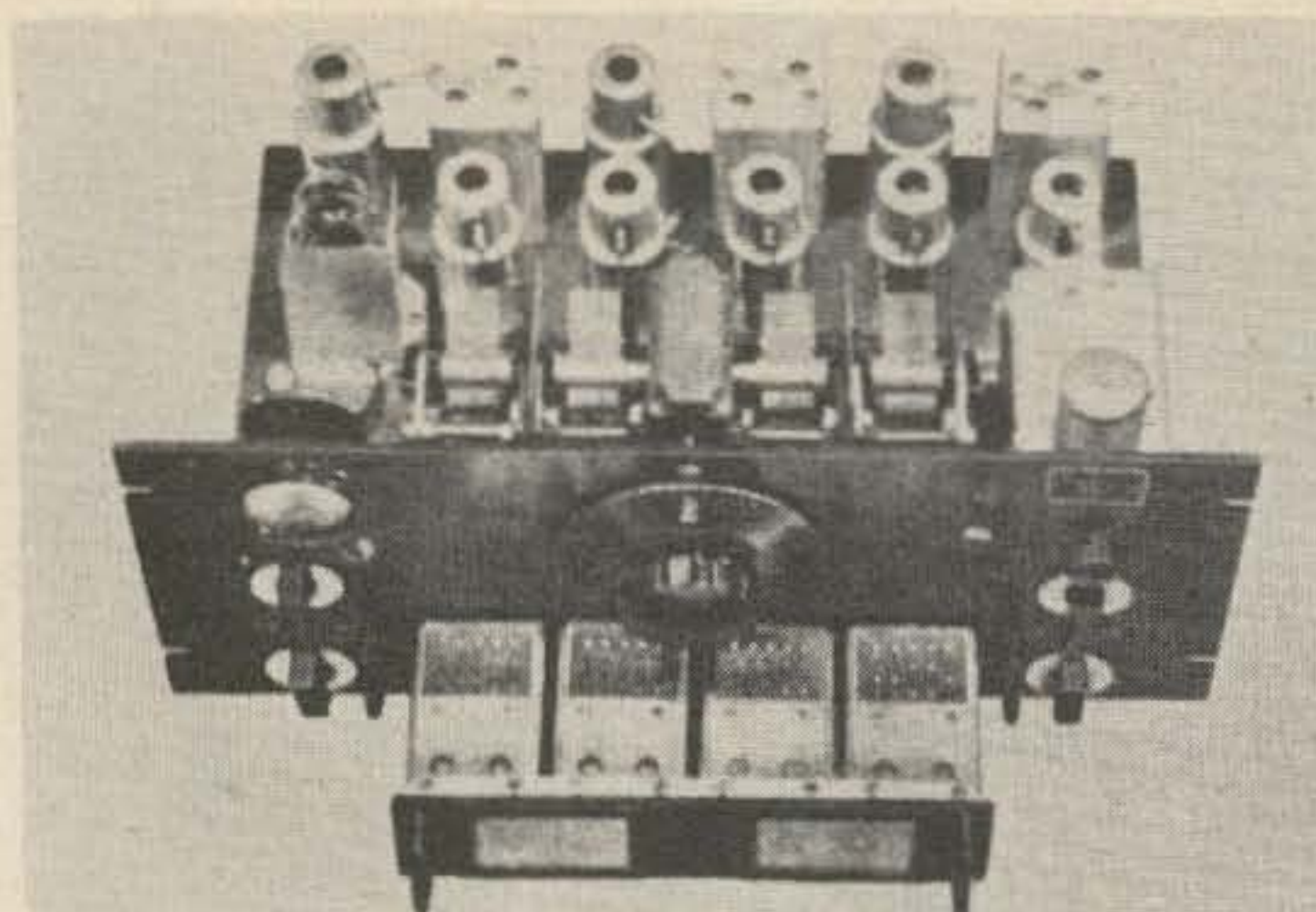
frequencies, and iron core i-f transformers. The communications receiver manufacturers immediately introduced new sets incorporating improved techniques and components.

Hallicrafters, Silver (5-C), RCA (AR-60), Patterson (PR-16), Breting (12) and Sargent (20) all came out with new receivers during 1935. Tobe-Deutschman marketed both a general coverage and an amateur-bands-only receiver kit designed around the "Tobe Tuner," a pre-wired front-end.

During 1935 Hallicrafters twice revamped their line, so fast were developments made. In January they announced three new models of the Super Skyrider, the S4, S5 and S6, differing in the frequency ranges covered. There was an optional crystal filter which added an "X" to the model designation, i.e., SX-4. In September they again revised the Super Skyrider. The new SX-9 had nine tubes and was the first communications receiver to use metal tubes and iron core i-f transformers. This was the last of the Super Skyriders with a built-in speaker. From 1936 Hallicrafters offered a complete line of receivers starting with the \$29.50 Sky Buddy. By the end of the decade the model numbers had reached the SX-24. Other models which carried the Super Skyrider name were the SX-11, SX-16, SX-17 and SX-28.

Hallicrafters specialized in giving the most possible features for the dollar and in bringing new developments to the market in the fastest possible time. They did this by using almost all purchased components, capitalizing wherever possible on the low-priced, high-volume parts developed for all wave broadcast receivers.

National approached the manufacture of communications receivers differently. They designed and manufactured most of their own components including tuning capacitors, i-f transformers, coils and tuning mechanisms. When, in 1937, they brought out the medium-priced NC-80 series they were quite apologetic in their advertising. The accepted approach is to say that through superior engineering and a reckless disregard for profits a superior receiver is offered at a low price. National said, "Most amateurs do not need to be told that when a



Early photograph of a rack mounted version of the classic National HRO.



National HRO-600, a modern professional class receiver. A receiver with remotely similar performance would have occupied two six-foot relay racks in the 1930's.

communication receiver is to be sold for as low a price as the NC-80X it is necessary to make compromises."

It is also interesting that National did not employ the conventional coil switching method of band changing in any but their cheapest receivers until 1947. The HRO used plug-in coils until 1959. Other receivers in their line from 1937 used the movable coil system. Up to 24 coils were mounted in individual compartments in a die-cast aluminum pan installed on the bottom of the receiver. Sets of coils were moved into position and plugged in by moving the entire pan on rails through a geared arrangement from the band-change knob on the front panel.

The National HRO, the most famous and long-lived of the receivers which were intro-

duced in late 1934, seemed doomed as an anachronism before it ever appeared. Yet it remained in production, basically unchanged, until 1949. It underwent modifications through the late 1950's, retaining to the last the famous PW dial and the plug-in coils. The receiver did not have direct calibration and had a separate power supply. It was a triumph for uncompromising design, disregarding as it did fashion, fad and expediency. A comparison of the performance of the original HRO with more modern receivers is given in the Table.

In 1933 Hammarlund started design of the ultimate receiver, the Super Pro, which was scheduled for release in early 1935. Their approach, like National's, was uncompromising. They designed a unique band-switching mechanism, i-f transformers with variable coupling and a special twelve gang

Performance of the original HRO compared with some modern receivers.

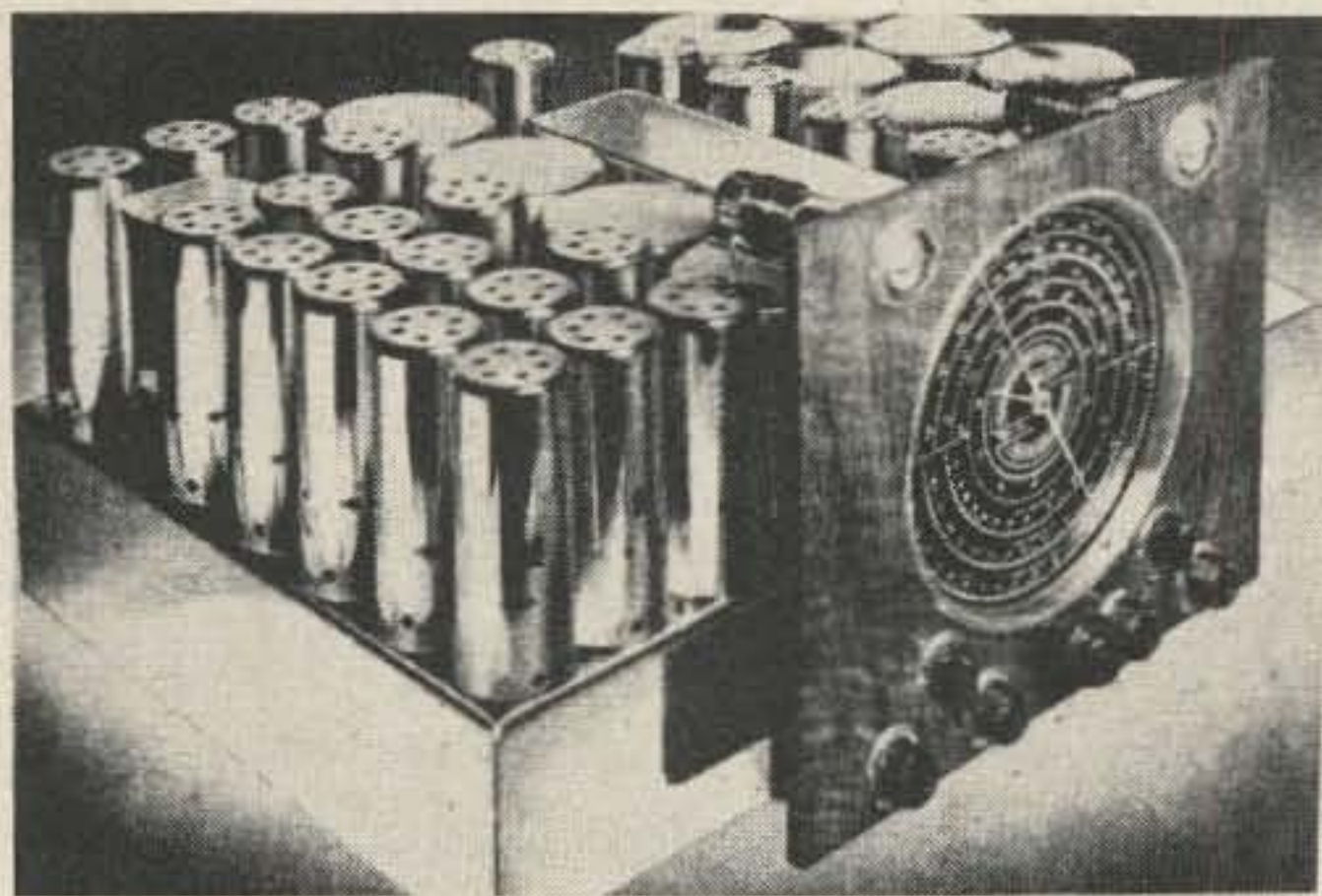
	National HRO (1935)	Hammarlund SP600 (1950)	National HRO-600 (1971)	Drake SPR-4 (1971)
Frequency Stability @ 14 MHz (max. drift)	28 kHz	1.4 kHz	30 Hz	100 Hz
Noise Figure	15 dB	10 dB	12 dB	11 dB
Frequency Readout Accuracy @ 14 MHz (max. error)	42 kHz	28 kHz	0.1 kHz	1.0 kHz
CW Selectivity	200 Hz @ -6 dB	200 Hz @ -6 dB	400 Hz @ -6 dB	400 Hz @ -6 dB
Bandwidth and Shape Factor	6-60 dB SF 30:1	6-60 dB SF 30:1	6-60 dB SF 6:1	6-60 dB SF 7:1
Phone Selectivity	3 kHz @ -6 dB	3 kHz @ -6 dB	2.4 kHz @ -6 dB	2.4 kHz @ -6 dB
Bandwidth and Shape Factor	6-60 dB SF 8.5:1	6-60 dB SF 6:1	6-60 dB SF 2:1	6-60 dB SF 3:1
Input Impedance	500Ω	100Ω	50Ω	50Ω
Image Ratio @ 30 MHz (min.)	25 dB	80 dB	90 dB	50 dB

tuning capacitor for the receiver. The project was so ambitious, however, that it was mid-1936 before the bugs had been eliminated and receivers were ready for delivery. But it was worth the effort, because the Super Pro turned out to be the most long-lived of all receiver designs. Minor revisions were made in the design in 1939 (SP-200) and in 1945 (SP-400) and in 1949 the SP-600 with double conversion and turret type coil changing was introduced. The SP-600 was sold as late as 1970.

Hammarlund brought out the HQ-120, a medium priced complement to the Super Pro, in 1939. This receiver was aimed at the amateur market to compete with receivers in the Super Sky rider price class. It became extremely popular and after the war evolved into the HQ-129, HQ-140, HQ-150 and finally the HQ-180 which was produced until 1970.

Meanwhile, the all wave broadcast receiver was reaching the height of its development in the creations of E.H. Scott and McCurdo Silver. Both companies specialized in custom receivers sold by mail and promoted through advertisements in magazines like *Radio News*. The sets were versatile in order to appeal to both the high fidelity music lover and the DX fan. They reached a peak in performance and ostentation with the new models late in 1937.

"The Amazing New Scott Philharmonic, World's Most Powerful Radio," headlined a full page ad in the September, 1937, *Radio*



Scott Philharmonic XXX, circa 1937. The receiver had a total of 30 tubes including four 6L6 audio output tubes on a separate chassis. It tuned 150 kHz to 80 MHz in six bands and its bandwidth was continuously variable from 2 to 16 kHz.

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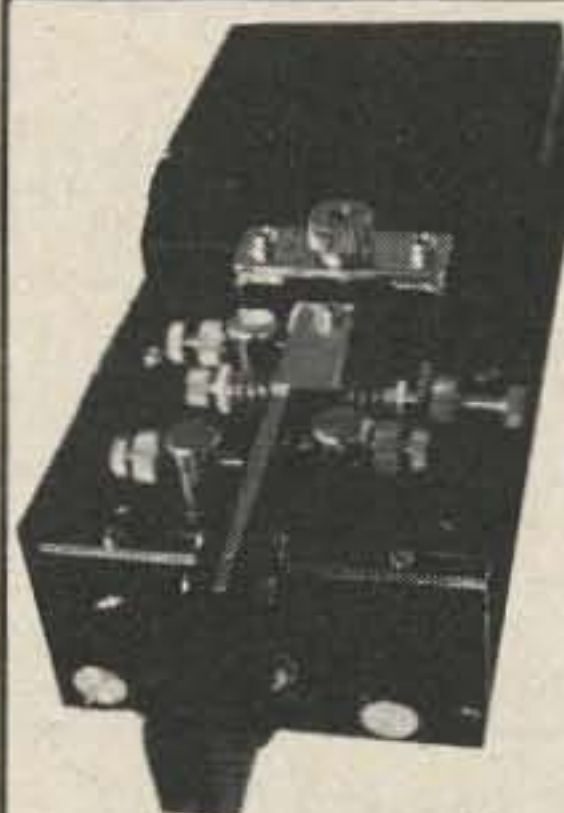
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News. The receiver contained thirty tubes on two chassis, had a 40 watt Class A audio amplifier, covered .15 to 80 MHz in six bands, had two separate amplified agc systems, one controlling the two rf amplifiers and the other the four i-f stages, and it had continuously variable selectivity from 2 to 16 kHz. This was perhaps the finest all wave broadcast receiver ever manufactured.

Silver's claims were no more modest and his receiver no less gaudy. "New McCurdo Silver Masterpiece VI, the Finest Receiver Ever Built," asserted his full page ad in the same issue of *Radio News*. While Silver's tube count was only 21, it generally matched the Scott feature for feature. It tuned .14 to 70 MHz in five ranges. It had two rf and three i-f amplifiers and dual amplified agc. There were four i-f bandwidths of 4, 8, 12 and 32 kHz and the 4 kHz bandwidth had a 6-60 dB shape factor of 2.25:1 and a 6-80 dB shape factor of 3.75:1!

World War II ended an era in the development of the communications receiver. Over 130 different models had been marketed by twenty-odd manufacturers. Of these only Hallicrafters, Hammarlund, National and RME resumed receiver production after the war. Gone were Howard, Breting, Patterson, RCA, Sargent, Meissner and Guthman. Gone also was much of the glamor and excitement because you rarely heard anymore about the people and ideas behind a new model. Big business methods prevailed and the new receivers were the product of anonymous engineering teams in obscure laboratories.

Looking back on the pre-war days from a distance of 35 years, the receivers now seem unimaginative after the original 1934-35 models. Everyone made the same receiver dressed a little differently. The standard communications receiver had one or two rf amplifiers, a mixer, a high frequency oscillator, a crystal filter, two or three 455 kHz i-f amplifiers, a second detector, bfo, and a couple of stages of audio. The techniques for SBB, dual conversion, lattice filters and most of today's refinements were available, but it wasn't until Collins introduced the 75A in 1947 that any manufacturer departed from Lamb's basic 1932 receiver design.

...Moore