

The First *Walkie-Talkie* Radio

An Affectionate Look Back in Time and Some Thoughts About the First True Fabled Walkie-Talkie

by Leonard H. Anderson, 25 June 2005

At the beginning of this new millennium, every two-way radio from cell phone handsets to *toy* FRS handheld transceivers has been labeled as a *walkie-talkie*. That name began in the beginning of the USA's involvement in World War II and the definite need for a small-unit land force transceiver, one that could operate down to the squad level. The final result was the first of these *walkie-talkies*, the **SCR-300**, a backpack VHF (40 to 48 MHz) FM transceiver that could reliably reach out 5 miles in the field.

Just before 1940 the Galvin Manufacturing Company of Chicago, better known by its already-established trade name of *Motorola*, had begun designing the first true *handie-talkie*, a small boxy HF (3 to 6 MHz) AM transceiver that could be operated in one hand.¹ The result was the SCR-611 with Motorola awarded a production contract. The Secret Service is said to have used this new *handie-talkie* in their job of protecting President Franklin Roosevelt before the outbreak of WW II here. That little handheld transceiver depended on quartz crystals to hold its frequency stable (fixed, no manual tuning). It would turn out that quartz was in great demand after 1941 and Motorola would become a central civilian coordinating point for a massive quartz crystal unit production effort.²

A few in the U.S. Army had already expressed interest in FM for its vehicles and armor. That from the success of civilian trials of mobile FM transceivers in a few police departments. The Army already had VHF transceivers for small-unit operation communications, the SCR-194 and SCR-195, but those were two-tube, modulated super-regenerative receiver/transmitter types of dubious frequency stability and dependability. Some in the Army still had a fondness for horse cavalry and that seemed to continue on nostalgic inertia beyond the discontinuation of horse cavalry. Interest in VHF FM radios for vehicles, both armored and general-purpose, had begun to grow.

¹ Galvin formally changed its corporate identity to Motorola in late 1947. The Motorola logo and trade name was already well-established as both a two-way radio maker for public safety vehicles and in broadcast receivers for civilians' cars. According to Motorola corporate history and Paul Galvin's biography, Galvin was requested to look into the matter of field radio communications for the U.S. Army. Their design result was the fabled *handie-talkie*. The origin of that nickname is obscure but it was used in advertising by Motorola during the WW II days, along with *walkie-talkie*. Throughout this paper, Galvin Manufacturing is referred to as Motorola.

² USA quartz crystal unit production would reach 1 million per month in the last three years of WW II. The full story is excellently given by Virgil I. Bottom in a paper available at the Corning Frequency Control website and a few other places. Quartz crystal unit production priority rating would be second only to the Manhattan Project in the USA.

Small-Unit Land Forces Radio Just Before the End of 1941



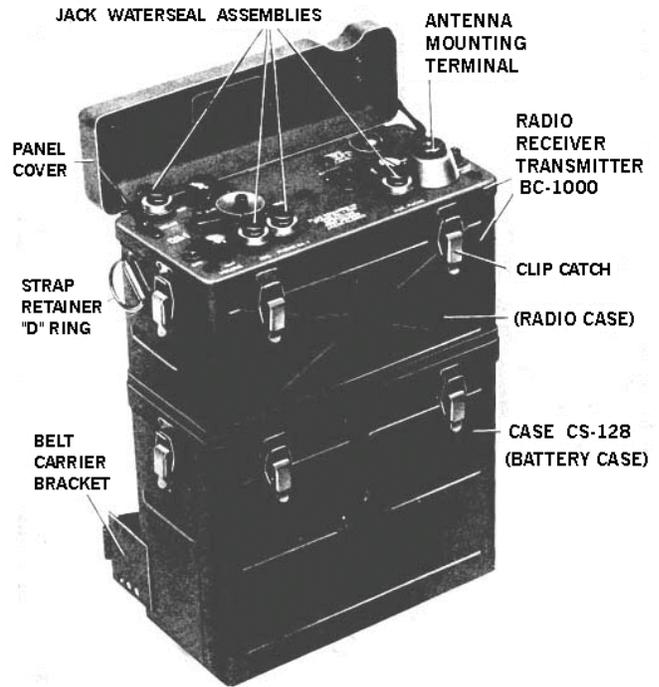
At left, an SCR-194 transceiver, battery-powered, shown in the field on maneuvers. A telephone handset with added twist-to-talk switch on its handle is the voice input-output device. The soldier is shown with the Chemical Corps gas mask (supposedly required of all troops but seldom done in practice) visible in front of his left hand, canteen visible behind his left hand, pistol handle just visible on his right side. The manual tuning dial of the two-tube radio transceiver is visible on his backpack. Purpose of the large bag at the soldier's right side (below pistol handle) is unknown.

Several types of field radios were operational then, but the majority required vehicular transport for any sort of rapid force movement. None were truly portable in the modern sense.

Enter the SCR-536, the famous *handie-talkie*, shown at right in a staged photo of a beach landing (note adoption of the then-new helmet as compared to the old tin hat shown above). Relatively minimum weight, minimum bulk for the foot soldier who has to carry so many other very necessary things with him. There were **no** equivalent small portable radios for the land forces in those early days of 1940. This portable transceiver could talk to an SCR-284, a larger set at a base location and on the same low-HF fixed frequencies.



At left, a *horsie-talkie*? This is an undated Signal Corps photo of a mounted cavalryman outfitted with an SCR-511 single-channel HF (3 to 6 MHz) transceiver. The actual radio is in the small box under the rider's right hand, his thumb almost ready to depress the pull-down-to-talk switch at the base of the whip antenna. The chest pack has both the flat dry battery pack and a combination microphone-speaker with curved horn sound guide. The bottom support pole fits into the *guidon* socket on the right stirrup. This may be a prototype unit. Production contracts for the SCR-511 radios were let *after* horse cavalry was disbanded in the U.S. Army. Motorola would also manufacture SCR-511 sets during WW II. It was sometimes called the *pogo stick*, so shown in technical manual TM 11-245 on cautions of not using it as such. See Appendix C of this document.



The SCR-300 shown above left on a soldier's back and at right by itself with the hinged panel cover flipped up. Two whip antennas were provided: The *short* one, 33 inches long and with a short gooseneck at the base for normal use; a 10 foot 8 inch non-gooseneck whip for fixed locations. The bottom 3/5 of the total case was

for the battery pack. Two batteries, interchangeable, were available, the BA-70 (15 pounds) with 20 to 25 hours continuous operating time, the BA-80 (9 pounds) with 12 to 14 hours operation. The same TS-15 handset used with the SCR-194 was standard here but the operator could listen via the HS-30 headset which had little *ear bud* style flexible inserts. That was good for continuous monitoring. Close-talking microphone T-45 (used with other radios) could be plugged in for relatively hands-free operation.³

The SCR-300 was a *heavy* radio. With the big battery, the total weight was 38 pounds. Using the smaller battery brought that to 32 pounds. For ultimate mobility, discarding the CS-128 case, using the small battery plus a cross-chest single belt instead of the pack harness brought total weight down to 25 pounds. That would be halved by the time of the Korean War and the new (AN/PRC-8 through -10) walkie-talkies.⁴ A curious feature, perhaps intended as a safety thing for support, was the extra battery-holding straps such that the battery case did not have to take all the battery weight. Those straps enabled discarding the battery case entirely for maximum weight reduction. Even so, the whole radio set was still heavy for a foot soldier. It did leave both hands free (unless having to talk) and one could *hit the dirt* in case of incoming ordinance without a number of bags and things falling all over in a tangle. With a two-operator system (one carrying and perhaps monitoring, the other doing the talking) it was excellent for artillery spotting and general recon reporting.

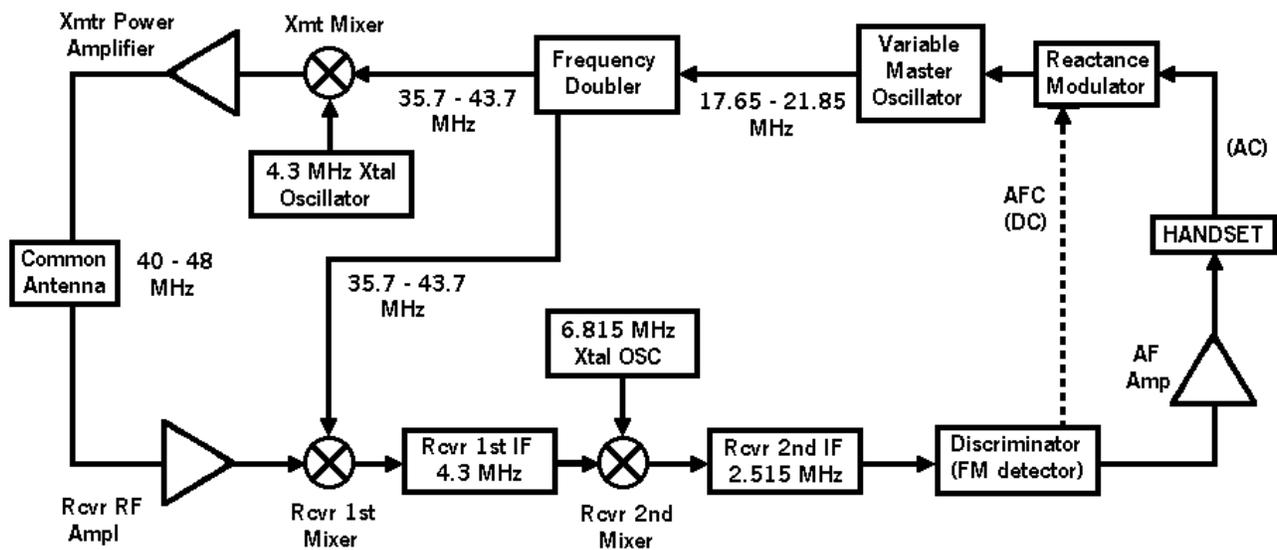
The breakthrough in communications came about via FM for voice. A gamble by the designers at the time (for a portable radio), it proved to be the right call to make.

³ The T-45 mounted, via ear straps, between the upper lip and nose. Those with a moustache could forget any comfort when using one...and also some attenuation since it depended somewhat on bone conduction of the voice. The Army Air Corps *throat mike* used by air crew might have been better, but not much.

⁴ In the author's opinion (as a soldier 1952-1960), the H-33 handset introduced with the PRC-8/-10 family was far superior to the old-style, heavy *telephone* handset. For one thing, the H-33 was slimmer and the receiver end could slide up underneath the helmet edge. For another, the new handset could be attached to a pack strap while en route; audio output was higher so that one could hear a call-in without having to hold it up to the ear.

The Start of the SCR-300's Design and Development

While the date of this (then revolutionary) portable two-way radio design is somewhat obscure, one can speculate on its beginnings from several known end-points. Appendix B (untitled) of this paper, *Theory of Operation of the BC-1000*, is a cleaned-up version of Chapter 5, Section 1, of TM 11-242 dated 26 February 1945, that one superseding an earlier edition of 15 June 1943 plus technical bulletin TB 11-242-1 dated 14 July 1944. Based on other reference sources, the SCR-300 began life in 1942, probably in the first half of that year.⁵ The design began in Chicago at the Motorola engineering department after some talks with Army people in Washington. One constraint was to lessen the number of quartz crystal units; mass production of those units had not yet ramped up fully to the million/month production in the USA in the latter half of the war.



The end result would be as in the block diagram shown above. Just two crystal units were needed. The number of channels was operator-variable for a choice of 41 over the 40 to 48 MHz tuning range. Variable tuning stability was enabled by the Automatic Frequency Control or **AFC** that would automatically lock onto an incoming signal, centering the tuning electronically. A revolutionary concept was to keep the receiver *on* when transmitting...the transmitter frequency would center itself to the receiver's tuning frequency!

While the *hot receiver* (on during transmit) concept would require a lot of work to pare down the battery power demand, most of the circuit blocks were common to both receiving and transmitting. Only two stages in the transmitter, the transmit mixer on crystal oscillator combination and the power amplifier were active in transmitting. In a judicious choice of the transmit crystal oscillator frequency (4.3 MHz), it could be used for a quick check of tuning dial calibration (10th and 11th harmonics at 43.0 and 47.3 MHz respectively). This provided assurance to the radio operator in the field, a sort of field calibration procedure to cancel most frequency drifts. The 2nd receiver mixer image would be 9.33 MHz, well out of the 4.3 MHz first IF bandpass response. The receiver 1st mixer image would be 31.4 to 39.4 MHz, below the transmit frequency and then unused by most other field radios. Channel spacing was 200 KHz and the lock-in range of the AFC probably

⁵ For a chronology, refer to Appendix A at the end of this paper.

allowed at least a ± 50 KHz drift of tuning.⁶ Manual tuning had both a push-to-test-dial-cursor and cursor illuminator switch and a manual tuning lock. As tactical needs required channel changing, it would be a simple matter to unlock the tuning, recheck dial cursor calibration, then turn the tuning control to the new channel, locking tuning when done. No need to return to base to retrieve a channel crystal. No need to carry boxes of crystals along with a unit constantly moving.⁷

The transmitter power amplifier could guarantee 300 mW carrier output and the receiver sensitivity was a guaranteed 4.5 μ V minimum, all at any channel. With a short antenna that promised at least a 3 to 5 mile range in varying terrain.⁸ Two antennas were provided with each SCR-300 set: AN-130 was short at 33 inches and included an L-C matching circuit in its base to compensate for impedance changes of an electrically-short whip antenna; AN-131 was a full half wavelength, 10 feet 8 inches, and was carried in 9 sections, the sections remaining together through a stainless steel cord going through all of them. The half wavelength whip would allow a lower elevation angle of the antenna pattern than the choice of a quarter wavelength.⁹

Battery choice was slim. It was either the heavy lead-acid battery common to vehicles or the carbon-zinc dry battery pack. Alkaline, nickel-cadmium and lithium dry battery types were for future years. The carbon-zinc type, called a *Leclanche* cell or more familiarly known as a *flashlight battery*, could be packed in series for higher voltages, something already done then. *Wet* cells (lead-acid required an acidic liquid electrolyte) were limited in series stacking to about 24 VDC as done for aircraft. Plate supply voltages for battery-filament tubes needed at least 45 Volts for any sort of efficiency. Special battery pack types BA-70 (15 pounds, normal operating time of 20 to 25 hours) and BA-80 (9 pounds, 12 to 15 hours operating time) were devised to work with the SCR-300 and the final BC-1000 design.

The so-called *battery filament* tubes (all 7-pin miniature all-glass envelope) had 1.4 and 2.8 VDC ratings. If many were used, the filaments were wired in series-parallel so that a 4.5 VDC nominal filament supply could be used. That is a compromise which is based on battery pack cell size. Large cells, to handle higher current at the 1.5 V nominal cell structure, would be bulky; physical cell structures were cylindrical. Smaller cells for

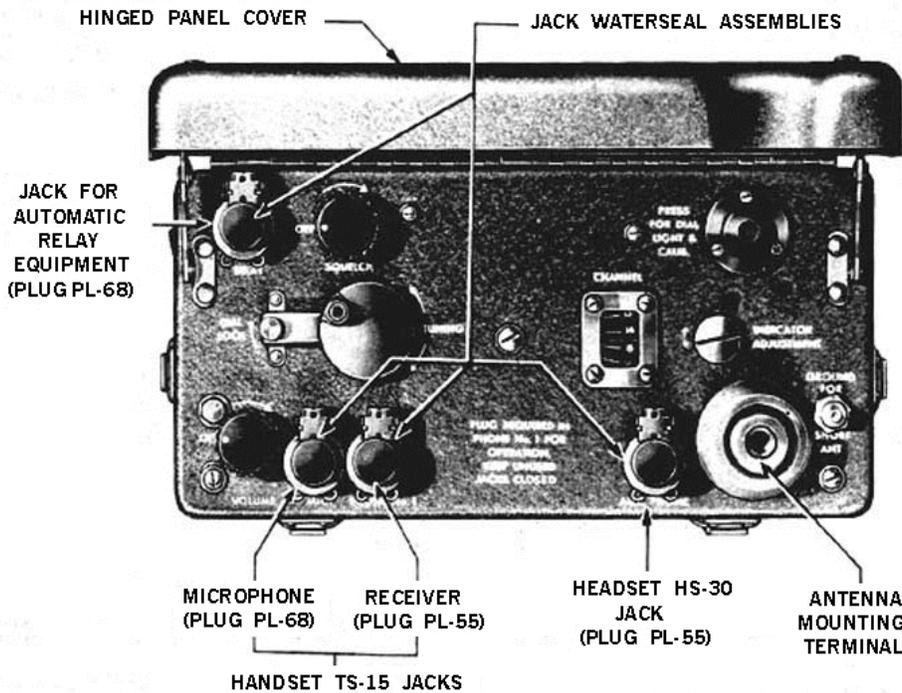
⁶ Supposition by the author. It was probably more than this but a safe bet is that it was less than half the channel separation frequency.

⁷ At least 9 other radio systems each had boxes of crystal units with about three dozen in each box. At the time the only source of radio-grade quartz was South America and of that material only about 10 percent was good enough for oscillator crystals. Man-made crystal growth would not happen until a couple years after the end of WW II. It was important to limit the number of quartz crystals per radio to ease the tremendous crunch in crystal unit fabrication in the USA.

⁸ That is not to be scoffed at by *DX-chasing* radio amateurs. Military land force operations aren't conducive to hobby-type radio operations nor are there available radio stores (with sales brochures) found in battlegrounds during wartime. The object is to keep contact with a usually constantly moving base location regardless of uncomfortable obstacles along the way.

⁹ Another supposition. Since the metal case and radio operator make up about a quarter wavelength, the *other half* of the antenna's image is unknown and difficult to estimate. Only a series of radiation tests could confirm the actual efficiency of the arrangement and it could also be supposed that some of that testing was done. Note: Modern VHF base station antennas are typically several multiples of a quarter wavelength today in order to keep the antenna patterns close to the horizon. Motorola may have been a pioneer in that as well. The NEC or Numerical Electromagnetic Code *Method of Moments* analysis tool would not arrive until 40 years later...along with computers that could do all the number crunching.

a higher voltage would pack more efficiently. There was a limit in the series-parallel arrangement due to the equivalent cathode voltage being biased away from common ground. To compensate, resistive voltage dividers would have to be added if the filament supply went too high. Series stringing of filaments is also limited by the number of bypass capacitors needed to keep the directly-heated cathodes at RF ground.

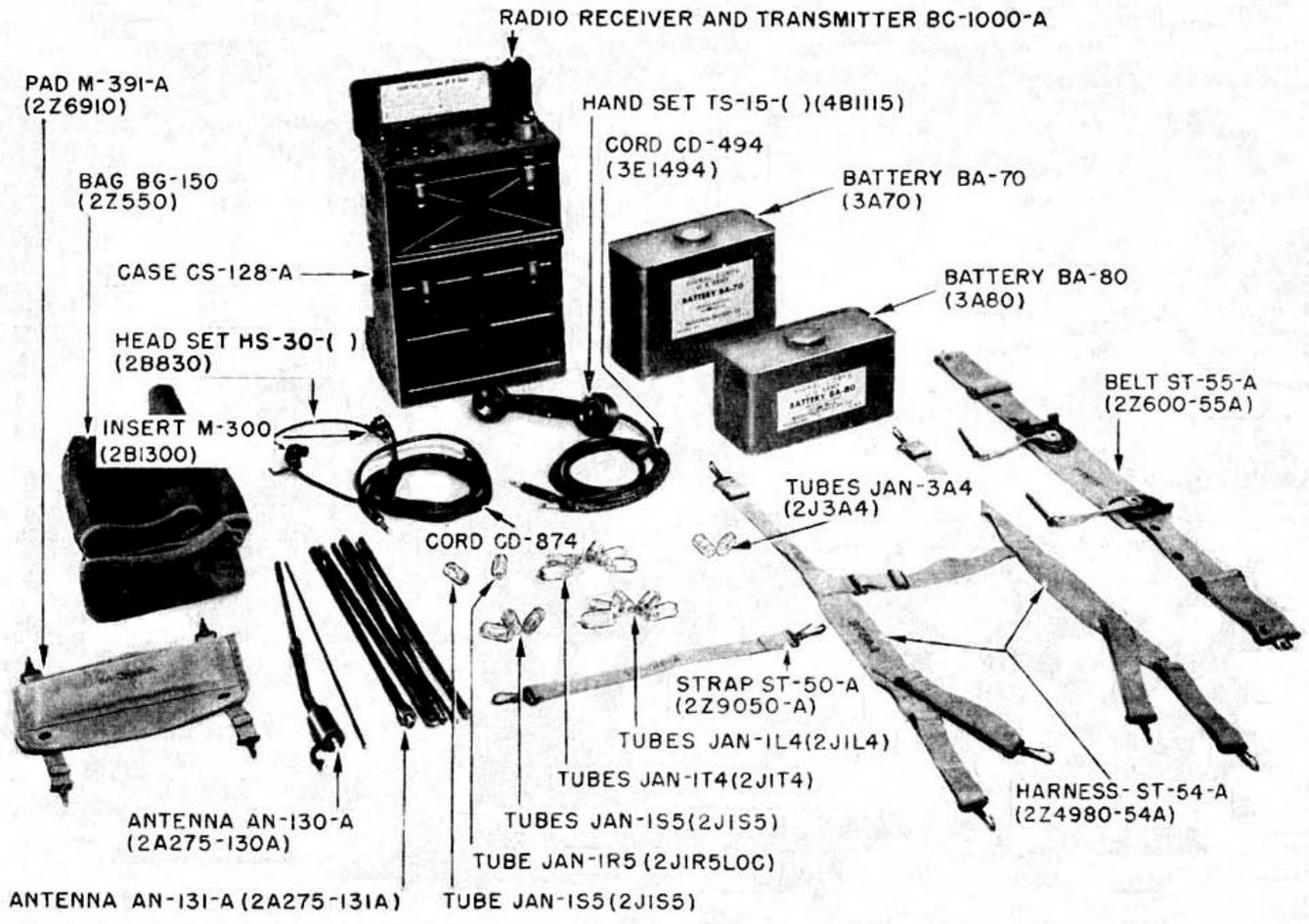


At left, the rather sparse front panel of the BC-1000 R/T with hinged cover flipped open. The crank knob on the left center does the channel tuning, those visible through a small window at right center. The dark object at upper right is a rubber-sealed push button to both turn on a small light beside the dial and to turn on the 4.3 MHz crystal oscillator to check dial calibration. The small knob at right center adjusts the dial hairline position for individual calibration at 43 and 47.3 MHz. Once calibration is confirmed and a channel set, the tuning knob is locked by a knurled screw to the left of the knob.

At lower right is the threaded-insert whip antenna mounting insulator, large for mechanical support rather than any need for high voltage insulation. The hinged cover has a recess to fit around that insulator base; cover is normally closed to keep off rain and dirt. At lower left is the combined power switch and audio volume control. An added feature is that either the TS-15 Handset or the HS-30 headphones *must* be plugged in to turn on the BC-1000. This helps unnecessary draining of batteries; no speaker is included so all audio is from an earphone.

The jack marked *automatic relay equipment* is for use as a *repeater*. Carrier-received signals can be picked off the *squelch* control circuit (knob to the immediate right of the jack), used to operate another SCR-300 (on a different channel) or another radio set. Squelch is a new feature in military radios of the early 1940s, available from the use of FM. It is a boon to radio operators who don't have to listen to AM sets' front end noise when no one is calling in.¹⁰ All four jacks have water seal hinged covers. The entire SCR-300 can be submerged in water briefly or exposed to rain without damage.

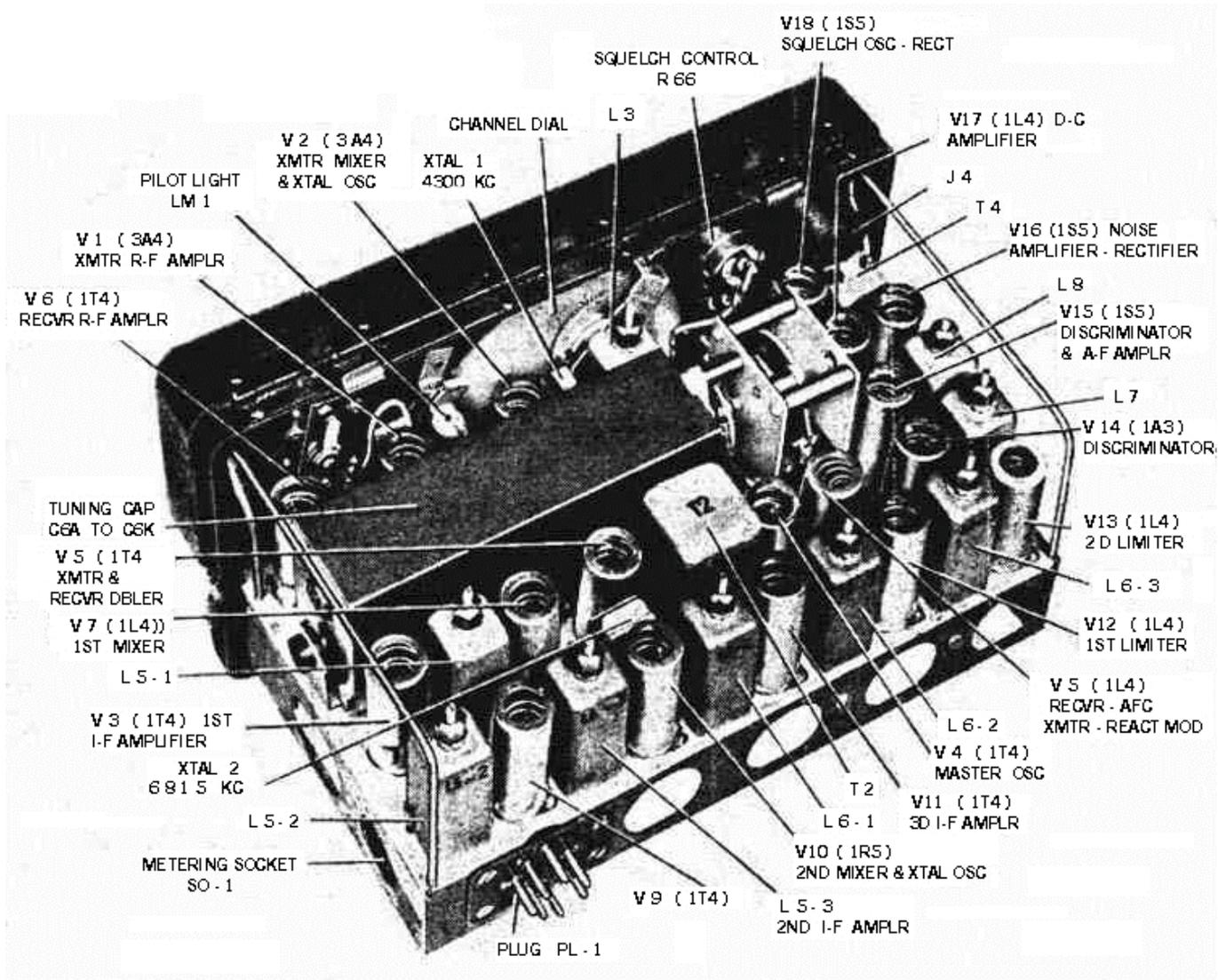
¹⁰ *Front-line* radio operators had to be constantly aware of their surroundings. Distractions such as noise or static from a radio were not good things to have in such an environment.



The entire SCR-300, all components laid out. Spare tubes were part of the kit although normally kept at base and not carried for operation. Numbers in parenthesis are Signal Corps stock numbers then in use. Pad M-391 was an essential for eliminating chafing of the carrying operator's back. With the heavier battery pack BA-70, the entire set weighed 38 1/4 pounds! Using the lighter BA-80 battery pack brought that down to 32 1/4 pounds. For maximum lightness, case CS-128 could be removed, only one pack strap used for across-the-chest carry, bringing total weight down to 25 pounds as in the photo at right. Still a heavy load to carry. In winter weather and with an M-1 Carbine, a radio operator was lugging a total of about 97 pounds of clothing, helmet, weapon, and radio. Just the same, the SCR-300 operated better than any other portable military radio out to 3 miles plus.

A curious thing with the battery. Four webbed straps were provided to secure the battery packs to the back of the BC-1000. That may have been for mechanical reinforcement in case the CS-128 bottom case was too weak. The set was designed to be the lightest weight possible but the case material was thin. Webbed straps allow stripping down to the lightest possible carry weight while still holding the battery pack in place.

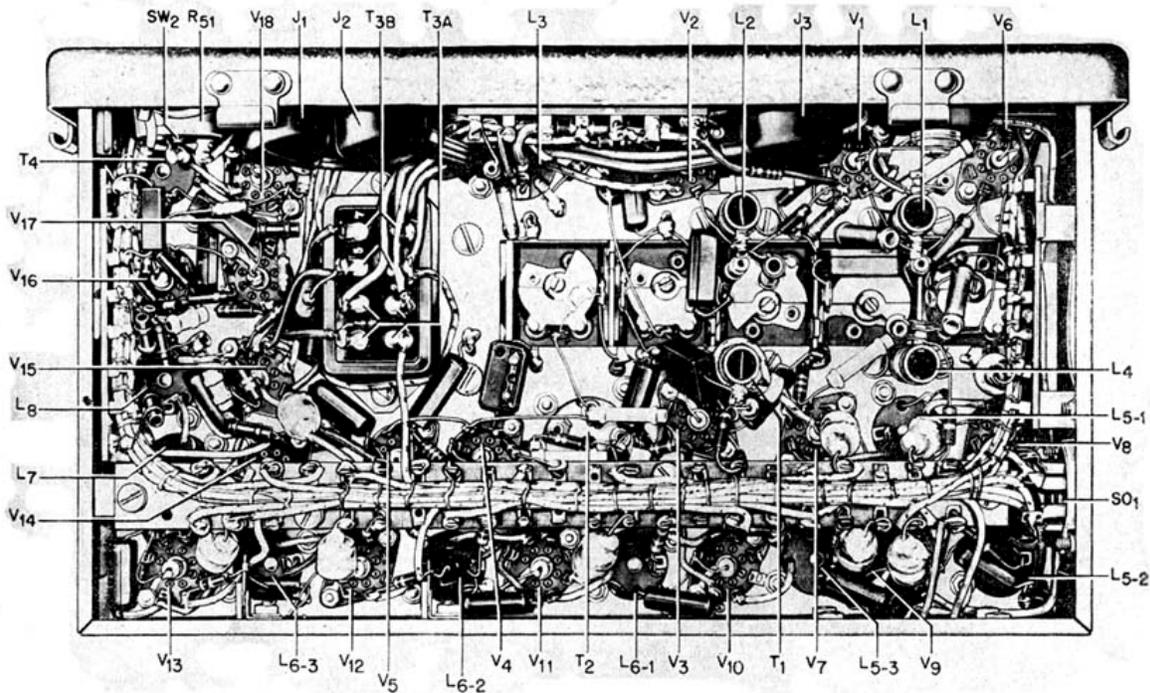




Chassis arrangement of the BC-1000 above. The final version had 18 miniature all-glass envelope 7-pin tubes, kept in their sockets by spring-loaded tube shields (metal shields also for RF isolation). The chassis is about 5 1/2 inches deep by 10 1/2 inches wide. Total height is about 4 1/2 inches. The dark box in the middle is a rectangular metal cover for a 5-gang variable tuning capacitor (C6x) which has integral trimmer capacitors accessible from the bottom. Tuning capacitor drive is a combination of a worm gear and spur gears.

The battery pack connector is PL-1 on the back side. A *metering socket*, SO-1, is on the side rear corner, used for quick checking of significant internal voltages. The BC-1000 case has to be removed for accessing that servicing socket. The battery connection is provided by a small harness having right-angle-wire-exit rubber plug and socket covers. Abbreviations in the labels are as they were used in the early 1940s. Note the KC for kilocycles that persisted until the post-War II adoption of KiloHertz.

The chassis layout was quite compact, perhaps the most compact of that time. Just the same, the under-chassis wiring (next page) was not restrictive or over-crowded. Good planning and teamwork between designers and production people.



BC-1000 under-chassis view. It probably set the standard for compact tube assemblies. The cable harness and (barely visible) width-wide terminal strip under it reduced the wiring clutter, yet allowed point-to-point wiring as needed for the low-VHF circuits. The common $0.01 \mu\text{Fd}$ bypass capacitors were all mica dielectric for least size and weight. Tubular and mica dielectric capacitors were used for smaller values. Many of the resistors were radial-lead types unlike today's common axial-lead package. Trimmer capacitors for the C6 tuning capacitor are clearly seen here. The hook-like devices on the rim of the front panel are half of the clip-catches that fastened the BC-1000 case-cover, it having similar clip-catches to fasten CS-128, the battery case-cover.

Some Circuit Details

Theory of operation of each stage and subsystem of the BC-1000 is explained well in Appendix B, a copy of that material from TM 11-242. Such a detailed explanation was common in those early days, an excellent mini-textbook for those of us just becoming interested in the inner workings of electronics. This author encountered TM 11-242 first nearly a half-century before writing this paper. As a *CQ* or Charge of Quarters for my Signal Company, my first task was to spell the Battalion *CQ* for supper.¹¹ Battalion headquarters building had a large collection of TM s. Having bought a Hallicrafters portable 4-band receiver that used 7-pin miniature glass tubes, I was curious as to similar circuits in the BC-1000, also using 7-pin miniature glass tubes. The differences perked my curiosity and interest, something that never left me. Some salient points follow.

¹¹ A *CQ* in the U.S. Army was an NCO who would be awake all night until the next morning, within telephoning of whatever might happen that night. That duty was about 5 PM to 8 AM the next day, local time.

Receiver Front-End and Transmitter Rear-End

Part of what seems an over-use of the number of tubes may be due to lower gain at VHF. Electron transit time is the upper-frequency limiter with vacuum tubes. Transit time is partly influenced by low filament heating common to *battery-type* tubes. A 3A4 power amplifier tube (V1) is rated for 0.6 Watts RF output at HF but in the BC-1000 it is specified at 0.3 Watts. Since the receiver is always on, even during transmissions, the receiver RF amplifier (V6) control-grid and filament-cathode diode junction rectifies the transmit voltage and effectively cuts itself off during transmission. Enough RF gets through to perform the AFC action. The use of two 1st IF amplifiers in cascade may be due to low conversion loss of pentode mixer V7. Using a pentode there might have been due to an even lower conversion loss if a pentagrid (1R5) had been used.¹²

Odd Man Out Half of Discriminator, V14

The then-common Foster-Seeley FM discriminator circuit needed a diode with above-ground plate and cathode. Directly-heated tubes don't have isolated cathodes. The 1A3 *indirect-heater* structure is a rarity in the battery-filament tube group. Speculation is that the 1A3 was developed expressly for this sort of circuit. An obvious question is why not use a semiconductor diode? The answer is that they didn't exist then and, probably, priorities for radar receiver mixer silicon diodes such as the 1N21 didn't allow them to be made available for ordinary radios. The alternative was a copper-oxide junction diode (as used in telephone equipment and volt-ohmmeters) but those dropped off in frequency response beyond audio frequencies. A 1A3 took three times the filament current of another 1.4 V tube, the 1T4 pentode.

Three-Tube Squelch Circuit

V18 is a free-running oscillator at about 400 KHz. That oscillation is rectified by the diode of V18 and that negative voltage is used to cut off audio output amplifier V15. To hear incoming signals, V18 must stop oscillating. V16 amplifies *high-frequency noise* from half of the Foster-Seeley discriminator and does some shaping of the noise impulses. What seemed astounding to some (even a decade after its development) was using V17 as a *DC amplifier*.¹³ Very unusual for a battery-powered set whose voltages could be expected to vary more than a line-powered set.

At no signal, the front-end noise of the receiver would be expected to be rather high at the discriminator. That random noise would be random in frequency as well as amplitude. Passing only the higher-frequency components of the noise would differentiate from normal speech spectrum content of mostly low frequencies. When a signal would come in at a limiting level, the front-end noise would be much less at the discriminator due to limiter stages V12, V13 passing the non-random signal carrier power. V16 would have lower pulse output and the screen grid voltage of V18 would be too low to sustain the 400 KHz oscillations. Audio amplifier V15 would not be cut off and audio would go through to the headphone.

Squelch was disabled by opening the series filament connection of V16, V17, and V18. It seems to be rather

¹² Supposition again. Lab measurements at the frequencies used are necessary to ascertain gains. Databook values are for much lower frequencies and many tubes were tested for low-level characteristics at only 1 KHz.

¹³ Actual DC gain seems much less than the now-familiar op-amp and actual gain between V16 and V18 would depend on the screen grid characteristics of V18, something not in databooks.

complex to enable the squelch feature now, but there must have been a compelling reason for the unusual method of sensing and controlling an incoming signal carrier. I feel rather certain that the squelch subsystem went through a lengthy but rapid prototyping process in the Motorola labs back then.

Reactance Modulation and the Master Oscillator

The variable-frequency master oscillator V4 operates at slightly less than half the air frequency; it is doubled in frequency through V3 before mixing with 4.3 MHz. The probable reason for this scheme would be for stability reasons in the master oscillator and the necessity of obtaining sufficient linearity of modulation in conjunction with reactance modulator V5. Both of those reasons can be attributed to the effects of electron transit time on circuit operations. Transit time has a direct bearing on phase shifting that takes place in V5. It would also effect, perhaps to a lesser degree, the tuning linearity (which might vary with different 1T4 tubes in a production lot) and frequency stability with temperature on the ends of the tuning range. Motorola lab notebooks might have a definitive answer to that, but those aren't in public domain.

Transmitter Mixer V2

If one redraws the crystal oscillator circuit portion of V2, the circuit operation as an oscillator becomes more apparent. However, the action as a *mixer* is unconventional, not easily seen. I would judge that particular circuit to be derived from an inspired guess and some empirical data derivation in the lab.¹⁴ It works and thousands of them were built in a few years of the 1940s.¹⁵

The filaments of power amplifier V1 and transmit mixer V2 were turned on only with the handset push-to-talk lever. All other filaments were on continuously. For a calibration check of the dial, only V2 filaments were turned on by the front panel push-button; that was in series with dial lamp LM-1 glowing for checking at night. With V2 filaments on the 4.3 MHz crystal oscillator would be running allowing harmonics to get into the receiver front-end.

Battery Pack Power Demand

Receive, 3.6 Watts total
4.5 V @ 0.3 A
90 V @ 25 mA

Transmit, 12.0 Watts total
4.5 V @ 0.5 A
90 V @ 25 mA
150 V @ 50 mA*

* Each battery pack had a 60 VDC section in series with the 90 VDC section for transmitting. The 150 V output was not drained during receive-only except during the push-to-check dial calibration. Presumably the cell sizes within each pack were adjusted for least weight coincident with necessary current demand.

¹⁴ More familiarly known as *cut and try*.

¹⁵ Production total of SCR-300s was almost 50,000 by the end of World War II.

Appendix A - Who Did What and When

According to at least three separate *Firsts* listings originating with Fort Monmouth, NJ, now the Communications and Electronics Command or CECOM of the U.S. Army, there is the brief timeline notice:

1936 - The labs develop the SCR-300 handheld "walkie-talkie" for front-line troops.

That is in error. Firstly, the 38 pound SCR-300 cannot possibly be considered as *handheld*. Secondly, to get all the functions of the '300 into one package, it requires 7-pin miniature all-glass envelope tubes; those tubes were only available about 1939 and in limited quantities.¹⁶ The only manpack portable transceivers for troops to use in the field of 1939 were the two-tube SCR-194 and SCR-195, both using larger-envelope tubes.

In another timeline notice, same documents, the following appears:

1941 - The SCR-510 FM back-pack radio is developed to provide reliable, static-free tactical communications.

While it is true that FM is static-free, the SCR-510 FM transceiver is *vehicular*, and powered from the *vehicle power*, not a portable dry battery. The '510 is too big, too angular for back-packing. That timeline entry is also in error. The SCR-511 was for *front-line troops*, particularly horse cavalry, except it was AM and on HF, not to mention there was no more mounted cavalry in the Army by 1943.

A more reliable source would be the biography of Paul Galvin, *A Founder's Touch*, describing in detail the various developments and products of Galvin Manufacturing Co., and the Motorola Inc. it became in 1947. In that biography, the SCR-300 existed first as a concept presented to the Army in early 1942, then began as a corporate R&D project in Galvin's Chicago labs. Two rapidly-done prototypes shown to the Army were sufficient for a first contract award for the SCR-300. The first edition of TM 11-242 was done by 15 June 1943, the design and production plans having been completed by then. By the end of WW II, nearly 50,000 sets had been produced. After WW II the '300 was licensed out to various countries' militaries. In Great Britain it became Wireless Set No. 31 after some minor modifications. The SCR-300 remained in Army service until the mid-1950s when it was replaced by the lighter, smaller AN/PRC-8, -9, -10 manpack VHF FM sets.

There's a similar story with the SCR-536 *handie-talkie* that began in 1939 with a visit of two Galvin engineers to Army maneuvers in Wisconsin. They said Galvin/Motorola could do *better*. By 1940 two prototype units proved they could and Galvin Manufacturing got an Army contract to finish developing the '536 with the first handie-talkies becoming operational in mid-1941. Motorola corporate history claims 40 thousand handie-talkies were built during WW II while other references put that as many as 130 thousand (additional probably built by other companies).

The erroneous Fort Monmouth *Firsts* claims will probably appear on other WW II radio histories despite their inaccuracy. Others will copy that as *official*. That is unfortunate. Motorola deserves their credit for setting a new standard in portable communications that would live on into the semiconductor era.

¹⁶ Those were available for consumer electronics designs **after** WW II. The origin of first availability of the 1T4-1L4-1R5-1S5-1S4-3Q4 etc. family is difficult to find via the Internet. Since tubes from that family were used in the SCR-536 which began design in late 1940, they had to exist then in order to choose them then.