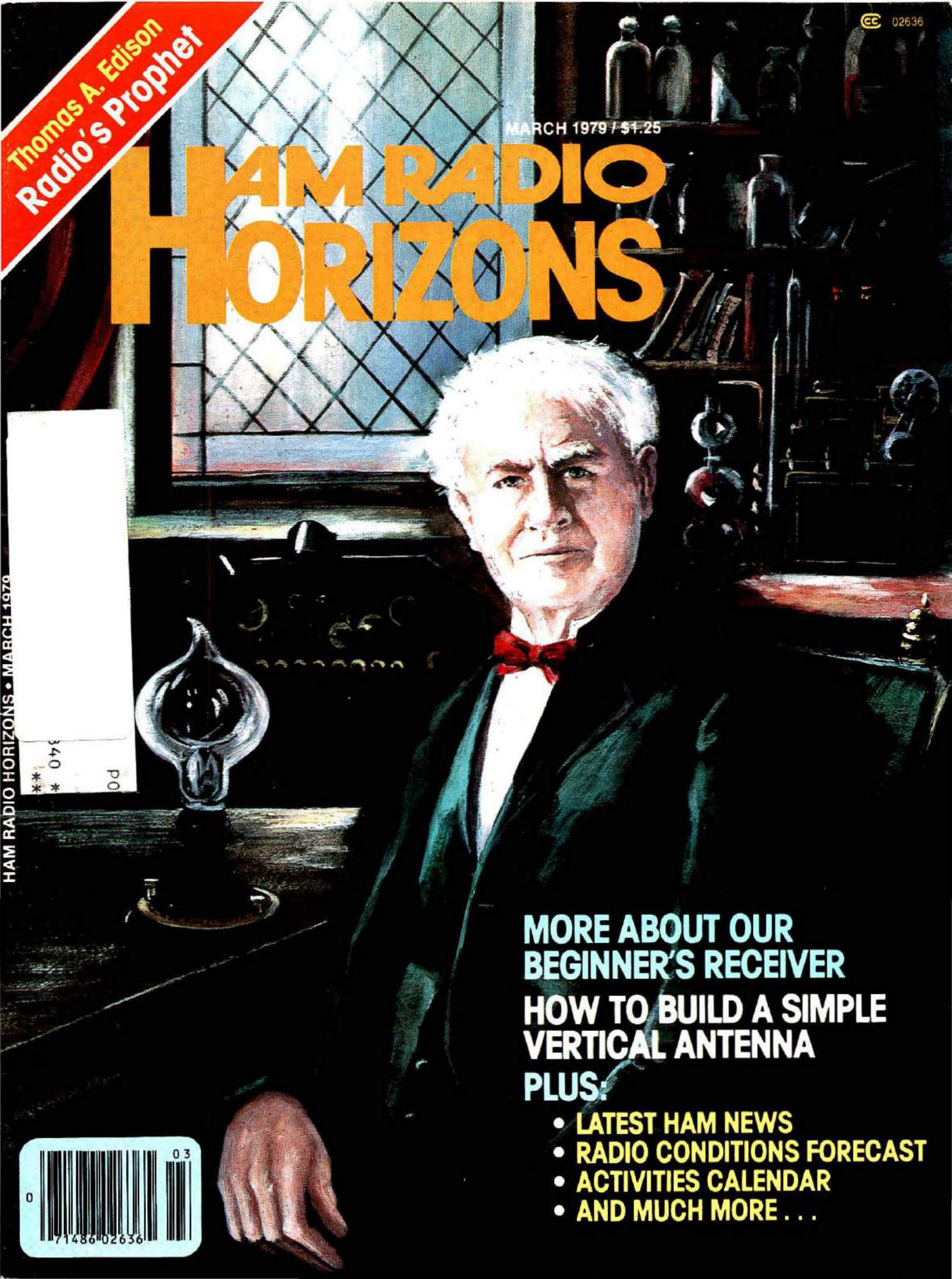

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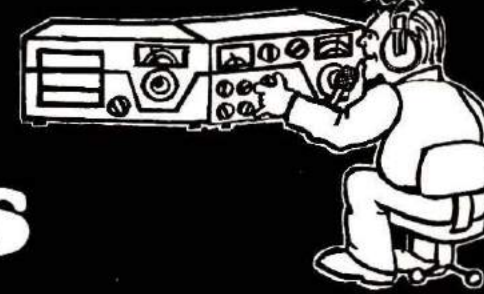

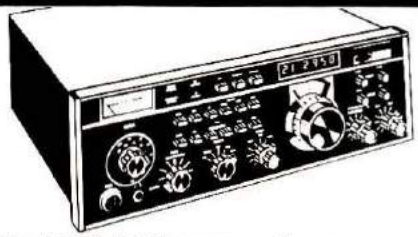

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THIS MONTHS HORIZONS

Edison And Wireless

There are plenty of stories about Edison and his light bulb work, his power plant and distribution systems, and, of course, the phonograph. But, did you know that he also discovered — and patented — a form of wireless transmission and reception? Authors Kates and Smith have some interesting details on Edison's wireless work, which he called an "Etheric Force," along with other experiments. The story provides some marvelous insight into the workings of this most prolific of our inventors. It's quite timely, since this is the anniversary year of his successful light bulb experiment in October of 1879.

Beginner's 80/40 Meter Receiver

In this, his second article about the beginner's receiver, W8YFB talks about winding the coils, passes along some hints about mounting components, and tells you where you can make a few substitutions. There are some photographs and drawings to help you in putting things on the chassis and in the cabinet, after which you can test the circuits. The end result should be a neat receiver that performs as a good receiver should. Bill also drops a hint that there will be a converter for the higher bands following very soon.

A 40-Meter Vertical

Vertical antennas are simple to build, easy to install, and work well — at least that's what the books lead you to believe. Here's what happened when a nonengineer ham tackled one, and how he solved the several problems that the books don't warn you about. It's a fine example of how to follow through until you obtain the desired result.

The Hamfest Scene From An XYL's Viewpoint

Here is a charming piece by an amateur's wife who went with her husband to a typical hamfest. She had listened to the voices of hams talking to her husband on the air and had tried to imagine what they looked like. Her account of this experience is typical of what the wife of a ham might expect to find at a hamfest. It's all in good fun and makes interesting reading.

How To Pass The FCC Exam — With Frustrations

Taking the ham license test in the United States is one thing. What if you're overseas and want a ticket to operate in a foreign country? Author Carlson, WD9HBB, relates some experiences he had in Germany trying to obtain a ham license — an example of what you can do if you really want to get on the air.

VHF Propagation

The means by which vhf signals get from one place to another are as variable as the seasons, and sometimes related to the time of year. In addition to conditions that produce very loud signals, there are several that can propagate a signal that is very weak, or sometimes garbled. In this second part of the story of the vhf world, K2OVS talks about what the Aurora Borealis can do for you, and what hams on either side of the equator are finding out.

The Cover

This year marks the 100th anniversary of the invention of the incandescent electric bulb, Edison's most publicized product. Our story about Edison and his works, on page 14, talks about this and other subjects investigated by the great experimenter. Original painting by Brigitte Fail of Long Beach, California.

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March, 1979
Volume 3, Number 3

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CONTENTS

THE VIEW FROM HERE

This year Amateur Radio may be facing one of its biggest challenges in 20 years. What I'm referring to, of course, is the World Administrative Radio Conference which will convene this fall in Geneva, Switzerland. Better known in ham circles as WARC 79, this conference of ITU member nations will consider all the high-frequency allocations, including those of Amateur Radio, broadcasting, maritime mobile, and the other radio services which require operating frequencies.

There are some Amateurs who would like you to believe that the high-frequency Amateur bands will be completely decimated at this conference — ravaged by foreign broadcasters and other interests who covet our bands for their own selfish purposes — but I think that the people who are all too eager to promote that turn of events are either alarmists or poorly informed; probably both. Obviously, it's impossible to forecast the outcome of WARC 79 at this point in time, but the Amateurs I've talked to who are officially involved with preparations for the conference are, to a man, cautiously optimistic that the high-frequency Amateur bands after WARC will be pretty much the same as they are now. And they are the ones who should know, not the purveyors of gloom and doom who apparently get their information from the Wizard of Oz — or some other equally unlikely source.

In the past, dozens of magazine articles have been written about the "terrible drubbing the Amateur Radio service has taken at every international frequency allocation conference." If you carefully review the record, however, you'll find that exactly the reverse is true; in every case American Amateurs have actually *gained* more high-frequency spectrum than they lost.

It is generally believed, for example, that at one time Amateurs had exclusive use of all wavelengths below 200 meters. That's a fable which has been quoted so often it's now accepted as fact. Actually, the 1912 regulation in question restricted *all* stations not involved in commercial traffic from going *above* 200 meters. That included *all* private, commercial, and experimental stations not transacting business or developing equipment for business purposes. Amateurs had no exclusive claim on "200 meters and down" — they shared that spectrum with virtually every other radio service. In fact, Amateur Radio stations at that time were required to specify their operating wavelengths, which were invariably 150, 175, or 200 meters — three spot frequencies below 200 meters.

In the early 1920s it became apparent that the 1912 law was hopelessly inadequate for the then existing conditions. More stations were on the air than ever before, the broadcast boom was well underway, and Amateurs had demonstrated the long-distance capabilities of the short waves. The scramble for short-wave territory was on, and every service was pushing for all the high-frequency spectrum it could get. To bring order to the ensuing chaos, a domestic radio conference was held in Washington in 1924; part of the outcome was the establishment of four harmonically related Amateur bands: 160, 80, 40, and 20 meters. It's important to remember that this was not an international agreement, however, nor in fact did it have the authority of law — it was simply a mutual agreement between the various radio services in the United States.

The 1927 International Radio Conference in Washington saw precious kHz shaved off the American 160, 40, and 20 meter bands, but in return we received an exclusive new band at 10 meters. Amateurs in Europe fared less well, and some will argue that American Amateurs now had to share 40 and 80 meters with the foreign broadcasters, but that was true *before* the 1927 conference convened. Compared with the spot frequencies given to Amateurs in 1912, the new international allocations of 1927 were a vast improvement.

There was no change in the Amateur bands at the Madrid conference in 1932, nor at Cairo in 1938. The next conference was scheduled for Rome in the spring of 1942, but because of the war, the next International Radio Conference was not held until 1947, in Atlantic City. Amateurs lost some space on 160, 20, and 10 meters at Atlantic City, but we received a nice bonus in return: a brand new band at 15 meters. Hence, there was not a net loss at all, but a gain! These are the same bands we are still using today.

In reviewing the record of high-frequency Amateur allocations, we have progressed from what was essentially spot-frequency operation in 1912, to 3485 kHz of high-frequency operating space in 1927, to 3500 kHz today. Based upon past performance, and the proven service of Amateur Radio to the public, I believe we have every reason to be optimistic about the future.

Jim Fisk, W1HR
editor-in-chief

FOCUS & COMMENT

It seems the world's attention is on Edison and his inventions, as you can tell by glancing at many electronic, scientific, and popular magazines, including this month's *Ham Radio Horizons*. Celebrations and observations are planned in various cities and schools all across the land — most of them in connection with Edison's electric light bulb. While the bulb was a major breakthrough in itself, an undertaking of parallel importance was that of developing a system to distribute the power required to make the bulbs glow. Almost everything was needed — generators, power lines, insulators, sockets, fuses — and the demand grew as the success story became more widely known. It was a tremendous undertaking, pushed forward with uncommon fervor.

However, Edison's original system was all dc, and, great though it was, it had several drawbacks which amateurs of early days found to be considerable. For instance, how do you obtain a voltage higher than that which is delivered to your wall outlet? Today, we have neat boxes inhabited by transistors, transformers, diodes, and capacitors which transform a dc voltage to a higher one suitable for the plate of an rf amplifier tube; they'll even turn dc into ac so you can run your home equipment from a car battery. Early-day hams had to invest in a motor-generator set. It was a dc motor, mechanically coupled to a dc generator which provided the stepped-up voltage for the plate circuit. They were expensive — the equivalent of 3 to 6 month's salary was not unusual. They were noisy — to run a kilowatt you needed a 2 or 3 horsepower motor, taking inefficiencies into account, and they had brushes and commutators, creating sparks, electrical noise, and requiring constant maintenance. Some were so noisy that they had to be shut down during receive periods — not much good for break-in operation.

Now, I don't wish to diminish the importance of Edison's work, or his genius, in the slightest — but how lucky we are that Nicola Tesla came along with his system for generating ac, distributing it, and building motors to run from it. How easy it is to plug in a transformer and obtain a voltage anywhere from a fraction of that supplied by the mains, up to thousands of times higher. They're quiet, clean, and last for years without maintenance. It's a pretty safe bet that there would be no desk-top kilowatt linear amplifiers without the alternating-current/transformer type of power distribution.

The Edison dc system did not go down without a struggle, however. It was many years before all of New York City had ac power available, and, even then a lot of buildings were wired for both ac and dc — some still are. As recently as 1975, I gave a talk before a radio club in Manhattan, and an extension cord from another part of the building provided ac for my slide projector; the baseboard outlets in the meeting room were all 110 Vdc!

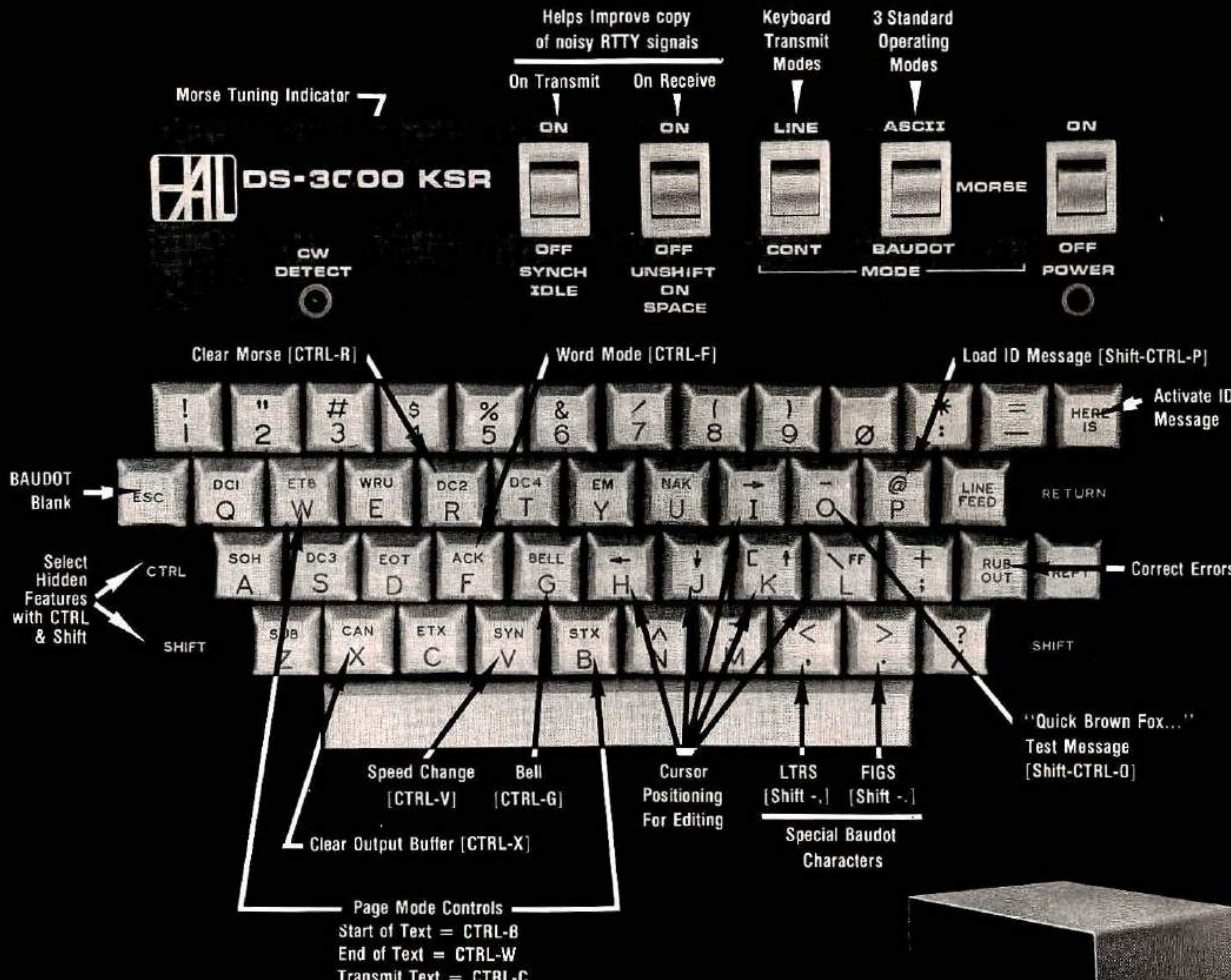
Even with the coming of ac power, there was controversy in some areas. I can remember, in my early days of hamming, hearing 50 and 100-cycle ripple on some CW signals from parts of New York City, and the same was heard from parts of Canada as late as the middle 1950s. Not only was there a group of dc adherents and a group of ac adherents at odds with each other, but the ac people were divided as to whether 50 or 60 cycles (hertz, as we call it these days) was the more efficient for power distribution. The argument continues in many parts of the world.

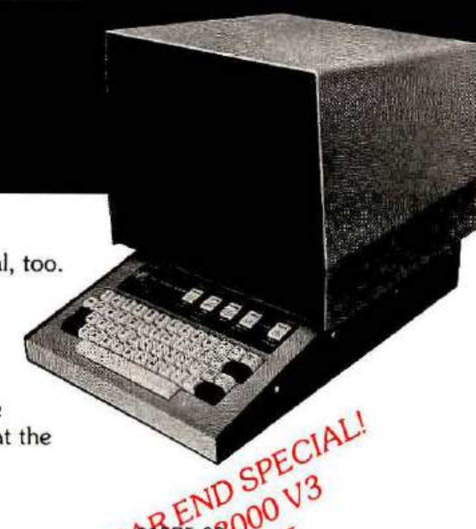
However, aside from all that, Thomas Edison did launch many industries, and many of his inventions spawned further developments, and it is entirely fitting that we should commemorate a great inventor and experimenter. There's a notice on page 25 of this issue about an International Festival of Light. If you happen to live or travel near any of the sites of the celebrations, take a look. The exhibits and demonstrations are bound to be thought provoking and loaded with nostalgia.

And, just for the fun of it, wherever they have a replica of the original electric light bulb burning, ask if they are using ac or dc to make it glow.

Thomas McMullen, W1SL
Managing Editor

Super Terminals with
Hidden Features





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Our keyboard works in MORSE, BAUDOT, and ASCII codes *and* controls the terminal, too. You can edit a message, program the HERE IS message, send the "QUICK BROWN FOX . . . " test message, change speeds, and change the terminal modes, all from the keyboard itself. In fact, the KOS (Keyboard Operated Switch) feature even turns the transmitter on and off from the keyboard, The DS-3000 KSR also features full-length 72 character lines (16 lines per screen), 5 speeds of BAUDOT and ASCII RTTY and Morse code from 1 to 175 wpm (Version 3), and word wrap-around to prevent splitting of words at the end of a line. When combined with the HAL ST-6000 Demodulator, you have the ULTIMATE in RTTY equipment.

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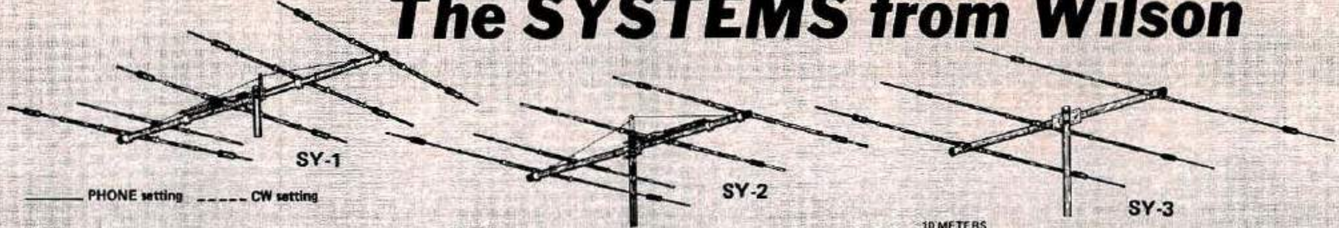
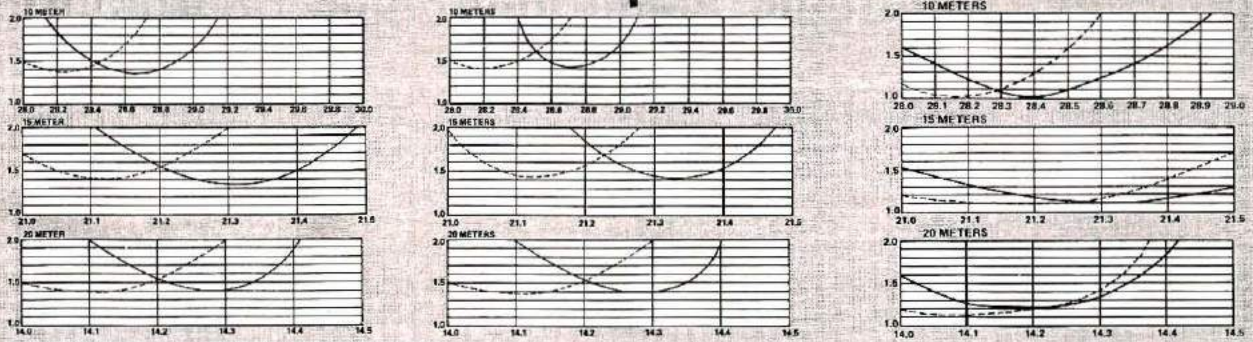
The SYSTEMS from Wilson

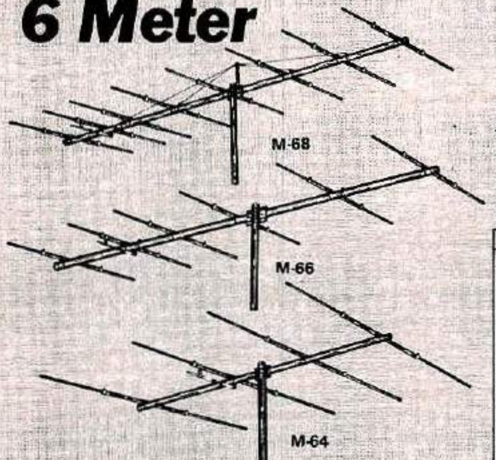


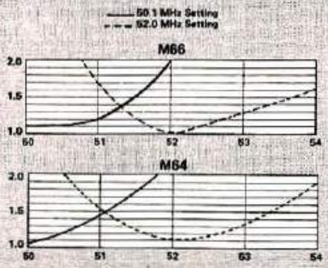


SPECIFICATIONS	SYSTEM ONE	SYSTEM TWO	SYSTEM THREE
Band MHz	14-21-28	14-21-28	14-21-28
Maximum power input	Legal limit	4 Kw	Legal limit
VSWR at resonance	1.5:1	1.5:1	1.3:1
Impedance	50 ohms	50 ohms	50 ohms
Boom (O.D. x Length)	2" x 26'	2" x 18'6"	2" x 14'4"
No. of elements	5	4	3
Longest element	26' 7"	26' 7"	27' 4"
Turning radius	18' 6"	16' 4"	15' 9"
Maximum wind survival	100 lbs.	100 lbs.	100 lbs.
Maximum mast diameter	2" O.D.	2" O.D.	2" O.D.
Surface area	8.6 sq. ft.	6.15 sq. ft.	5.7 sq. ft.
Wind loading @80 mph	215 lbs.	153 lbs.	114 lbs.
Assembled weight (approx)	60 lbs.	47 lbs.	37 lbs.
Shipping weight (approx)	65 lbs.	50 lbs.	42 lbs.
Matching method	Beta	Beta	Direct feed

Designed by Hams and for Hams, the SYSTEM series of tri-banders are the newest antennas on the market, and with the latest engineering practices. Ranging from the long distance SYSTEM ONE to the space saving SYSTEM THREE, you will find the antenna to fit your needs among them. Using a high grade of aluminum, with super hardware, they are designed to stay up and give years of satisfaction in use and durability. The many hundreds of Hams on the air using the SYSTEMS testify to their dependability, ease of installation and satisfaction. See your favorite dealer for the antennas of the decade . . . "THE SYSTEM SERIES".

6 Meter



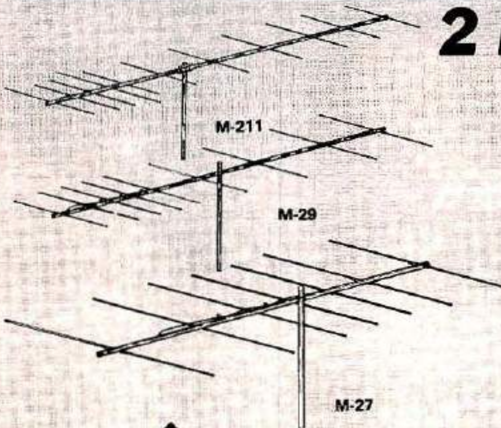


The Wilson 6 meter beams satisfies even the most critical amateur today. With the most popular sizes available, Wilson offers you the performance you want, at a price less than you would expect. The workmanship in the parts will immediately give you the impression of an antenna that will last through the years. For your latest copy of the Ham Buyer's Guide, featuring the 6 meter beams, contact your favorite dealer.

SPECIFICATIONS	M68	M66	M64
Band MHz	50-54	50-54	50-54
Maximum power input	4 Kw	4 Kw	4 Kw
VSWR (at resonance)	1.1:1	1.1:1	1.1:1
Impedance	50 ohms	50 ohms	50 ohms
Boom (O.D. x length)	2" x 36'10"	2" x 25'8"	1½" x 11'6"
Number of elements	8	6	4
Longest element	9' 8"	9' 8"	9' 8"
Turning radius	19' 0"	13' 10"	7' 6"
Mast diameter (O.D.)	2"	2"	1½"
Boom diameter (O.D.)	2" to 1½"	2"	1½"
Surface area	5.8 sq. ft.	4.5 sq. ft.	1.5 sq. ft.
Wind loading @80 mph	145	112	37
Assembled weight (approx.)	34 lbs.	26 lbs.	11 lbs.
Shipping weight (approx.)	39 lbs.	31 lbs.	13 lbs.
Matching method	Gamma	Gamma	Gamma

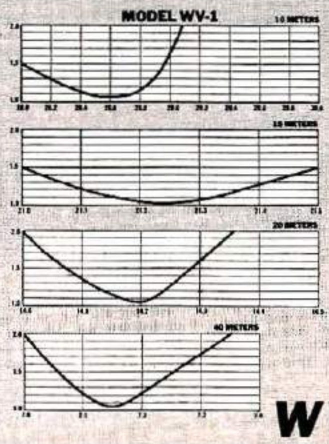
2 Meter

MODELS M211, M29 and M27



Wilson's new 2 meter series combines the ultimate in design and quality materials. These top performing beams feature 7, 9 or 11 aluminum elements held to the heavy walled boom with the exclusive molded Lexan® boom to element mounting. The four driven elements use Log Periodic design for broad band characteristics providing full 144-148 MHz coverage with less than 1.2 to 1 VSWR across the band. Universal mounting is provided for vertical or horizontal polarization.

SPECIFICATIONS	M27	M29	M211
Band MHz	144-148 MHz	144-148 MHz	144-148 MHz
VSWR	1.2:1	1.2:1	1.2:1
Impedance	50 ohms	50 ohms	50 ohms
Boom (O.D. x length)	1" x 64"	1" x 120"	1.5" x 12'6"
Number of elements	7	9	11
Longest element	40"	40"	40"
Beam width @3dB pt.	27 degrees	24 degrees	21 degrees
Turning radius	37.13"	63.24"	97.97"
Mast diameter (O.D.)	1" - 1½"	1" - 1½"	1" - 1½"
Surface area	.44 sq. ft.	.93 sq. ft.	1.11 sq. ft.
Wind loading @80 mph	5.5 lbs.	24 lbs.	28 lbs.
Shipping weight (approx.)	6.5 lbs.	8 lbs.	9 lbs.
Assembled weight (approx.)	3.5 lbs.	5 lbs.	6 lbs.



WV-1

WV-1 WILSON VERTICAL TRAP ANTENNA

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NEWSLINE

BROADCAST INTERESTS MAY THREATEN the U.S. Amateur Radio WARC position far more than the question of sharing 220 MHz with Maritime. U.S. international broadcasters, not satisfied with the 865 kHz of new high-frequency spectrum proposed for them in the Commission's carefully worked out WARC Report and Order, are now waging a behind-the-scenes battle to double that amount at the expense of other users. If they succeed it will mean cuts for the other services whose expansion was proposed in the U.S. position, and, in the process, will destroy much of the carefully worked out agreement achieved by various government agencies and industry advisory groups during the past several years.

FCC'S PROPOSED PROTECTION of its monitoring stations from potential interference could have an impact on Amateurs in the vicinity of any of the Commission's 13 monitoring facilities. Those stations are located in Allegan, Michigan; Anchorage, Alaska; Belfast, Maine; Douglas, Arizona; Ferndale, Washington; Fort Lauderdale, Florida; Grand Island, Nebraska; Kingsville, Texas; Laurel, Maryland; Livermore, California; Powder Springs, Georgia; Sabena Seca, Puerto Rico; and Waipahu, Hawaii.

CW ABILITY WOULD NO LONGER be required but only "recommended" for the Amateur Service, the FCC proposed in its just released final Report on WARC 79. Article 41 of the international regulations now requires that operators of Amateur stations shall have proved ability in Morse code, with the proviso that governments can, if they wish, waive the CW requirement above 144 MHz. Under the FCC's proposed change in Article 41, it would only be recommended that Amateur operators should have demonstrated Morse code ability, without any reference to frequency limits. This change would, the Commission said, permit governments to develop their own licensing requirements.

A NEW DEPARTURE IN FCC preliminaries to rule making is being tried in the Commission's inquiry into RFI problems, General Docket 78-369. This new approach hinges on the widespread distribution of attractively presented, color-coded special editions of the Notice of Inquiry, complete with survey forms for the recipients to fill out and return.

The Inquiry, which will "study the problem of radio frequency interference and the need for Government regulation to help lessen such interference," was announced November 15, but the special consumer-oriented Notice of Inquiry packets didn't become available until January. Supplies have been sent to all Commission Field Offices, and they're to be distributed in places where they can reach the maximum number of people.

Due Date For Comments on General Docket 78-369 will be May 1, with Reply Comments due July 1.

FCC EXAM SUGGESTIONS should no longer go to Bob Kite, as cited in several club bulletins. Jay Jackson of the Personal Radio Division, (202) 634-6619, is now the exam contact.

THE SYNCOM IV SATELLITE has been scratched, thus dashing any hope for having an Amateur transponder in synchronous orbit in the near future. However, AMSAT Canada will complete their transponder, with the expectation that another opportunity will come.

DUNCAN, ARIZONA, ISOLATED by pre-Christmas flooding in that usually dry state, depended very heavily on Amateur Radio for communications during the emergency. Ten Duncan Amateurs, working around the clock, provided the Red Cross and National Guard units with necessary communications from noon, December 19, through Christmas Day. Both 2 meters and 450 MHz were part of the operation, which used remote base stations WB5QHS and WB7KUM to link the city with aid from as far away as the West Coast, until commercial communications were restored.

AMATEURS HOLDING MORE than one callsign, who wish to retain the call assigned to their secondary station when renewing, must be sure to renew well before the expiration date. One West Coast contester lost his prized 1x2 call recently when his renewal application — complete with request to reassign his 1x2 to his primary (surviving) station license — arrived at Gettysburg a few days after the license expiration date. Because his no-longer-renewable secondary license had expired, its 1x2 callsign was no longer his and thus could not, under the rules, be assigned to him.

CANADIAN COAST GUARD and operators from the personal communications services will join forces in a recently announced Canadian Coast Guard Auxiliary. The new unit will make use of General Radio Service (Canadian CB) and Amateurs for monitoring marine emergency channels, communications safety training, and as participants in emergency operations.

WA2KBI WON FIRST PRIZE in Ham Radio Horizons' just-ended sweepstakes, taking home a complete station that includes a TR-7, Tri-Ex Tower, CushCraft beam, Hy-Gain vertical, and a Wilson 2-meter hand-held (see page 60, this issue).

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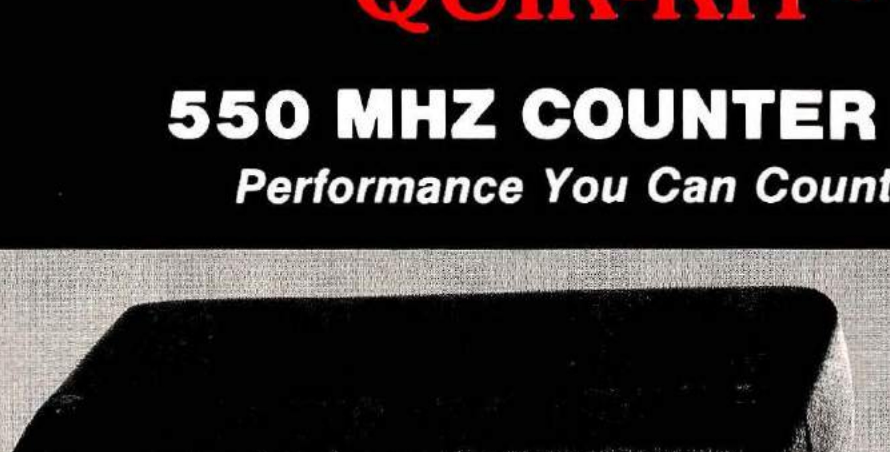

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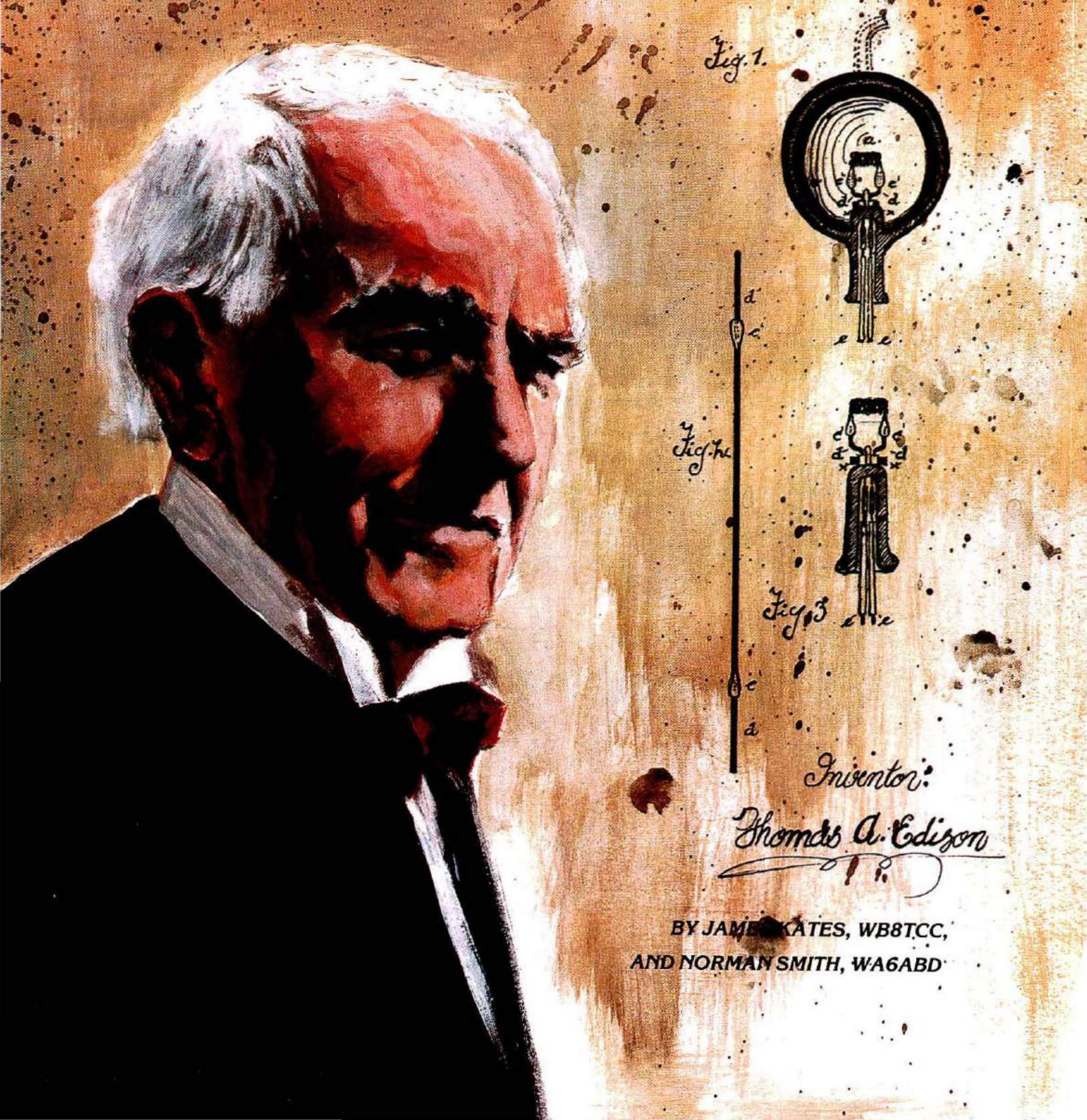
Thomas Edison, Radio's Prophet

The Edison effect was more than just a light bulb phenomenon



BY JAMES KATES, WB8TCC,
AND NORMAN SMITH, WA6ABD

In the latter part of April 1870, a 23-year-old telegraph operator turned inventor named Thomas Edison was ushered into the office of General Marshall Lefferts, the president of New York's Western Union Telegraph Company. Lefferts went straight to the point: he wanted patent rights to Edison's newest group of stock tickers.

"Well, young man," he said, "what do you think your improvements are worth? Let's settle up our bill."

Edison thought a moment. He felt his new inventions were worth at least $5,000 — but he was willing to settle for three. At last he replied.

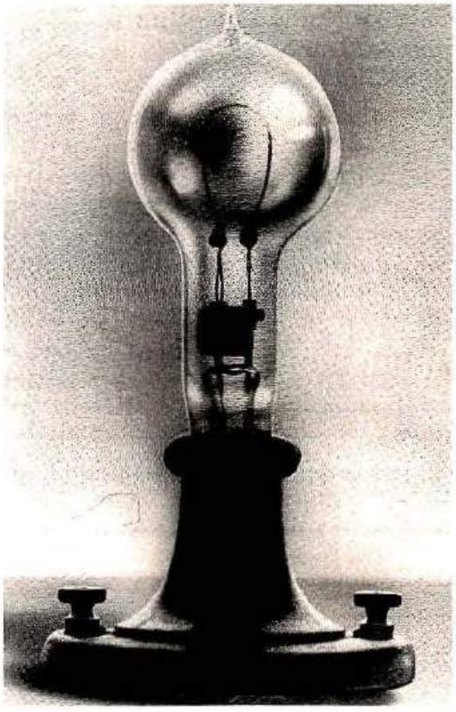
"Well, General, suppose you make me an offer," he said.

"How would forty thousand dollars strike you?"

At the mere mention of the sum Edison nearly fainted, but he pulled himself together and accepted the offer. Years later he would laugh at what happened next.

Three days later, Lefferts handed Edison a contract and a check for $40,000. The inventor was convinced he was being tricked. Forty thousand dollars! Skeptically he handed the check to a bank teller, who noticed that he had failed to endorse it. The teller handed the check back to Edison and tried to explain what was wrong, but Edison, having been almost totally deaf since the age of twelve, couldn't understand what the teller wanted; he had never before received a check. Sadly, he dropped out of line and trudged back to Western Union. So he *had* been tricked, after all. When he explained his problem to Lefferts, the General merely laughed and sent Edison back to the bank with a clerk. The clerk had Edison endorse the check and identify himself; the teller played his own little joke by paying Edison $40,000 in ten and twenty-dollar bills.

Edison had never cared much for money — only what he could buy with it. He invested every cent of the $40,000 in a four-story brick building at 10-12 Ward Street in Newark, hired a couple hundred men, and started manufacturing his "Universal" stock tickers for Western Union. While the hired men worked at the machines, the "old man" experimented in the back room of the shop and began to unlock the secrets of electricity.



Edison's basic incandescent electric lamp, patented January 27, 1880 (*photograph from The Bettman Archive*).

Most people associate Edison with the light bulb, the phonograph, and motion pictures — but *not* with radio. His name is often left out of radio history books or perhaps mentioned in passing. But during the years from 1875 to 1885, Edison pioneered some radio fundamentals which are still in use today — and the first of these discoveries was made at the lab in Newark.

The "Etheric Force" experiments

The "etheric" phenomenon, like most of Edison's radio contributions, was discovered while working on a more famous invention — in this case, a telegraph instrument that would send more than one message on a single wire.

On the night of June 2nd, 1875, Edison was experimenting with a new kind of multiple-telegraph apparatus: a *harmonic* telegraph. Alexander Graham Bell and other inventors had been working on the same kind of device, whereby a complicated system of wires, tuning forks, and relays allowed as many as eight messages to be sent simultaneously on one wire.

As Edison applied current to the electromagnet in the new circuit, he noticed a strange spark jumping from the magnet's iron core to a piece of iron directly above it. He'd seen these sparks before, and had always assumed them to be strictly electrical in nature. But, on this evening, he decided to investigate.

Edison's lab assistant, Charles Batchelor, kept the notebook on the first experiment. The sesssion lasted all night, but the test, titled "experiments to discover a new force," revealed nothing, and it was shelved in favor of work on the telegraph. The "new force," though, was not forgotten.

James Maxwell, the mathematical theorist, had published in 1873 his conclusion that electrical apparatus radiate some sort of electromagnetic waves which would obey the laws of light waves, but Edison is not believed to have read this work — he had little respect for theorists. Even in 1875, though, Edison could imagine uses for "etheric force," and he went to work to prove its existence.

On the night of November 22nd, Edison hooked up an electromagnet with its current supply rapidly switched on and off, as in a doorbell buzzer. Above it he fixed a bar of steel. Once more, the strange sparks jumped from the core of the magnet. But they *wouldn't* obey the conventional properties of electricity. A gold-leaf electroscope, an instrument for measuring static charges, was brought near the spark with no results; the spark, when passed through a wire, wouldn't swing the galvanometer needle. It wouldn't even charge a Leyden jar! Edison hooked a wire to the bar of steel and wrapped the end around a gas fixture — and found that by simply holding a wire in his hand he could draw the "etheric" sparks from any gas fixture in the house, even though the entire system was grounded! Fortunately, Batchelor kept copious notes of the whole experiment, and he was not cautious in his conclusion. "This is simply wonderful, and a good proof that the cause of the spark is a true unknown force." The unknown force, obviously, was that of electro-magnetic waves.

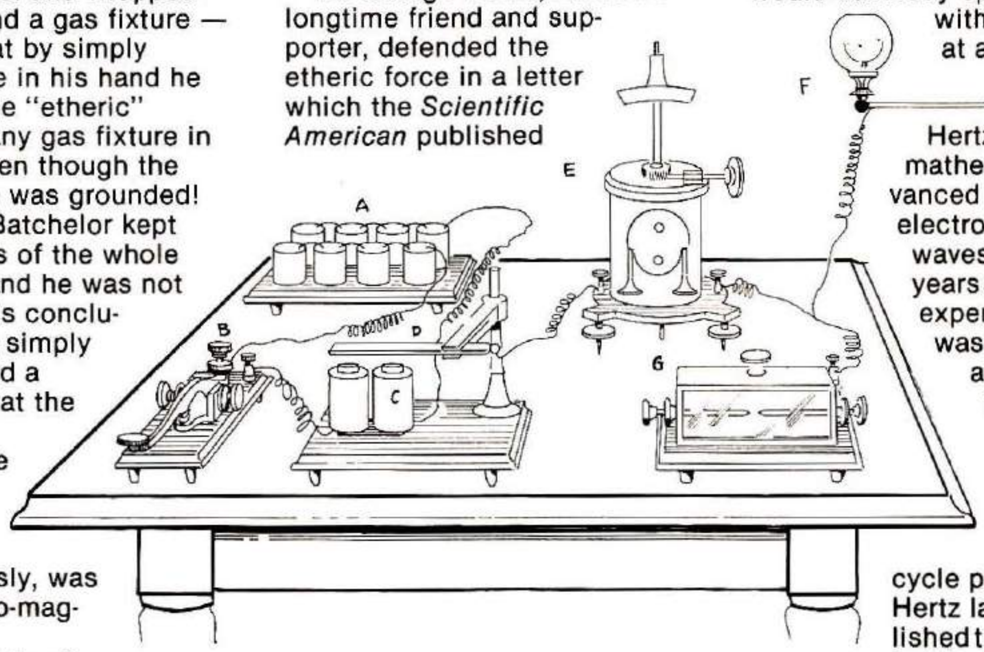
The scientists of the day, however, didn't all share Batchelor's enthusiasm. While daily papers like the New York *Herald* called the etheric discovery the unlocking of a "great secret of nature," the *Scientific American* was more conservative, at first, proposing that perhaps etheric force was "electricity of a form between the static and galvanic kinds," and called the conclusion of a new force "rather hasty." Later when they weighed the data, they joined the daily papers and predicted that Edison would "rank with the most fortunate and eminent of scientific discoverers." And indeed he would — but not for his work in etheric force.

Though the *Scientific American* saw the uniqueness of the new force, many scientists, calling Edison a braggart and a fool, did not. One such scientist, in a letter to the *Scientific American*, flatly denied the existence of a new force, saying it *couldn't* be nonpolar and indifferent to ground, and proving his claims with mathematical theories. Edison ignored the man — he had disproven theories before.

Dr. George Beard, Edison's longtime friend and supporter, defended the etheric force in a letter which the *Scientific American* published on January 22nd, 1876. Calling the nature of the force "of admirable clearness," Dr. Beard supported Edison's idea that the force was "radiant . . . somewhere between light and heat on the one hand and magnetism and electricity on the other, with some features of all these forces."

Edison hardly needed Dr. Beard's support; he had always ignored his critics and would continue to do so for the next fifty years. He continued experimenting with the new force, using it to send messages as far as 75 miles on uninsulated wire. The critics were still unconvinced. "As etheric force is assumed not to require insulation," one of them wrote, "if we place its wires upon poles we shall save merely 40 insulators at 12 cents apiece to the mile, or $4.80. This certainly is not practical value." Little did this adversary of Edison's imagine that the etheric force would someday span the globe without any wires at all.

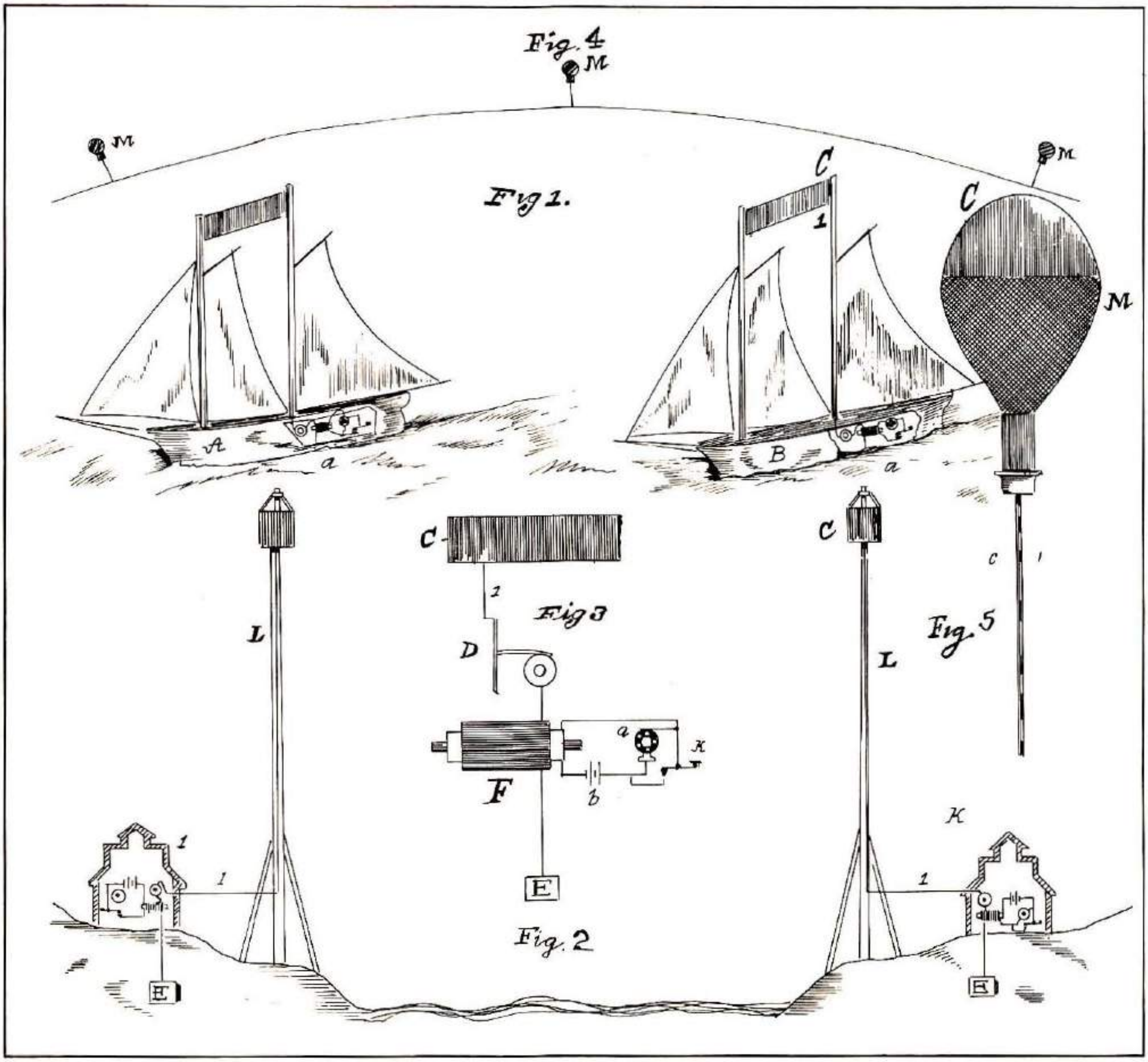
Heinrich Rudolph Hertz, the brilliant mathematician, advanced his theory of electromagnetic waves in 1887, 12 years after Edison's experiments. Hertz was subsequently awarded the title of "father of the wireless," and his name is used today to mean one cycle per second. Hertz later established the mathematical basis for waves that Edison could never have dreamed of. Still, the fact remains: Thomas Edison discovered electromagnetic waves, and had he not been diverted by more pressing work in stock tickers, telegraphy, and later in phonograph, telephone, and the electric light, he might have sent signals across the Atlantic years before Marconi.



The apparatus Edison used to investigate the "etheric force" in his laboratory. Note that the circuit through the key, **B**, the pair of coils, **C**, and the batteries, **A**, has no electrical connection to the bar, **D**, suspended above the coils. The bar is connected to a gold-leaf electroscope **E**, a spark gap, **G**, and the whole system is "grounded" to a gas pipe, **F**. The etheric force induced in the bar and whatever it was connected to could be made to appear as sparks in any part of the system, including the gas pipes in other parts of the building or the whole city! *(Drawing retouched from the original of December 25, 1875, with permission of Scientific American.)*

Telephone and microphone experiments

Perhaps the skepticism first associated with the telephone is best illustrated by this account from a Boston newspaper of 1865: "A man has been arrested in New York for attempting to extort funds from ignorant and superstitious people by exhibiting a device which he says will convey the

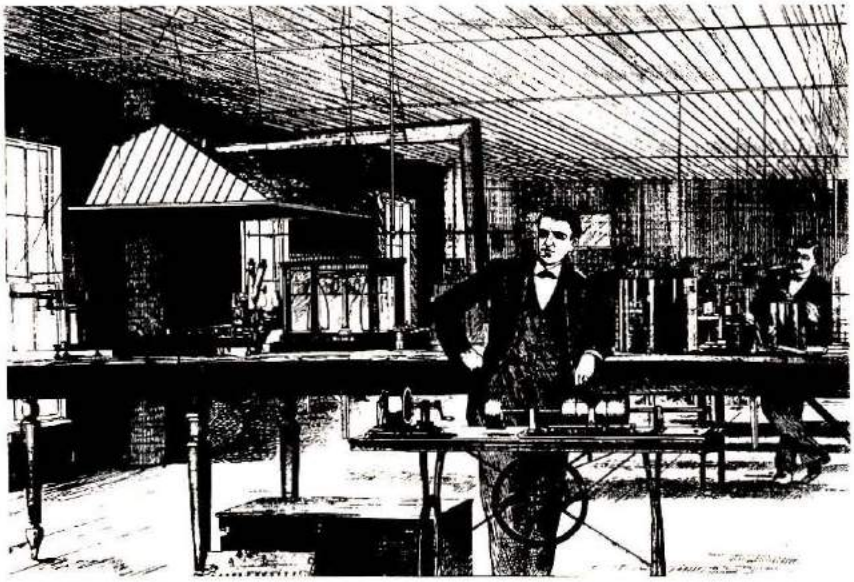


Edison's wireless telegraphy system was described in the *Scientific American* for January 16, 1892. His **Fig. 1** inset shows the apparatus used in ships, **Fig. 2** for land stations. **Fig. 3** is a close-up of the system itself wherein **C** is the so-called condensing surface (we would call it a top-loaded antenna), **D** is Edison's electromotograph receiver (earphone), **F** is an induction coil, and **a** is a rotary breaker-point device to interrupt the current from a battery, **K** is a normally closed key, and **E** is earth ground. His **Fig. 4**, at the top, represents the idea that the "etheric force" would travel beyond the horizon, following the curvature of the earth. (*Drawing retouched from the original, with permission of Scientific American.*)

human voice any distance over metallic wires. Well-informed people know that it is impossible to transmit the human voice over wires, and that, were it possible to do so, the thing would be of no practical value." Alexander Graham Bell astounded the world with his telephone only eleven years later.

Bell's instrument, which became known as a *magneto* telephone, was largely a curiosity at first. The same device was used both as a transmitter and receiver. A coil of fine wire was fixed around a rod-shaped permanent magnet, and a diaphragm rested in front of the two. When the device was spoken into, the vibrations of the diaphragm in the magnetic field induced a tiny current of electricity in the coil, which traveled to the other instrument. This instrument's coil acted as an electromagnet when current flowed through it, vibrating the diaphragm.

Bell demonstrated his telephone over wires as long as 100 miles, but the instrument's inherent problem was that it generated its own current, which wasn't strong enough to overcome the resistance of the telegraph wires. One reporter theorized that Bell's magnetic



An 1878 woodcut depicting Edison's laboratory and machine shop at Menlo Park, New Jersey, where he was working on the phonograph and the telephone (*from The Bettman Archive*).

telephone would never work on a wire more than 200 miles long. Western Union, sensing a possible gold mine in the telephone business, put Edison under contract to improve Bell's instrument.

About the same time he signed the telephone contract, Edison began looking for a new laboratory site. He was now relatively famous, and tired of being disturbed by reporters, scientists, and curious laymen who dropped by the lab at all hours. In 1876, he purchased several lots at Menlo Park, New Jersey, a quiet country hamlet 20 miles southwest of New York City. He built a house, a library, and a two-story clapboard building where he and his staff could do nothing but invent things, free from the city's distractions.

Once he was settled at Menlo Park, Edison made hundreds of experimental telephone transmitters to test his theories. He knew the problem with Bell's — its lack of ability to generate a strong electronic current — and felt he could solve the problem by placing a battery in the circuit and using a Bell receiver along with a transmitter that would fluctuate the battery current in response to the voice's vibrations. He tried hundreds of substances in the transmitter — water, strips of paper, even mercury — but finally hit on carbon. In his search for the ideal telephone transmitter, Edison invented the carbon microphone.

Edison's microphone of April 1st, 1877, was similar in principle to the modern carbon mike. He attached a button of carbon to the back of a large diaphragm. As the diaphragm moved, it moved the button, which vibrated against several pieces of charcoal held in a line behind it on strips of spring steel. One wire was attached to the rear piece of charcoal, and the other to the carbon button.

One wire from the microphone was attached directly to a terminal of Bell's receiver, and the other wire ran through a battery to the other terminal. When spoken into, the microphone varied its resistance in direct proportion to the strength of the voice, and allowed more or less current to flow to the receiver. The resulting receiver volume was several times that of Bell's magneto system — and Edison had invented the device that would give radio its voice.

Soon after, Edison applied for his first patent covering the use of "lampblack" (carbon) in a telephone transmitter. The new carbon transmitter had several times the power of the old magneto type, and it was rugged, cheap, and dependable. Western Union made quick use of it. The Western Union system, however, was still using Bell's magneto receiver; Bell, on the other hand, was using the carbon transmitter, and realized he couldn't have a practical system without it. A fiery court battle looked inevitable. In Edison's own words: "They infringed on my transmitter and we infringed on their receiver, and there we were cutting each other's throats. Well, of course this could not go on forever, and consolidation had to come."

Western Union and the Bell Telephone Company finally agreed to arbitration, but Edison felt that the Bell people were asking for more than their share. He cabled Western Union: "Do not accept terms of consolidation. I will invent new receiver and send it over." It took him less than three months.

Edison's new receiver relied on the *electromotograph* principle, which he had discovered several years earlier at Newark. He had discovered that should he run a wire from one pole of a battery to a piece of metal, and the other to a flat piece of chalk, he could draw the metal across the chalk with practically no friction whatsoever! Should the battery be disconnected, the normal friction returned.

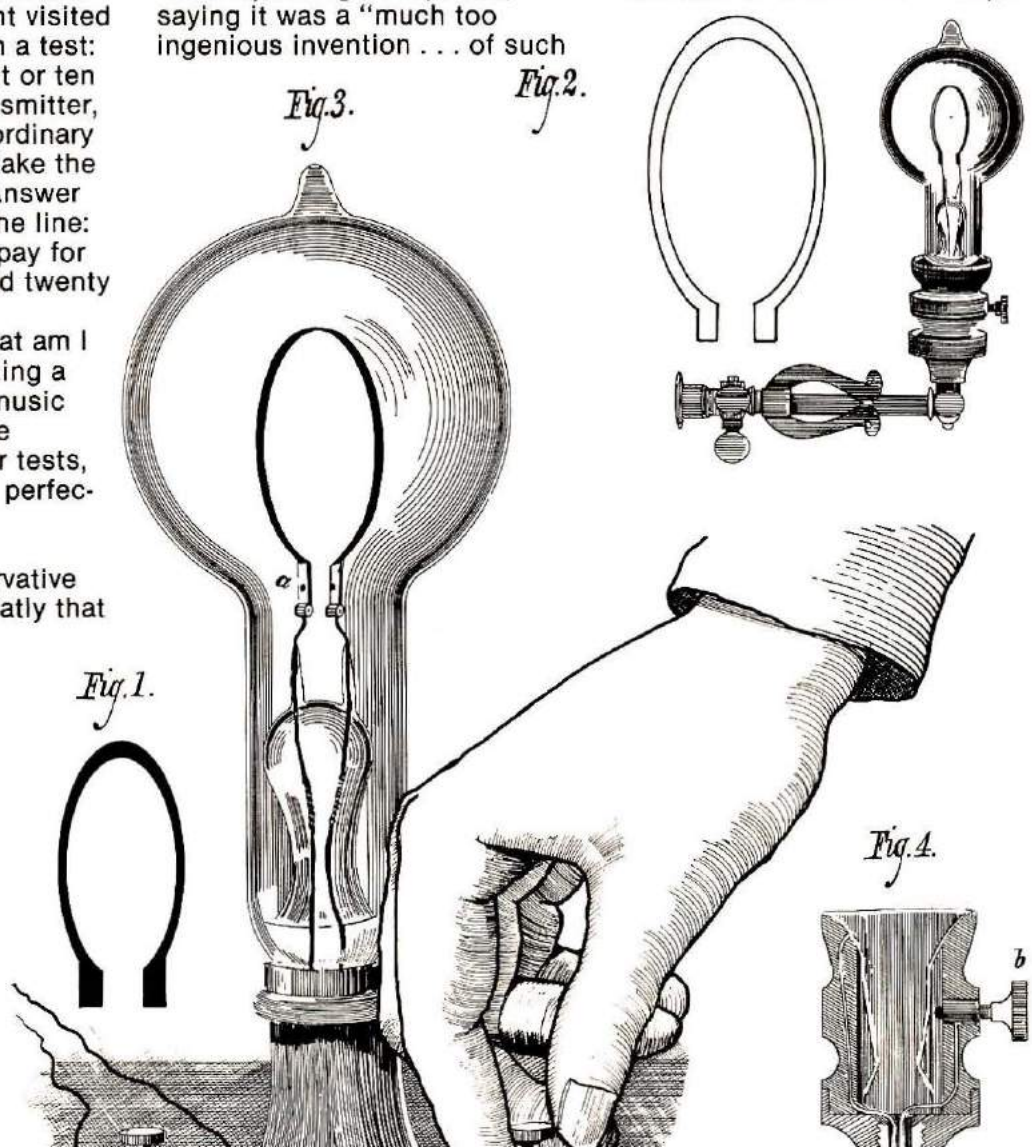
In Edison's "electrochemical" receiver, a small cylinder of chalk was rotated by a hand crank at the side of the receiver, and a metal rod rested on top of the chalk. The other end of the rod was attached to a large diaphragm at the front of the instrument. When an electrical impulse entered the receiver, the friction between the rod and the chalk lessened, which pushed the diaphragm outward proportionately. When combined with the carbon transmitter, the result was a telephone of startling efficiency — and it was 100 per cent Edison's! The motograph receiver produced ample volume to fill a room with sound. Indeed, it was the first electrochemical loudspeaker ever made. And the carbon transmitter was so sensitive that one could carry on a telephone conversation while standing several feet away from the instrument. One *Scientific American* correspondent visited Menlo Park during such a test:

"Standing some eight or ten feet away from the transmitter, Mr. Edison said, in an ordinary tone of voice, 'Do you take the *Scientific American*?' Answer from the other end of the line: 'I do.' Q. 'What do you pay for it?' A. 'Three dollars and twenty cents a year.' Q. (while crumpling a paper) 'What am I doing now?' A. 'Crumpling a paper.' Then followed music from a music box of the smallest size, and other tests, showing the wonderful perfection and power of the instrument."

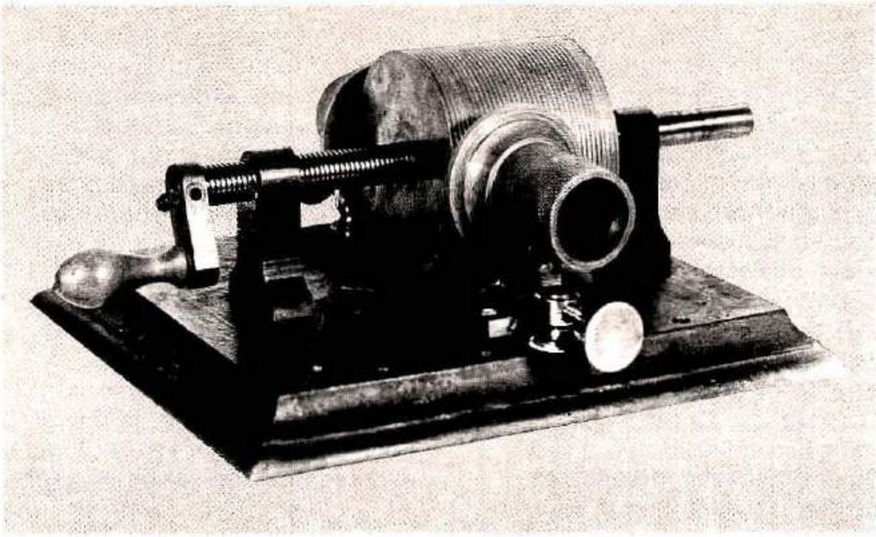
The ordinarily conservative London *Times* stated flatly that Edison's receiver was "far superior to Bell's." In time, though, the motograph receiver proved *too* superior. The telephone was not an instrument for public exhibit; it was an instrument for private conversation, and, after the court battles ended, the Bell receiver/Edison transmitter combination proved ideal for this purpose. George Bernard Shaw, the playwright, worked briefly for the Edison Electric Company in Great Britain, and later commented about the "loud speaking" telephone, saying it was a "much too ingenious invention . . . of such stentorian efficiency that it bellowed your most private communications all over the house." And so the motograph receiver never came into general use, but it did give Western Union a little more leverage in the negotiations when it finally settled its legal differences with Bell in 1879.

The electric light and the Edison Effect

Edison's most famous invention, of course, is the electric light. The years of work and tens of thousands of exper-



The electric lamp, which occupied so much of Edison's time in the laboratory. This reproduction of the original drawing shows the carbon filament, **Fig. 1**, and the cardboard from which it was made, **Fig. 2**. **Fig. 3** shows the completed lamp and its base, and a hand for size comparison. The inset above the hand is a wall fixture for the new lamp — it draws heavily on the architecture of gas lamps of the era. **Fig. 4** is the lamp socket — the lamp is turned on or off by means of the thumb screw, **b**, which makes or breaks contact with a metal strip in the socket. (*From the January 10, 1880, issue of Scientific American, with permission.*)



Edison's original phonograph, patented in 1878 (*photograph from The Bettman Archive*).

iments he devoted to the perfection of a practical light bulb and its subsequent power generation and distribution systems earned him not only fame and fortune — in the process he was to discover a little-publicized phenomenon that would prove to be the foundation of later electronics.

After completion of his telephone work in the summer of 1878, Edison was badly in need of a rest. When Edison's friend, Professor George F. Barker, invited him to join a group of scientists traveling to Rawlins, Wyoming, to view a total solar eclipse, he gladly accepted. The party set out in July; Edison carried his *microtasimeter*, an instrument for measuring very slight changes in temperature. Like several of his recent inventions, the tasimeter proved to work *too* well — the heat of the sun's corona drove the needle right off the scale!

Edison enjoyed the trip immensely, and he spent hours talking over his inventions with the other scientists. But one thing in particular captured his imagination: they were talking about electric lighting. Edison could hardly wait to return to Menlo Park. *Here* was a brand-new challenge!

On the return trip, Edison and Barker stopped near Yosemite, where teams of miners extracted iron ore from the ground by hand.

"Barky," said Edison, "that work would be easier if we could harness Yosemite's falls and turn the power into electricity. Someday our great waterfalls will make electric power enough to light every home and factory in the world, and we won't have to bother with gas anymore."

"You ought to meet Bill Wallace, a friend of mine," said Barker. "He's trying to make an electric lamp."

"Let's go!" said Edison.

Edison visited Wallace in September. The Connecticut inventor was working on an *arc light* — in which two rods of carbon were brought close together, and a high voltage jumped across the gap. Already, some streets and factories were lighted by the arcs, but their harsh, blinding light, short life, and noxious odor made them impractical for home use. Edison saw no future in the arcs — he needed a lamp which would provide a soft, glare-free light. Still, he was impressed by Wallace's operation. "I saw for the first time everything in practical operation," he said later, "and I saw that the thing had not gone so far but that I had a chance." Edison ran from the row of glaring arc lights to the generator and back again. "Mr. Edison was enraptured," said Wallace. "He sprawled over the table with the simplicity of a child and made all kinds of calculations."

At last Edison finished his tour — now there was work of his own to be done.

"Wallace," he said, "I believe I can beat you in making electric lights. I don't think you're working in the right direction. I believe that to chain electric current we will have to divide it, so the light won't be so hot and blinding."

"Divide electric current!" Wallace laughed. "Why that's impossible!"

"I believe it can be done," Edison stated calmly.

From then on, Edison was hooked — and he returned to Menlo Park more determined than ever. Edison was rarely overconfident, but he predicted that he'd have a practical light within six weeks. In reality, it was to take him about 14 months — the most trying project of his career. "I was never discouraged," he said later, "but I can't say the same for other people who were working with me."

Edison and his assistants tried hundreds of filaments; they performed over nine thousand separate experiments. They first experimented with rare metals like platinum and rhodium, but later tried everything imaginable: grasses, palm leaves, bamboo — even a hair from Charles Batchelor's beard!

The early experiments with metals were largely unsuccessful, although Edison *did* patent an early platinum lamp. "Often," recalled Francis Jehl, a young lab assistant, "I saw Edison, as he reached a crucial point in an experiment, dart his fingers through his bushy hair distractedly, or throw away a half-smoked cigar and absent-mindedly take another out of a vest pocket to tear off the tip with a savage bite. No one can guess how many platinum lamps were tested during these experiments, or how many times he sat there past midnight poring over them."

One morning Edison turned to Jehl. "Francis," he said, "have we got a pump around here?" Jehl brought the pump, and Edison mounted a platinum spiral inside a bulb and pumped out the air. The same filament that had produced five candlepower in air produced twenty five in the vacuum! Edison figured that the higher the vacuum he could obtain, the longer his lamps would burn. He assigned Ludwig Boehm, the glassblower, to work on an improved version of the "Sprengel" pump, in which a column of mercury running through a tube literally pushed the air out of the bulb. Boehm delivered the model — a large board covered with tubing. At last, Edison had the vacuum he needed.

Even in the vacuum, though, the platinum filaments were unsatisfactory. To burn brightly, they had to be brought near their melting point, and usually they disintegrated.

One night, Edison sat alone in the laboratory, the flickering gas jets casting dim shadows on his face. Why was it, he thought, that he couldn't seem to find the answer? His backers had advanced him $100,000, but now that money was gone and there wouldn't be any more. The days and nights of the "insomnia squad" just hadn't paid off, and the men were beginning to lose confidence. There *had* to be a solution.

As Edison sat thinking, he toyed with a mortar full of carbon particles at his side. He rolled them between his fingers into a filament. Carbon, he thought — that hadn't worked either; it had always broken apart as the current was applied to it. But then he sat up with a start.

"But that was before we had the vacuum bulb!"

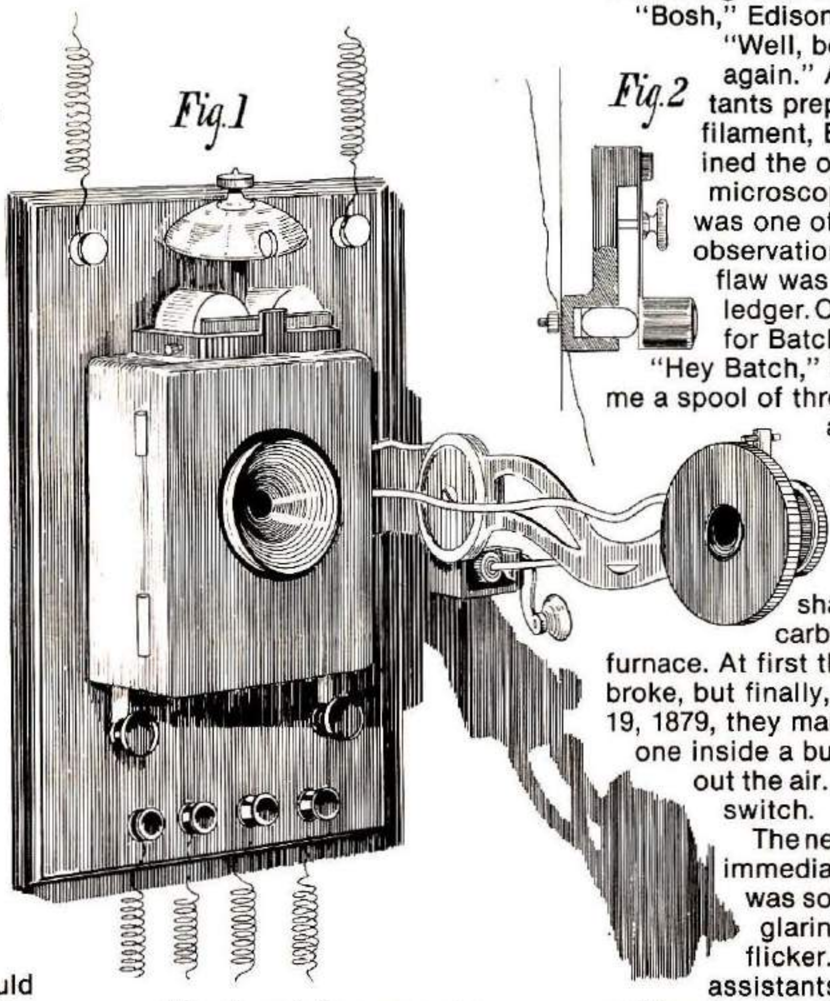
For the next several weeks, Edison and the staff worked with carbonized filaments. For each of the tests, the filament — be it paper, hair, or even a strip of grass — was rolled in the carbon particles, shaped into a horseshoe, and baked in the furnace. Then came the most difficult step: getting the delicate filament into place without shattering it. Usually it would crumble into pieces as it was being inserted in the bulb.

"Bosh," Edison would say. "Well, boys, let's try again." As his assistants prepared another filament, Edison examined the old one under a microscope. His method was one of careful observation, and every flaw was noted in the ledger. One day he sent for Batchelor.

"Hey Batch," he said, "get me a spool of thread. I've got an idea."

Edison cut a short length of thread and formed it into a hairpin shape; Batchelor carbonized it in the furnace. At first the filaments broke, but finally, on October 19, 1879, they managed to seal one inside a bulb and pump out the air. Edison hit the switch.

The new light glowed immediately. Its light was soft, not harsh or glaring, and it didn't flicker. Edison and his assistants sat watching, waiting for irregularities — but there were none. As word of the new lamp spread around the little village to the boarding house, the men filed by the lamp and stared in awe. A lamp lasting more than a few minutes seemed unusual; in fact, they had become accustomed to failure. At first they were silent, but then they laughed, patted Edison on the back and bet each other cigars on how long the lamp would burn. Eventually, though, most of them tired of staring at the



Edison's new telephone as depicted in the July 6, 1878, *Scientific American*. Although the electrical parts changed, the style remained for many years. The microphone (a carbon-button type) is mounted on the wooden box. The jointed arm on the right carries the "receiver," which was a marvelously miniaturized version of his electromotograph earphone. To use the receiver, a person had to turn the little crank (under the arm, right) by hand. This turned a moistened chalk cylinder, which reacted to electric current by producing more or less friction against a stationary contact. This difference in friction was turned into sound waves by means of a diaphragm. The arm was hinged to allow folding out of the way when not in use. (*Drawing retouched from the original by permission of Scientific American.*)

Thomas Edison and Dr. Irving Langmuir discussing the vacuum tube at the General Electric Research Laboratory (*photograph from The Bettman Archive*).

bulb and went back to the boarding house. Only Edison and Jehl remained. The lamp burned through the night and into the next without a flaw.

Between one and two o'clock on the afternoon of October 21st, Edison was satisfied that he had found the answer. He yielded to temptation, and forced more and more current into the lamp, until it expired without warning. Edison recalled the incident: "We sat and watched it with anxiety growing into elation. I was sure that if this rather crude experimental lamp would burn forty-five hours, I could make a lamp that would burn hundreds of hours, and even up to a thousand."

At last the secret had been revealed. Edison was pleased, though not overjoyed — there was much work ahead. The bulb itself was only one link in an immense chain Edison had envisioned from the start of his experiments: an advanced power generation and distribution system that would make gas lighting obsolete.

When Edison announced a public demonstration of his electric lighting system for New Year's eve, his assistants thought he was insane. There were hundreds of devices — switches, fuses, sockets and the like — that had to be invented within 60 days.

Edison finally settled on a filament of carbonized cardboard, and forty of these were made up for the system and installed on Menlo Park's gas fixtures. The dynamo also needed improvement. Edison had previously used batteries for his electric light tests, but now he needed a system that would power dozens of lamps reliably. He made dozens of tests, and readied his first practical dynamo, the "Long-Legged Mary Ann," only days before the demonstration.

As the first of the excursion trains rolled into Menlo Park on New Year's eve, Edison threw the master switch, and forty lamps glowed in unison. The crowd aboard the car was one of New York's finest. The people, dressed in their most elegant party clothes, gasped at the sight and rushed into the lab. Soon, trains, carriages, and wagons arrived, carrying hundreds of curious people. Edison threw open the doors and invited everyone in. "Some of them behaved very badly," wrote a reporter for the New York *Sun*. "Eight electric lamps were stolen . . . a malicious rascal was caught trying to destroy the current and put out the lights by putting a piece of metal across the exposed connecting wires . . . Even kind, patient, and good-natured Edison was angry . . . and perhaps his ill humor was slightly helped by the knowledge that an inebriated pseudoscientist was in the crowd villifying him and belittling the results achieved."

Edison, dressed in an old gray shirt, flannel coat and chalk-stained trousers, stood by the generator and caught quips of conversation — most people mistook him for a coal stoker. Occasionally someone would recognize him, and at the cry of "There's Edison!" people crowded around the famous inventor.

"Many of them had come in," reported a New York newspaper, "with the expectation of seeing a dignified, elegantly dressed person, and were much surprised to find him a simple young man attired in the homeliest manner, using for his explanations not high-sounding, technical terms, but the plainest and simplest language."

The New Year's exhibit was a great success in the eyes of the public, but some critics were skeptical of the new system. On January 4th, 1880, the New York *Times* encouraged "sensible people not to throw away their gas stock or rush into speculation on electric stock." Just the same, the investor's confidence in "The Wizard of Menlo Park" was overwhelming, and shares of stock in the new Edison Electric Light Company floated at $100 soared as high as $4,000.

It was during the improvements on the electric light that Edison discovered a phenomenon which is still made use of in today's radio equipment. Just as he had with the "etheric force," Edison stumbled upon it by accident; and his keen sense of observation led to a new discovery which was to become the basis of modern electronics.

Edison's carbonized-filament lamps were remarkably efficient, but they had one overriding problem: after they had burned a few hours, they left a dark film on the inner surface of the bulb.

A lab assistant, William Hammer, is said to have pointed out that there was a small line of glass — a "ghost", as they called it later — that didn't become blackened. It appeared almost as if the positive leg of the filament had cast a shadow across the inside of the bulb. Edison tested the film, and his hunch was confirmed — the material was carbon. Apparently, the filament was giving off some sort of negative particles, which hit the inside surface of the bulb everywhere except directly behind the positive leg of the filament, which was soaking them up!

To test his theory, Edison sealed a wire inside the bulb between the positive and negative legs of the filament. When he connected the other end of the wire to the negative side of the battery, he got nothing; but when he connected it to the positive, the resulting current flow drove the needle of his sensitive galvanometer right off the scale. Later, at the Philadelphia Exhibition, Edison demonstrated that this current he pulled out of a vacuum was strong enough to operate a telegraph sounder!

What Edison had discovered, in effect, was an inexhaustible source of free electrons. He filed for a patent on the "Edison effect" on November 15th, 1883.

"I have discovered," he stated in his application, "that if a conducting substance is interposed . . . within the globe of an incandescent electric lamp, and said conducting substance is connected outside of the lamp with one terminal, preferably the positive one . . . a portion of the current will . . . pass through the shunt circuit thus formed, which shunt includes a portion of the vacuous space within the lamp."

Edison, of course, couldn't foresee the uses the "Edison effect" was to have in radio, but he did search for an application. His patent, which was granted October 21st, 1884, covered the use of the "Edison effect" bulb as a governor to control the output of electric generators. The effort failed, due to the difficulty of maintaining a high vacuum within the bulbs, and Edison, who was preoccupied with the expansion of his electric company, "didn't have time to continue the experiment."

In 1882, Sir John Ambrose Fleming, who was then an advisor to the Edison Electric Light Company in London, also experimented with the "Edison effect." Six years later, he discovered that the Edison-effect bulb could be used to rectify alternating current.

Beginning in 1899, Fleming worked as an advisor to the Marconi Wireless Company. A few years later, Marconi and Fleming were experimenting with a "coherer" — a primitive form of radio detector in which silver particles were enclosed in a glass tube. As a high-frequency radio wave coursed through the coherer, its silver particles aligned and effectively rectified the signal, but there was one drawback: the silver particles stayed in place even after the signal was gone, and the wireless operator had to "reset" the coherer by tapping it with a hammer!

One evening Fleming was experimenting with a new chemical detector when it occurred to him: why not try the lamps? Needless to say, the "lamps" worked perfectly. "The missing link in wireless was found," said Fleming, recalling the experiment, "and it was an electric lamp!"

The wireless telegraphy patent

In 1885, Guglielmo Marconi was eleven years old. Hertz was not to advance his theory of electromagnetic waves for two years. The longest telephone line in the country was less than 300 miles. And Thomas Edison filed for a patent on a system of wireless telegraphy.

Edison's system was based on induction, not "etheric force," but it was a remarkable prophecy of wireless to come. The system actually sent messages over short distances, and was the first to use transmitting towers. Marconi's system, some ten years later, was to use the high-frequency Hertzian waves, of course, but the similarity between the two is striking.

Edison's device consisted of a telegraph key hooked to a sort of electric buzzer that generated a rough electric spark. The spark was amplified by an induction coil, and sent to a tall antenna, where it leapt through the "ether" into a receiving antenna, through a motograph receiver, and into the ground. In his patent application, Edison predicted how radio was to be used:

Edison experimenting with the first motion picture machine — another of his fields of experimentation — in 1905 (*photograph from The Bettman Archive*).

"I have discovered," he stated, "that if sufficient elevation be obtained to overcome the curvature of the earth's surface and to reduce to a minimum the earth's absorption, electric telegraphy or signalling between distant points may be carried on by induction, without the use of wires connecting such distant points."

Edison sold his patent, #465,971, to Marconi in 1903, for what he termed "a song."

The wireless patent was put to use one year later, when it was used to send telegrams from moving trains on the Lehigh Valley Railroad. The rails acted as a ground, and the messages were sent via an antenna on the roof of the car to a telegraph wire running alongside the track. Though the messages were sent through only a few feet of air, this was probably the first practical application of "wireless" ever devised.

Edison did no further work with his "wireless," as he was diverted by other projects. But his conceptions of antennas, towers, "absorption," and the like were remarkable mirror-images of radio to come. A dozen years later, Edison remarked to a friend that he thought wireless signalling across the Atlantic might be possible someday, but he didn't know when. Marconi did just that in 1901, and Edison asked to meet the man "who had the monumental audacity to attempt and succeed in jumping an electric wave across the Atlantic."

Marconi recalled Edison's comments on his achievement: "I shall never forget Mr. Edison's laconic comment, 'If Marconi says it's true, it's true.' Nothing ever pleased me as these words."

Edison touched radio only indirectly; had he been born 20 years later, his best-known work would probably have been in that field. He pioneered in radio while the sending of messages through the air was still considered folly, and the critics gave him their worst. Fortunately, Edison had the foresight to turn his deaf ear on them. His was a method of trial and error, inexhaustible curiousity, and careful observation.

"In another age and time," said Henry Ford, Edison's lifelong friend, "each of Edison's inventions would have been considered either as unique scientific discoveries or as scientific toys. The older scientists made their discoveries as things of themselves and were so far away from the daily workaday world that they would have lost standing had they even suggested the possibility that their studies could have any commercial application. Then Edison came along — a greater scientist than any of them but without being bound by the old scientific traditions. He was a scientist, but also he was a man of extraordinary common sense. It was a new combination."

Certainly Edison's discovery of "etheric force" accords him a place in radio history; but when we add the microphone, the "wireless" experiments, and the "Edison effect" to the picture, his place in the development of radio becomes strikingly important.

"Discovery," Edison said, "is not invention, and I dislike to see the two words confounded. A discovery is more or less in the nature of an accident. A man walks along the road intending to catch the train. On the way his foot kicks against something and he sees a gold bracelet embedded in the dust. He has discovered that — certainly not invented it. He did not set out to find a bracelet, yet the value is just as great." So it was that Edison stumbled upon some of radio's most essential principles; and when, at the time, he couldn't find application for them, he blamed no one but himself. "My experience," he said, "is that for every problem the Lord has made He has also made a solution. If you and I can't find the solution, then let's honestly admit that you and I are damned fools, but why blame it on the Lord and say He created something impossible?"

Acknowledgement

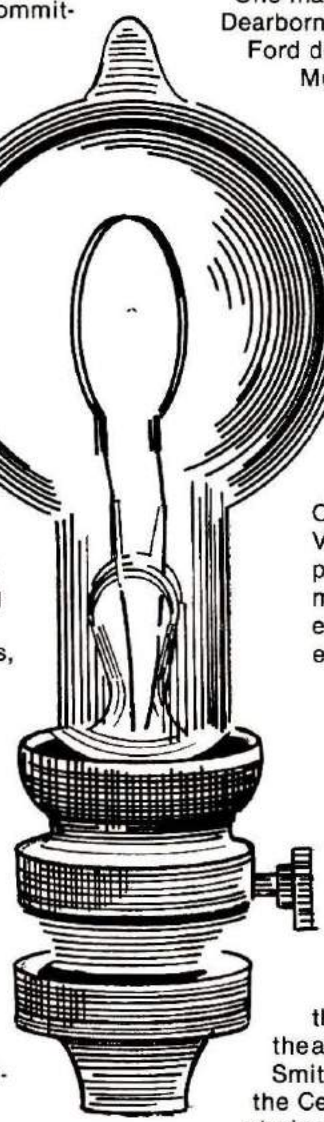
Thanks are due to the people at Greenfield Village and The Henry Ford Museum, Dearborn, Michigan, for their valuable assistance to the authors in preparing this article.

HRH

International Centennial of Light Planned for 1979

A year-long "Centennial of Light," an international celebration to commemorate the 100th anniversary of Thomas Edison's invention of the incandescent electric light bulb on October 21, 1879, was announced by Walker L. Cisler, chairman and chief executive officer of the Thomas Alva Edison Foundation, headquartered in Detroit, Michigan.

At the same time, Cisler announced that Robert I. Smith, chairman of New Jersey's Public Service Electric and Gas Company would head the International Committee for the Centennial of Light. The committee, made up of industrial leaders, will direct and coordinate the numerous activities planned for the centennial. "The main objective of the Centennial of Light," according to Committee Chairman Smith, "is to regenerate enthusiasm for invention and innovation. Clearly, Edison typified this enthusiasm for scientific and technological advancement as a service to mankind's quality of life. During the next year," Smith continued, "we will endeavor to instill in today's generation and future generations a recognition that there are solutions to today's problems. They only need to be sought and found."



Smith said that Edison is the pre-eminent example of the highly principled inventor-businessman, whose developments served to benefit civilization and freedom. Paraphrasing an Edison biographer, he said, "Although Edison led no armies, conquered no countries, enslaved no people, his life and his inventions have influenced the course of history more than any other person in recorded civilization."

Besides the incandescent bulb, Edison invented the entire system of electric generation and distribution which carried his "magic" first to cities, then to rural areas and, finally, throughout the world. He also invented the phonograph, the motion picture camera, and equipment that made telephone and telegraph systems commercially practical. His scientific genius had a direct bearing, according to industry leaders, on the growth of today's electronics world, including radio, modern motion pictures and television.

Since the light bulb is only one of more than 1,000 inventions patented by Edison, numerous and diverse organizations plan to participate in the Centennial celebration. Among those already planning special programs, events and activities for the Centennial of Light are the American Association for the Advancement of Science; the Smithsonian Institution of History and Technology; the United States Park Service; the Edison National Historic Site in West Orange, New Jersey, the site of Edison's research laboratory; and Menlo Park, New Jersey, the city in which Edison conducted his successful experiments with the incandescent lamp. Also, the New Jersey Historical Commission; Fort Myers, Florida, the site of Edison's winter home and former site of his "Fort Meyers Lab"; the Electric Power Research Insititute; the Edison Electric Institute; and Rutgers University, which is initiating a 20-year project to organize and publish all of Edison's scientific papers.

In addition, numerous corporations in the electronics industry, both here and abroad, will celebrate the Centennial of Light to honor the man whose genius was the source of their corporate technologies.

One major focus of Centennial activities will be Dearborn, Michigan, where 50 years ago Henry Ford dedicated Greenfield Village and the Ford Museum to American values and ingenuity, and to the man he considered the greatest genius the world has ever known.

To create the full effect, Ford removed the 82-year-old inventor's first laboratory board-by-board and nail-by-nail from its original site in Menlo Park. Ford was so particular about details that he even transplanted the actual earth from the building's front yard. Upon first seeing the reconstructed laboratory, Edison wryly remarked, "Wonderful, only our floor was never as clean as this."

On October 29, 1929, at the Greenfield Village site, Edison re-enacted the entire process of what is called the "miracle of the millenium," the invention of a long-lasting electric light that was safe, practical, and efficient. He was assisted by Francis Jehl, as he had been 50 years before. In addition to Ford, other dignitaries present were President Herbert Hoover, Madame Curie, George Eastman, Harvey Firestone, and Cyrus Eaton.

Another center of activity will be West Orange, New Jersey, where Edison lived and worked for many years. The National Park Service now maintains the site and conducts tours of the laboratory buildings and Glenmont, Edison's home. Plans call for the inviting of a number of dignitaries to the area and for a series of special celebrations.

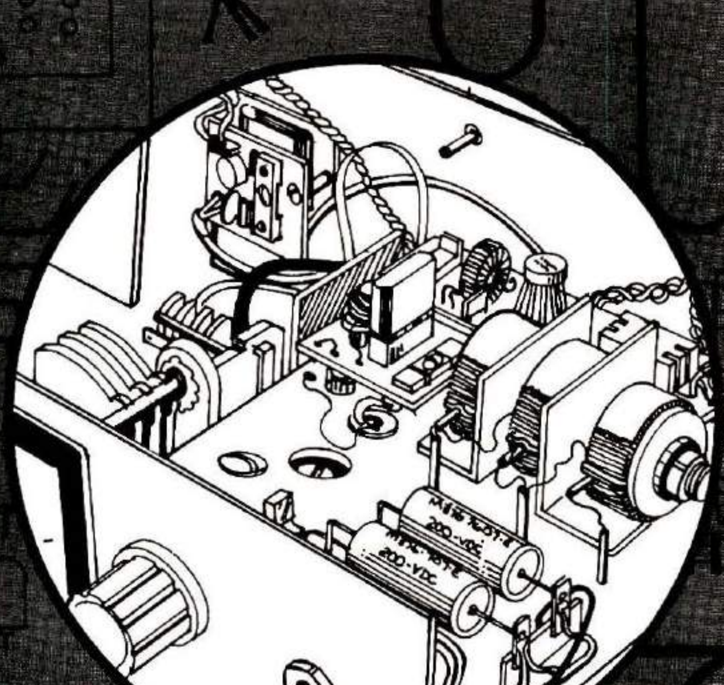
Smith also announced that major elements of the Centennial of Light are designed for students and educators. Symposiums will bring selected high school students and teachers to Florida's Disneyworld in February, and university students and professors to San Francisco, in April.

Furthermore, science fairs will be encouraged in elementary and high schools throughout the country. Educational materials and scholarship programs will emphasize the need to encourage young people to pursue scientific knowledge. Other plans include special films, television and radio programs, traveling exhibits, displays, lecturers, and parades.

For more information, contact George Shea, International Committee, Centennial of Light, Thomas Alva Edison Foundation, P.O. Box 1310, Greenwich, Connecticut 06830.

NOVICE RECEIVER

PART 2



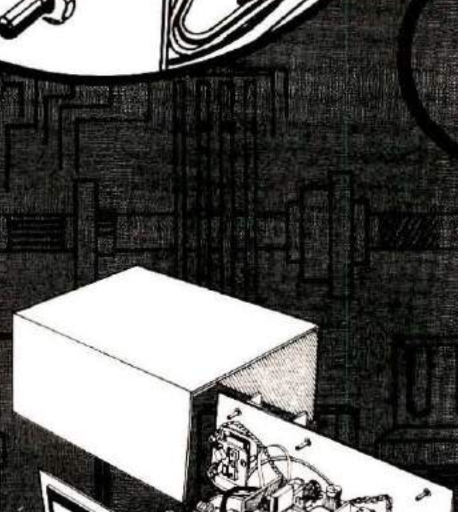
BY BILL WILDENHEIN, W8YFB

Last month, in **part 1**, I told you about some of the design features of the receiver, and how to make your own printed-circuit boards if you want to try your hand at them. This month I'll get into winding some of the coils, and a bit of testing the stages and the whole receiver. I'll include some more information on a couple of PC boards and on mounting the tuning dial and VFO tuning capacitor as well.

Speaking of the tuning capacitor — there are many substitutes which will work well there. I mentioned the surplus ARC-5 units in **part 1**. Another possibility is the three-gang fm broadcast receiver type which you'll find on sale as surplus from time to time. Or, you may be able to pick up a complete receiver as junk and salvage the capacitor. Use the ones that are for fm tuning only; the combination capacitors that tune both fm and a-m are too bulky. The fm units usually have a capacitance of approximately 15 pF per section. You can tie all three sections in parallel to obtain 45 pF, which will work well with L11 wound as described in **Table 3, part 1**, (February, 1979). If you find a capacitor with more than 45 to 50 pF, you may have to remove a few turns from L11. Don't stray too far from the recommended values, however, because the frequency coverage and tuning rate will suffer.

Other desirable features to look for in a capacitor are good bearings (smooth action, as well as good electrical contact to the rotor), a frame that is rugged (for stability), and plates that do not short together at any point in rotation. You may find some capacitors with a built-in ball drive for vernier tuning. Most of these drives are too fast for good tuning in this receiver, but you can add another drive to it for a very effective ratio. For instance, I picked up some surplus drive units with a 6:1 ratio at a flea market. They cost only 50 cents apiece, and, when placed ahead of an fm-type capacitor with its vernier drive, the combination performed very nicely.

Another place you can



Part 1 Available

February's *Ham Radio Horizons*, which contains **Part 1**: Build a Novice Receiver, is available for $2.00 postpaid from *Ham Radio Horizons*, Greenville, New Hampshire 03048.

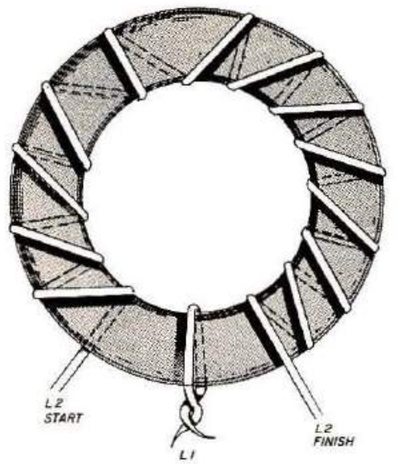


Fig. 21. Coil winding layout for L1/L2. Wind the secondary, L2, first. Remove the insulating varnish for approximately 12 mm (½ inch) at each end. L1 is one turn of insulated hook-up wire, ends twisted as shown. Remove the plastic insulation at the ends where the wires will connect to the circuit board.

substitute one component for another, and perhaps save a bit of money, is L12. This is a 500-microhenry rf choke, which you can obtain new, of course. However, if you have old tv sets kicking around, you'll find some in the video sections. They're called peaking coils, and many of them have a value near 500 μH.

Winding the coils

If you have never wound coils before, you might have difficulty in removing the insulation from the wire. Don't place the wire on a hard bench or table and scrape it with a knife, as I have seen some builders do. The bench is hard, and does not allow for any cushioning to prevent nicking the wire. You can learn to hold the wire against your thumb, with the knife blade pressing against the wires to scrape the insulation off. This provides a cushion, and allows you to feel how much pressure you are placing on the wire. Another method is to use a folded piece of fine sandpaper and pull the end of the wire through it until all the varnish has been removed for a half-inch or so.

Most of the coils are straightforward and can easily be wound with the number of turns given in **Table 3** in **part 1** of this article. The only tricky one is L6/L7, used for the product detector shown in **Figs. 1** and **5 (part 1)**. This is called a *quadrafilar* coil, which means that the winding is made up of four wires twisted together to form a stranded conductor. The stranded four-wire conductor is then wound into the toroidal core. You need this type of transformer to get very tight coupling between windings over a wide frequency range.

You'll note in the description of L6/L7 (**Fig. 23**), that some of the windings have black dots beside them. This means that the wires by the dots all come out on the same side of the toroid; it's a way of keeping track of their polarity. If the coils are incorrectly connected together, performance will be poor. The windings are connected as a 3-to-1 step-up transformer; with 1 volt in you get 3 volts out. If one winding is wrong, two of them will buck each other, you'll get a soggy 1-to-1 ratio; and the receiver will not work well.

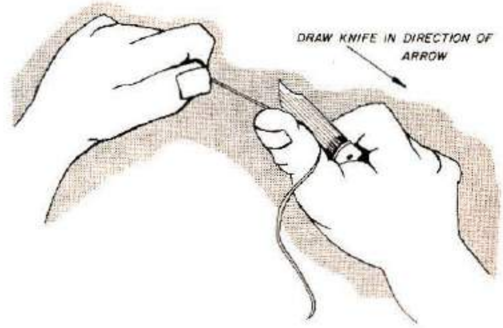
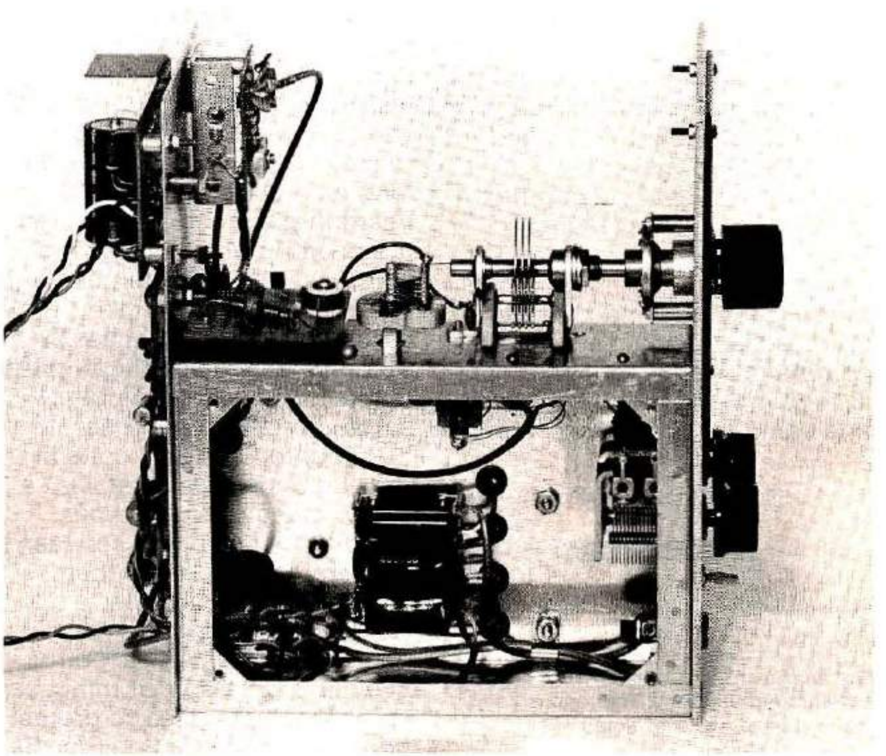


Fig. 22. If you like to use a knife to scrape insulation from wire, do it this way. Your thumb provides a cushion for the wire so the blade doesn't nick it, and you can easily adjust the pressure needed to remove insulation without damaging the copper.

Fig. 24 shows a little "twister" I made to twist wire together to form a stranded conductor. It's simply a little crank with a hook in one end to hold the wire, and a piece of

The capacitors which are part of the audio-filter circuit are prominent in their position at the bottom center of the chassis. The variable capacitor at the lower right, partially hidden behind the chassis lip, is the rf preselector tuning (or mixer-input tuning) C1. Note the trimmer capacitor, C27, next to the VFO tuning capacitor, C28, and the VFO circuit board mounted on the chassis near the back panel.



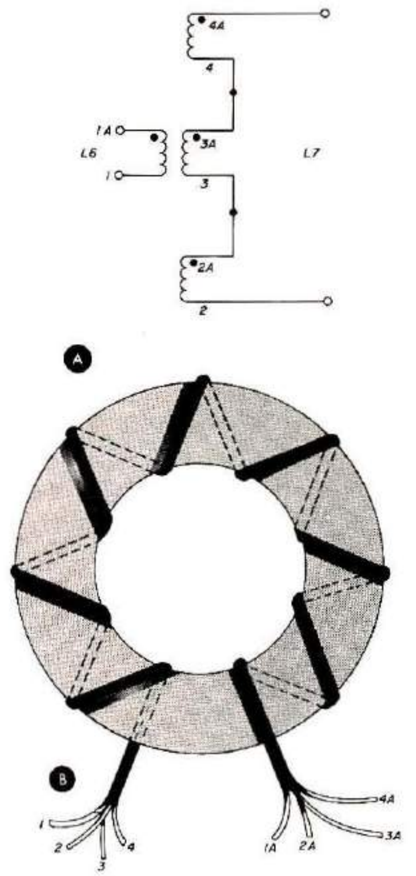


Fig. 23. The quadrafiler coil, L6/L7, is wound and connected as shown. The dots by the wires are a way of keeping track of the polarity of each winding. Check each wire for continuity, and label each with a piece of masking tape.

small-diameter tubing which you hold between the fingers of one hand while you turn the handle with the other. To use this twister to make the windings for L6/L7, clamp the ends of four 30-cm (12-inch) lengths of wire in a vise, tie the four strands to the hook, pull them tight, and wind them up until each wire makes a complete twist every 5 to 6 mm (3/16 to 1/4 inch). You can use this same twister to form the

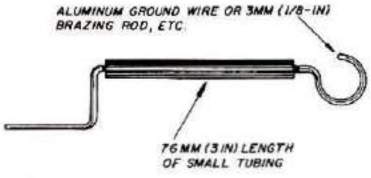


Fig. 24. A wire-twister is a handy tool to have around the shop. This one is easily made from a piece of scrap wire and a piece of tubing.

two-wire stranded conductors that go from the power-supply terminals to each of the PC board assemblies (see **Fig. 1**). Use two different colors so you can keep track of which is which, and be sure that the pair going to the audio amplifier is no longer than 15 cm (6 inches).

Mounting the coils

Toroidal coils can be difficult to mount if you don't know a couple of tricks. You must fasten them well enough that they will not move, yet not put pressure on the wire. Also, the windings must be protected from any sharp, metallic edges.

My method of mounting them makes use of a screw, some insulating sleeving, and two soft washers of rubber or plastic (**Fig. 25**). The screw goes through the center of the toroid, with some sleeving to protect the wires from the threads. A soft washer on either side of the toroid protects the windings and applies enough pressure to prevent the assembly from turning or moving. A self-locking nut is used to hold the whole package together. Self-locking nuts can be obtained surplus, or can be salvaged from junked airplane electronic gear being stripped for parts. If you have a piece of threaded rod, as I did, you can make it long enough to hold the PC board in place too. Just fasten the board in place on the rod with a regular nut, then use a short spacer to hold the assembly above the chassis. Some junked tv sets have extra-long screws which can be salvaged for this purpose.

I mounted all three coils in the audio lowpass filter with a single piece of rod and put sheet-rubber washers between the toroids to cushion them and keep them in place. Automotive floor mats are a good source of soft rubber or plastic for this sort of thing, as are the runners used to protect floors and carpets. See **Fig. 16**

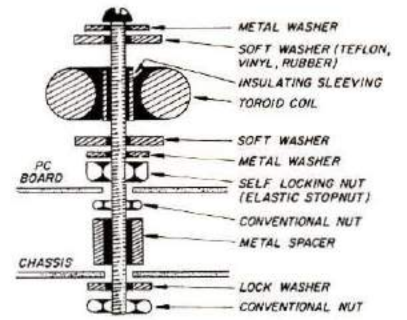


Fig. 25. The mounting hardware and assembly sequence for the toroidal coils. The pressure from the soft washers should be just enough to keep the coil from moving about. You don't have to mount the printed-circuit board below each one, but this illustrates how it can be done if you wish.

for the correct connections of the toroids in the audio lowpass filter.

Dial and tuning capacitor

Smooth tuning of the receiver depends upon proper installation and alignment of the dial and the variable capacitor it drives, so take particular care to get them just right. I used a Jackson Brothers dial, shown in the photographs, but you can obtain good results with many others. However, I caution you not to skimp on the dial — a quality product will provide smooth tuning and freedom from backlash for many years and is well worth the slight extra cost.

First, mount the capacitor (C27) on the side of the chassis. Carefully locate and drill the large clearance hole for the dial drive mechanism (just the part that drives the capacitor shaft, not the mounting holes at the edge of

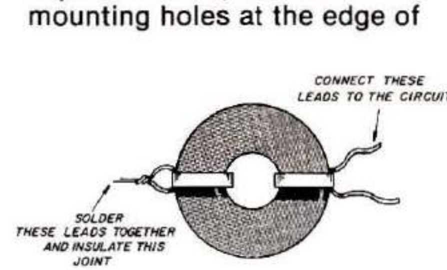


Fig. 26. The 88-mH toroids you buy as surplus usually have four wires coming from the windings. Connect two of them together, solder them, and insulate them with tape before you mount the coil.

the bezel). If the capacitor is too close to the panel, or might be damaged by the drill, remove it before drilling the panel. Place the dial in its proper position (hold it with some masking tape) and tighten the setscrew to the capacitor shaft. Then, being careful that nothing slips out of alignment, *start* the drill for the holes to mount the dial; don't go all the way through. Remove the dial (loosen the setscrew and remove the tape), and finish drilling the mounting holes all the way through the panel. Remove all burrs and chips and replace the dial.

When you have the dial mounted, turn the pointer to the "zero" mark or position on the scale. Rotate the capacitor shaft until its plates are fully meshed, then firmly tighten the setscrew. If you've gotten everything properly aligned, the knob should turn smoothly from one end to the other, driving the capacitor from closed to fully open.

Power-supply economy

Fig. 1, in **part 1** of this article, shows a power supply that uses a small transformer with a 12-volt secondary. If you were lucky enough to find a tv transformer with extra filament windings when you built the beginner's 50-watt transmitter (July and August, 1978, *Ham Radio Horizons*), you can save a bit of money by wiring it up as shown in **Fig. 27**. Remember what was said in that article about transformer windings aiding or bucking; if you connect them in series with the voltages aiding, you'll get 24 to 26 volts out of the rectifier bridge. This then feeds the regulator in **Fig. 1**.

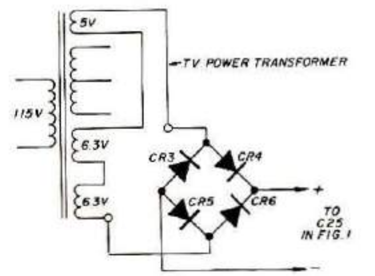


Fig. 27. You can "borrow" some voltage from the power transformer in your transmitter if it has enough extra windings. The diodes in the bridge rectifier can be mounted on the board on back of the receiver, or near the transformer in the transmitter. In either case, you'll need two wires from the transmitter to the receiver. Caution — be sure that no other voltages are present on these windings, or you may damage your receiver.

Polystyrene precautions

The polystyrene capacitors used in the VFO are sensitive to heat and to some chemicals. That is, some cleaning solutions will cause the plastic to dissolve or craze. Use common drugstore 91 per cent Isopropyl alcohol and a toothbrush if you must clean soldering residue from the PC board or anything near these capacitors. Also, use a heatsink on the leads going into the plastic when you solder the capacitors in place, just as you do for a transistor. Heat can soften the seals, or it can cause the plastic to expand, changing the characteristics of the capacitor. An ordinary alligator clip will serve as a heatsink if you do not have any of the special clips made for this purpose.

There are times when you need to know if there is rf

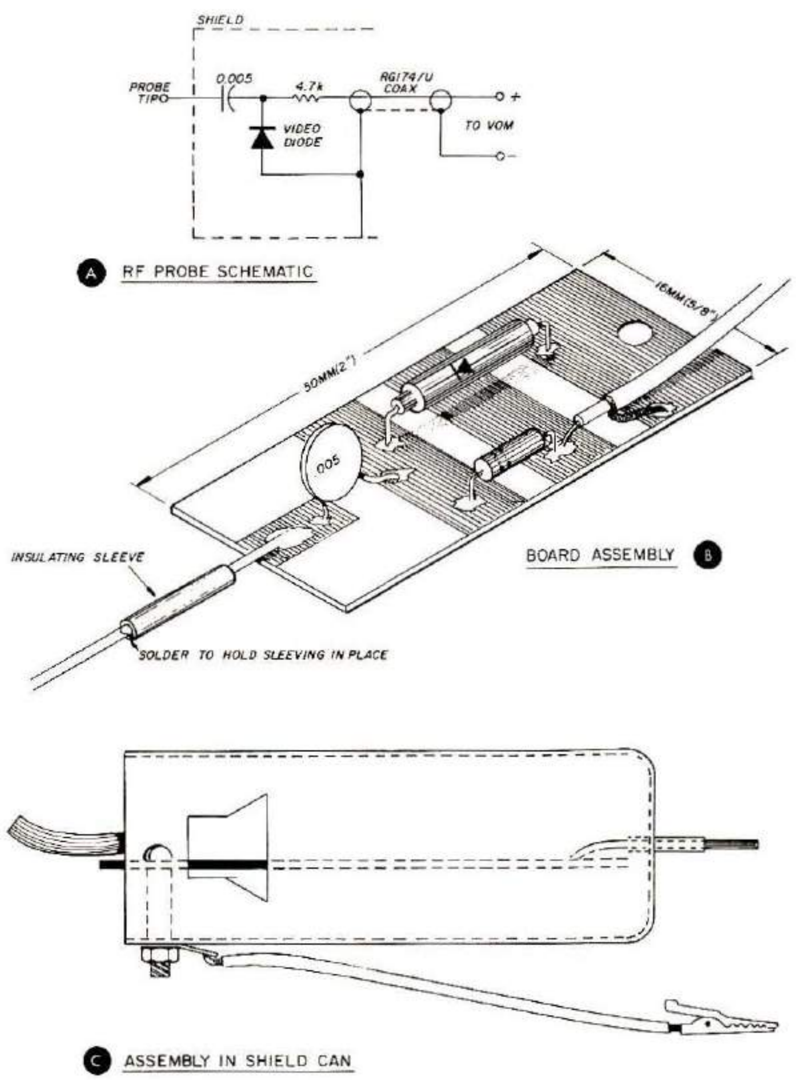


Fig. 28. You can make an rf-voltage probe out of a small scrap of PC board and the shield from an old i-f can. It will give you relative readings that will be very useful in testing oscillators and other parts of the circuit. Use a 20,000 ohm-per-volt VOM as an indicator.

energy in some part of the circuit, and approximately how much. For instance, suppose you cannot find the signal from your BFO crystal (while listening on another receiver). Without some means of measuring rf voltage, you can't be sure that the oscillator is working. **Fig. 28** shows details of a probe I built for essentially zero cost; it uses many parts from scrap tv sets. The diode is a germanium detector type, often used in the video section (it cannot stand much heat, so be careful while soldering). A shield can from one of the i-f stages provides protection for the assembly.

Although actual rf voltages can't be determined, this device will give you some *relative* readings. It will work with as little as 0.1 volt of rf to the probe. A 20,000 ohm-per-volt VOM makes a sensitive indicator for these tests. The probe is useful from approximately 50 kHz to 60 MHz.

Putting it all together

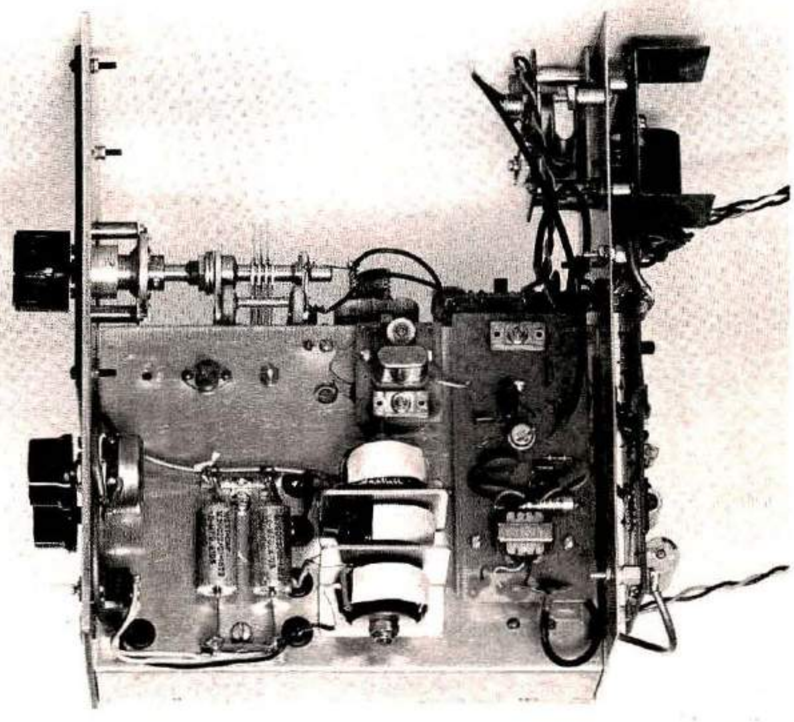
I assume that by now you have all the PC boards wired and are ready to consider packaging the receiver. There are many ways to go, but you can see in the photographs and in **Fig. 29** how I did it. Study the possibilities carefully before you make a move. I used a 12.5 × 17.8 × 5 cm (5 × 7 × 2 inch) chassis, but a larger one might be easier for a beginner to work with — perhaps 17.8 × 17.8 × 5 cm (7 × 7 × 2 inch). Keep in mind that a larger chassis will require a larger enclosure, too.

The mixer stage is built using conventional "point-to-point," chassis-type construction; I could have used printed-circuit board, as in **Fig. 18, part 1**, or perforated board. A couple of things to remember: keep the power supply and 1-watt audio board *outside* the compartment to minimize heating of the VFO components. Also, leave plenty of room around the VFO capacitor and associated circuits; this contributes to both mechanical and temperature stability.

When you have all the boards mounted and the mixer and VFO stages wired, you are ready to test the circuits, one at a time. Start at the audio section and work toward the front end — you'll be able to hear things happening as you go. If you have an audio oscillator, connect its output (through a high-value resistor) to the top (ungrounded) end of R3. You should be able to increase or decrease the volume in the speaker by turning R3 up and down. If not, check voltages and pin connections to find the error. Follow this same procedure with each stage; apply an input signal and listen for an audio response. The audio signal will work as far back as the output (pin 5) of T1. You'll need an rf signal at 1746 kHz (approximately) to test the product detector and KY* filter, and you should be able to hear 80 or 40 meter signals (or a signal generator in that range) when you get to the antenna input connector.

You can leave the KY filter disconnected for your initial testing if you wish. Just connect a jumper wire from the top of L4 to L6. With the filter disconnected you'll be able to copy ssb signals on 80 and 40 meters. The filter is easy to adjust when you decide to wire it in — rock the tuning capacitor dial back and forth while you listen to a steady carrier or CW signal. Adjust the filter tuning capacitor (C4) a little bit at a time until you

A top view of the receiver shows the toroid coils for the audio filter, and the crystal filter (KY filter) just above them at the center of the chassis. The board at the right of the chassis is the product detector. The crystal-controlled BFO is on the small assembly at the top right, mounted inside the back panel.



*The KY filter has been described in European literature, particularly in articles by DJ2KY. The crystal serves as part of the coupling between two transformers. An inductance or tuned circuit is placed in parallel with the crystal to tune out the capacitance of the holder.

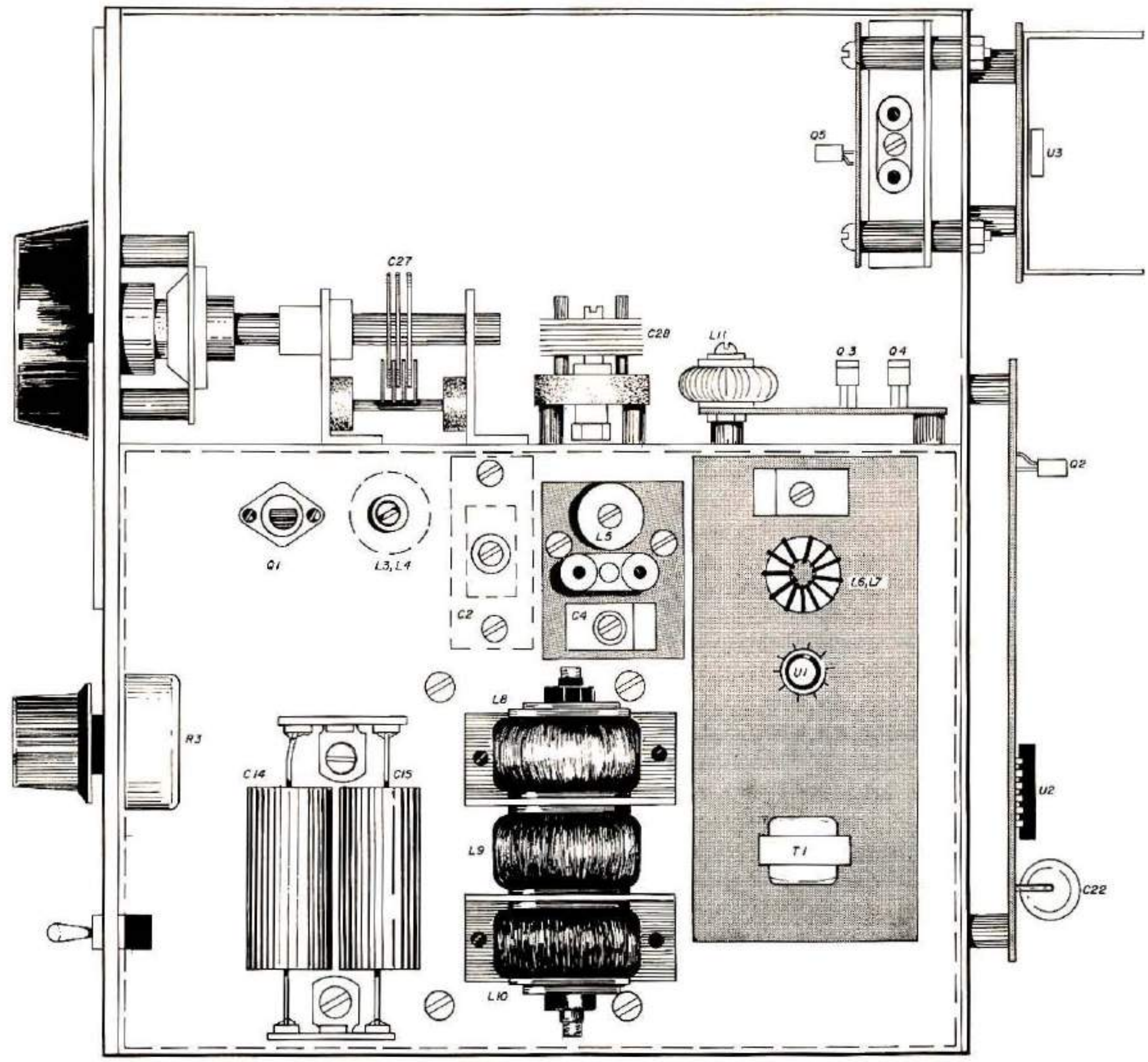


Fig. 29. This top view of my receiver layout will help you plan the parts placement for the one you build. Try the parts and circuit boards for size before you start drilling the chassis. If you use a larger chassis, be sure to keep the area around the VFO tuning capacitor (C27) clear.

notice that the audio note on one side of zero beat is weaker than on the other. Keep adjusting until the "low-volume" side is as weak as possible. This is how you get selectivity through the filter to eliminate interference from nearby signals. Now you'll find that *some* ssb signals cannot be tuned in — you've eliminated one sideband. If you feel like experimenting, you can mount a small wafer switch (single-pole, single-throw) very close to the filter and wire it up to short out the crystal in one position. The switch will require a shaft extension to the panel so you can operate it, of course. Now, you can listen to ssb signals simply by tuning in the proper sideband as before. The KY filter will have to be readjusted after the switch is added, however, because the wiring and switch will add capacitance to the circuit. Also, it would be wise to swap the crystals again, retuning each time, to be sure that you have them in the best position.

Audio amplifier

One adjustment must be made to the audio-amplifier transistor, Q2. Connect a VOM, set to read in the 10- or 20-volt range, between the *collector* of Q2 and the common (ground) bus. The positive lead goes to the transistor. The reading should be close to half of whatever your power supply voltage is. If it is more than 0.5 volt high or low, you should change the value of either R4 or R5 to bring the voltage to the right setting. An incorrect voltage here will not be destructive to the transistor, but will cause audio distortion — especially at higher volume levels.

Interference

There is not much selectivity in the front end of this receiver, so strong foreign broadcast stations at the "image" frequency may be annoying.* An external wavetrap will take care of most of them. I built one in a shielded metal box, **Fig. 30.** It is simply a series-tuned circuit tapped onto the center conductor as it goes through the box. This shunts the energy from the unwanted station to ground, instead of letting it get to your mixer and on into the i-f and detector stages. I've put a tap on the coil for use with the 20/15/10 meter converter (which I'll describe in a later issue of *Horizons*).

The trap is easy to adjust — simply tune the receiver to the 40-meter band and pick out a strong broadcast signal. Now, adjust the trap (C_t) for minimum signal. Next, tune the receiver to the 80-meter band and receive amateur signals there without image interference from the 40-meter broadcast stations. The same system works in the other direction too — if strong 80-meter signals are bothering you on 40, just tune the trap (C_t) to get rid of them. Keep in mind, however, that if you are tuning 40-meter amateur signals, this trap will *not* get rid of 40-meter broadcast signals! Only a change in the international frequency allocations can do that for you!

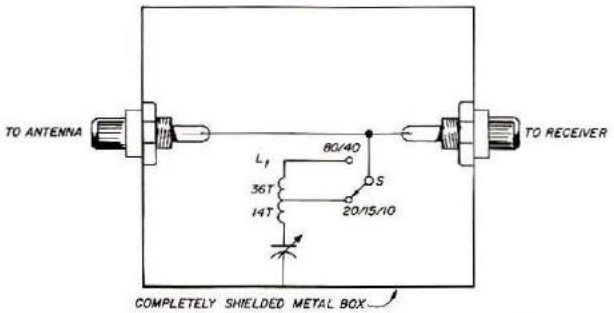
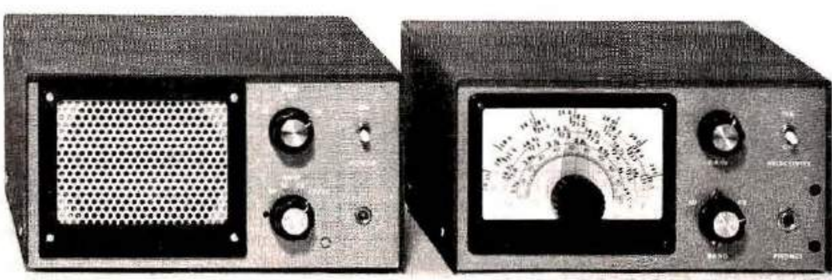


Fig. 30. A wavetrap is useful to tune out unwanted stations on the image frequency. It can be built in a small aluminum box with phono-type connectors on each end. L_t is 50 turns of No. 28 (0.3 mm) enamel-covered wire on a T-50-2 core. Tap at 15 turns. C_t is a 365-pF broadcast-set capacitor. The switch can be a small toggle or slide-type, single-pole, single-throw.

Comments

The completed receiver has performed so well for me that I am building another one much smaller, to be packaged with a small, solid-state transmitter. They'll form a self-contained station I'll carry with me as an emergency rig on research flights to the Arctic and other places. This, in itself, suggests one answer to the old question, "Does home brewing pay?" There are many other answers as well; even if a project turns out wrong, you've learned some valuable lessons. The trick is to develop a skilled craftsman's itch to do the impossible, and do it well. In a home workshop you may not have access to all the machinery and instruments that are in a commercial shop, but you will learn to substitute originality, skill, and persistence, to turn out quality products. You'll learn what and where to modify, you'll develop your own set of "pet tricks," and gradually you will become a "professional." The advantages of this type of experience will show up in many ways as you move up the ladder. I wish you could all have the fun of working with a "far-out" research crew, as I do — to be there when one of them muses, "I wonder if we can . . ." and to still be there when you and the team have proved again that impossible doesn't exist. Then, you'll know the answer to the question "Does home brewing pay?"

HRH



A companion enclosure contains a speaker and the power transformer for the receiver. It also contains a converter to allow the receiver to cover the 20, 15, and 10 meter bands, which will be described in the next issue of *Ham Radio Horizons*.

*The "image" signal in a receiver is produced by a heterodyne between the local oscillator (VFO) and a signal that differs from it by the intermediate frequency. Suppose you are listening to a signal on this receiver at 3730 kHz; the i-f is 1746 kHz, which means that your VFO is tuned to 5746 kHz (3730 plus 1746 equals 5476). A signal at 7222 kHz can be heard just as well, if it is strong enough to get by the first tuned circuit (L1/L2) in the receiver. The signal at 7222, minus the VFO frequency of 5476, equals 1746 kHz, which is the i-f in this receiver. So, if you are listening on 80 meters, the 40-meter signal (7222 kHz) is the image — if you tune to 40 meters, an 80-meter signal would be the image. **Editor**

THERE IS A DIFFERENCE IN QUARTZ CRYSTALS

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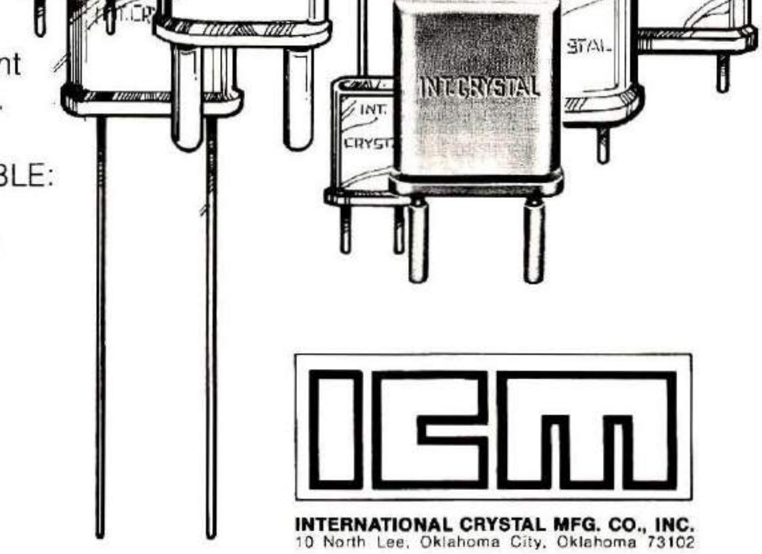

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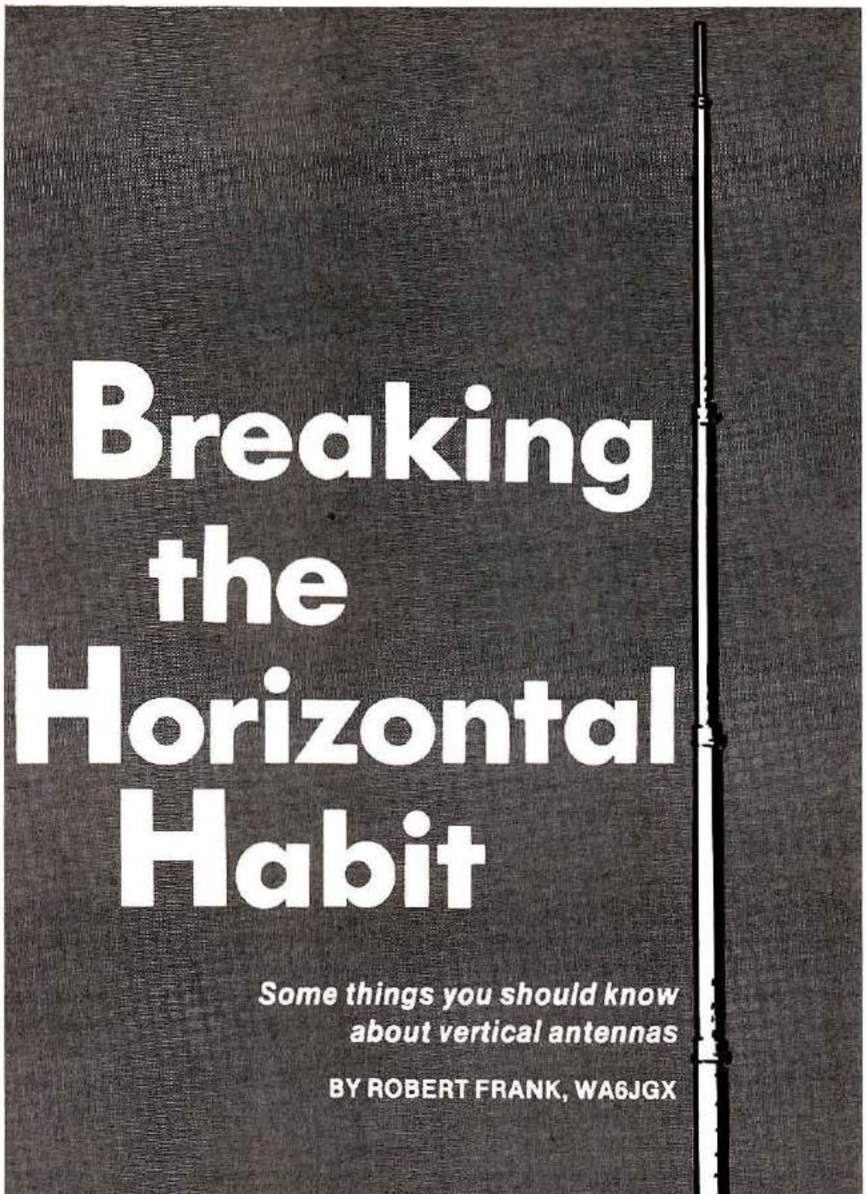
Breaking the Horizontal Habit

Some things you should know about vertical antennas

BY ROBERT FRANK, WA6JGX



There she stands, the uppermost tip waving gently in the breeze. She? Ever wonder why a vertical antenna would be a "she"? I'm not sure. But boats are feminine, hurricanes used to be exclusively feminine, and women are beautiful. To a ham, an antenna reaching skyward is a thing of beauty. Need I say more?

Before I go further, let me explain that I am not an electronics engineer. I'm in the health field and essentially self-taught in electronics and amateur radio. It's been fun all these many years (I was originally licensed in 1939). Unfortunately, I always seem to be at least five years behind the state of the art. First there were tubes, then transistors, then those little buggy things called integrated circuits, and now — the home computer? Well, at least antennas have remained somewhat aloof from these great leaps forward. One can sort of keep up with them. Perhaps my experience can be of some help to others who are self taught. Some of these tips may reduce frustration, cut down the frequency of unprintable outbursts, and perhaps keep blood pressure within acceptable levels.

Why

It all started when I finally accepted the fact that a low dipole (mine was at 4.3 meters, or 14 feet) was anything but a "moon-raker," to use the lingo of my CB friends. One gets highly agitated not being able to hear at all those stations other hams in the neighborhood are working. I decided to break the horizontal habit and go vertical. A 37-meter (120-foot) tower was out of the question because of nonunderstanding neighbors, not to mention rather restrictive zoning ordinances. So a choice had to be made that would satisfy several needs: low-angle radiation, the acceptability of a nonham environment, and — perhaps most important of all

— low cost. A slim, inconspicuous (*is* there a paint which can make things invisible?), unguyed, ground-mounted vertical antenna seemed to fill all the requirements.

How

Aluminum is light, strong, and easily worked with home tools. By using 1.8-meter (6-foot) sections of aluminum tubing available in local hardware stores, you can start with a 3-meter (10-foot) section of 19-mm (3/4-inch) ID lightweight steel electrical conduit. Mate this to a 1.8-meter (6-foot) section of 22-mm (7/8-inch) OD aluminum tubing, and then go to progressively smaller sections of aluminum: 19-mm, 16-mm, 13-mm, (3/4, 5/8, 1/2-inch). Finally, end with a plug of 9.5-mm (3/8-inch) aluminum rod at the top. This plug can be made longer or shorter to tune your vertical to the desired frequency. The plug also makes it watertight. I chose 7150 kHz, as this frequency is dead center in the 40-meter band and I enjoy both CW and ssb.

Here's something to watch for: slide the smaller sections far enough into the larger sections so that bending moments generated by the wind are not too severe. This means that more of each piece of tubing is hidden in the one below it the closer to the ground you get. **Fig. 1** shows how I did it.

The vertical is exceedingly whippy but has withstood three years of hard blows. It took some time before I could remain calm while watching it bend into a 90-degree arc and point like a weather vane.

Details

To ensure good joining of the sections of aluminum tubing, cut a groove the width of your hacksaw blade for about 100 mm (4 inches) in one end of the larger section (into which the next smaller tube will slide). Use hose clamps to tighten things down. Installing a couple of screws all the way through (after assembly) further prevents sliding about or rotation of one section within another.

To mate the 19-mm (3/4-inch) ID steel conduit with the 22-mm (7/8-inch) OD aluminum tubing, use another 1/4-meter (4.5-foot) section of 19-mm (3/4-inch) aluminum tubing, sliding half into the steel side and half up into the 22-mm (7/8-inch) section. Electrical continuity at this joint was achieved by running short pieces of no. 12 (2 mm) AWG wire between screws that hold the inner brace mentioned above.

Anodizing is a wonderful process used in the manufacture of aluminum tubing to give it resistance to salt air and corrosion. It also makes aluminum wonderfully resistant to electrical current. In fact, anodized aluminum is essentially an insulator.

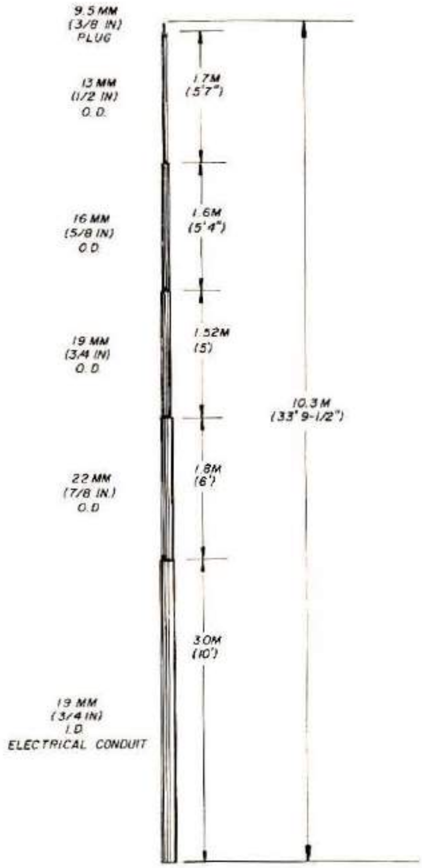


Fig. 1. Details of the homemade vertical. The bottom section is made from steel electrical conduit. The remaining sections are made from 1.8-meter (6-foot) lengths of aluminum tubing found in the "do-it-yourself" section of a local hardware store. (See text about removing anodization before you start construction.) The plug at the top is used to tune the antenna; it's made of aluminum rod.

Picture this: having spent the better part of one weekend building my vertical (it was lying on the ground in the back yard), I tried to grid-dip the resonant frequency. No dip could be found anywhere in the 40-meter band. Was I too far off the calculated length? I remeasured. No. Was the dipper working? Yes. Was there a poor electrical connection between one or more of the aluminum sections? You bet there was! My ohmmeter read to the top of the scale. After an afternoon of bewilderment, a fellow ham told me about removing the "anodize". This process required a lot of elbow grease and emery paper to remove the coating from the outside of the end that was to slide *into* the next lower section. But how to you get the anodization off the *inner* surface of the mating aluminum section? My son came to the rescue. We took a 6/4-mm (1/4-inch) wooden dowel and glued the abrasive paper around the dowel. Then we seated the dowel into the chuck of an electric drill motor. If you don't push too hard, the anodization can be removed from the inner surface without breaking the dowel. It works, but easy does it.

I rebuilt the vertical. I retightened the hose clamps, and lo! It dipped near the calculated frequency of 7150 kHz. We tuned it exactly by sliding the 9.5-mm (3/8-inch) solid aluminum rod at the top in and out.

Dipping

Here are some tricks worth mentioning — some adopted, others the result of my trial and error. First of all, to get into the ballpark, the equation for a quarter wavelength may be used:

$$L = \frac{72}{f_{MHz}}$$

where L is the length in meters and f is the frequency in MHz. Using the English system of measurement, the equation is

$$L = \frac{234}{f_{MHz}}$$

where L is length in feet. In my case, a quarter wavelength turned out to be 9.97 meters (32.7 feet). The *exact* length isn't critical.

This length will usually be slightly off because of the effect of downspouts, power lines, and other obstructions. If the effect of these obstructions is to decrease the resonant frequency, your vertical is too short, so cut it slightly long. Each 25 mm (1 inch) of height equals about 18 kHz in the 40-meter band, so when you start pruning or sliding the rod, go easy. Sneak up on it; you may prune right by your target and have to start over. I know — I did it!

As to using the grid-dipper, this is certainly no laboratory-type instrument. Have you ever tried to read a grid-dipper closer than 100 kHz in the 40-meter band? That's over 5 inches (127 mm) on my vertical, and twice as wide as the Novice band on 40 meters. But there are tricks:

1. Forget the markings on the dial; you can't read them accurately anyway.

2. Couple *very, very* lightly, or you seemingly move the resonant frequency. Make the dip as sharp and shallow as you can. Just a flicker of the needle is all you need.

3. Books say you can dip an antenna "naked." I've never figured that one out. I needed a little loop at the big end of the vertical. Make this loop as small as possible and use only one loop. You are, in fact, adding inductance to the vertical and effectively baseloading it.

4. When you get the dip, hands off — leave the dipper on and find the frequency on a receiver.

I actually ran into the house and could read my dipper (as a weak, raspy signal) from energy pickup from that low dipole. If there's any doubt as to which whistle is your dipper, have your wife put her hand *near* the coil (don't touch it) and you'll hear the frequency change.

The setup

To hold up a vertical — and one that's relatively whippy — without guying turned out to be easier than I first imagined. I dug a hole about 1 meter (4 feet) deep, flaring it out at the bottom (**Fig. 2**). Then, I filled it with water and waited until it completely drained away (it took two days in our hard clay). This ensures that the pour of concrete will completely fill the hole and not be loose. The first pour was about 150 mm (6 inches) of the mix, and then I set the redwood brace (it was 100 × 100 mm × 3 meters, 4 × 4 inches × 10 feet). Then, in went the remainder of the concrete. If you pour in all the concrete first, you'll never get the post set deep enough. Use a plumb line or level to get things perfectly vertical.

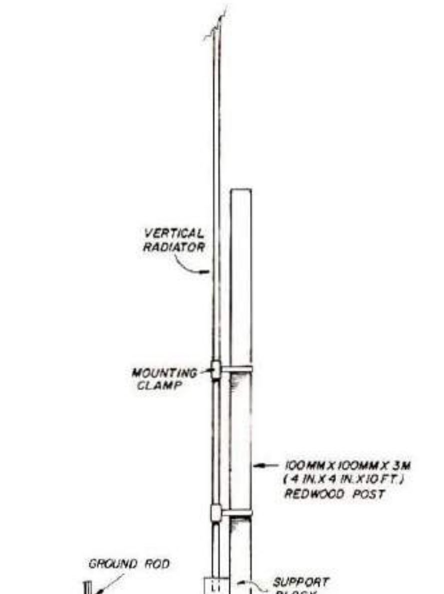


Fig. 2. Base of the vertical antenna. No guys are needed. The redwood post is buried in a hole about 1 meter (3½ feet) deep, which is filled with concrete.

Oh yes, mount the "holder" of your antenna to the main redwood brace *before* setting things into the concrete. The "holder" is ridiculously easy to make. Cut a 100-mm (4-inch) cube off of one end of the long post. Nail it to the side at the height you wish the bottom of the vertical to be. Then drill a hole the size of the outside diameter of the steel conduit about one-third of the way through the nailed cube. This "socket" provides support for the bottom of the antenna. The vertical is held against the redwood by some clamps I bought for 29 cents each at the local hardware store.

The big test

So up went the vertical, down went a ground rod, and I added three radials. As a temporary setup I ran the coax down the hall, through the bedroom, out over the patio, across the lawn, and to the base of the antenna. It loaded well! I ran an swr curve. It was 1:1 at resonance and essentially flat across the entire band. I was ecstatic! After two hours of operating, though, I was convinced I had one genuinely lousy antenna. I had quickly proved the old adage: *A vertical is an antenna that radiates equally poorly in all directions.* My wife suggested I coil up the coax and put the house back in order.

The solution

Several weeks later, after corresponding with W2FMI (by mail — not by low dipole), I awakened to the fact that swr is important *only* if you understand what it means. There are times when a perfect match may in fact be undesirable. In most cases there is no significant power loss with standing waves, even with a ratio of 10:1 or higher. Some decrease in the efficiency of the transfer of energy? Yes. But significant loss? No! You do have to watch voltage maximums if you're using a solid-state final amplifier. But you can ignore the "loss of power" or "reflected power" myth.

The swr does tell you something, however. If you read 1:1 with a 50-ohm coax going out to the antenna, you are indeed looking at a 50-ohm load. A quarter-wave vertical (at its design frequency), working against a lossless ground, should have about 36 ohms nonreactive impedance. If you're reading 1:1, then there's *no mismatch* where there really *should* be one, and you have 14 ohms of ground loss, which (to quote Jerry, W2FMI) is "warming the worms." Remember, ground loss is real power loss — current turned into heat. In my case, about 28 per cent of my output was not being radiated. More important, however, is the fact that with increased ground loss the angle of radiation rises and you lose the advantage of the vertical over the dipole.

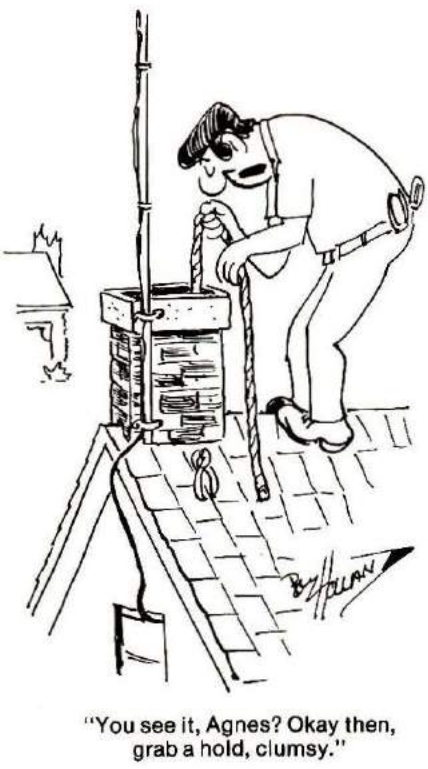
"Add RADIALS!," Jerry said. "Add a lot of radials!" And so I did; as the number of radials increased, so did my swr.

Incidentally, radials are in parallel and thus share the current. Small-diameter wire may be used. If you're lucky, as in my case, and have ivy as a ground cover, the radials don't have to be buried in the lawn, merely laced through the ivy. It works very well!

Now with 33 radials I'm looking at slightly less than 37 ohms impedance, or an swr of almost 1.4:1. But, I've got a veritable bomb in my back yard! Ground loss is almost nil, the radiation angle is down, and my hi-fi (and occasionally that of my neighbor) knows it. To prove this (all on 40-meters) I have QSLs from all continents except Europe. You can't work 'em if you don't hear 'em. Last winter, however, KC4 stations were easy pickings — and all this with only 150 watts PEP!

It was a long haul, very frustrating at times. But that slender waving pole sure has been a good antenna. Now I have two of them nicely spaced a quarter wavelength apart, with all the goodies of phasing, delay lines, and relays. However, that's another tale with many more pitfalls, all educational.

Try a vertical. Do it correctly and you, too, can get into your neighbor's hi-fi. That ZS6 card may not be worth the resulting hassle, but it sure can be fun getting there. **HRH**



"You see it, Agnes? Okay then, grab a hold, clumsy."

The Ham Behind The Mike

BY ANN ALDRIDGE, WN7TSY

You can't judge a book by its cover or a ham by his voice. The second truism became evident at Arizona's hamfest last weekend. (No, a hamfest isn't a festival of pork lovers — or over eager actors.)

"Ham" is the name Amateur Radio Operators go by. And a hamfest is a meeting of amateurs for the purpose of swapping equipment, attending technical sessions — and swapping equipment.

My husband, Don, is a ham. He looked forward to this hamfest for weeks because he hoped to replenish his junk box. The junk box is the thing that sets the ham apart from the Citizens Band operator. The ham must pass an FCC examination in radio theory before he's licensed to operate, so he must know something about electronics and have the knowhow to build some of his operating equipment himself.

This makes the junk box, whether it's a tattered cardboard box or a carefully labeled system of cabinets, a necessity. In it, the amateur stores capacitors, resistors, coax cable, and all the other electronic components he can scrounge.

The hamfest scene

I wanted to go with Don to the hamfest so I could meet other hams Don talks to on the radio. There was Harry, with the resonant voice and deep chuckle, whom I pictured as an elderly grandfather. He sat at his microphone with a full head of white hair, twinkling blue eyes, and a ready smile.

Roy talked with a Texas twang, and I could see him as a tall lanky type in Stetson, Levi's, and cowboy boots.

The one female operator Don sometimes talked to was Linda. I dreaded seeing her. Her voice was sexy, and I was afraid she would be just as lovely in body as she was in voice and prove to be a threat to marital bliss. (More about this later.)

When Don and I arrived at last weekend's hamfest, most of the crowd was already poring over the ham gear that lay on tailgates, in hatchbacks in the parking lot, and on tables set up inside the pavilion. This was the swap meet part of the hamfest.

The hams were like children in the toy department at Christmas time as they wandered wide-eyed through the swap meet. Don's eyes lit up when he saw a potato-chip canister filled with diodes and shoe boxes full of resistors and integrated circuits. (Maybe vultures would prove a better comparison than children. The hams circled the swap meet, slowly, hungrily, time and again.)

Most of the items for sale looked like surplus from the bottom of someone's cardboard box. But one ham's surplus is another's bonanza. And as the weekend wore on, it was obvious that the swap meet was where the action lay for most hams.

At first I padded along after Don from hatchback to tailgate to card table, *ad nauseum*. Then, tired of circling the carrion heaps, I wandered over to a large bulletin board. Hams arriving at the fest were encouraged to pin their QSL cards to the board so that everyone could see who had arrived. QSL cards are post card communiques that amateurs exchange through mail after meeting over the air. Several hams from the Tucson and Phoenix areas used color scenes of the desert as background for the printed information. Some cards included both the husband's and wife's names and call signs if both were licensed operators.

A lot of the hams here wore name tags with their call signs printed on them. Meandering through the crowd, I tried to read name tags so I could find Harry, Roy, and Linda — among others.

I spied Don across the pavilion talking with someone. I walked over to them, and, when close enough, looked at the other man's name tag. WA7XYZ — Harry. *This* was Harry? Here was a man in his late thirties with thinning, sandy hair. Harry wore a somber expression as he and Don talked. He pursed his lips and furrowed his brow. But then Don said something to make Harry laugh, and I recognized that deep, friendly chuckle.

After lunch, Don wanted to attend a technical session on 2-meter communications. He entered one of the side rooms off the main hall, and I was left to my own devices.

Further impressions

Back to the bulletin board to see if any other QSL cards had gone up. WB7ABC. K7XX. WB7ZZZ — Linda! She was here — somewhere. I set out to get close to the name tags. I wanted to get a look at Linda so I could decide just how big a threat she posed.

I peered at every woman's tag. No Linda. Omigosh! She's probably in the technical session with Don, I thought. And he's giving that lovely body a lusting eyeball.

A man and woman in matching striped rugby shirts stood hand in hand at a nearby table looking at the items for sale. I walked quickly to the other side and leaned across the table to stare at a coffee can full of carbon resistors. When I thought I had pretended enough interest in the resistors, I raised my eyes to look at the woman's name tag. It revealed that this was WB7ZZZ — Linda. I took a second look at the couple. Matching wedding bands. Matching shirts. Arms around each other's waists. Linda was attractive enough, I decided, but no immediate threat.

The group who had attended the technical session burst out of the side room to circle the swap meet again. I saw Don hurry toward me. He said, "C'mon. Let's go see if the mike we looked at this morning is still for sale." I replied, "Oh, Don, you don't need that microphone. You have five mikes at home already. . ."

We meet another ham buddy

I followed Don outside toward the tailgate of a four-wheel-drive vehicle. The owner was standing beside his pile of gear. He looked like a voice I'd never heard before. Barrel-chested, the fellow stood with his short, heavy arms folded. Gazing at our approach from beneath a baseball cap, he smiled and hollered, "Howdy! Need anything I've got here?"

"Well, I don't know," Don hedged, "Could be."

The ham looked from Don to the goodies on the tailgate and back to Don again, trying to determine just what item Don wanted and how badly he wanted it. He looked at Don's name tag. "WA7AAA? I've worked you. I'm WB5YY — Roy."

"Sure," Don answered, and they shook hands.

So this was Roy. He was no tall, lanky type in Stetson, Levi's, and cowboy boots. The voice did hint of a Texas twang, though, and when I closed my eyes and listened to the sales pitch he was giving Don, I could still see my original image of Roy.

Homeward bound

When Don and I left the hamfest and headed home the next day, we were richer by one mike, one power supply, and a shoe box of assorted switches, knobs, banana plugs and jacks, and rubber grommets. The hamfest didn't cure me. I'm still putting faces to the voices I hear on the radio. And I heard someone new on Don's radio last night. He sounds middle-aged, and the Boston accent is heavy. I'll bet he's graying at the temples, wears a necktie while at his microphone. . . **HRH**

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WAS IT REALLY WORTH IT?

BY JOHN A. CARLSON, WD9HBB

An inspiration for those taking the Amateur exam

The big day had finally arrived. It's a long wait for a GI in Germany; you can only take the amateur radio operator test every six months, when the FCC examiner comes over. Six months of study. Code, code, code, theory, theory, theory, and of course the waiting for the big day. That's the worst part; waiting is always the hardest part.

We'd studied hard and were ready. My friend Chuck Martin, WA4YRA/DA1NR, had tutored me since day-one about eight months ago, through the Novice exam and the long hours of code practice and theory getting ready for the General Class test. Bill Pardue, AA4AG/DA1KV, had helped also with on-the-air listening and code tests.

The night before the big day we'd sat down to plan our events. A lot of things had to be done. We would drive to Ramstein Air Base, pass the tests, get my German application filled out and notarized, drive to Koblenz to file the license application with the German authorities and then home. No problems were anticipated.

The big day

It started at 5:00 am. Breakfast, last-minute code practice, and on the road by 6:30. Ramstein AB is about an hour and a half away, so we had plenty of time to make it for an 8:30 show time. Last minute cramming on theory during the trip made the time pass quickly, and we arrived with no doubts about the outcome of the tests. Chuck was confident about passing the Extra-Class test and I was, well, *almost* confident about passing the General-Class test.

Without ever having made a contact on the air, the General-Class seemed a long way away. I have a Novice license, but the German authorities don't recognize it. The Germans will issue an American GI the German equivalent of the class of license held by the American. The Germans don't have a license equivalent of the American Novice, and I'd held mine for almost six months without being able to get on the air. It was a very long and frustrating six months having a license and only being able to listen. As a General-Class amateur, I could get a German license and finally get on the air. I *had* to pass the test. Another six month's wait would be too much to bear.

The code test

The FCC examiner is very cordial and cracks jokes to ease the tension: nothing like the steely-eyed monster I'd heard and read about. I start to feel a little more relaxed, that is, until the examiner says the 13 wpm code test would be the first order of business. The moment of truth had arrived. My heart starts pounding . . . dits and dahs race through my head. The examiner gives instructions.

"You'll receive one minute of practice, followed by a group of Vs, followed by the test. Is everyone ready?"

I brace myself. I copy the practice code without too much difficulty, but of course the practice doesn't count. It seems faster than I'm used to.

The big day started at 5:00 AM.

Not too bad, though. I relax a little.

VVVVV . . . so far so good. Boy, that seems fast. My hand isn't working right. It doesn't seem to be hooked to my brain. Relax! That's better. Oops, I miss a letter; miss a few more! Don't think about the ones you missed, stupid, you'll miss some more! Settle down. Didahdidahdit.

That's it? It's over? Boy, I was just getting into the groove. Now all I have to do is decipher my hieroglyphics, answer ten questions, and the code test would be over. I look at my paper. No way can I find the answers to ten questions in that little bit of material. I search, decipher. Seven out of ten for sure and three hopefuls. I had to be sure of at least one more. Eight out of ten is passing and I'm only sure of seven. More searching, more deciphering. Let's see . . . yes, it could be . . . that's it, I hope. I rise on trembling legs and reluctantly turn in my test paper.

Now I wait some more while the examiner grades the tests, failures going in one pile and those that passed in another. I watch and count, especially the "fail" pile. One . . . two . . . three. Depression hits me. Six months of practice, study, and waiting down the drain. I turn around and look at Chuck for some encouragement. A big smile and "thumbs up" tells me he still has faith in me. It's comforting, but I still don't feel much better.

The examiner hasn't read the names of those who failed yet, so there's still a glimmer of hope, small as it may be. I look at the examiner. He looks up and grabs the "failed" pile. I close my ears so I won't hear him call out my name, but I can hear anyway. He reads off the names of those who failed and it's over. No . . . wait! He didn't call my name! I can't believe it! I look at Chuck again and all I see is teeth from one side of his face to the other. I feel faint and ecstatic at the same time and almost fall off my chair. I really made it!

The pressure is off, but not for long. The examiner explains that those who passed the code test will take the written portion while he gives the 5- and 20-wpm code tests to the Technicians and Extras. Again my mind races. Ohm's Law —

Now all I have to do is decipher my hieroglyphics.

PEP — resonant circuits. I was never very good with electronics and I start to feel the pressure once again.

I start the test. There's no time limit, so take your time. Watch for key words: "all except", "is not", "will not." I annotate my scratch pad with the number of the questions I'm not sure of. I quickly figure out how many questions I can miss and still pass the test. Eighty questions. Let's see, if I miss twenty, I'll still end up with 75 per cent. Half way through . . . hang in there. I look at Chuck again. He has just finished the code test and looks confident. He's been through this before, getting his General and Advanced tickets. Maybe it gets easier each time. I sure hope so. The results for the 20-wpm code test are read and Chuck passed. I feel glad for him, give him "thumbs up" and get back to my test.

Three-forths of the way through . . . almost done. Chuck has already finished his written test and has passed.

The pressure is off him and he relaxes. I wish I could say the same about myself. Question eighty finally. I check my scratch pad and count the number of questions I'm not

On to Koblenz!

sure of . . . 21. Oh boy, not again! I've got to be sure of a few more just to have a pad. I look over those questions again, find a few key words I'd missed, and add a few more questions to the "sure of" list.

All done, and again I arise and take the test results to the examiner. I wait while he grades my test. I watch him to see if I can catch a change of expression that will let me know how I'm doing. Nothing. He looks up at me and says, "John Carlson, you passed." The faint feeling returns, and again I almost fall off my chair. The pressure is off and I almost can't contain myself. I get my white interim license from the examiner and run for the door. "Whoopee." I can't believe it's over and I passed! Six months of practice ended and it paid off. I thank Chuck for the many hours of training, practice, and support.

Next stop: Koblenz

Back in the car we review our agenda. Get the German license application notarized and off to Koblenz to file it with the German authorities. Koblenz is about a three-hour drive and it's almost noon. We decide to celebrate at McDonalds. In Germany that's a real treat, because the closest McDonalds is a two-hour drive from where we're stationed.

With my application notarized and a Big Mac and fries under our belts, we head for Koblenz. We check the time: 12:30. Three hours to Koblenz will get us there at 3:30. That doesn't leave too much time to spare, because the Postal Director's office (where the applications are submitted) closes at 4:00 sharp. Because of other obligations, if we don't get my German license today it'll be at least two months before I can get on the air. I just couldn't stand that, so we press on.

The ride is a lot more relaxed than the drive earlier this morning — lots of yelling, laughing, and joking. The time passes quickly and before we know it, we're in Koblenz. Now, to find the Postal Director's office. We hail a pedestrian and in our best German ask directions to the Post Office. "Straight ahead and it's on the right." Great! We check the time: 3:20. Forty minutes to closing time. We've got it made.

Problems. Was it worth it?

A truck stops right in front of me and the car dies in the middle of the intersection. I turn the key . . . nothing. It sounds like the starter. So we push the car to the side of the street, open the hood, and I check the starter. It's loose, but with no tools I can't fix it here. I give it a shake for good luck, close the hood, and turn the key — it starts. Through the intersection, straight ahead to the Post Office. We made it with a half-hour to spare.

Chuck runs in to make sure we have the right place and I sit in the car. A few minutes pass and I watch the door. I see Chuck motion for me to come in, so I quickly grab all the paperwork, lock the car doors, and run into the Post Office. The man at the information window explains that we have the wrong building. We must turn around, go three stop lights and turn right. He says more, but our German isn't all that good and we don't understand him.

We race for the door. I check my pockets for the car keys and at the same time I see them hanging from the ignition switch. The car doors are locked. Great! We have to find a coat hanger to open the car door, but where do we find one?

Back into the Post Office — no hangers here. Outside Chuck sees a man getting into his car and asks him if he has a coat hanger. He doesn't but points out a store where we

The car dies right in the middle of an intersection.

can buy one. Chuck speaks better German than I do, so he runs across the street toward the store. On the way he spots a car backing out of a parking lot and sees a coat hanger in

the back seat. Chuck stops the car, quickly explains our situation, and pleads for the hanger. The German shrugs — figures we're just a couple more of those crazy Americans, and gives up the hanger.

I check my pockets for the keys . . . they're still in the ignition!

Doors open, car started, we're off again. We check the time: 3:40 — 20 minutes to go. Three stop lights, turn right and . . . nothing. Another pedestrian, more directions. "Turn left along the river and you can't miss it." We do and we did — miss it, that is. We turn left again and spot a German policeman. More directions. "Turn left at the next light and it's about 300 meters on the left."

We're off again, turn left at the next light, and 300 meters on the left we see the building. As I park the car, Chuck runs into the building. I get out of the car and start toward the building and see Chuck running out — wrong building! We have to go to the end of the block, turn left and we're there. We decide to run because it'll be faster. We check the time: 3:50 — ten minutes to go.

We get to the end of the block, around to the left, up the stairs and we're there. We run up to the information window and explain what we want. "That office isn't in this building," the man says. "Go outside, around the corner to the left and it's in the bank building."

Out the door we go, down the stairs, around the corner to the left and there it is — about a block down on the right. We set an Olympic record for the one-block dash and into the bank.

It's 3:55 as we run through the doors. The man at the information window says the office we want is on the third floor, room 306. We hit the elevator at a full run and zoom to the third floor, room 306. Wrong office. We can't believe it! It just can't be true! The man in room 306 is very nice and explains that the right office is just across and down the hall. He shows us where it is, and we get there just as the man working in the office is getting ready to leave.

It's definitely the right office and we breathe a sigh of relief. We explain why we're here and what we've been through trying to find the right office. He appears touched and sincere, but regretfully tells us that he's not the man who handles Amateur Radio licenses. That man is on vacation and won't be back until April 10th. He does take my application, however, and tells us that he'll have his colleague act on it as soon as he gets back. We thank him and walk slowly to the car.

An hour's drive and we'll be home. We'd lost the battle getting my German license, but we'd still won the war. Chuck was an Extra and I was a General. We drove home with that thought in our minds. The excitement of the day was still there but had been dulled slightly by the exhaustion.

Was it really worth it, you ask? *You bet!* — every minute with the cassette recorder practicing code and the long hours reading and studying electronic theory. I am finally a real "ham." I am finally a member of a fraternity that dates back many, many years to the very beginning of radio communications. I'm proud to be an amateur radio operator. I'm proud of the heritage that amateur radio has. I'm proud of the technical advances that would not have been possible without hams, of the many lives that have been saved because of alert hams, and, of course, of the many phone patches made between the United States and isolated GIs overseas.

Ten minutes to go!

What it's all about

There are a couple of things I want do do now besides becoming an Extra. I want to become a good ham; an inspiration to future amateurs living up to the standards established by our forefathers. I also want to find someone I can help become a ham — someone I can smile at and give "thumbs up" while they wait for their test results and share in their excitement when they pass. That's amateur radio and I'm proud to be a part of it. **HRH**

A GUIDE TO VHF PROPAGATION

Part 2

BY JAY BUSCEMI, K2OVS

Last month I talked about several of the loud-signal modes of propagation — modes that allowed a signal of only a few watts to bounce down to you from thousands of miles away, yet be as loud as if they were coming across town. There are other conditions which help you chase vhf DX, with quite variable signal strength and quality. In fact, one of these modes really garbles the signal, causing it to get a "buzz" on it, as the vernacular has it. As with many other modes, it requires cooperation from the sun in the form of emissions that cause the "northern lights," or Aurora Borealis.

Aurora

The aurora borealis, commonly known as the northern lights, will reflect vhf signals when its ionization level gets sufficiently high. Solar disturbances emit bursts of high-energy particles which arrive at the earth a few days after their occurrence. The best indicator of an impending aurora is the appearance of weak, fluttery signals on the high-frequency bands, particularly 80 and 40 meters. A buzz or raspiness appears on CW signals, and voice signals exhibit severe distortion, making some of them unreadable. Amateurs in the higher latitudes can visually observe the auroral display in the northern sky.

All bands from 50 through 432 MHz are affected by auroral propagation to some extent, although 6 and 2 meters have the most pronounced effects. As a general rule, auroral activity tends to peak between 4:00 and 8:00 p.m. local time, although at times sufficient ionization in the auroral curtain will persist for several hours.

The characteristic "buzz" of auroral signals is caused by the randomly ionized nature of the aurora. A signal directed at the aurora produces a large number of reflected signals, see **Fig. 8**, all slightly different in phase. The received signal is actually a combination of all these phase-shifted, reflected, signals. This has the effect of producing a wide, phase-modulated carrier in your receiver. A voice signal is extremely distorted at the receiving station, usually to the point where it is very difficult to understand. Therefore, most auroral work is down on CW, especially at frequencies above 144 MHz.

Auroral ionization is produced near the north pole, so both the transmitting and receiving stations should point their antennas in a generally northern direction. Final aiming of the array can be accomplished by peaking it for maximum "buzz" on a local station. The optimum direction may vary by as much as 30 degrees over a period of two to three hours, so some repeaking is generally required.

Aurora tends to favor the northern latitudes; it is virtually unknown in Florida or southern California, but quite common in Maine and Wisconsin. Working distances between stations average out to about 900 km (600 miles), although occasional contacts to 1600 km (1000 miles) or so have been reported. High-power transmitters and directional antennas on both ends of the communications path extend the workable range considerably, especially under marginal conditions near the beginning and end of the auroral disturbance.

Meteor scatter

When meteors pass through the upper levels of the earth's atmosphere they produce intense patches of ionization which can reflect vhf signals.[7] Random meteors are always producing this ionization to some extent, but periodic streams of meteors, called "showers" greatly increase the average ionization level. The Perseids in August and the Geminids in December are the most consistent showers of reasonable intensity, so they are the most commonly used by Amateurs.

Of all the vhf DX modes, meteor-scatter requires the most attention to time and frequency synchronization. On two meters, almost all meteor-scatter work is done on prearranged schedules; random contacts are difficult at best. High-speed CW is preferred, although many voice contacts are made each year. Minimum output power should be around 100 watts, and you should have a 10-dB gain antenna. A good noise figure in the receiver also helps considerably.

The optimum distance between scheduling stations is between 800 and 1600 km (500

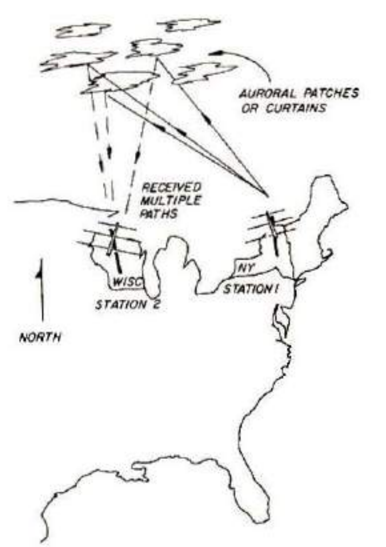


Fig. 8. The Aurora Borealis will reflect signals from the highly ionized patches or curtains. Because the curtains and streamers flicker and shift about, the signals may not be steady, and the varying density of the ionized patches creates multiple reflections that give the signal a distorted, sometimes watery, sound. CW usually sounds raspy, but can be copied with ease — voice is often distorted beyond recognition. Auroral openings are more prevalent in the northern latitudes, but have been known to get as far south as Georgia and Arkansas.

and 1000 miles). Closer-in work has been attempted by stations using an elevation control on antenna arrays to tilt the antenna up 10-20 degrees from the horizon. Ideally, antennas should be aimed at the ionized area, but for practical antenna beamwidths (greater than 10 degrees), both stations should aim their antennas in the general direction of each other. Schedules are generally carried out on unpopular frequencies to avoid QRM by local stations; 50.0 to 50.5 and 144.2 to 144.5 MHz are commonly used for schedules on six and two meters, respectively.

The minimum exchanges of information and the manner in which it is given is well established for meteor-scatter contacts.[8] Both calls and signal reports must be exchanged and confirmed by each station for a contact to be considered valid. This is generally mandatory because of the prearranged schedules (both stations know each other's call before the contact is made). It is customary for the westernmost station to transmit the first and third 15-second period of each minute; the easternmost station transmits the second and fourth 15-second periods. Schedules are maintained for at least one-half hour, and one- to two-hour schedules are common.

In your first attempt at meteor-scatter, you should arrange a schedule with an Amateur familiar with the mode. For the August Perseids and the December Geminids, it is best to arrange schedules with these stations at least a month in advance; they usually are saturated with schedule requests as the major showers get near. When setting up a schedule, specify the exact frequency, mode (CW or ssb), starting time, length of the schedule, and the number of days the attempt will be made. Also make sure you exchange telephone numbers so last-minute cancellations can be made. There is nothing so frustrating as keeping a two-hour schedule and finding out that the other station was called out of town at the last minute and couldn't reach you to cancel the attempt.

Many stations now use automatic CW memory keyers such as the AUTEK Research MK-1. These programmable keyers allow the operator essentially to preprogram most of the contact and avoid the tired arms and sending errors. In addition, they can be set to automatically cycle in the 15-second transmit/receive system now in common use.

Trans-equatorial scatter

Very little is known about the physical nature, and relationship to the solar cycle, of trans-equatorial (TE) scatter. Contacts as far as 4800 km (3000 miles) have been made on two meters using this mode in recent years. Apparently a belt of ionized particles sometimes exists near the equator, and stations on either side of the equator can use this band of particles to reflect six- and two-meter signals in a generally north-south path.

Most successful TE work to date has been accomplished on six meters, but signals on 144 and 432 MHz have been heard.[9] The TE effect seems to be available only to stations in the middle latitudes and only in the north-south direction. When conditions are optimum, as little as 10 watts output has produced successful contacts. 145.1 MHz on two meters is presently being used as the most common calling frequency. Amateurs in the southern U.S. should look south in the evenings for potential TE contacts with South America, particularly Venezuela and Argentina. Signals tend to be weak and fluttery, and ssb is preferred. Recent work has indicated that there may be some significant relationship between major solar disturbances and TE enhancement; the same solar flare that influences aurora activity may also enhance TE signal levels.

TE scatter offers a real challenge to the vhf operator because it is a relatively uncharted area of propagation. Successful contacts via this mode should be reported and published so the entire amateur community may benefit.

F-layer skip

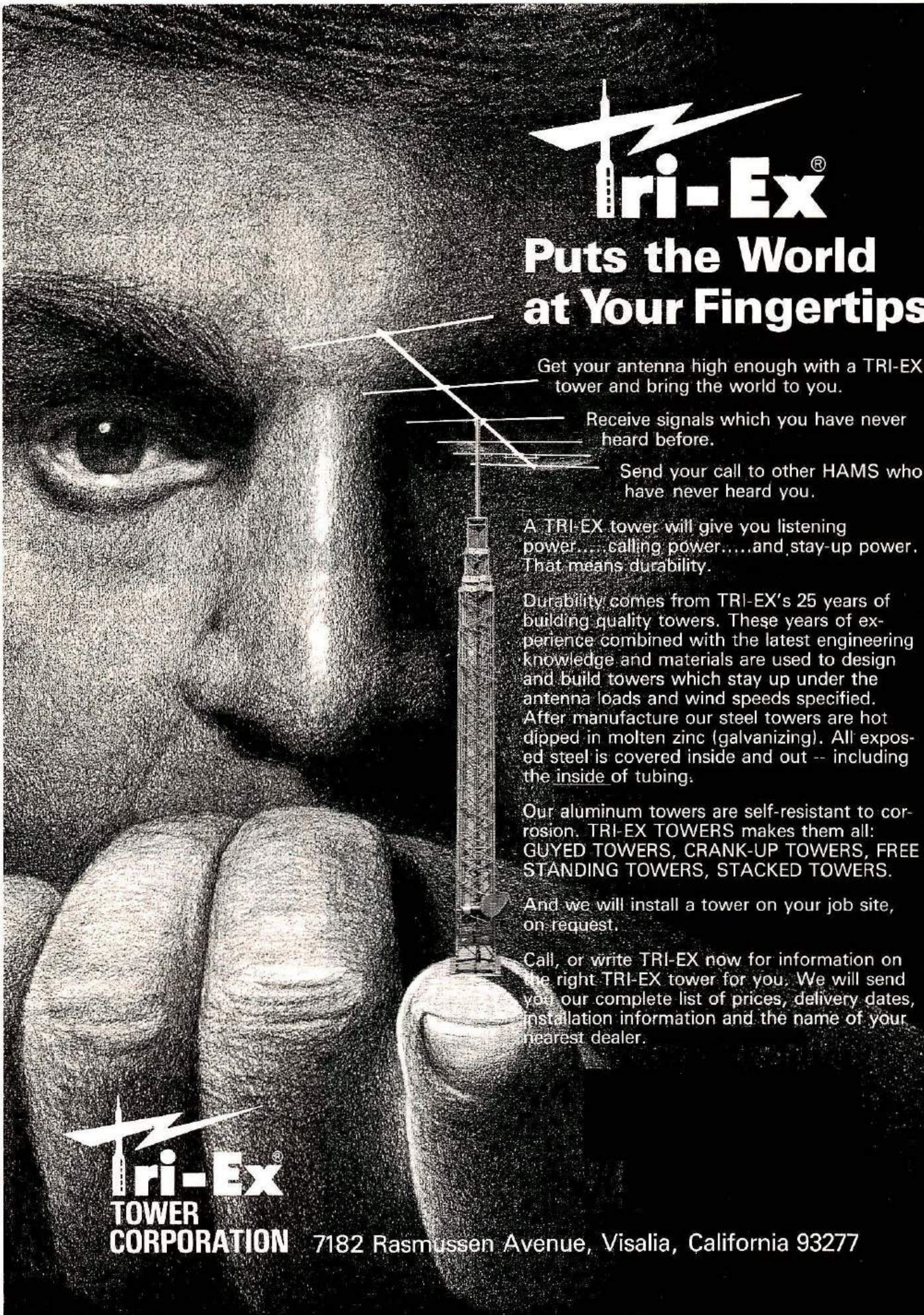
Perhaps the least frequently occuring DX mode for the vhf operator is F-layer skip. It can produce exciting contacts out to 8000 km (5000 miles) or so on the 50-MHz band. During sun-spot-cycle peaks, the F-layer maximum usable frequency can exceed 50 MHz, producing world-wide DX contacts similar to those experienced on ten meters. Very intense F-layer signals on 28 MHz will indicate that the MUF may be rising into the vhf spectrum. Monitor the public service band between 30 and 50 MHz to follow the MUF. British amateur signals on 70 MHz were heard on the East Coast of the U.S. during the 1958 sunspot cycle peak, indicating that trans-continental six-meter DX is entirely possible.

High power and elaborate antennas are usually not required when the band is open via the F-layer. Moderately equipped six-meter stations have successfully worked this mode with S9 signals. Short calls and listening periods are more likely to produce results, as the MUF may rise past 50 MHz for a very short time. The standard calling frequency of 50.110 is probably the best spot to watch.

The vhf bands offer exciting DX possibilities when the basic mechanisms of propagation are understood. Constant monitoring of weather conditions, public service communications, TV broadcasts, and the ten-meter band provide the vhf operator with the indicators he may need to take full advantage of the DX modes. In addition, the more esoteric modes, such as TE scatter, are relatively uncharted, so an amateur station may substantially contribute to the body of knowledge relating to vhf. I hope these tips will encourage more of you to enter the fascinating and challenging world of vhf-DX.

HRH

7. Walt Bain, W4LTU, "VHF Propagation by Meteor-Trail Ionization," *QST*, May 1974.
8. James Stewart, WA9MVI, "VHF DX via Meteor Scatter," *QST*, December 1977.
9. World Above 50 MHz, *QST*, April 1978.



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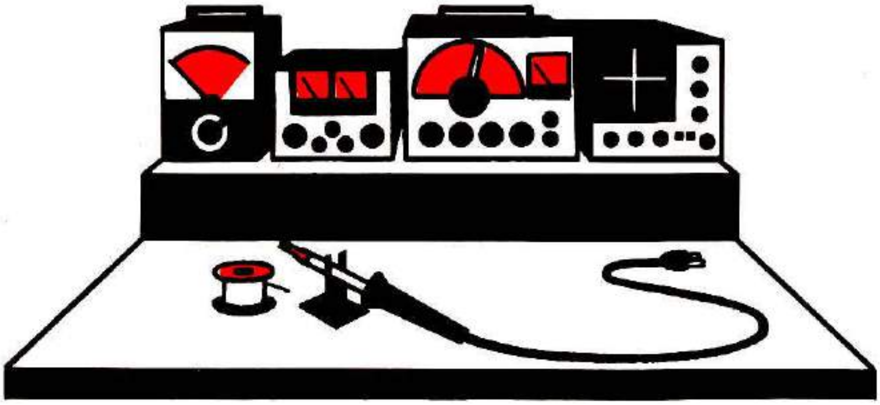

BENCHMARKS

Better Mobile Installations

Whenever "mobile fever" strikes us, we turn to checking out the mobile rig, building and installing accessories and convenience gadgets, and generally upgrading the installation. Listed below are a few mobile construction ideas and practices I've used that can dress up the installation.

Sticky-Back Mounting. When constructing and installing accessories such as converters, preamps, tone pads, and the like in small plastic or metal boxes, rather than drill into the transceiver or dash, mount the unit by using heavy-duty double "sticky-back squares" — not carpet tape, but rather the small squares typically used by cable-TV outfits to fasten their switchboxes to the backs of TV sets. This type holds very well, is available at CATV suppliers, and can often be obtained free for the asking (in small quantities) from the local cable TV outlet. The squares can be removed at a later date without marring the surfaces. They can easily be cut to size. I use the stuff to mount an external programmer to my IC-22S and to stick a field-strength meter to the dashboard.

Magnetic Mounting. For relatively heavy projects constructed in small metal boxes (which normally are furnished with rubber mounting feet), remove the feet and epoxy in their place a half-dozen or so small magnets of the type sold over-the-counter at Radio Shack stores. The box will then adhere well to either the metal cabinet of the transceiver, or to any flat metal section of the auto's dashboard, without damaging the surfaces. It can be removed easily for theft protection.

Mike Clip Mounting Trick. Lightweight accessories using underdash-type plastic or metal mounting (such as CB-type extension speakers and small digital clocks) can be temporarily mounted to metal surfaces by using three of four standard CB-type magnetic mike clips. The clips are simply lined up horizontally on the desired surface and the U-bracket slipped into the clips. Small rubber grommets inserted into the clips will prevent chafing of the bracket and will tighten up the whole affair.

Dymo Panel Labeling. Any project should have its controls and switches properly labeled. Dymo label tape provides the most convenient method of labeling and can be made to look highly professional. I have standardized on using 9.5-mm (3/8-inch) *gray* tape for front-panel labeling of what the box is, and 6.5-mm (1/4-inch) *black* tape for individual control and switch nomenclature. Whenever possible, the tape should run horizontally across the entire panel for maximum adhesion and best appearance; use a razor blade to cut off the excess. The gray and black tapes look particularly good with the silver and black, or white and black, color schemes of most small boxes sold by Olson, Lafayette, and Radio Shack. Dymo tapes should not be subjected to direct sunlight, as the white lettering may disappear when exposed to extreme temperatures.

Rubber Adhesive Mounting Feet. I've found the large soft-rubber *adhesive* mounting feet which are 6.5 mm (1/4 inch) thick by 19 mm (3/4 inch) diameter and usually sold on cards of 36 (another hamfest treasure), to be invaluable little gems. They require no drilling, don't mar the surface, adhere well, and are thick enough to provide some real cushioning. They are very soft and compressible, and can prevent chafing of equipment when inserted between metal surfaces which may vibrate against one another. I use them to separate a 2-meter fm transceiver and a 40-channel CB rig that are bolted together via the side-mounting screws, to prevent chafing. I also use the little stick-ons indoors, attaching them to the sides of most of the main pieces of station gear to prevent scratching adjacent cabinets.

Simple Hash Filter. Having trouble with alternator hash and other electrical garbage leaking through the dc line to your equipment? This problem can be identified by removing the antenna to see if the hash remains. If it does, it's almost certainly coming in through the dc line. Before attempting more drastic cures, first try connecting paralleled 3000 to 5000 μF, 20-volt electrolytic and .005-mfd disk ceramic capacitors across the dc line to the transceiver. Mount the filter as close to the rig as possible — just be sure to observe polarity on the electrolytic! This simple procedure has worked wonders in removing a persistent buzz and alternator whine from both the CB and 2-meter rigs in my 1972 Dodge.

Double-Duty Antenna Mounts. For the occasional 2-meter fm buff who already has a CB trunk-mount antenna installed, I've found that the mount can do double duty by constructing a simple 1/4-wave antenna out of a 48 cm (19 inch) length of steel rod stock (or the remains of an old whip), inserted into a standard PL-259 connector and UG-175/U or UG-176/U reducer combination, and then epoxied in place. By clipping off the center pin of the coax connector to about half the normal length, the pin will make good contact with the vertical center-pin of the CB mount. I use an inexpensive coax switch mounted under the dash to switch between the 2-meter rig and the CB rig. Besides saving the cost of a complete new antenna assembly, it also keeps the vehicle from becoming too cluttered in exterior appearance.

Simplifying Tone-Pad Installation. Building an external tone pad for a transceiver that has no separate input for it? Bring a source of dc to the front-panel mike connector (usually one pin is not used in the standard 4-circuit connector), run a multiple-conductor shielded cable to a mike plug which can be plugged into the chassis connector in lieu of the regular mike. Then, mount a chassis-mount connector on the tone-pad box to match that on the mike, thus allowing it to be plugged in. Wire the box with a DPST miniature toggle switch to allow the tone circuitry to be removed from the dc and audio lines when not in use. The tone box can be "sticky-back" or magnet-mounted to the dash or transceiver.

Karl T. Thurber, Jr., W8FX

Voltage Safety Valve

The safety circuit in **Fig. 1** was developed after several ac-

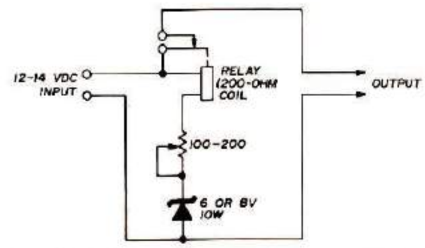

Fig. 1. Over-voltage protection circuit. Potentiometer can be set so relay opens at any preset voltage between 14 and 24 volts.

cidents where a power transistor shorted in a low-voltage power supply causing the transformer output voltage to be supplied to a solid-state transceiver. This voltage could be up to three times the rectified voltage and could cause considerable damage to the transceiver.

A high wattage Zener diode could be used across the output of the power supply, but it takes a very large diode to blow a fuse. Furthermore, the Zener diode could burn open if used to carry currents above its rating.

What was needed was a circuit that would respond when a set limiting voltage was reached, and cut off the current flow. The circuit in **Fig. 1** is simple and cheap, and uses a relay with contacts large enough to handle the required current (6 or 8 amperes should be ample). The relay coil should be about 200 ohms, the potentiometer 100 ohms or more, the Zener diode is a 6 or 8 volt, 10 watt unit.

This circuit can be adjusted to trip at 14 to 24 volts. When the limiting voltage is reached the relay opens up, breaking the circuit to the transceiver. The residual charge in the circuit will hold the relay open until the voltage drops or the power is disconnected.

Harold C. Dressel, W2UVF

Simple Crystal Oscillator

National Semiconductor has a new IC designed to flash an LED from a single voltage cell. It is called LM3909N and is similar to the standard minidip. I've found that the LM3909 makes a very efficient crystal oscillator in the i-f range of 100-500 kHz. A 100-kHz crystal will generate strong harmonics beyond 30 MHz. Power drain is less than 0.5 mA at 1.2 volts; an AA cell should last for months.

All you need is the LM3909N, a minidip socket, a crystal, and a penlight cell. For ultra-low current drain, you may add up to 200 ohms of resistance in series with the cell, which will drop the drain to about 0.25 mA.

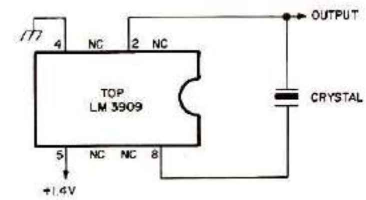

Fig. 2. Schematic of the simple crystal oscillator using the National LM3909 integrated circuit. The crystal can be adjusted for its exact frequency by connecting a capacitor in series with pin 8.

For a low-power i-f signal generator, use a 465-kHz crystal. I couple the oscillator output to a receiver input via a 100-pF capacitor. For more precise frequency control, connect a capacitor in series with pin 8 of the IC. About 10 pF brought my 100-kHz crystal to zero-beat with WWV.

Isaac Queen, W2OUX

Mounting BNC Connectors

Whenever I mount a BNC connector on a panel, I end up scratching the panel as I tighten down the connector's retaining nut. The answer to this problem lies in a simple homemade tool. I cut the tip off an old screwdriver and epoxied a BNC female fitting to the shaft with metal epoxy. Now, when I install a BNC panel connector, I use the modified screwdriver to hold the connectors while I tighten the nut — no more frayed tempers or scratched panels.

Elliott Kanter, W9KXJ

POST BOX

Dear Horizons:

After reading your "Focus and Comment" in the November, 1978, issue, I feel I should comment on the old days. It seems to me your comments included mention of only the worst of the old and the best of the new. Surely a keyed oscillator is crude, but is digital synthesis necessary in a hobby transmitter? Personally, I think many of the nostalgic, older hams miss the practicality, the simple logic of earlier Amateur Radio . . . Eleven years ago I ran a-m on 10 meters only, and had an endless number of solid, enjoyable QSOs, both stateside and DX. The cost was low, and the circuitry was much easier to build and maintain than it is for ssb. Would this be so terrible today? Would it be such a cardinal sin to provide an avenue (for newcomers especially) whereby one could operate a sensibly priced, simply designed transmitter using telephony?

After working with state-of-the-art for five days out of seven, I assure you there's no desire at my station to do the same for free and call it a hobby.

I feel my soapbox giving under my weight, so I will sign here, and thank you for listening.

Paul Zimmerman, WD5BRR
Brandon, Missouri

Thanks for taking the time to write, Paul. No, digital synthesis is ***not*** *necessary in a hobby transceiver; it's in the class of "bells and whistles" that many manufacturers produce, and many Amateurs buy, because it is the "in" thing right now. Don't confuse tinsel and glitter with progress. The progress I had in mind was the type of engineering necessary to prevent Amateur equipment from lousing up the other users of the spectrum. TV sets are only a small part of the problem, although they are a very noticeable one. To most Amateurs, turning a bunch of beginners loose on 10 meters with a-m rigs would not be a sin of any kind, but your TV-viewing neighbors would think otherwise, as evidenced by the uproar over TVI caused by CB rigs, which are a-m.*

As to cost — we've recently published an article about a beginner's transmitter which can be assembled at a parts cost of perhaps $50 (if you're a good scrounger and can make workable substitutions) or, up to $150 (if you're faced with an empty junk box and insist on top-quality, all-new components). There's no reason why an enterprising manufacturer couldn't match that price range for a kit or a partially assembled unit. It's not necessarily the cost of progress that runs the price up, but the "do-everything" complex that makes our black boxes (in glittering colors) cost so much. You can add filtering and bypassing for TVI-proofing at a cost of pennies; adding digital dials, VOX, six-band coverage, all-mode capability, and making it smaller than a bread-box becomes expensive. Now my soapbox is creaking! ***Editor***

Dear Horizons:

I've sent in my renewal for *Ham Radio Horizons* — after trying all the rest of the ham magazines, I enjoy that one the most. It seems to have the most interesting articles for a retired PhD physicist ham of two years. It's a terrific hobby!

Charles DeVoe, WA2IUJ
Painted Post, New York

Dear Horizons:

If your magazine sponsors, encourages, or reports on contests, you will do all of us a tremendous service and favor by reminding contest participants to abide by FCC regulations and rules of common courtesy.

It isn't my purpose here and now, to challenge the propriety or usefulness of contests — although I doubt seriously that such a challenge could be intelligently contested. I suggest only that you remind contest participants that the Amateur bands are not reserved for their peremptory use during contest periods.

As the vast majority of Radio Amateurs have no interest in contests, it is grossly unfair to have ordinary use of the ham bands so disrupted by the arrogant selfishness of so many contest participants. Especially in view of the coming WARC 79, I wonder how the face of the "ugly American" is affected by contests. Certainly I hope that Amateurs abroad don't consider American contest operators as being representative of American operators in general.

A. J. Massa, W5VSR
New Orleans, Louisiana

Dear Horizons:

I enjoy *Ham Radio Horizons* very much. I've been a Novice since January 1978 and at the present I'm working toward a General class license. Many of your articles on theory have been very helpful. By the way, my name is *Edi*, not Ed. You see, I'm one of the YLs and my husband is not a ham, although I'm working to get him to join in the fun.

Edi Garriott, WD8QFK
Rochester, Michigan

Dear Horizons:

Almost two years ago, I subscribed to your other magazine, *ham radio*. To my dismay, I found out that the technical articles were way above my limited knowledge. So, I changed the subscription to *Ham Radio Horizons*.

Now, that is quite another story! Since January, I have found again and again valuable information and interesting stories. I just want to thank you for this perfect beginner's blend.

The funny thing is that I am an oldtimer. But time and technical developments have passed so quickly that I sometimes just sit and shake my head in wonderment. Is this still ham radio?

Thank you for your fine article on QSL cards. I have included my latest design, of which I am very proud, though the handdrawn diagrams are a bit shaky. The idea was to represent the progress which ham technology has made in my own shack during 40 years of ham radio. I selected six typical transmitters or finals which I used or am still using.

Keep up the good work you do! I am eagerly waiting for the next issue of *Ham Radio Horizons*!

Albert Heine, DK7CN
Lindau, West Germany

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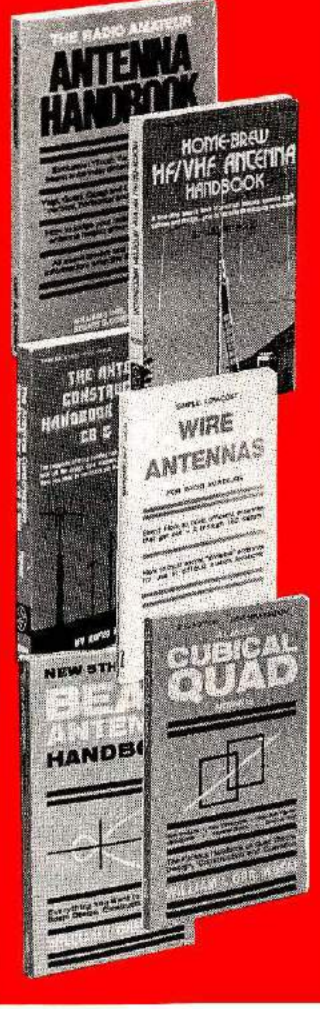

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1978 Sweepstakes Winners

The big winner at the December 8, 1978, *Ham Radio Horizons* Sweepstakes drawing was Mr. Harry Kane, WA2KBI, of Clifton, New Jersey. Harry said that being picked as Grand Prize winner was the biggest surprise of his life, and the most pleasant.

It was, indeed, a *big* surprise — the Grand Prize was a complete station. The list of items reads like a shopper's guide to Amateur dreamland: A **Drake TR-7** Transceiver, complete with **DR-7** digital readout, **PS-7** ac supply, and the **Drake 7707** Desk Microphone. This new transceiver covers all bands from 160 through 10 meters, is all solid-state, with 250 watts output. Next came a **Wilson Mark II** Two-Meter hand-held transceiver — a six-channel handful that will provide either simplex or repeater communications wherever it's needed. A **Telex CM-1320** Deluxe Headset was included as part of the station, and, just to be sure Harry had a place to stack all this, another part of the prize package was a radio desk from **S-F Amateur Radio Services.** A **Ten-Tec KR-50** Ultramatic keyer, a **Dentron MT-3000A** Antenna Tuner, and a **B & W Model 375** Coaxial Switch completes the indoor part of the station.

BY THOMAS McMULLEN, W1SL

However, the prize list didn't stop in the shack. Harry had a choice of towers — either a **Tri-EX W-51**, a free-standing, crank-up tower that will extend to 51 feet, or a **Tri-EX 910K**, a 90-foot guyed tower made up of stackable 10-foot sections. In the antenna department, Harry won a **Cushcraft ATB-34**, three-band antenna for 20, 15, and 10 meters, and a new **Alliance HD-73** heavy-duty rotator to point the beam where he wants it. Also, to complete the antenna picture, he received a **Hy-Gain 18AVT/WB** vertical that covers 80 through 10 meters.

Dust covers from **Cover Craft** were included so the rigs would stay in top shape when not in use.

You can see why Harry was pleased! He has been licensed 6 years, and holds a General class license. His special interests include 2-meter operation and working with Army MARS.

Harry is an electronics Technician for Lockheed Electronics in Plainfield, New Jersey. His job -- testing microwave dishes! There are no other hams in the family, but he says his three-year-old grandson is getting mighty curious about all those wonderful things in the shack.

Harry Kane, WA2KBI, of Clifton, New Jersey; *Ham Radio Horizons* 1978 Sweepstakes Grand Prize winner and proud owner of a complete new station.

There is some homebrew gear at WA2KBI, including several antenna tuners.

There were 100 Second Prize winners drawn on the same date, and they each had their choice of a piece of equipment from **MFJ Enterprises**: A CWF-2BX CW filter, MFJ40-T QRP transmitter, SBF-2BX SSB filter, MFJ200BX Frequency Standard, or a CPO-555 Code Practice Oscillator.

Third Prize was Paul Stack's book, ***Radio Angels***, and 250 copies of this new and thrilling account of Amateur Radio emergency work were sent to the lucky winners of that part of the drawing.

All of us here at *Ham Radio Horizons* are most grateful for the tremendous response to the Sweepstakes announcements. It was an exciting event for us, and even more exciting for 351 winners out there in the world of Amateur Radio. **HRH**

PRODUCT SHOWCASE

Transceiver With Amplitude-Compandored Speech

Stoner has just introduced a new and revolutionary product. It is the first Amateur-Radio transceiver to employ amplitude-compandored speech, the Model PRO-10. The impressive performance of this radio is the result of a tiny integrated circuit from Signetics. This chip contains the equivalent of a six-foot rack of tube-type speech processing equipment!

Amplitude compandoring involves logarithmic speech compression and expansion with no audible distortion. Part of the IC compresses the speech to raise the average modulation. The other half of the Signetics chip is used to expand the voice on receive. The company stresses that both the incoming and outgoing signal are enhanced significantly even when the PRO-10 communicates with conventional ssb radios. A technical paper on amplitude-compandored speech is available from Stoner upon request.

The PRO-10 is described by the company as a platform for high-technology ssb concepts and operates on 10 meters. The ssb/a-m/CW transmitter features 100 watts minimum power output over the entire band. The receiver has a sensitivity of 0.5 microvolts for a 15 dB S+N/N ratio. A built-in, six-digit frequency counter, which reads to ±100 Hz, features jumbo 12.7 mm (0.5 inch) high LEDs.

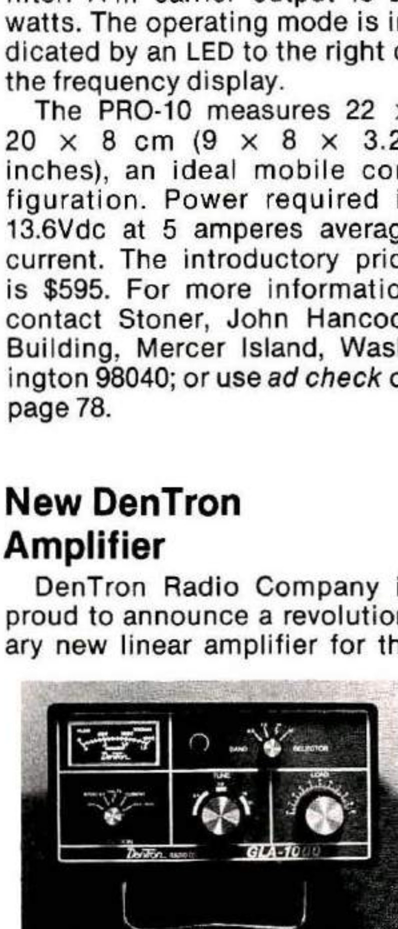
The PRO-10 also features state-of-the-art electronic tuning (fast or slow) from either the panel or the microphone. A PLL (phase lock loop) tunes the radio in 10-kHz steps, while a VFO provides continuous tuning (1 kHz per turn) between steps. A built-in memory stores the last frequency used when the radio is turned off. Break-in CW operation is provided by carrier offset (at 50 watts power output).

Another feature of the PRO-10 is the inclusion of amplitude modulation (a-m). Noting the popularity of converted CB radios on 10 meters, Stoner incorporated provision for this mode by employing a dual bandwidth (2.5 and 5.0 kHz) crystal filter. A-m carrier output is 25 watts. The operating mode is indicated by an LED to the right of the frequency display.

The PRO-10 measures 22 × 20 × 8 cm (9 × 8 × 3.25 inches), an ideal mobile configuration. Power required is 13.6Vdc at 5 amperes average current. The introductory price is $595. For more information contact Stoner, John Hancock Building, Mercer Island, Washington 98040; or use *ad check* on page 78.

New DenTron Amplifier

DenTron Radio Company is proud to announce a revolutionary new linear amplifier for the



Amateur frequencies, the **GLA-1000**. Incorporating four D-50A (6LQ6) final-amplifier tubes, the **GLA-1000** is rated at 1200 watts PEP ssb and 1000 watts CW input. It features a black-scale multimeter for monitoring of critical currents and voltages, complete compatability with any exciter or transceiver, front-panel bypass switch, transmit indicator light, and a built-in relative power monitor for easy tune up. The **GLA-1000** is compact, ideal for portable or fixed operation. It is shipped ready for 117Vac power, with 80- to 15-meter frequency coverage (and most MARS frequencies just outside the Amateur bands). FCC Type Acceptance has been granted. Suggested retail price is $379.50. The **GLA-1000** is now available at DenTron dealerships worldwide. Write DenTron Radio Company, 2100 Enterprise Parkway, Twinsburg, Ohio 44087; or use *ad check* on page 78.

New Cushcraft Vertical Antennas

Many hams are convinced that to work a lot of DX they need a couple of thousand watts and a monster antenna array. While that undoubtedly helps, where is it written that the ham suffering from a money or space cramp can't compete for his day in the DXCC sun?

The three new Cushcraft verticals, the ATV-3, ATV-4, and ATV-5, provide a common-sense solution to a commonplace problem. Specifically designed for the DXer, these antennas provide the low angle of radiation necessary for long-haul DX communications, along with the performance and quality long associated with the Cushcraft name. The ATV-3, ATV-4, and ATV-5 operate over the 10, 15, and 20 meter Amateur bands. The ATV-4 has built-in 40-meter coverage, and the ATV-5 is all set for complete five-band operation.

All antennas feature a built-in

PL-259 coax connector and stainless-steel hardware for all electrical connections; all are matched to 50 ohms and rated for a full 2000 watts PEP. Factory-marked tubing and plain English instructions make assembly a snap.

Built to withstand the severest weather, the ATVs feature specially designed, high-Q traps employing large-diameter enameled-copper wire and solid aluminum, air-dielectric capacitors. The trap forms are manufactured from fiberglass for minimum dielectric loss and high strength.

Available from dealers worldwide, the ATV-3, ATV-4, and ATV-5 retail for $49.95, $89.95, and $109.95 respectively. For more information and a full-color catalog highlighting the entire Cushcraft antenna line, write to Cushcraft, P.O. Box 4680, Manchester, New Hampshire 03108; or use *ad check* on page 78.

New Bird Amateur Wattmeters

The models **4360** and **4362** HAM-MATE directional wattmeters are designed specifically for the Amateur Radio service. The 4360 covers the 1.8-30-MHz range (200 and 2000W), and the 4362 is for use in the 140-180-MHz range which includes the popular 2-meter band. Model **4362** has 25 and 250W scales. The design of the HAM-MATE is basically that of all Bird THRULINE* rf wattmeters except that these do not use plug-in elements. Instead, the sensing element is permanently installed in the line section and is rotatable from the front panel to provide the choice of reading either forward or reflected power.

Both wattmeters are dual-range to allow measurement of both low and high power, and the meter reads directly in watts with the high range being read on the upper arc, and the low range on the lower arc. The down-scale portion of each range is expanded for easier reading. The average power output of CW, a-m, fm, and ssb transmitters can be measured wtih ease, and the wattmeters can be left in the line to allow continuous monitoring of the power output. The HAM-MATE wattmeters are especially useful during the tune-up of an Amateur transmitter.

The new HAM-MATE wattmeters have directivity of 20 dB (100:1) minimum, an absolute must for meaningful reflected power (and vswr) measurement.

*THRULINE is a registered trade name of Bird Electronic Corporation.

Bird HAM-MATE directional wattmeters are priced at $94.00 and delivery is from stock. Write Bird Electronic Corporation, 30303 Aurora Road, Cleveland (Solon), Ohio 44139; or use *ad check* on page 78.

Hamtronics Converters

Hamtronics, Inc., announces a new series of low-cost vhf and uhf converters for use in receiving Oscar and other exciting signals on your present high-frequency receiver. At prices of $34.95 for the kit (or $54.95 wired and tested), they're quite a bargain for the enjoyment you'll get from listening to the ever increasing activity on these bands.

The converters are small in size: only 7 x 11 x 2.5 cm (2-3/4 x 4-1/2 x 1 in). They can be constructed and tested in only a few hours. Built-in test points make alignment simple. The converters feature new high-Q coils, compartmental shielding, and ferrite-bead decoupling.

Any 2-MHz segment in the vhf and uhf range can be covered, using the 10-meter band on your existing receiver. Standard models are listed below, and other rf and i-f ranges are available on special order at the same price. An attractive extruded-aluminum-case kit is available as an option for $12.95 additional.

Standard converters for 28-30 MHz i-f

Model	Input Range
C50	50-52 MHz
C144	144-146 MHz
C145	145-147 MHz
C146	146-148 MHz
C110	Any 2 MHz of aircraft band
C220	Any 2 MHz of 220-MHz band
C432-2	432-434 MHz
C432-5	435-437 MHz
C432-7	427.25 (61.25 MHz i-f)
C432-9	439.25 (61.25 MHz i-f)

To order, or to request a free 40-page catalog on vhf and uhf transmitters, receivers, preamps, and accessories, call 716-663-9254; or write Hamtronics, Inc., 182F Belmont Rd., Rochester, New York 14612; or use *ad check* on page 78.

Improved 2-Meter Rig from Heath

Heath Company of Benton Harbor, Michigan, has made available an improved version of their HW-2036 frequency-synthesized 2-meter transceiver kit, the HW-2036A.

The HW-2036A has the same features and specifications as the HW-2026 except that the newer version allows operation on any 4-MHz segment of the transceiver's 143.5- to 148.5-MHz operating range. For those not already familiar with Heath's 2-meter rig, it features a phase-locked synthesizer/VCO loop for switch-selectable QSY operation, and a choice of simplex or standard plus or minus 600-kHz-split operation. An auxiliary switch lets the operator choose his own offset.

The synthesizer is locked to a precision 10-MHz time base. A NAND gate logic system displays locked/unlocked status and inhibits out-of-band transmissions by preventing transmitter key up. Other HW-2036A features include sub-audible tone encoding, built-in 5 and 11 Vdc regulators, a hash filter/regulator, and a gimbal mount. A standard push-to-talk microphone is included in the HW-2036A-2 kit at the mail-order price of $269.95. When HW-2036A-1 (illustrated) is specified, the standard microphone is replaced by the HD-1984 Micoder II combination microphone/tone-button pad. The HW-2036A-1 sells for $289.95. Both prices are mail order FOB Benton Harbor, Michigan.

For more information about the upgraded HW-2036A and a free catalog, write to Heath Company, Dept. 350-640, Benton Harbor, Michigan 49022; or use *ad check* on page 78.

Free Surplus Catalog

Hobbyists, educators, technicians, and dealers alike are sure to be interested in the new *Surplus Electronics* catalog just published by Etco Electronics, because almost every item in it doesn't fit the usual concept of "surplus."

A look through the catalog will reveal an amazing variety of items, ranging from parts and components and test equipment to educational, industrial, and consumer equipment acquired from leading manufacturers.

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Get a copy of this fascinating catalog today; it's FREE. Write Etco Electronics, Dept. 029, North Country Shopping Center, Route 9N, Plattsburgh, New York 12901; or use *ad check* on page 78.

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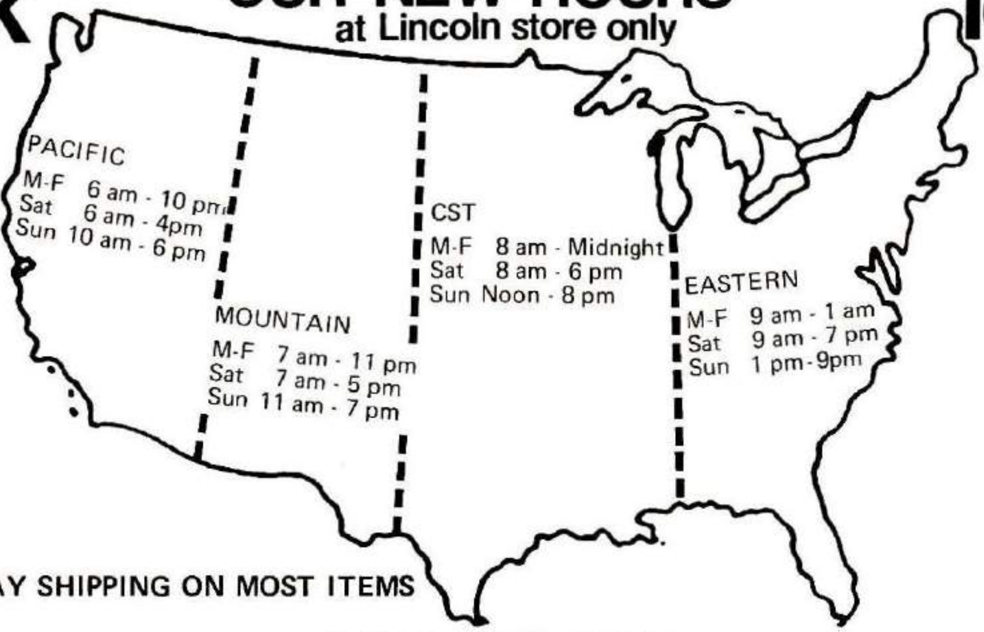

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2M30-160P	30W in 160W out 144 MHz	269.95
2M10-250P	10W in 250W out 144 MHz	419.95
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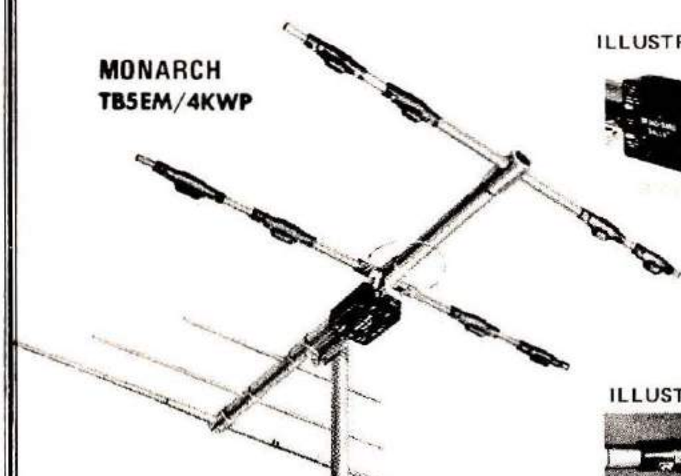

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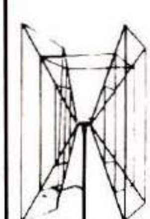

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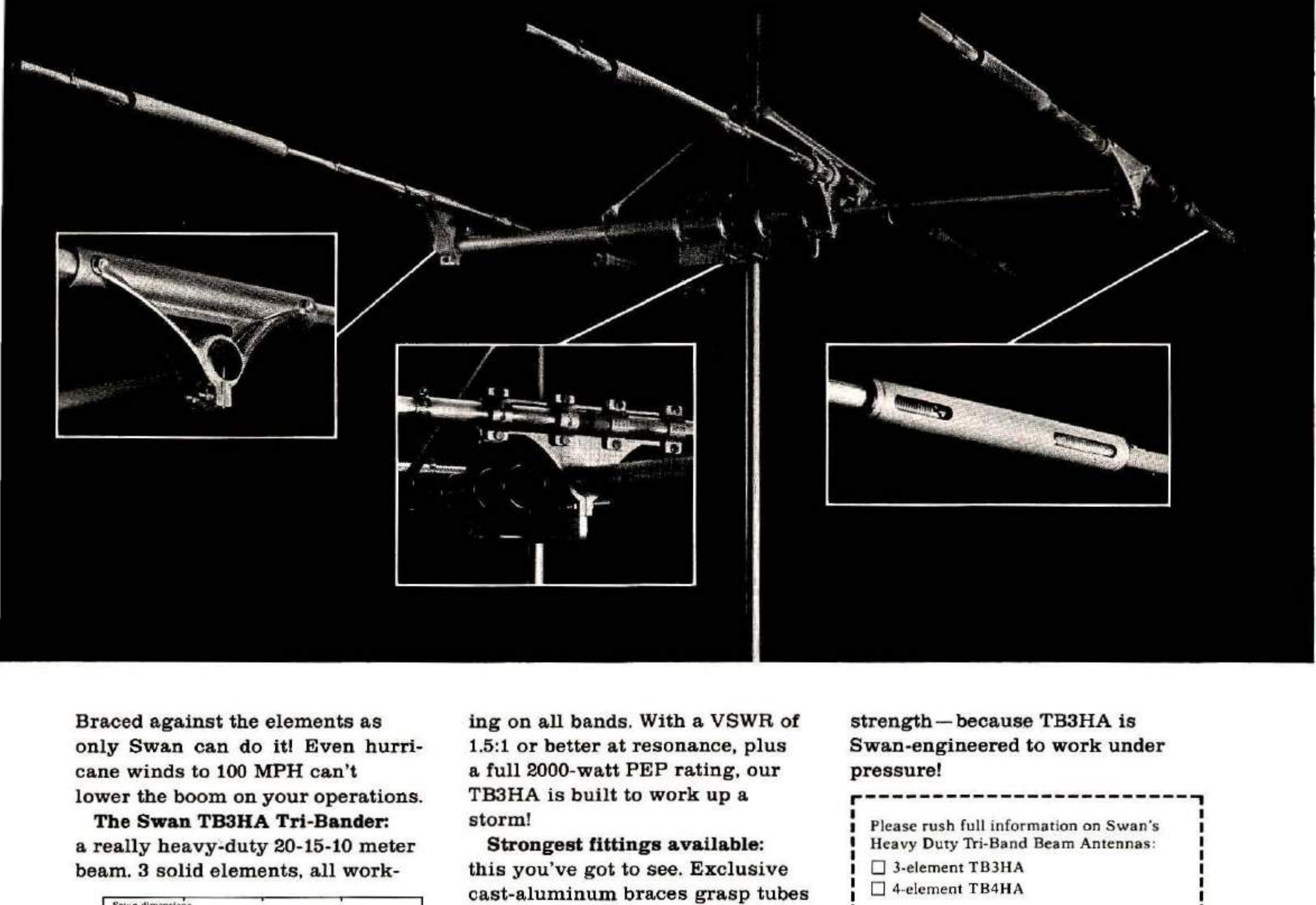

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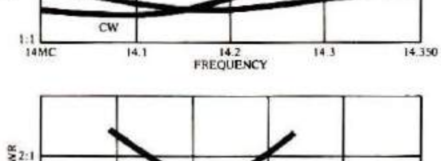

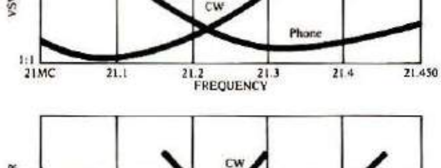

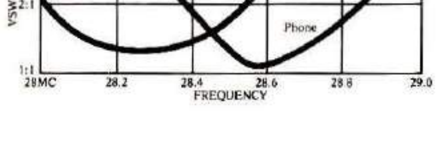

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OHIO: First Annual Lake County ARA Hamfest, April 1, 8:00 AM to 4:00 PM. Lake County Armory, N.E. corner Painesville Fairgrounds, Rt. 20, Painesville, (35 miles east of Cleveland). All indoors for exhibitors and flea market, 1:00 PM auction. Reserved tables — full $2.00, half $1.00. Admission: $2.00. Under 12 free. Talk-in on 52/52 and 147.8121. For info: LCARA, P.O. Box 868, Painesville, OH 44077 or call (216) 257-4486.

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NAMETAGS — 1½″ × 2½″ — One line $2.50. Each additional line $0.50. 12 colors. Tag-it Co., Box 2062, Indianapolis, IN 46206.

RADIO EXPO '79 September 15 and 16, 1979, Lake County Fairgrounds, Routes 120 and 45, Grays Lake, Illinois. Manufacturer's displays, flea market, seminars, ladies programs. Advance tickets $2.00. Write EXPO, P.O. Box 305, Maywood, IL 60153. Exhibitors inquiries: EXPO Hotline (312) 345-2525.

MOBILE IGNITION SHIELDING provides more range with no noise. Bonding strap sale less than 50¢ each. Literature. Estes Engineering, 930 Marine Drive, Port Angeles, Wash. 98362.

CUSTOM Printed and photo QSL's, very economical; free samples, stamp appreciated. Stu, K2RPZ, Box 412, Rocky Point, N. Y. 11778. (516) 744-6260.

SST ANTENNA TUNERS — your best buy. SST Electronics, Box 1, Lawndale, CA 90260.

QSL CARDS 500/$10. 400 illustrations, sample. Bowman Printing, Dept. HRH, 743 Harvard, St. Louis, MO 63130.

CODE PRACTICE OSCILLATORS, hand keys, electronics keyers, other products. Free catalog. Globalman (W6PHA) Products, Box 388-HO, El Toro, CA 92630. 714-533-4400.

HW-2036/HW-2036A OWNERS — Add plus and minus 1-MHz splits. No crystals. Wired and tested PC board easily installs in minutes. Only 5 wires to connect. Complete, ready to install. Only $13.50 ppd. Wallace Enterprises (K2ORY), 83-15 98th Street, Woodhaven, N. Y. 11421.

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NEW CONCEPT — Novice instructional package, theory tape & study material. Complete license study package, $17.95. General study package, $19.95. MARI, 1320 Canary Drive, West Columbia, SC 29169.

RADIO EXPO '79 September 15 and 16, 1979, Lake County Fairgrounds, Routes 120 and 45, Grays Lake, Illinois. Manufacturer's displays, flea market, seminars, ladies programs. Advance tickets $2.00. Write EXPO, P.O. Box 305, Maywood, IL 60153. Exhibitors inquiries: EXPO Hotline (312) 345-2525.

PENNSYLVANIA: Annual Reading Radio Club Hamfest, Hamburg Field House, Hamburg, PA, Sunday, May 27, 1979 starting at 9 AM. Door prizes, food, tailgate sales, dealer space available. Rain or shine. Talk-in on 31/91 and 146.52. For more info, write The Reading Radio Club, Hamfest Committee, P.O. Box 124, Reading, PA 19603.

UPGRADE NOW — to Ham Radio Magazine, the technical journal for all radio amateurs that brings you the latest ideas, construction projects, new circuits, and state-of-the-art advances in electronic communication. You can't afford to miss it at only $15 per year. Ham Radio, Greenville, New Hampshire 03048.

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MISSISSIPPI: The Old Natchez ARC Hamfest will be held on Sunday, April 1, 1979 at the Natchez Convention Center. Indoors, air-conditioned. Free admission and swap tables. Talk-in frequency 146.31-146.91 and 146.52. For info: ONARC, 1226 Magnolia Ave., Natchez, MS 39120.

PENNSYLVANIA: 15th Annual Penn Central Hamfest Sunday, April 29, 1979, 11:00 AM to 5:00 PM at the Woodward Township Fire Hall. Talk-in on 13/73 and 52. For info write K3QDA, Richard Sheasley, R.D. #1, Box 454, Linden, PA 17744, or call W3RON, George, (717) 323-1353.

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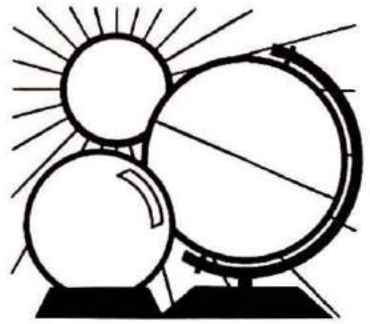

DX FORECASTER

The month of March could well produce the best DX conditions since the peak of cycle 20, nearly 11 years ago! Maximum usable frequencies will often extend into the six-meter band, so be sure to have those beams ready. In addition to the high sunspot activity associated with the rapidly approaching peak of cycle 21, March also brings the Spring Equinox — a period when days and nights of equal length facilitate trans-equatorial propagation. If you don't work a logbook full of DX this month, it's *your* fault!

Last-minute Observations

For the sky observers, there will be a partial eclipse of the moon on the night of March 13th. The beginning part will be visible from the Western Pacific Ocean, Australia, Asia, the Indian Ocean, Africa, Europe, part of Antarctica, the eastern Atlantic Ocean and the Arctic. The end of the eclipse can be seen in western Asia, the Indian Ocean, Africa, Europe, the Atlantic Ocean, eastern South America, northeastern North America, Greenland and part of Antarctica. Full moon occurs at the same time, while perigee occurs on March 26th.

Expect minor geomagnetic field upsets during the first week of the month, some additional disturbances during the second week, and the likelihood of a major ionospheric upset sometime between the 19th and 23rd. During the times of the predicted disturbances, listen to WWV propagation forecasts and geomagnetic reports at eighteen minutes after each hour on 2.5, 5, 10, or 15 MHz so that you will be able to plan your DXing activities accordingly. For example, minor geomagnetic field upsets tend to be short-lived, producing polar-path disturbances and tending to wipe out east-west DX paths, but sometimes enhancing north-south paths across the equator. Major upsets with both ionospheric and geomagnetic field effects often produce very poor conditions, even communications blackouts. It is unlikely that March will produce anything quite that severe, however. Conditions toward the end of the month are expected to be good with no particular disturbances foreseen.

Band-by-band Conditions

Look for openings on bands from *one-sixty* through *six meters*! Increasing static noise levels will tend to make the DX a bit difficult to hear on *one-sixty* and *eighty* — and sometimes on *forty* as well — when thunderstorms are active in the southern parts of the U.S. At other times, use the charts to plan your listening, and expect excellent conditions.

Here's a tip: Look on the bands indicated at the times shown, with your beam pointed in the favored direction. However, you should also try the next *higher* frequency band, particularly when marked with an asterisk (*). Because the chart is keyed to the highest band usable, *forty* and *eighty meter* openings are shown only when one of the higher bands is not listed. You can find DX on forty and eighty at other times, too, usually after local hours of darkness and in early morning hours.

HRH

MARCH

WESTERN USA

GMT	PST	N (Central Asia)	NE (Europe)	E (S. Africa)	SE (S. America)	S (Antartica)	SW (New Zealand)	W (W. Australia Oceania)	NW (Far East)
0000	4:00	15	—	10	10	15	10	10	10
0100	5:00	10	—	10	10	15	10	10	10
0200	6:00	10	—	15	15	15	10	10	15
0300	7:00	10	—	15	15	20	15	10	15
0400	8:00	10	—	15	15	20	15	15	15
0500	9:00	15	20	15	20	20	15	15	15
0600	10:00	15	20	20	20	20	15	15	15
0700	11:00	20	20	20	20	20	20	15	20
0800	12:00	20	20	20	20	20	20	20	20
0900	1:00	40	40	40	20	—	20	20	40
1000	2:00	40	40	40	40	40	20	20	40
1100	3:00	40	40	—	40	40	20	20	—
1200	4:00	—	—	—	40	40	20	20	—
1300	5:00	—	—	—	—	—	20	20	—
1400	6:00	—	15	20	20*	—	20	—	—
1500	7:00	15	15	20	15	—	20	—	—
1600	8:00	15	10	20*	15*	—	15	20	20
1700	9:00	15	10	20	10	—	—	15	20
1800	10:00	—	10	20	10	—	—	15	20
1900	11:00	—	15	20	10	—	—	15*	20
2000	12:00	—	15	20	10	—	20	10	15
2100	1:00	—	15	—	10	—	20*	10	15
2200	2:00	—	15	—	10	—	15	10	15*
2300	3:00	—	—	—	10	15	15*	10	10

MID USA

GMT	MST	N (Central Asia)	NE (Europe)	E (S. Africa)	SE (S. America)	S (Antartica)	SW (New Zealand)	W (Australia)	NW (Far East)	CST
0000	5:00	15	40	15	10	15	10	10	15	6:00
0100	6:00	15*	40	20*	10	15	10	15	15	7:00
0200	7:00	10	40	20	15	20	15*	15	15	8:00
0300	8:00	15*	40	20	15	20	15	15	15	9:00
0400	9:00	15	40	20	20	20	15	20	20	10:00
0500	10:00	15	40	40	20	20	20	20	20	11:00
0600	11:00	15	40	40	20	20	20	20	20	12:00
0700	12:00	20	80	40	20	—	20	20	20	1:00
0800	1:00	20	80	40	20	—	20	20	20	2:00
0900	2:00	20	80	40	20	40	20	20	40	3:00
1000	3:00	20	80	40	40	40	20	20	40	4:00
1100	4:00	20	80	20	40	40	20	20	40	5:00
1200	5:00	20	20	15	40	—	40	20	40	6:00
1300	6:00	15	20	15	20	—	20	20	40	7:00
1400	7:00	10	20*	15	20*	—	20	20	40	8:00
1500	8:00	10	15	15	15	—	20	20	20	9:00
1600	9:00	10	15	15	15	—	20	15	20	10:00
1700	10:00	10	15*	15*	10	—	20	10	20	11:00
1800	11:00	10	15*	10	10	—	20	10	20	12:00
1900	12:00	10	15	10	10	—	20	10	20	1:00
2000	1:00	10	15	10	10	—	15	10	15	2:00
2100	2:00	10	20	15	10	—	15	10	15*	3:00
2200	3:00	15	20	20*	10	—	15	10	10	4:00
2300	4:00	15	20	20*	10	15	15	10	15*	5:00

EASTERN USA

GMT	EST	N (Far East)	NE (Europe)	E (Central Africa)	SE (S. Africa)	S (S. America)	SW (Oceania)	W (W. Australia New Zealand)	NW (Australia)
0000	7:00	15*	40	15	20	20	15*	15	10
0100	8:00	20	40	20	40	20	15	15	15
0200	9:00	20	40	20	40	20	15	15	15
0300	10:00	20	40	40	40	20	20	20	20
0400	11:00	20	40	40	40	20	20	20	20
0500	12:00	20	40	40	—	20	20	20	20
0600	1:00	20	40	20	—	20	20	20	20
0700	2:00	40	40	20	—	20	40	40	40
0800	3:00	40	40	20	—	40	40	40	40
0900	4:00	40	—	40	—	40	40	40	40
1000	5:00	40	20	40	20	40	40	40	40
1100	6:00	40	20	20	20	20	40	40	40
1200	7:00	20	15	20	20*	20*	20	20	20
1300	8:00	20	10	15	15	15	20	20	20
1400	9:00	20	10	15*	15	15*	20	20	15
1500	10:00	—	10	15	15*	10	20	20	20
1600	11:00	—	10	10	10	10	20	20	20
1700	12:00	—	10	10	10	10	15	20*	20
1800	1:00	—	10	10	10	10	15*	15	20
1900	2:00	—	15	10	10	10	10	15	20
2000	3:00	15	15	10	10	10	10	15*	15
2100	4:00	15	20	10	10	10	10	10	10
2200	5:00	15*	20	10	15*	10	10	10	10
2300	6:00	10	20	15*	15	15	10	10	10

HAM CALENDAR

March 1979

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
*All international events such as contests are shown on the GMT days on which they take place even though they may actually begin on the evening of the preceding day in North America. Hugh Vandergrift, FØXA/WA4WME, will present his famous movies and slides of the 1978 Clipperton Island DXpedition at the annual dinner meeting of the Iowa-Illinois Amateur Radio Club March 17, at 6:00 PM at the Arion Restaurant, 210 North Main, Downtown Burlington. Info: Mary Jo Johnson, 417 Huston, West Burlington, IA	Workshops: A new and expanded series of four 3-day hands on workshops on 8080/8085 Design, Microcomputer Interfacing, Software Design and Digital Electronics are being given by the authors of the popular Bugbooks. Participants have the option of retaining equipment used in these courses. Dates are March 19 to 28, 1979. For more information contact Dr. Linda Lettel, C.E.C., Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061 (703-961-5241).			1	ARRL Southeastern Div Convention — Orlando, FL — 2-4 2	DX Competition — Phone — 3-4 YL OM Contest — CW Sterling Rock Falls ARS Hamfest — Sterling High School Fieldhouse, Sterling, IL Teays ARC Ham Fiesta — Pickaway County Fairgrounds — Circleville, OH 3
4	FLORIDA HAM NEWS — SWAP NET By the Broward ARC 146.31-91 at 7:30PM GLENHURST RADIO SOCIETY Transmits Amateur Radio News — 222.66/224.26 MHz via WR2APG and 21.400 MHz USB WEST COAST BULLETIN Edited & Transmitted by W6ZF 8PM PST 3540 kHz, A-1, 22 WPM 5	AMSAT Eastcoast Net 3850 kHz 8PM EST (0100Z Wednesday Morning) AMSAT Mid-Continent Net 3850 kHz — 8PM CST (0200Z Wednesday Morning) AMSAT Westcoast Net 3850 kHz 7PM PST (0300Z Wednesday Morning) 6	West Coast Qualifying Run (W60WP prime, W6ZRJ alternate) 10-35 WPM at 0500Z 7	8	9	ARRL Hamfest — Lafayette, LA — 10-11 Commonwealth Contest — CW — 1200Z 3/10 - 1200Z 3/11 QCWA Membership QSO Party — Phone — 10-11 Virginia State QSO Party — By the Sterling Park ARC — 1800Z 3/10 - 0200Z 3/12* 10
See March 4, 5, 7, 10, 15, 17, 19, 26, 31  11	FLORIDA HAM NEWS — SWAP NET By the Broward ARC 146.31-91 at 7:30PM GLENHURST RADIO SOCIETY Transmits Amateur Radio News — 222.66/224.26 MHz via WR2APG and 21.400 MHz USB 12	AMSAT Eastcoast Net 3850 kHz 8PM EST (0100Z Wednesday Morning) AMSAT Mid-Continent Net 3850 kHz — 8PM CST (0200Z Wednesday Morning) AMSAT Westcoast Net 3850 kHz 7PM PST (0300Z Wednesday Morning) 13	14	W1AW Qualifying Run 10-35 WPM at 0300Z* 15	16	ARRL South Carolina State Convention — Greenville, SC Cherryville Repeater Association Hamfest — Field House of Hunterdon Central High School — Flemington, NJ DX Competition — CW — 17-18 Treasure Coast Hamfest — Vero Beach Community Center, Vero Beach, FL 17
Tri County ARC Hamfest — Jefferson County Fairgrounds, Jefferson, WI 18	FLORIDA HAM NEWS — SWAP NET By the Broward ARC 146.31-91 at 7:30PM GLENHURST RADIO SOCIETY Transmits Amateur Radio News — 222.66/224.26 MHz via WR2APG and 21.400 MHz USB WEST COAST BULLETIN Edited & Transmitted by W6ZF 8PM PST 3540 kHz, A-1, 22 WPM 19	AMSAT Eastcoast Net 3850 kHz 8PM EST (0100Z Wednesday Morning) AMSAT Mid-Continent Net 3850 kHz — 8PM CST (0200Z Wednesday Morning) AMSAT Westcoast Net 3850 kHz 7PM PST (0300Z Wednesday Morning) 20	21	22	Lawton-Ft. Sill ARC Hamfest Montego Bay Motel Complex, Lawton, OK — 23-25 23	ARRL Hamfest — Fort Walton Beach, FL — 24-25 CQ World-Wide WPX SSB Contest — Full 48-hour period — 24-25 Knight Raiders VHF Club Fleamarket — St. Joseph's Church, East Rutherford, NJ Metrolina Hamfest — Charlotte, NC — 24-25 24
Libertyville & Mundelein ARS Hamfest — J.M. Club, 708 Greenwood Avenue — Waukegan, IL 25	FLORIDA HAM NEWS — SWAP NET By the Broward ARC 146.31-91 at 7:30PM GLENHURST RADIO SOCIETY Transmits Amateur Radio News — 222.66/224.26 MHz via WR2APG and 21.400 MHz USB W1AW Qualifying Run 26	AMSAT Eastcoast Net 3850 kHz 8PM EST (0100Z Wednesday Morning) AMSAT Mid-Continent Net 3850 kHz — 8PM CST (0200Z Wednesday Morning) AMSAT Westcoast Net 3850 kHz 7PM PST (0300Z Wednesday Morning) 27	28	29	ARRL Great Lakes Division Convention — Muskegon, MI — 30-31 30	ARRL Hamfest — Holiday Inn-Holidome — Kearney, NE 3/31-4/1 Columbus ARC Hamfest — Columbus Municipal Auditorium, Columbus, GA — 3/31 - 4/1 Tennessee QSO Party — 2100Z 3/31 - 0500Z 4/1 — 1400Z - 2200Z 4/1 Wisconsin QSO Party — 2100Z 3/31 - 0300Z 4/2* ZL3 Canterbury Chapter of International 10/10 Net QSO Party 0000Z 3/31 - 1200Z 4/1* 31

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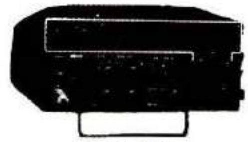
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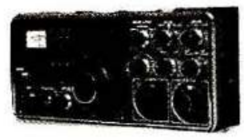
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MARCH 1979

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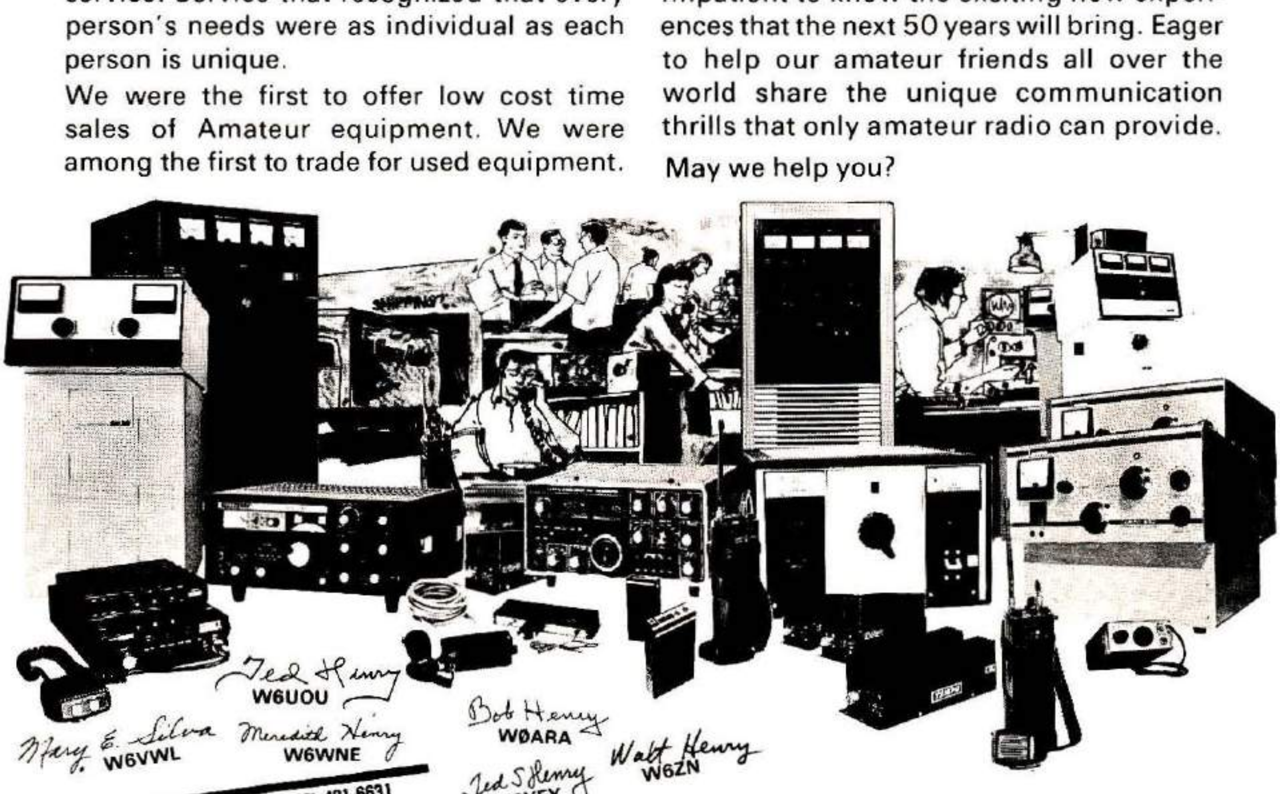
We were the first to offer low cost time sales of Amateur equipment. We were among the first to trade for used equipment. Even then we had an expert service department to assure that each piece of equipment operated the way it should. We pioneered "satisfaction guaranteed" and the ten day free trial policy. Then as now we recognized our obligation to provide amateurs everywhere with fine equipment and good service.

At Henry Radio we don't know any other way of doing business. Since we have been active amateurs for all these years, we know the correct answers when we ask ourselves, "Is this the way I would want to be served if I were a customer of Henry Radio?"

Looking back, 50 years seems a long time. Looking ahead we feel like eager youngsters impatient to know the exciting new experiences that the next 50 years will bring. Eager to help our amateur friends all over the world share the unique communication thrills that only amateur radio can provide.

May we help you?



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The SB-201 uses a pair of 572B/T-160-L tubes for a full 1200 watts PEP input on phone and 1 kW on CW. It has a multi-function front panel meter for SWR, grid current, plate current, relative power and plate voltage, and easy to operate controls. The SB-201 is mail order priced at **just $449.95.**

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SB-221 SPECIFICATIONS

Band coverage: 80, 40, 20 & 15 meters. **Driving power:** 100 W. **Max. power input:** SSB, 2000 W. PEP; CW, 1000 W.; RTTY, 1000 W. **Duty cycle:** SSB, Continuous voice modulation. CW, Continuous (maximum key-down 10 minutes). RTTY, 50% (maximum transmit time 10 minutes). **Third order distortion:** −30dB or better. **Input Impedance:** 52 ohm unbalanced. **Output Impedance:** 50 ohm unbalanced; SWR 2:1 or less. **Front panel controls:** Tune, Load, Band, Sensitivity Meter Switch, Power, CW/Tune – SSB, Plate meter, Multi-meter (Grid mA, Relative Power and High Voltage) **Rear panel:** Line cord, circuit breakers (two 10 A). Antenna Relay (phono). ALC (phono). RF Input (SO-239). Ground post. RF Output (SO-239). **Tubes:** Two Eimac 3-500Z. **Power requirement:** 120 VAC, 50/60 Hz at 20 amp. max. 240 VAC, 50/60 Hz at 10 amp. max.

SB-201 SPECIFICATIONS

Band coverage: 80, 40, 20 & 15 meters. **Maximum power input:** 1200 watts P.E.P. SSB, 1000 watts CW. **Driving power required.** 100 watts. **Duty cycle:** SSB, continuous voice modulation; CW, 50% (key down time not to exceed 5 min). **Third order distortion:** −30 db or better at 1000 watts P.E.P. **Output impedance:** 50 to 75 ohm unbalanced; variable pi-output circuit. SWR not to exceed 2:1. **Input impedance:** 52 ohm unbalanced; broad-band pretuned input circuit requires no tuning. **Meter functions:** 0-100 ma grid current, 0-1000 ma plate current, 0-1000 relative power, 1:1 to 3:1 SWR, 1500 to 3000 volts high voltage. **Front panel controls:** Load; Tune; Band; Relative Power Sensitivity; Meter Switch, Grid-Plate-Rel. Power-SWR-HV; and Power Switch, on/off. **Tube complement:** Two 572B/T-160-L (in parallel). **Power requirement:** 120 volts AC @ 16 amperes (max.), 240 volts AC @ 8 amperes (max.).

Prices are mail order F.O.B. Benton Harbor, Michigan. Prices and Specifications subject to change without notice.