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THE EVOLUTION OF RADIO

by

HUGO GERNSBACK

THE RADIO CLUB OF AMERICA, INC.

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OF THE
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THE EVOLUTION OF RADIO
BY
HUGO GERNSBACK

Hugo Gernsback addressing
The Radio Club on "The Evolution of Radio".

MR. CHAIRMAN, LADIES AND GENTLEMEN: FIRST LET ME CONGRATULATE THE MEMBERS OF THE RADIO CLUB OF AMERICA ON ITS SUCCESSFUL 50th ANNIVERSARY, WHICH TAKES PLACE THIS YEAR.

I INDEED REMEMBER ITS INCEPTION VERY WELL AND KNEW ITS FOUNDERS, TOO. AS THE FIRST 50 YEARS ARE USUALLY THE MOST DIFFICULT OF ANY ORGANIZATION, I KNOW THAT THE UPCOMING 100th ANNIVERSARY WILL BE NEGOTIATED WITH COMPARATIVE EASE AND THAT THE YOUNGER MEMBERS OF THE RADIO CLUB OF AMERICA WILL BE THERE TO CELEBRATE IT TOO.

MY BEST AND MOST SINCERE WISHES FOR THAT FUTURE OCCASION TOO.

In 1904 the word radio had not been coined. Marconi and other scientists had been busy in Europe with wireless, while in this country, Dr. Lee de Forest also embraced the new art. Amateur wireless likewise was unknown up to that time.

It was about then that I started the Electro Importing Company (the E. I. Co.), sometime in the fall of 1904. I had a friend by the name of Lewis Coggeshall with whom I had been rooming. He happened to be a telegraph operator with the Erie Railroad, and I thought it would be a good idea to start a new company to import all sorts of electrical educational instruments from Europe.

We immediately got out a small catalog for the Electro Importing Company, and at the same time I began to work on the Telimco wireless, the world's first home radio. This particular set, a 1" spark coil with 2 spark balls and a high-speed interrupter, 3 dry cells and a telegraph key, was the transmitter. The spark balls had two 10" antennas. The transmitter was mounted on a board.

The receiver was a coherer, which I manufactured; a decoherer, which was nothing but a bell; a 75-ohm pony relay and two 10" antennas. This transmitter and receiver worked very well, even through stone walls. If you used an outdoor antenna, and ground, its signals could easily be transmitted up to a mile.

Naturally, all transmission in those days was done in the usual Morse code. The only trouble with the Telimco gear was that once in a while there was outside interference, as from elevators and such. This was something we could not overcome in those days. Secondary defects also occurred from the minute spark of the silver contacts on the pony relay. As we didn't have small capacitors in those days, I used a high-resistance of between 750 and 1000 ohms, which extinguished the sparks successfully.

The coherer had a mixture of 90% soft iron filings and 10% silver. We could have gone to jail in those days if the government had found out how we got the silver filings. The easiest way was to take a dime and file it into coarse filings, which of course was against the law. Fortunately, we didn't use up too many dimes.

It is worthy of note to record that the Telimco sold for the huge sum of $7.50 for the whole set. I have an idea that it cost us more than that to produce, but we didn't have cost accounting then and sales were brisk, so from the profit we made from selling other apparatus, the first amateur wireless was born. This had an excellent sale at New York's biggest toy store, F. A. O. Schwarz, at Macy's, Gimbel's, Abraham and Strauss', and even in Chicago, at Marshal Field's.

It is difficult to believe that the first amateur wireless gear actually was a short wave set. When, many years later, I demonstrated the Telimco for nearly 1,000 members of the Institute of Radio Engineers, I found it was necessary to obtain a license to operate it. The Federal Communications Commission was kind enough to supply me with a

> "Radio Station License, good for operation between March 7, 1956 and March 25, 1956. <u>Call letters</u> were KE2XSX; <u>frequency:</u> above 30 megacylcles; <u>hours of service:</u> not to exceed 5 seconds during each 15 minute period; purpose: to demonstrate radio transmitting equipment of early design at the annual meeting of the Institute of Radio Engineers.
>
> "This authority is granted upon the express condition that no ground connection or elevated antennas will be employed; that no interference is caused to any other station or service, and may be cancelled at any time without hearing if in the judgment of the Commission such action should be necessary."

Incidentally, the set on that evening was operated by veteran Jack Binns.

It is of note that the first radio set advertisement in the world appeared in the January 13, 1906 issue of SCIENTIFIC AMERICAN, two years after the birth of the apparatus. A replica of the set is today in the Henry Ford Museum at Dearborn, Michigan, where it is on display.

Sales of the first wireless set were not always without incident. One day two husky policemen came in and gruffly demanded to know what we fakers were up to. They waved an advertisement from SCIENTIFIC AMERICAN under our noses and told us that it was impossible for anyone to sell a wireless that actually worked over a distance for $7.50, when everyone knew that wireless sets cost thousands of dollars. They had been sent by the then Mayor Gaynor of New York who had received complaints about the advertisement.

We asked one of the cops to hold the receiver end in his hands and we asked him to tell us how many times the bill should ring. He said five. We pressed the key five times, and the bell rang five times. That particular day, we were lucky because there was no interference from the elevator, and when the cop subsequently asked for 3, another 5, then 6 rings, the bell did its duty and rang accurately.

We then suggested the policeman step into the corridor and asked him again to tell us how many times the bell should ring. He told us three, and again the set performed as well as ever. The cop came back and scratched his head, still looking dubious. New York cops are not defeated so easily. He looked quizzically at the set, which of course had connecting wires from the batteries to the coherer, and triumphantly said: "Didn't you fakers advertise that this was a <u>wireless</u> set? Well, what are them wires here for?" But he winked at us and he and his buddy departed.

About that time I also constructed what was probably the first walkie-talkie, even if it did not actually talk. We had fashioned a sign, which one of my employees wore on his shoulders. This carried the complete transmitter only, no receiver. We had another man a little further back, and every time the man with the transmitter pressed the key, the receiver, a little distance away, would work. The sign which the transmitter man carried advertised it as a "complete wireless set for $7.50."

We also had some circulars which he handed out. As a rule, he circulated in the downtown streets, Park Place, Fulton Street, and Wall Street, but we soon had to give this up, because the police again interfered, this time not because they doubted that the Telimco set worked, but because the crowds that assembled blocked the streets. So the first walkie-talkie set had to be discontinued for obstructing traffic.

For the next ten years, the Electro Importing Company continued to import such material as Geisler tubes, small X-ray tubes that worked exceedingly well and sold for $3.50, Volt- and Ammeters, and other gear, but we got more and more into wireless. In 1907, for instance, I designed during that particular year, an improved coherer, an auto-coherer. I launched the first electrolytic detector, various tuners, single and double slide, and I brought out the first ball slider which made contact with the bare wire turns of the tuners. There is an interesting note about this slider. For many, many years, Western Electric bought thousands of these sliders every year and kept on buying them. I could never find out how and where these sliders were used. Originally these were made in metal, but later on I had the slider made in composition--the first time I ever used composition. About that time I also brought out what was the world's first molded capacitor. It sold for 50¢.

That year, too, I brought out the first variable slide-plate capacitor. It probably was the first such capacitor ever sold commercially. There was also the potentiometer which had a carbon graphite resistor rod. The good old ball slider was used again for contracting purposes. It is interesting to note how we got the resistor rods. As we could not get any manufacturer to make less than 5,000 of these, we simply bought several hundred carpenter's pencils. These we dropped into a large pail and boiled them, loosening the graphite-carbon rods, which we then carefully dried. It worked well, too, as a potentiometer.

That year, too, I designed a transmitting helix with clips to vary the inductance, as well as a transmitting variable capacitor.

The E.I. Co. catalog for 1907 had a new cover. It used the words MODERN ELECTRICS. The cover, too, showed a good deal of wireless material, including two large chicken netting antennas. Later, during 1909 there was a wireless boom that had been caused by the sinking of the S.S. Republic. It was on this occasion that Jack Binns became famous because hundreds of people were saved, chiefly because of the wireless, when Binns flashed his CQD, the then distress call which is our SOS today.

During 1908 our correspondence in the E. I. Co. became so huge that we had to hire extra people to answer the letters from experimenters and amateurs who wanted to get information on all sorts of subjects. Finally this became so burdensome that I thought it wise to get out a magazine which would answer the various questions--many of which recurred- in a special Question and Answer department. Therefore, in April 1908, I brought out what was to be the world's first radio magazine, MODERN ELECTRICS. At the peak of its successful career, we printed over 100,000 copies, selling at 10¢ each.

There were many, many "firsts" in MODERN ELECTRICS, too numerous to mention in detail here. There was the Wireless Association of America, which had as its President, Dr. Lee de Forest. John S. Stone was Vice President, William Maver, Jr., Secretary, and myself as Chairman. This was announced in the January 1909 issue of MODERN ELECTRICS.

There was also an editorial which I wrote for the February 1912 issue of MODERN ELECTRICS, which said in part: "There should be a bill passed restraining the amateur from using too much power, say anything above 1 K.W. The wave length of the amateur wireless station should also be regulated in order that only wave lengths from a few meters up to 200 could be used. Wave lengths of from 200 to 1,000 meters, the amateurs should not be allowed to use, but they could use any wave length above 1,000. . . . . "

This subsequently became the Wireless Act of 1912, the first radio law in the country, which repeated, almost verbatim, my recommendations, as follows:

"No private or commercial station not engaged in the transaction of bona fide commercial business by radio communication. . . shall use a transmitting wave length exceeding two hundred meters or a transformer input exceeding one kilowatt except by special authority of the Secretary of Commerce and Labor contained in the license of the station . . ."

Up to that time, there had been, of course, no radio law of any kind. This particular law gave the amateurs the rights they have had ever since. Curiously enough, the law makers reasoned that the 200 meters idea was a huge joke, but it was thought that it would keep the amateurs quiet, since they probably couldn't do a thing with such high frequencies! Time proved how ill-founded such an assumption was.

Later on, the E. I. Co. continued to grow and manufactured practically everything that an amateur could use. Before the enactment of the first wireless law, I had also developed an electrolytic interrupter in 1910, as well as a 1/2 kilowatt coil to go with it for transmitting purposes. This gear drew such a frightful amount of current that if you did not wish to have the fuses blown all over the house, you had to take them out and put a good-sized jumper over the contact points. Nevertheless, the outfit became famous because you really could transmit over respectable distances by its means.

There is a more or less hilarious story connected with this, which gives a faint idea of just what happened in those days. Two amateurs somewhere in Pennsylvania started to communicate with each other one night. One man was in a valley, the other near the top of a mountain. The distance between them was some 15 or 20 miles, and on a clear day you could see across the distance.

One night, when one of the boys was working his outfit and looking out of the window, he noticed that there was something unusual happening in the vicinity. He called his friend on the telephone and told him that he didn't have to listen to the signals at all, because every time his distant friend pressed the key, the street lights and the house lights would all go dim. Therefore he could easily read the code simply by looking at the street lights near his friend's house!

There was a further "first" when the E. I. Co. sold the first audion, now known as the vacuum tube. It sold for $4.50, and was advertised in the E. I. Catalog No. 10, page 93. MODERN ELECTRICS had another "first" and that happened in 1911. At that time, I was running my novel RALPH 124C 41+ in the magazine. The story was laid in the year 2660, and in the December 1911 issue, there appeared the first technical description of what is now known as radar. This was thirty years before the event. In a letter to me dated December 20, 1944, Dr. Lee de Forest said: "Your fanciful suggestion as far back as 1911 should certainly have suggested to a later investigator of ultra-high frequency radio beams the possibility of using that principle as radar has now been used, for the detection of hostile airplanes. The chances are, however, that no investigator of UHF (Ultra High Frequency) radiations in the 1930's had ever read what you wrote in 1911. You may, however, take justifiable pride in the far-sightedness of many of your startling suggestions."

So much for the past. What about the future? What will radio amateurs do in years to come. I for one hope that they will be enabled to work on millimeter waves. In the June 1959 issue of RADIO-ELECTRONICS, I expressed some thoughts on this subject in an article entitled "Millimeter Waves":

> "As we ascend the scale of radio frequencies beyond the ultra-high range, we emerge into the millimeter waves. This band lies between 30,000 and 100,000 megacycles (10 and 3 millimeters). There have been under intense study for a number of years, yet they are still largely in the unutilized realm of electromagnetic radiation. The new waves can be generated by crystal-diode harmonic producers, klystrons, backward-wave oscillators and high-voltage beams.
>
> The difficulty thus far has been that these generators are not very efficient transmitters at such high frequencies. As the transmitting power at present is microscopic--a few watts at most--the signal is weak, too. The range so far has been limited to between 10 and 20 miles.
>
> So far, transistors can be used up to less than 2,000 megacycles, while millimeter waves start at 30,000 mc. It is possible, however, that some solid-state device for generating millimeter waves will evolve.
>
> Millimeter radio waves approach light waves, and in many ways act like them. They are often called quasi-optical waves.*
>
> When these waves are transmitted through the air, water moisture or vapor and oxygen, particularly, interfere with the transmission, making for poor reception. In this way, millimeter waves act very much like light waves in a dense fog--signaling for both becomes unreliable.
>
> So far, at the lower limits of these frequencies, wave-guides (hollow metal pipes) seem to work out best in transmitting these extremely short waves. Such guides are most efficient, at the present state of the art, causing comparatively little loss of power.
>
> The waves are so short that they can be sent through what are essentially hollow wires. The opening in that case would have to be greater than 1/2 a wavelength, say 1/8 inch, for 5-millimeter waves having a frequency of 60,000 megacycles. The difficulty here is that transmission through such small holes creates losses, while very straight pipes 2 inches in diameter appear much more useful.
>
> Unfortunately, ordinary solid wires cannot be used in transmitting millimeter waves because wires radiate too much power at the ultra-high frequencies. Ordinary antennas cannot be used. For best transmission, "horn" antennas and parabolic reflectors seem to give best results.

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* See RADIO-ELECTRONICS, March, 1952; January, 1957; Arpil, 1957.

At a recent session in New York early in April, several hundred scientists and engineers discussed millimeter waves at great length. All admitted the great future of these waves if only a more satisfactory means could be found for their generation, transmission and, particularly, their control.

It will probably take a number of years before new instrumentalities have been invented to make millimeter waves as common as longer radio waves. In this respect, we have to go back to Heinrich Hertz and Marconi, who also had to grope along unknown paths to make wireless practical.

Yet we already know that millimeter waves are not only here to stay, but that they are the forerunner of vast changes in radio, electronics, television and other communications.

Whether we use waveguides or an entirely new means of transmission, millimeter waves are certain to be used intensively in the foreseeable future. The chief reason is that, at these quasi-light frequencies, we will eventually be able to handle with ease several hundred thousand millimeter-wave telephone channels, with hundreds of television channels, simultaneously along a single transcontinental or transoceanic line.

As a matter of fact, far more channels are available in the millimeter range than in the entire radio-television-radar frequency spectrum combined. And, as every technician knows, our present radio channels are practically exhausted now. Hence the urgency for opening the millimeter band.

In the space age now dawning, the new ultra-high waves will be especially useful. It is quite certain that millimeter transmitters can also be miniature in size, possibly as small as a matchbox, yet powerful enough to cover vast distances in space. According to Dr. John R. Pierce, physicist of Bell Telephone Laboratories, who kindly gave us considerable factual data used in this article--if one used parabolic antennas hundreds of feet in diameter, a few watts at millimeter frequencies could easily reach our nearest star, Alpha Centauri, 4 light years distant!

What is more, these microwaves are not affected in their transmission in free space, as they are in our dense oxygen- and water-soaked atmosphere. There is little doubt that spacemen of the future, as well as all spaceships, will be equipped with millimeter radio equipment.

Millimeter radar gear in space is quite feasible and will surely be used in the foreseeable future on the moon and spaceships. It should be particularly effective in detecting even small meteorites. This, as all future spacemen are well aware, is vital in "sidestepping" these lethal bodies, which travel at the rate of 5 to 10 miles a second. If they can be detected and intercepted early enough, the spaceship can easily change course and evade the celestial missiles.

There is also the possibility that millimeter waves may prove highly important in biology and in the treatment of diseases. Just as high-frequency radio waves have been used very effectively in radiothermy, so the new waves are certain to find other health uses, perhaps even more important ones."

In the foreseeable future, too, the radio amateur must concern himself with space. Soon he will have to be on the moon, too. This will not be immediately, but certainly sometime during the 70's. And here is a suggestion which I believe has not appeared in print to date to the best of my knowledge:

Radio transmission on the moon cannot be compared to transmission on the earth for the simple reason that on the moon, which has no atmosphere but an excellent vacuum, there is no Heaviside layer. Hence you cannot transmit at any frequency further than the horizon. We have, therefore, several alternatives.

One would be to select the highest moon mountains, of which there are many, and use automatic relays. Thus you could telegraph around the moon as long as there are sufficient mountain tops, which are quite abundant on the moon.

This, however, is a most roundabout and expensive way of signaling. It might be cheaper to use wire transmission if you wish to keep your radio activity completely on the moon.

There is, furthermore, a much simpler way. The first explorers on the moon will simply not use the moon at all, but the earth. The amateur can use almost any spot on the moon and then transmit to the earth, which will in turn re-transmit the message to the moon. Thus, if one explorer is near the North pole of the moon, he can send his message to earth, which then will relay it, let us say to the South pole of the moon where the second operator or operators are. There is no difficulty in doing this except one, and that is the short delay of 2-1/2 seconds for the round trip of the signal.

I was the first to point out such signaling in my article "Can We Radio the Planets" in RADIO NEWS for February 1927. 19 years later, the U. S. Signal Corps made its first moon contact--on 111.6 megacycles. My predicted time in 1927 was 2-1/2 seconds; the actual time was 2.4 seconds. I erred by .1 of 1 second.

If enough amateurs on earth are alerted for transmissions from the moon, there is no reason why there should not be a heavy traffic later on if more explorers are on the moon. By using the earth to relay back the signals originating on the moon, and by using different frequencies, perhaps millimeter waves, thousands of messages can be sent every day without any difficulty. Once the moon becomes sufficiently organized, relays on the moon will probably be used exclusively. That, however, would be a second phase.

So far we have spoken only of code signaling. There is, of course, no reason why phone signaling should not be used with equal ease.

GREETINGS

The Radio Club of America was started by amateur enthusiasts in the then one-and-only scientific sport: wireless. During the last century hundreds of similarly interesting fields have stemmed from basic principles discovered during the investigation of this one art. Then and now, it has been a major objective of this Club to foster progress in interesting technical pursuits by cooperation. The spirit of this cooperation is that of encouragement of individual efforts in research. It has published many noteworthy discoveries of individuals who have worked without the benefit of huge research facilities and military and industrial grants. In spite of the currently expressed comments to the contrary most basic inventions and discoveries are started by some one person's personal initiative. Collective research keeps to the main roads and thereby speeds past many interesting bypaths. Many of these could and should be explored by lone workers or by groups as a hobby, recapturing again the initial concept of the Club's founders.

These possible activities cover the whole range of electronic operations and most of them would provide fine subjects for interesting our members. Such hobbies often lead to whole new careers. These pages are always open to such reports, to suggestions and statement of problems, and to member's requests for possible cooperation of others. A CLUB indicates fraternal co-operation of kindred spirits. This basic concept fifty years ago when the Radio Club started is still cognent. Possibilities exist in many fields: in medical diagnostic equipments; ultrasonics; infrared applications; underwater television explorations, and many others. Recreational pursuits using transistorized versions or aids afford basic avenues of "study". One can easily become a known authority in some unusual scientific field if his activities are directed toward some useful end, and his conclusions published.

Since our membership is now nation wide, your Officers and Directors are seeking augmented services for members who cannot attend our regular meetings. Several plans are under way. The most logical method is an expanded publication program for the PROCEEDINGS, both in size and frequency. Hereafter we will have a fixed publication schedule. Ye Editor is setting up a large Publications Board to handle this. Greater participation by all members will be needed, more publication material is being sought to supplement the papers published following presentation at our meetings. Volunteers among members outside of the New York area for this Board are sought, among members who can be on the lookout for material that will interest our readers.

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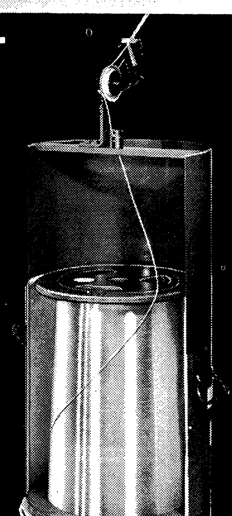

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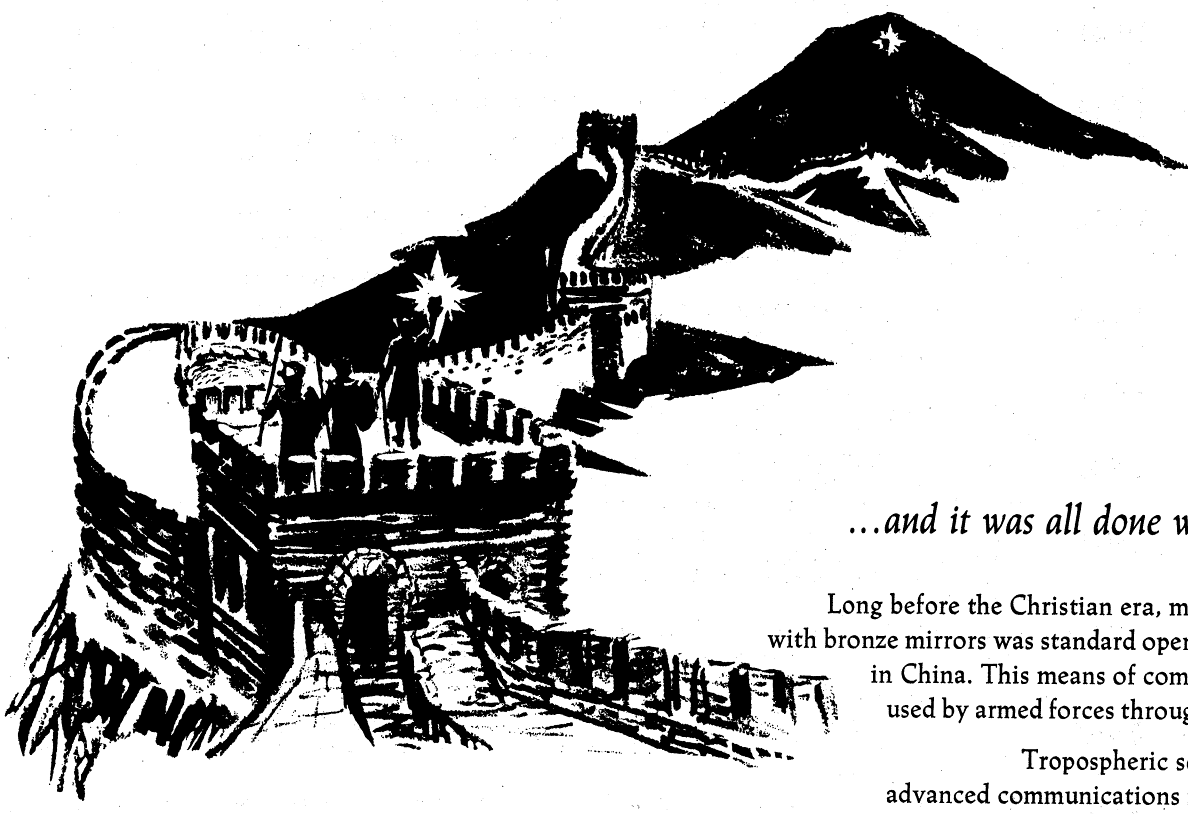

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