The Final Days of Ham Spark

Generations before today's ham nostalgists took up the plaint that "real radios glow in the dark," the realest real radios whined, roared and hurled blue lightning. What on earth could have made "the visible and mighty heart of radio" fall still?

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September 26, 1919, was a red-letter day for Amateur Radio. On that day, the US government announced that the ban on transmitting by amateurs, imposed on transmitting and receiving in April 1917, was lifted. The ban on receiving had been lifted in April 1919.

It took some time for hams to obtain new licenses and get their prewar rigs set up again, but by November hordes of stations were back on the air. Of those early days, Arthur L. Budlong wrote:

King Spark!

Grown now to full maturity, developed and perfected by years of pre-war and war experience, it reached its highest peak in the succeeding eighteen months. Glorious old sparks! Night after night they boomed and echoed down the air lanes. Night after night the mighty chorus swelled, by ones, by twos, by dozens, until the crescendo thunder of their Stentor bellows shook and jarred the very Universe! A thousand voices clamored for attention. Five-hundred-cycle's high metallic ring. The resonant organ basso of the sixty-cycle "sync." The harsh resounding snarl of the straight rotary.

Character: Nervous, impatient sparks, hurrying petulantly. Clean-cut business-like sparks batting steadily along at a thirty-word clip. Good-natured sparks that dwindled lazily and ended in a throaty chuckle as the gap coasted down-hill for the sign-off.

Survival of the fittest. Higher and higher powers were the order of the day.

The race was on, and devil take the hindmost.

Interference.

Lord, what interference!

Bedlam!

Well, it could not be Utopia.

It's probable that at that heady time no one thought that this cacophony of ham spark signals would disappear within a few short years, never to be heard again. So far as we know, no one recorded for posterity the sounds of one of those early nights, but you can still hear a spark rig and learn about its construction in a video available electrically—producing a damped wave, so named because its successive oscillations diminish in strength. The longer the transformer rang, the narrower on-the-air signal would be.

Fig 2 shows the idealized waveforms in the primary and secondary of the oscillation transformer. The gap was supposed to discharge the condenser as rapidly as possible, then quench—extinguish—immediately to keep efficiency high. The resonant frequency of the condenser/oscillation transformer/antenna combination broadly determined the transmitter's operating wavelength.

Transformers and Condensers

Hams usually purchased their high-voltage transformers. A so-called "1 KVA" model (Fig 3) might produce 25,000 volts. Although good high-voltage mica and Leyden-jar condensers were available, many hams made their own. These consisted of plate-glass sheets with metal-foil circles glued to each side, all suspended in a tank of oil. Few hams knew their condensers' actual capacitance; they merely added or subtracted plates until they got the results they wanted.

Anatomy of a Spark Rig

In basic form, a spark transmitter (Fig 1) consisted of a high-voltage transformer, a condenser (capacitor), a spark gap and an oscillation transformer. The transformer charged the condenser. At a high voltage, the spark gap fired and discharged the condenser into the oscillation transformer, which rang—in effect, reverberated from ARRL HQ for loan to affiliated clubs, or see, hear and smell one working at the Antique Wireless Association Museum.

The All-Important Gap

A spark transmitter owed much of its on-the-air sound to the type of gap it used.
Early spark gaps consisted merely of metal contacts on an insulating base (Fig 4). The raspy transmitted signal of a station using one of these would be modulated at twice the ac-line frequency (120 Hz with 60-Hz ac)—a tone too low for good readability through noise and interference. A major practical drawback offsets the plain gap’s apparent simplicity: Its spark quenches poorly even with very wide electrode spacing, sometimes leading to continuous arcing that blew ac-line fuses and closed a station down in a hurry!

Spark communicators solved the plain gap’s tone and quenching problems with one solution: the rotary gap, sometimes called just rotary, that mechanically interrupted the spark with a motor-driven wheel (Fig 5). The relative movement between a rotary gap’s whirling and fixed points quenched its spark by brute force.

Interrupting the spark hundreds of times a second also modulated the spark with a higher, more musical tone to help the signal better cut through interference and static. The more electrodes, and the faster the rotary gap turned, the higher the modulating frequency. Heated debate on whether higher or lower tones were better was common; asking almost any ham with a rotary for opinion on “high note versus low” would net you an earful!

Merely interrupting the spark with a rotating wheel meant that the spark discharge might occur anywhere on the ac-line waveform. This non-synchronous or asynchronous operation was relatively inefficient because it caused successive discharges to differ in strength, varying the excitation of the oscillation transformer. And an asynchronous rotary’s tone represented a mix of twice the line frequency and its rotor’s spark-interruption rate. The synchronous rotary gap, a means of keeping the spark-discharge strength uniform by keeping it in phase with the line-ac waveform, solved these problems but introduced another. Synchronizing a rotary for one discharge per line peak at 60 Hz unavoidably set the spark rate to 120 Hz, giving a tone generally considered too low. “Commercials” solved this problem by using motor-generators to power their syncs with higher-frequency ac; 500-Hz supply, which gave a 1-kHz tone, was common. The overall expense of using a synchronous gap and getting a high tone made them relatively uncommon in amateur stations. Most hams used asynchronous rotaries and put up with reduced efficiency and a less-pure tone.

Spark transmitters using rotary gaps can be described with one word: deaferning. The crackling rasp from even a small spark set could make your ears ring, and some commercial installations could be heard for miles if the wind was blowing just right! (As if the danger to hearing wasn’t enough, the spark also manufactured the pungent, poisonous gas ozone [O₃], which we now know to be a health hazard.) Quenched gaps quieted the roar by confining the
Important Reductions in Prices of Thordarson Apparatus

Type "RS" Transformers
A non-remnant transformer with a lower secondary potential designed to give you the highest possible power factor.

- KVA 1000 Volts
- KVA 3000 Volts
- KVA 10000 Volts

- 1.5 KVA 10000 Volts $20.00
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Other Thordarson Equipment

- POWER CONDENSER (.0018-.0009 MFD) $25.00
- OSCILLATION TRANSFORMER $10.00
- RF ROTOR (4 TOTH.) $5.00
- RF ROTOR (6 TOTH.) $10.00
- R12 ROTOR (12 TOTH.) $3.00

Thordarson Electric Manufacturing Co.
515 S. Jefferson St., CHICAGO, ILL.

Fig 3—This April 1921 QST ad for Thordarson high-voltage transformers seems to reflect falling demand for spark gear.

Fig 4—There's nothing fancy about a plain spark gap—just two electrodes mounted on an insulating base and capable of width adjustment. But its low tone with 60-Hz supply, its inability to quench the spark rapidly, and its tendency toward continuous arcing made spark communicators favor rotary gaps. (from Bucher)

ings acted as a double-tuned circuit, over-coupling its primary and secondary could cause a double-humped response that made the transmitter transmit "a double wave." By 1920, the US radio regulations encouraged "single-wave" or "sharp" emission by limiting the amplitude of any second wave to one-tenth the amplitude of the stronger, desired wave.

The Personality of Spark

With the tremendous variety of gap speeds, electrode shapes and number of electrodes in use, every spark station had its own characteristic tone. This was actually an advantage. A spark signal was broad, and with all hams operating near the same wavelength with overlapping signals, communication would have been even more difficult if all signals sounded the same. Many spark stations could be identified by their tones alone, without waiting to hear their call signs. Because spark signals were broad, beat-note reception was not used; especially before World War I, modest ham stations used only diode detectors—sometimes a non-oscillating vacuum tube, but, much more commonly, a diode consisting of a galena or silicon chunk contacted by a thin wire (cat whisker). Regenerative detectors, operated below the point of oscillation for spark reception, were just coming into amateur use as QST debuted in December 1915. They offered the additional (and tantalizing) capability of undamped or continuous-wave (CW) reception—tantalizing because, with them, spark-bound hams could listen in on the growing acceptance of CW by commercials.

Limits of Wavelength and Power

The Radio Act of 1912 limited Amateur Radio operation to 200 meters and shorter wavelengths, at a maximum power input of one kilowatt. At first, hams tended to violate the 200-meter limit because of the general belief, common to commercial and Amateur Radio users alike, that longer wavelengths meant better DX. Enforcement of radio regulations was relatively lax. As for power, physics and the 200-meter restriction made it difficult for hams to exceed 1 kW input with the components available. Antenna (aerial) technology was primitive, the main idea being to get as much wire as high into the air as possible, commonly in the form of a T or inverted L, and maximizing its RF-current drain as indicated on the station RF ammeter.

As far as we know, very few hams experimented with CW transmitters before World War I. In government and commercial circles, CW, produced by high-power transmitters, had begun proving itself superior to spark transmission a few years before ARRL's founding in 1914. The three-element vacuum tube was well-known by 1915 to be capable of regeneration and oscillation. It could therefore generate CW, but—with the tube available to amateurs—only at tiny, impractical powers incomparable to those achievable with spark. World War I spurred transmitting-tube development and gave hams who worked with radio communication during the war hands-on experience of what CW could do.

The Rise of CW

Shortly after US amateurs returned to

Oscillation Transformer

Built to put ALL of your condenser energy into the open circuit. No metal parts near the windings to absorb the energy. Formica isolation throughout. Woodwork natural finished walnut. Heavy brown ribbon. Secondary is 18" diameter and has 8 turns of 15c. ribbon. Primary is 18" diameter and has 3 turns. TH-1 has 11½"ribbon on primary. TH-2 has 3½. Can be mounted in either vertical or horizontal position. Coupling easily variable.

TH-1 . . . $14.50
TH-2 . . . $18.50

We have in stock at all times a complete line of spark and CW equipment.

T & H RADIO CO.

Fig 5—Most hams used, asynchronous, motor-driven rotary gaps to get good quenching and a musical spark tone. A wide variety of rotaries appeared on the market; here is the popular "Benwood" as advertised in August 1921 QST. Some hams made their own rotaries: Hiram P. Maxim (1WH, 12M, 1AW and 1W1AW), co-founder and first president of the ARRL, built "Old Betsy," which had four electrodes and ran at 7000 rpm, giving a spark rate of 467 Hz—a pleasant tone to copy.

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the air in 1919, occasional ham CW signals could be heard. Urged on by QST, more and more hams built CW rigs. This was hampered at first by the unavailability of suitable tubes. A West Coast company named Moorhead produced and advertised "five-watt" plate dissipation, not output—transmitting tubes for hams. The newly formed Radio Corporation of America, which had acquired the patents controlling the production and sale of vacuum tubes for such purposes, promptly sued Moorhead. By 1921, spurred by the broadcasting boom, RCA was marketing a variety of high- and low-power transmitting tubes—improved versions of tubes that had been produced in quantity during the war. Hams bought them, too, and amateur CW stations gradually increased in number. Spark began to decline, but tradition and the fierce loyalty of its adherents kept it alive.

Using spark and CW, superpower commercial and government stations were working intercontinental distances at will by the time the US entered World War I in 1917. Yet, as 1921 began, no ham signal from this side of the Atlantic had ever been reported heard in Europe. At the 1-kW ham power limit, were the wavelengths "200 meters and down" really useless for international DX after all? ARRL sponsored one-way transatlantic tests in December 1921, and sent Paul Godley, 2XNE, a well-known amateur and engineer, to England with the latest receiving apparatus. Godley set up in a tent on a windswept Scottish beach, and during the test period copied nearly thirty American hams, CWs outnumbering sparks almost two to one. Godley heard a spark signal first—IAAA, apparently a bootlegger, ragchewing near 270 meters—but CW had won the race.

Despite this, many die-hard spark enthusiastic held on—for a while. Many gave up ham radio completely rather than convert to CW. To them, spark embodied a romance that CW could never evoke. They lamented that all CW signals sounded the same and lacked individuality—something certainly not true of spark!

By 1922, advertisers for spark components were fast disappearing from the pages of QST, and HAM-ADS was full of spark sets for sale, probably with no takers. The radio world swung inexcusably away from spark and toward CW—so swiftly that spark was forbidden on the new 80, 40, 20 and 15-meter amateur bands when we got them in 1924.

Three years later, spark was officially prohibited for use by US amateurs in the new regulations that arose from the Washington Conference of 1927. But there was no body left to bury. In December 1923 QST, Porter Bennett, 5IP, had nostalgically written:

"Here it is, OM. The idea hit me while listening in last night. Nary a spark did I hear, and I thought how good it would be to hear one closing down with the power still on and the note descending on the 'dah-de-deh.' But all I could hear were signals that stopped with a sudden abruptness that left something lacking. C.W. is better than spark and I like it better, but the ringing of the cowbells sounds sweet to a farmer still."

Spark was dead.

Notes
2. Write to HQ's Educational Activities Department to order request forms and a copy of our AVP library rules for borrowing microfiche NHC copies of this tape, in which Ed Redington, W4ZM (now a Silent Key), assembled a working spark transmitter piece by piece while describing his boyhood adventures (and misadventures!) in spark communication.
14. Cartoons by Phil Gildersleeve, W1CJD, from May 1934 QST.

Additional References
ARRL staff, Fifty Years of ARRL (Newington: ARRL, 1965). Available from the ARRL Bookshelf as #0135.
J. Stokes, 70 Years of Radio Tubes and Valves (Vestal, NY: The Vestal Press, Ltd., 1982).
Cartoons by Phil Gildersleeve, W1CJD, from May 1934 QST.