HRO: PORTRAIT OF A CLASSIC

Elton Byington, N2KXT

For those who grew to love shortwave radio in the 1950s, as I did, few modern receivers inspire the awe that was attached to a few older radios of legendary performance: the **Hammarlund *Super Pro*** and ***HQ-129X***, and the **National *HRO-50.*** All three had their roots in the depths of the Great Depression, and all three could serve as models of superb radio engineering, even today.

However, faced with the prospect of using one of these relics for serious DXing, a newcomer might very well forget about radio and take up gardening, instead. For these are formidable machines, festooned with knobs and dials bearing arcane names, like *Crystal Phasing* and *BFO Pitch.* But somehow, the HRO-50 seems more out-of-date than the others, probably because it uses plug-in coils to change bands.

Indeed the HRO-50 was an anachronism when it was introduced in 1950, fifteen years after the first receiver in the HRO line. The series would continue for another twenty years, well into the era of the "modern" receiver.

With the HRO-50, the National Company yielded two points to "modernity:" they put the power supply inside, and they added a calibrated tuning dial. Before the HRO-50, all HROs were tuned by referring to nomograph-like tuning charts attached to the plug-in coils. These radios were built before "ergonomics" entered the language.

From the beginning, the HROs were held in high esteem by hams, DXers, and professional monitors because these radios are among the most sensitive ever produced. Used properly, even the oldest HRO can give a fine accounting of itself, especially on the tropical bands and below.

BIRTH OF THE COMMUNICATIONS RECEIVER

All radio people should be familiar with the name of **Edwin Howard Armstrong** and with his great contributions to modern communications. Armstrong's fertile mind brought forth the concept of *regeneration*, which vastly increased the amplification of the three-element *audion* tube, invented by **Dr. Lee deForest**, by a process called *feedback*, where a portion of the tube's output was fed back into its input for reamplification. (1,2)

Armstrong found that a properly controlled amount of feedback made the audion, which we now call a *triode*, extremely sensitive to the radio waves received by an antenna. If he increased the feedback just slightly, the triode began to *oscillate*, in other words, it became a *transmitter*. A key difference between Armstrong's oscillating vacuum tube and the emissions from the spark transmitters of those days was that the oscillator produced *continuous waves*, or *CW*. He made this discovery before World War I, but it wasn't brought into regular use until about 1920, with the advent of broadcasting.

During the war, Armstrong developed several innovative radio circuits, including one that became the foundation of virtually every receiver today, the *superheterodyne*. Today it seems preposterous to hear that the superhet was looked upon at the time as an interesting novelty, of little value in communications.

The early superhets were well adapted for such things as radiotelephone reception in homes or for spark-transmitted Morse, which produced a raspy buzz in the receiver. These were both *wide-bandwidth* signals that could be heard with a hunk of galena in a crystal set.

But with the introduction of continuous waves, the superhet had real disadvantages. Although it was very sensitive and stable, especially when compared to the regenerative receivers of the day, it lacked adequate *selectivity* to cope with crowded shortwave bands -- ***and it was stone deaf to CW!***

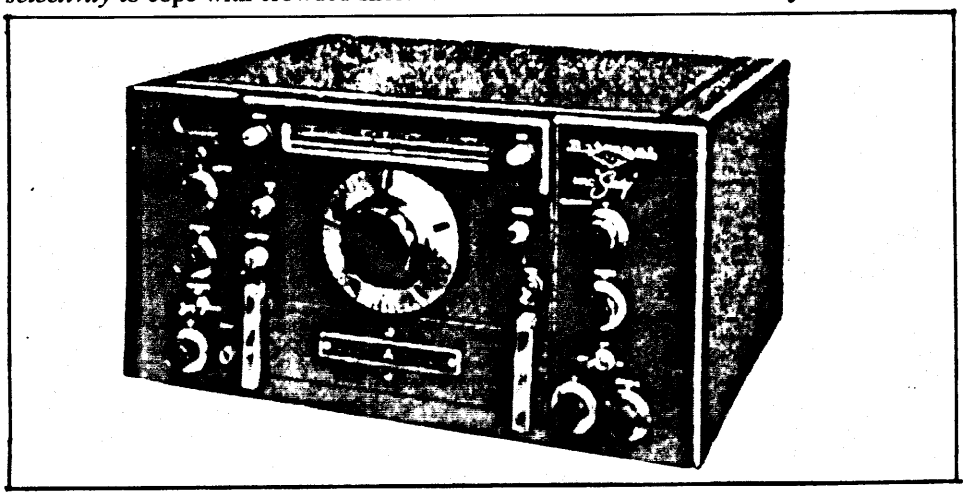


FIGURE 1.
The HRO-60 was the last of the tube-type radios in the HRO line. The receiver was introduced in 1952 and remained in production until 1965.

ENTER JAMES LAMB

In an article called **"What's Wrong With Our CW Receivers?"** that appeared in the American Radio Relay League's magazine *QST* for *June 1932,* technical editor James Lamb argued that the regenerative receivers then in use were woefully inadequate for "modern" band conditions, and that the superhet would need a lot more work before it could fill the bill.

Lamb soon supplied answers to the questions he'd posed with an article describing what he called the **"Single-Signal Superhet,"** published in *QST* for *August 1932.*

The single-signal superhet contained a *beat frequency oscillator (BFO)* that allowed the listener to hear a musical note when tuned to a CW transmission. And it contained a simple, elegant circuit that paved the way for the true communications receiver: the *crystal lattice filter.*

Lamb's filter -- a quartz crystal cut to resonate at the intermediate frequency (IF) of the receiver, bridged and bypassed by a couple of variable capacitors to make it adjustable -- became the key to the selectivity the ordinary superhet lacked. When brought near resonance, the filter produced a pronounced peak in response, often only a few hertz wide. This allowed an operator to peak his receiver on one signal, rejecting all others.

Within six months several receivers hit the market using Lamb's basic principles, including the direct forebear of the HRO, the National AGS-X. One could argue, with justification, that James Lamb was the father of the modern communications receiver. (3)

EARLY AIRLINES AND RADIO -- THE NATIONAL AGS

Despite the Depression, the early 1930s saw the birth of an industry that would eventually shrink the world: scheduled commercial passenger service by airplane. Air travel then was only for the adventurous (or foolhardy) and wealthy. It was risky, partly because air-to-ground communications were rudimentary, at best.

Because the technology of the day was built around fragile vacuum tubes, the equipment was cumbersome and heavy. And, because the early radiotelephone transmitters were enormously complicated and difficult to operate, simple CW rigs were used. An airplane carried a simple CW transmitter and a regenerative receiver. Both were small and reasonably easy to operate.

But there was an economic problem at work here: because they used CW, these simple rigs required the full-time attention of a trained radio operator, one who knew how to send and receive in Morse Code. The operator added weight to the plane's load, so it could carry fewer paying passengers.

The Department of Commerce, which oversaw the development of the airlines as well as of radio, recognised the problem and moved to overcome it. The department proposed the development of an entirely new system of aircraft communications, one that would use radiotelephone, so that the plane's pilot could do the communicating.

The contract for the receivers to be used at the ground stations was awarded to the National Company of Malden, Mass., and the delivered product was called the **AGS,** for *Aviation Ground Station.* (3,4)

National's AGS was a 9-tube superhet that used four sets of three plug-in coils to cover the frequency range of 2.4 to 20 MHz. It had a BFO for CW reception and a circuit called *automatic volume control (AVC)* for 'phone. The AVC detected changes in the strength of incoming signals and automatically adjusted the RF gain of the receiver to avoid overload. *(Today, we call this circuit automatic gain control or AGC.)*

Variations in the basic AGS receiver extended its coverage down to 1.5 MHz, introduced a variable BFO pitch control, and incorporated Lamb's crystal filter in the final version, the AGS-X, produced in 1933.

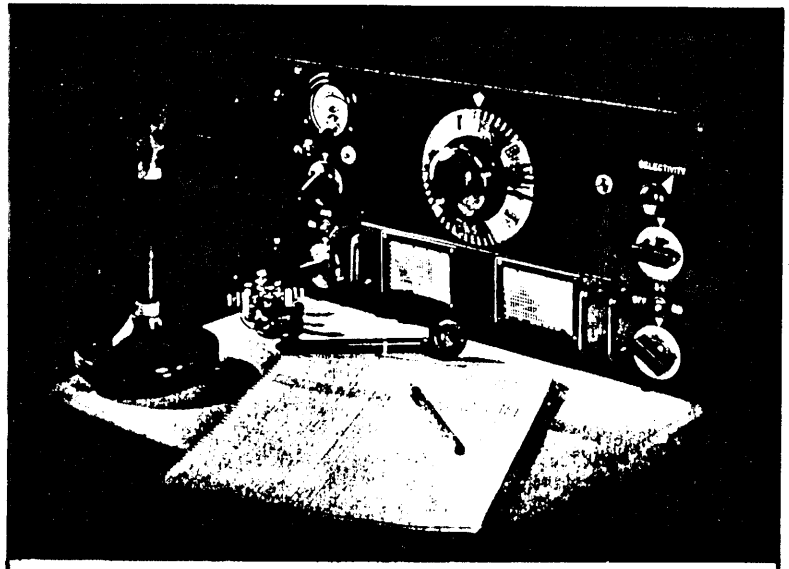
To change frequency bands on the AGS, the operator had to fumble with six separate plug-in coils, one each for the RF amplifier, the mixer, and the high-frequency oscillator stages of each frequency range. The coils were marked A1, A2, and A3 for one range, B1, B2, and B3 for another, continuing through the C-, D-, and E-series coils for progressively lower bands. Plug the coils in in the wrong order and you were asking for trouble! Clearly, there had to be a better way.

JAMES MILLEN, MECHANICAL ENGINEER

National's chief engineer at the time, James Millen, was a ham radio operator and a mechanical engineer by training. His solution to the coil problem reflects his background: he devised a way to gang the coils together in the proper order, so that it was impossible to mix them up. (4)

Then he designed a special right-angle worm-gear drive and attached it to a precision four-gang variable tuning capacitor.

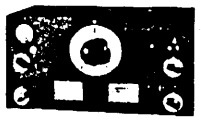
And finally, Millen designed the unique "PW" tuning dial that would be a distinguishing feature of HRO series receivers until the introduction of the last version, the HRO-600, in 1970. The micrometer-like PW dial is 4 1/2 inches in diameter and has five windows in its skirt that allow the operator to see numbers that change as the dial is turned: 0-10-20-...-490-500. This results in an effective dial scale length of nearly 12 feet! It's probably the most precise mechanical tuning dial ever devised.



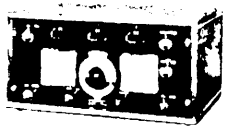
ANY night on the amateur bands you will hear a better advertisement of the Standard HRO than we could write. The unqualified enthusiasm of men who have spent years mastering the fine points of high frequency communication counts for more than a long list of unusual details, even though those details include such items as the PW Precision Condenser, calibrated band spread and a crystal filter as effective on phone as c.w. The demands of modern radio are rigorous, and the proof of the pudding is in the eating.

An illustrated folder describing this receiver will be mailed on request

NATIONAL COMPANY



HRO, Jan. 1935



AGS, July 1932

FB7, Feb. 1933

SRR, April 1933

RESALE VALUE

SW3, Aug. 1931

YOU will probably never wish to sell your National Receiver. Few amateurs ever do; there is a friendly integrity about them that makes them hard to part with. But the most acid test of a receiver's real worth is its value in dollars and cents after long and hard use. As an owner, you will be pleased to know that your enthusiasm in your National Receiver is not misplaced.

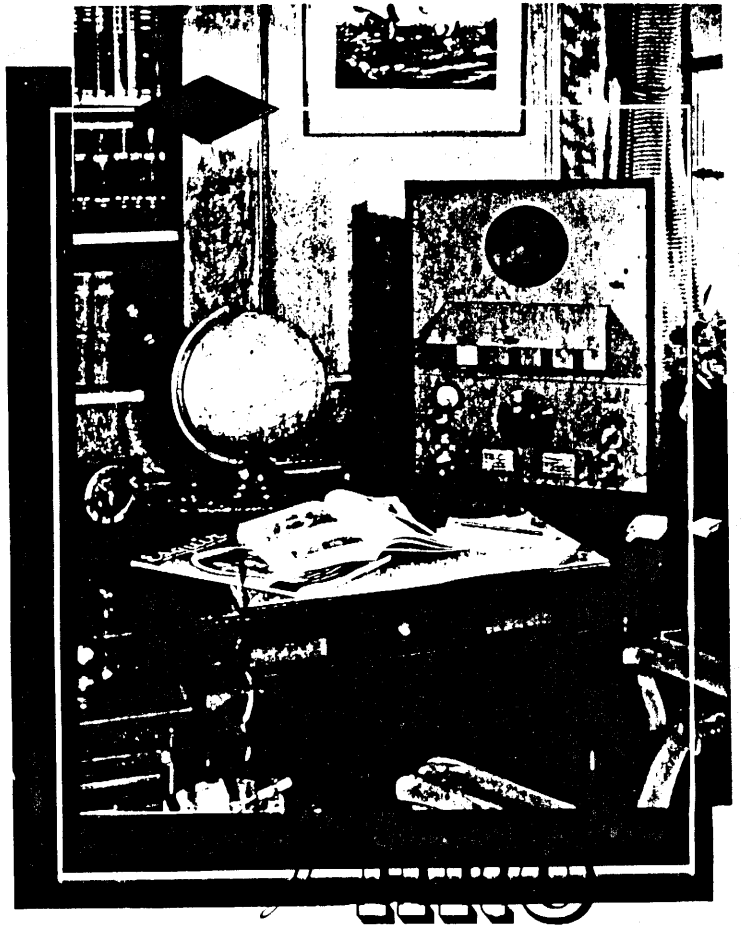
For more than four years the little SW-3 has been proving the soundness of its design and the honesty of its construction, and while other receivers have passed from memory, the popularity of the SW-3 has steadily grown.

Gadgets will sell any receiver the first year, but character alone can maintain resale value afterwards. To this acid test we invite you to apply any National Receiver, however old.

NATIONAL COMPANY

F31.3

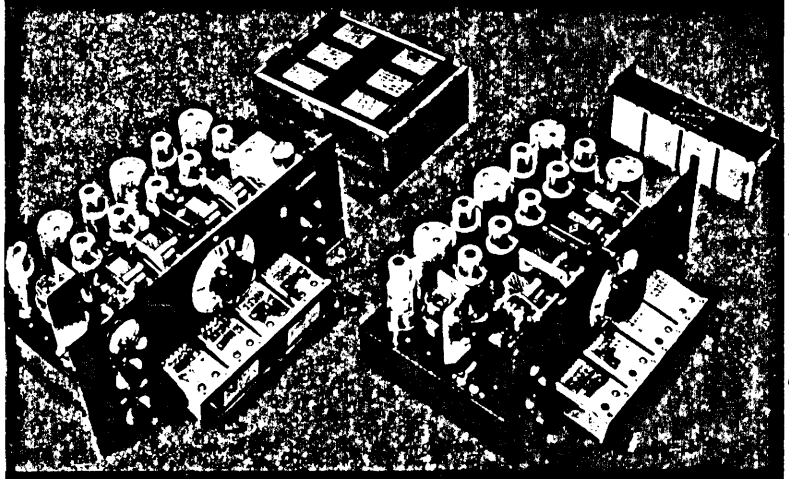
FIGURE 2A. For more than 30 years, advertisements from the National Company graced the pages of QST magazine. These ads amount to a chronicle of the HRO series from it,s introduction in December 1934 to the end of its run in the 1970s. Shown here is an early HRO ad from 1935 and one showing the major steps from the regenerative SW-3 of 1931 to the HRO in 1935.



IN REPLY to professional demand, a Combination Panel consisting of a spare-coil cabinet, matched speaker and power supply is now offered as an auxiliary to the HRO Receiver. Making a compact well-appointed receiver with its speaker properly segregated to prevent annoying mechanical feed-back. Your choice of finish, either rich grey or black leatherette. Retail prices are: HRO receiver, relay rack type, with coils covering 1.7 to 30 megacycles, $179.70; Combination Panel type SPC, $52.50; Table-model Relay Rack type MRR, $13.50.

ATIONAL COMPANY

IFFERENT ONLY IN VERSATILITY AND IN PRICE



THE STANDARD HRO :: THE HRO JUNIOR

ANNOUNCING THE HRO JUNIOR

For those who need the high performance of the HRO, but do not require its extreme versatility, a Junior model is offered. The circuit details of both receivers are identical in every respect, but the lower priced model has been greatly simplified by omitting the crystal filter and the S-meter, and by designing coils for "continuous band spread" only.

Although these omissions do not greatly restrict its usefulness, they make it possible to price the Junior HRO at a very attractive figure. A complete description of the HRO Junior and of the Standard HRO will be mailed on request.

HRO Junior	*List*	*Amateur Net*
With tubes, one set of coils, 10 to 20 meters (2 amateur bands)	$165.00	$99.00
Additional HRO Jr. coils — per range — (2 amateur bands)	16.50	9.90
5897 AB Power Pack — for above — less tube	26.50	15.90

NATIONAL COMPANY

FIGURE 2B. Shown here is another ad from 1935 illustrating the Table-model Rack type MRR. The second ad is the introductory ad for the HRO Junior (1936).

HELLUVA RUSH ORDER!

James Millen and his crew were working 'round the clock in 1934 to design a receiver that would combine the best features of the AGS and eliminate its drawbacks. They worked under pressure to meet a Department of Commerce prototype deadline set for midyear. It was still more difficult because the electronic design was being carried on at the other end of the country, in Pasadena, California!

Overseeing the project was Herbert Hoover, Jr., son of the former president and also a ham, W6ZH. Hoover had been president of the ARRL and was an electrical engineer. His electronic design team was composed of engineers from Western Electric, part of the Bell System. (3,4)

Hoover's specifications called for superior image rejection, more precise tuning, improved AVC, better frequency stability, and superb selectivity. The first criterion was met by including two tuned RF amplifiers ahead of the receiver's mixer; Millen's superb PW dial took care of the mechanical part of the second, and James Lamb's crystal filter provided the last. Much experimentation was required to fine tune the receiver's AVC, but it eventually became quite effective.

The matter of frequency stability or "drift," however, would go on to plague the HRO and other vacuum tube receivers until Arthur Collins devised the dual-conversion 75A receiver, with its crystal-controlled HF oscillator and permeability-tuned second oscillator, in 1946. The vacuum tube HRO receiver never overcame that problem. They ALL drift.

James Millen's team's mad rush to finish the new receiver on time led National's workers to dub the project the **HOR,** for "hell of a rush." In those more temperate times, however, cooler heads prevailed, and the new radio was rechristened the **HRO.** It was first advertised in the December 1934 issue of **QST**, and delivery began the following March. (4,5)

DESIGN CONCEPTS

From the start, James Millen designed the HRO as a no-compromise receiver, both mechanically and electrically. The radio is built on a welded steel chassis, all wiring is painstakingly laced into place, critical RF and IF leads are made as short as possible, and component selection is extremely conservative.

The key to this superb design is the HRO's unique coil drawer or "catacomb," as National called it. The four coils are ganged together in such a way that they rest directly below their associated section of the tuning capacitor. Each coil is encased in an aluminum can and each section of the tuning capacitor is separated from its neighbors by a Faraday shield.

Leads from the coils are brought out to silver-plated contacts embedded in a ceramic terminal strip atop the coil can, where they mate with spring-loaded contacts beneath the tuning capacitor sections. When you plug in a coilset, it makes sure, firm contact.

In the "classic" HRO, each coil is tapped to allow the receiver to be used for general coverage or for bandspread on the ham bands only. The option was selectable by the operator by moving a screw, on the early receivers, or by twisting a butterfly valve-like switch on later models.

Each coil was designed to cover two amateur bands when in general coverage mode, so one coil would cover 80 and 40 meters with bandspread on 40, the next one would cover 40 and 20 meters with bandspread on 20, etc.

The radio and its coilsets were manufactured as a unit and were aligned that way. They were meant to be kept together, so trading coilsets with your ham buddy was not a good idea. Your coilsets would work in his HRO, but the receiver would not track properly. Remember this if you're looking for HRO coilsets at a local hamfest! If you have the option, ***buy the entire receiver,*** rather than separate coilsets! (5)

There are exceptions to this rule, however. The original HRO was supplied with four coilsets, covering 1.7 to 30 MHz. National also sold coilsets that extended the receiver's coverage down through VLF range, to 175 kHz. These sets were NOT supplied with the receivers and they are exceedingly hard to find. Alignment on these accessory coilsets is only approximate, but is usually quite adequate. The two coils that cover the broadcast band are also very hard to find. ***They are well worth finding!***

The original HRO had nine tubes. There were two RF amplifier stages, a mixer (called a first detector in those days,) a high-frequency oscillator, two 456 kHz IF amplifier stages, a demodulator/AVC detector/1st AF amplifier stage, a separate tube for the BFO, and an AF output stage. The power supply was in a separate box because the engineers believed it would contribute to hum, noise, and heat if built into the radio. It contained a type 80 rectifier tube.

The original receiver came in two variations as well: 2.5 volt and 6.3 volt, referring to the heater voltage of its tubes. For this reason, it is important to get the right power supply for the radio. They should always be sold as a unit. (Later HROs all had 6.3-volt tubes.)

FIGURE 3.

The "Classic" HRO was often called the "HRO Senior" after National began making a "Junior" version, in 1936.

SEVERAL VERSIONS

In his excellent book, *Communications Receivers, The Vacuum Tube Era: 1932-1981,* Raymond Moore lists more than ten different versions of the "classic" HRO. Most of the changes were incremental and internal. Some were for receivers built to unique specifications for the military. Other models were contained in rack-mount cabinets, complete with loudspeaker and power supply, and a place for storing unused coilsets.

A few months after the introduction of the original HRO, the National Company began producing a stripped-down version, aimed at the amateur radio market. The **HRO-Junior,** as it was called, dispensed with Lamb's crystal filter and the S-meter, and it didn't have provision for bandspread on the ham bands. The coilsets were aligned for an "average" receiver, not for each radio. (5) It sold for $99.50, as opposed to the $168.50 of the HRO, itself. Even that was a lot of money in those days, when a good job (if you could find a job at all) paid something like $25 a week, and a new car could be bought for about $500.

Of special interest to anyone searching for a "classic" is the HRO-5, built in the thousands for the military during World War II. Its distinguishing feature is that it does NOT include bandspread for the ham bands. Many of these receivers wound up on the surplus market in England for some reason, where they were advertised through the early 1960s in the British magazine *Wireless World.* The HRO-5, like all the others, has a separate power supply. (This receiver is often referred to as the HRO-M.)

Another version, built for a couple of years just after the war, has an automatic noise limiter control between the tuning dial and the S-meter. It controls the triggering level of a shunt diode (a tube) that bypasses received noise bursts around the detector. The "ANL" concept never worked very well, although it held on through the 1950s.

The last "classic" HRO didn't really look like one, except for the distinctive PW tuning dial. It was the HRO-7, introduced in 1947. The HRO-7 had 12 tubes, including a voltage regulator that tried to stabilize the receiver's frequency drift, and it was packaged in a sleek, streamlined cabinet. Make no mistake, though, for lurking behind that pretty face was the same basic receiver that had been in production since 1935.

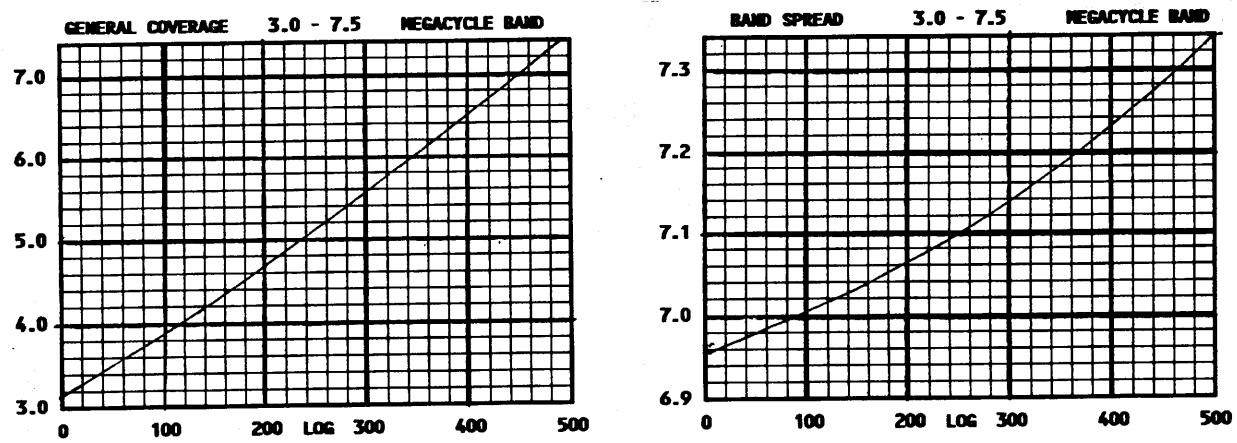
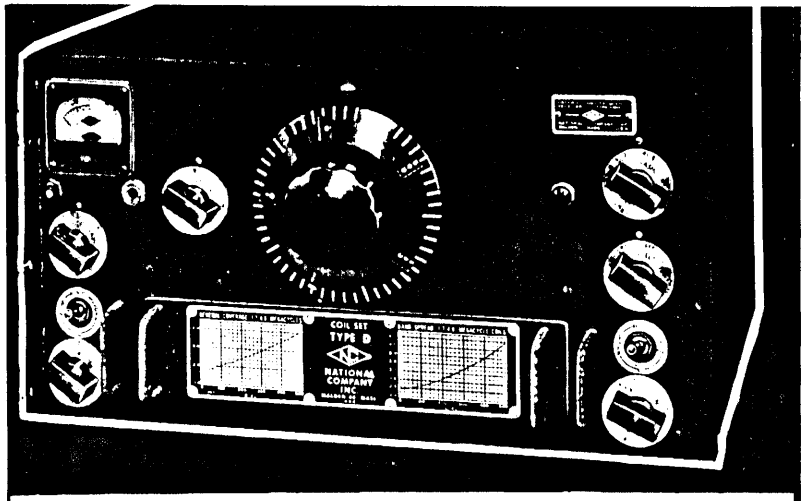


FIGURE 4. Until the advent of the HRO-50, every receiver in the series was tuned with the aid of charts like these, attached to each coilset. The tuned frequency is plotted vertically and the corresponding PW dial readings are plotted horizontally. To find the frequency your receiver was tuned to, you read the PW dial, looked up the reading on the horizontal axis, then followed the line straight up to where it met the calibration line. Next, you'd look left along the horizontal line that intersects at that point and eventually find your frequency! The chart at left is for general coverage; the one at right is for ham band bandspread.

FIGURE 5A. THE HRO GOES TO WAR. When the United States entered WWII, the National Company got the word: "Start building HROs; we'll tell you when to stop!" During the War, the Company's workforce increased tenfold, from about 250 to 2500 people. (5)

When the going is tough and there is a man's job to be done, old friends of proven dependability are doubly welcome.

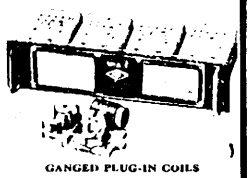
NATIONAL COMPANY, INC., MALDEN, MASS.

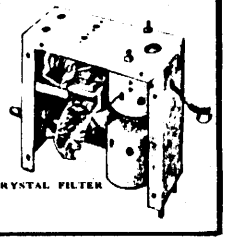


HRO-5A1

WHEREVER the choice of a communication receiver is based on proven performance, the HRO is a logical selection. For the HRO is cleanly designed for crack operators, free from superfluous tubes or details, yet including everything that can aid the user's skill. The HRO combines ease of operation with brilliant performance and superb reliability.


FOUR SECTION PRECISION CONDENSER


GANGED PLUG-IN COILS


WIDE RANGE CRYSTAL FILTER

NATIONAL COMPANY, INC.
MALDEN, MASS.

FIGURE 5B. Another WWII ad for the HRO indicates the relation of the National Company and the HRO to the War effort. One does wonder how many US Marines stood radio watch in their dress blues. The second ad illustrates the immediate post-War offering of the HRO-5A1 to the amateur market.

TIME FOR A CHANGE

World War II did two things for America: it ended the Great Depression and it pushed the United States to the cutting edge of technology. In the euphoria that followed the war, at least until Korea put the brakes on, it seemed Americans could do no wrong.

Television was revolutionizing the way we lived, jobs were abundant, the economy was booming. The Marshall Plan was in full swing, helping Europe rebuild from the war's destruction. America had ***The Bomb***, and nobody was going to push us around!

Shortwave radio was experiencing a postwar boom, too, with stations signing on from the far corners of the earth. A guy in Denmark named **Jens Frost** was putting together a pamphlet called the *World Radio Handbook* and publishing it every year.

Automobiles, too, were getting sleeker, less boxy, and suddenly, the radio receivers we'd used since the '30s seemed hopelessly dated and tired. Change was in the air, and radio manufacturers, using advanced techniques developed during the war, were ready to change with the times.

Up in Malden, Mass., the National Company saw in these booming times a chance to remake a winner, and the **HRO-50** was born.

PRIDE OF BREED

Beautiful, streamlined, heavy, the HRO-50 was everything its boxy progenitor was not. If the classic HRO looked like a Model T, its offspring looked like a new Cadillac.

Gone were the separate, clunky power supply and the arcane, difficult tuning charts. The new receiver had a regular power cord and, wonder of wonders, *a direct-reading, sliderule dial!* It was surprisingly accurate, too.

The new set's innards were state-of-the-art, too, if you could disregard the fact that you still had to swap coils to change bands. Many of the set's 15 tubes were of the new, rugged, miniature type, developed during the war. And it had a push-pull audio output stage that delivered a hefty eight watts -- enough to blow the doors off the shack!

Almost everything in the set had been miniaturized, with the exception of the coil catacomb and the tuning capacitors. The huge IF transformers of yore had given way to modern, ferrite slug-tuned cans, yet the internal construction was very similar to the prewar models; everything was laced into place and built to last.

Introduced in 1950 and selling for $349, the HRO-50 was followed a year later by what was probably the ultimate extension of the single-conversion superhet concept, the **HRO-50T1**. (The "T" meant it was a table model; the same receiver mounted in a rack was called an HRO-50-1. When new, it sold for $383.50.)

THE GOLDEN AGE

With its three 455 kHz IF stages, comprising 12 cascade-tuned circuits, as well as two redesigned RF amplifier stages, the HRO-50T1 was then, and remains, possibly the best single-conversion receiver ever built. It is an awesome performer, capable of uncovering the weakest signals.

The radio handles well, sounds great, weighs a ton, and drifts like crazy. (Not as bad as other versions of the tubed HROs, though.)

Frequency drift had always been a problem with the HRO, and operators had long before developed a method of minimizing its effects: keep the coilsets warm! Stick the unused sets on the radiator in the winter or put 'em in a sunlit window in summer. I've heard of guys actually sticking them in the oven for a few minutes before a DXing session! This applies to all HRO coilsets.

The HRO-50T1 is a superb receiver for AM and CW signals, easily the equal of more modern sets, especially in the tropical bands and below. Its tuning dial will drive you whacky and its drift will have you reaching for the ICF-2010, but for down and dirty DX, there's nothing that can match it.

It's a ***man's radio***, not for the faint of heart.

IMAGES: OR "WHY IS GUYAQUIL INTERFERING WITH WWV?"

Image rejection was one of the prime reasons for using two tuned RF amplifiers in the original HRO. All superhets are susceptible to images, because the action of the mixer stage produces two distinct products, one above, the other below the local (HF) oscillator's frequency.

So, if you are tuned to 10,000 kHz with a receiver that has a 456 kHz IF as did the early HROs, your local oscillator is producing a frequency of 10,000 plus 456, or 10,456 kHz.

Now, let's assume a strong utility station cranks up on a frequency of 10,912 kHz. It hits your mixer along with the station you want to hear, WWV on 10 MHz.

The arithmetic is simple: 10,456 minus 456 equals 10,000 kHz; but 10,456 plus 456 equals 10,912 kHz, too, and the result is an "image" of the utility station, heard along with WWV.

There are two ways of combatting a superhet's images: use a tuned RF preselector so that the signal from the interfering station is reduced to the point where it can't be heard, or use multiple mixers and oscillators in a multiple conversion scheme.

The traditional HRO, up to and including the HRO-50T1, used the former method and it worked quite well. The main problem with the scheme is the difficulty of getting the resonance of each tuned circuit to occur at the same points throughout the frequency range of the receiver. That's called *tracking a superhet*, and it's almost a black art.

But when you go to multiple conversion, things start to get complicated. All of a sudden you have mixing products showing up at very odd places, mixing among themselves and producing other, still stranger, images.

That's what happened with the last of the vacuum tube HROs, and it's not a pretty story.

A NEW WRINKLE: DOUBLE CONVERSION

Art Collins refined it, but its roots go back to the early 1930s. By the early '50s, the ham radio bands were abuzz with tales of the great advances in store for the next generation of shortwave radios, chief among which was a thing called *double conversion*, which few understood.

The consensus among hams and manufacturers was that this double conversion thing *must* be a great advancement, *because it was so damned hard to understand!* After all, how many people understood how the Atom Bomb worked, and look at what a big advancement that was!

Wishing to remain up to date (while retaining those anachronistic plug-in coils), the folks at National decided to create the ultimate receiver by building upon the success of the past.

The result was the fabulously expensive ($100 more than the HRO-50T1) **HRO-60,** using double conversion above 8 MHz, and it was less than perfect.

"I probably lost more sleep over the HRO-60 than any two things National made, except for the first NCL-2000 linear amplifiers, which were prone to very interesting self-destruction," says **Frank Gilmore, K0JPJ (ex-W5PVX),** a long-time National dealer and warrantee repairman. (6)

"When a customer paid the kind of money the 60 was bringing back then (almost $700), they were expecting a wondrous receiver, which the HRO-60 was not," he continues.

"In point of fact, the HRO-50T1 was the best of the whole series, and the engineers at National knew this and tried feverishly to come up with a fix.

"The 50T1 was was more sensitive on high frequencies, was more stable, and had a superior crystal filter.

"The HRO-60 was prettier in a cosmetic way, and it actually had a higher grade of components, but it just didn't perform as well."

Gilmore went on to describe some of the quirks he encountered when working on the HRO.

"The only HRO series receiver that I found had severe alignment problems was the HRO-7. By later versions is was very primitive. The HRO-5 was a joy to work on because of its simplicity, and it was really a very good receiver.

"The HRO Senior and Junior receivers were not that great by more modern standards, although for their day they were the top of the heap."

TRICKS OF THE TRADE

I've already mentioned the old trick of keeping your HRO coilsets warm to lessen the receivers' drift, but modern hams and SWLs might not realize another fact of shortwave life, up through the 1960s: ***accurate frequency readout wasn't all that important.***

Most of the great receivers of the day were designed for commercial operations and for hams. The commercial sets were used to tune relatively small segments of the spectrum, and their associated transmitters were usually crystal controlled. This made the job of the receiver that much easier: you simply tuned around until you heard the station you wanted to copy, then read the dial and logged its reading for future reference. The accuracy was all at the transmitter end.

Hams used a similar method, but they usually had crystal-controlled marker oscillators to warn them of the band edges.

For really accurate frequency measurements, we had to rely on surplus BC-221 series frequency meters sitting beside the receiver. These World War II relics used frequency charts similar to those found on the early HROs, but enabled you to make far more accurate readings. You'd tune the receiver, then zero-beat the BC-221 and read your tuned frequency from the meter's dial and chart. It was quite accurate.

If you couldn't afford a BC-221, which cost about $75 in those days, you could make your own tuning charts for your particular receiver. This was a laborious and time consuming task that involved tuning to known stations and logging the readings from your receiver's tuning dial.

Eventually, you were able to "map" your receiver's calibration, although with many receivers the charts you'd made were way off frequency the next time you returned to that band. The HRO was far superior to other receivers in that regard, mainly because of James Millen's superb mechanical design.

One side benefit of taking the time to "map" your radio is something a modern DXer often misses: ***you were forced to "learn" the bands.*** Certain signals served as "signposts" on each band, and an experienced DXer knew what they were, without even looking at his or her dial.

Knowing these "signposts" is what separates the DX pro from the DX novice. There is no shortcut to this knowledge, either. It takes years of daily listening to gain the experience, and no receiver, no matter how accurate its frequency readout, can supplant experience as the prime tool of the successful DXer.

In the world of shortwave DXing, that axiom belongs right up there with *caveat emptor.* It cannot be stressed too much.

THE "MODERN" ERA

By the middle 1960s, the HRO and other receivers of its type were becoming hopelessly long in the tooth. Many hams and DXers felt the firecrackers of old had overstayed their welcome, and they began demanding smaller, lighter, more accurate receivers.

The National Company heard their pleas, and in 1965 announced the first of the "modern" receivers, the **HRO-500.**

Here was a set that was fully transistorized, weighing a mere fraction of the HRO-60, yet it featured digital frequency readout, provided by neon "nixie tubes," and covered the whole mediumwave and shortwave spectrum in 1 MHz bands.

It was the first receiver of its type to reach the amateur market and it found ready acceptance, despite its fabulous price tag of $1,500.00.

The HRO-500 was built around a new concept called *crystal synthesis,* which provided crystal-controlled accuracy and stability to every frequency the receiver tuned. It was truly a radical departure from earlier receivers, and remains a superb DX machine.

Early samples of the HRO-500 had numerous problems with their synthesizers. "Birdies" and other artifacts abounded. Some of the early sets suffered from a lack of sensitivity above 15 MHz, too, but these problems were largely overcome in later production runs.

The HRO-500 was the last of the series to be built for you and me. It was also the last to have James Millen's incomparable PW dial.

But the boys in Malden weren't ready to give up the ghost. And the most famous series of radio receivers ever produced wasn't quite ready to end.

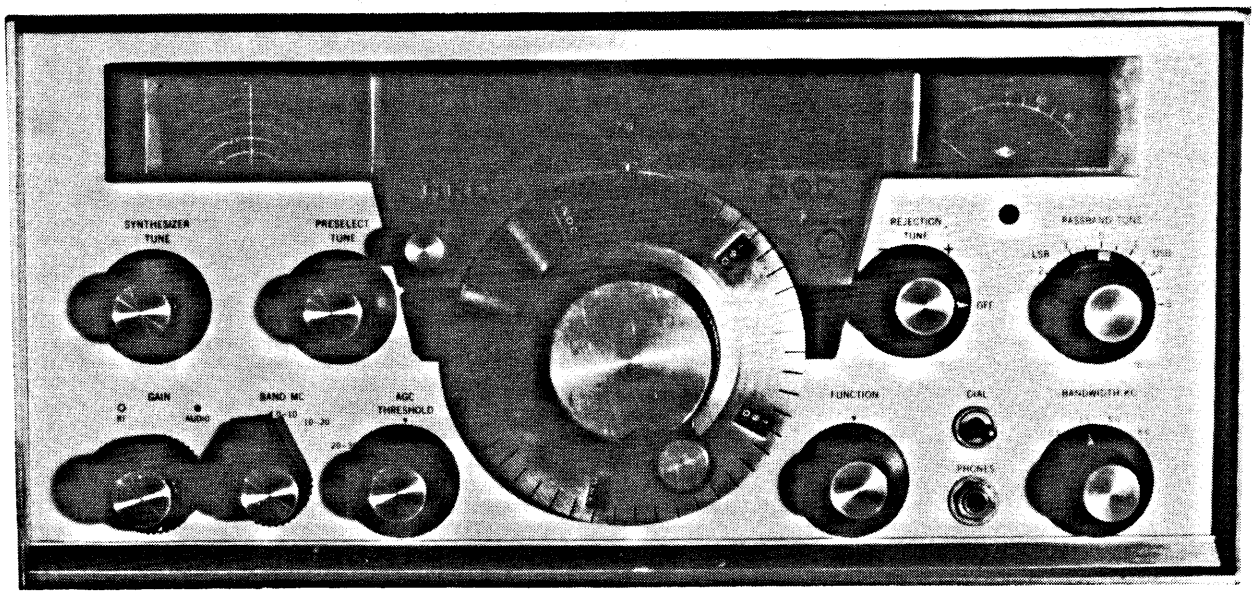


FIGURE 6. The HRO-500 was the last of the line that was built for ordinary mortals like you and me. When it was introduced in 1965, the receiver was truly state-of-the-art, using an advanced tuning scheme called *crystal synthesis* that made every frequency it tuned as stable as if it were crystal controlled. Crystal synthesis differs from the phase-locked loop arrangement common today in that frequencies are produced by heterodyning crystal oscillators against one another. It's a purely analogue technique that's inherently quieter than the digital schemes used today. This fine specimen belongs to David Clark.

A CLASSIC END-GAME

By the early 1970s the tide of radio technology had shifted to the far shores of the Pacific, as Japanese receivers, at first imitating and later surpassing American designs, began their inexorable progress toward domination of the amateur market.

Like most other American radio companies, National was caught between the jaws of an economic vise. Because National's method of production was extremely labor-intensive, it cost too much to build a superb modern receiver for the amateur market on these shores. Instead of abandoning the field entirely, National switched gears and produced yet another version of their premier receiver, calling it the **HRO-600.**

The HRO-600 didn't look like an HRO at all. Gone was the classic PW dial with its micrometer-like windows that had served generations of DXers so well.

Its place was taken by a plebeian plastic knob or a series of plastic thumb-wheel switches, set in the middle of a 5-inch relay rack panel.

With its "nixie tubes" intact, this redesigned HRO-500 was designed strictly for the needs of the commercial market, and its $5,000 price tag provided assurance that few, if any, of the new radios would reach the amateurs.

Two models were produced: one with continuous tuning, the other with discrete thumb-wheels for each tuning digit, and National continued to produce the HRO-600 until about 1980, when the economic realities of today's marketplace forced them under.

SIC TRANSIT GLORIA

By the early 1980s the once great National Company was dead, a victim of outmoded production techniques. It had reached its zenith during World War II and had continued to produce superb, if somewhat dated, communications equipment right up until the end.

The spirit of National lives on today in the hearts and minds of many who worked there during its heyday. They still have annual company picnics, and a National Ham Radio Net meets on 75 meters each week.

It's firm in the minds of the participants, and in the hearts of the many thousands who've owned and cherished National receivers over the years, that for four eventful decades the National Company of Malden, Mass., built the best radio ever made. And they called it the HRO.

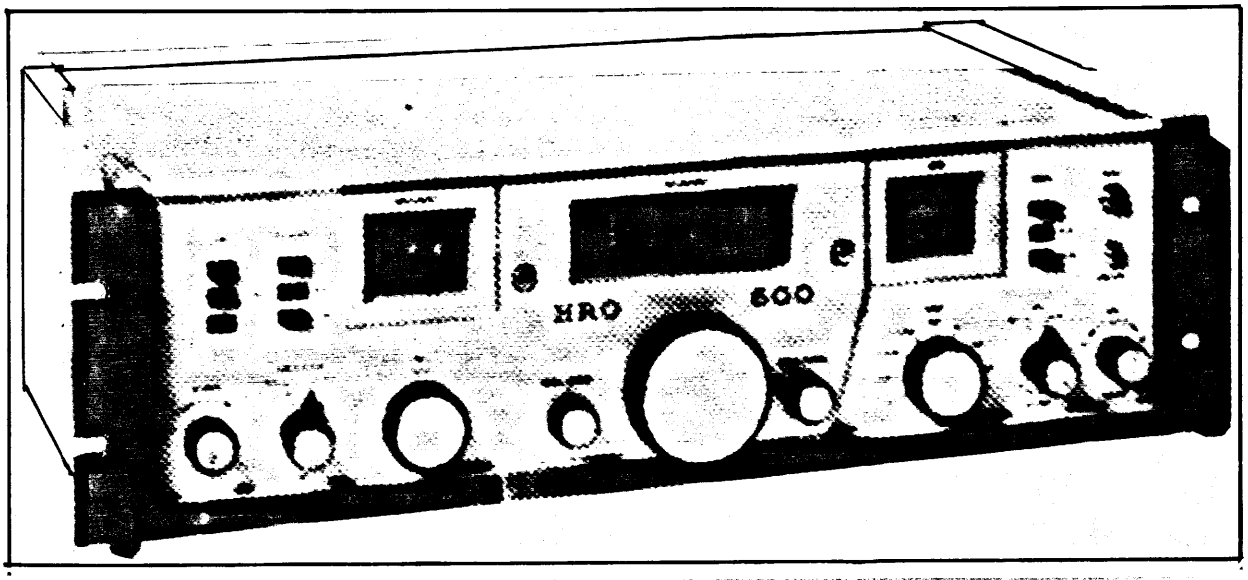


FIGURE 7. The last of the HRO breed, the commercial-grade HRO-600, came in two models, one with continuous tuning, the other with thumb-wheel switches for each tuning digit. These receivers were built until the late 1970s, when the National Company went into bankruptcy.

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