Transcription of the

New England Wireless & Steam Museum's Wireless Tour

as given by Robert W. Merriam on a Winter day in 2012

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Edited by Fred Jaggi, March 21, 2015

All text is transcribed from an audio recording of Robert's voice except for questions and comments from Fred Jaggi, as indicated in quotes.

The Radio Room of a Steamer

This is a replica of a 1920's ship radio room, or wireless cabin. The transmitter is a World War I Navy Standard, 1 Kilowatt Kilbourne & Clark Quenched-Gap spark transmitter. Perhaps it will be important to comment about things that the Titanic disaster generated. After the Titanic disaster, governments suddenly decided to pass international laws, which, among other things, required two 3-minute sectors on the radio room clock, marked in red, where it became illegal to transmit unless you were in distress. They also required an emergency lamp in the radio room, and, naturally, being on a ship, it had to be in gimbals.

They also required an antenna disconnect switch. Many of the receivers were nothing more than crystal sets with a cat whisker on galena, which were quite sensitive to static discharge. When the operator saw a storm on the horizon, he was supposed to ground his antenna. Then, when the storm goes by, he could reconnect the antenna.

Transmission was always simplex, that is, you transmitted for a period, and then you stopped, and you received for a period, listening for the reply. And the transmit/receive switch is this one on the operating table. Right now it is in the transmit position, but when it's down it's in the receive position.

The peculiar thing about the quenched-gap spark transmitter is that there are many sparks, which you don't see. They're out of sight, but the quenched gap makes a very clean signal. That's the spark electrode, and the corresponding face on the next one is the other spark electrode, so it sparks between this and the one next to it, all the way down the line.

The receiver is a classic IP-501-A, made by the Wireless Specialty Apparatus Company of Boston, Massachusetts, the building of which still stands on the East side of the main railroad line entering Boston from the South.

The 501-A is a 3-tube receiver. The tubes are in this compartment, and it can be used

either on crystal or tube. Throwing this switch will change it from tube to crystal. The crystal is mounted on a separate board.

To the left is an emergency spark transmitter, this little job up here. It was made by the Standard Communications Company of Denmark, and we were lucky to find it on the Danish bark, Denmark. When the tall ships came to Providence, I toured the Denmark and saw this in the Captain's cabin, all broken and rather sad looking. I happened to meet a Danish engineer in New York about six months later, and I told him about it, and he went back to Denmark, and somehow he got in touch with everybody, and had this sent back to the company which made it. They rebuilt it completely and they sent it back to us as a gift. This is our backup transmitter.

In radio history, Reginald A. Fessenden is an important name. Also in marine history, he is the inventor of the sonic depth finder. Here is an original Fessenden system sonic depth finder. It had a solenoid-controlled hammer in the bilge of the ship, and every time the little red light goes by zero, the hammer is tripped and it bangs the bottom of the ship, making the sound wave go down the ocean to the bottom and echo back. When it echoes back, the time duration, determined by the spinning wheel, flashes a light here, so you see the depth.

Telegraphy

Going down the central hall in the wireless building, there are twelve display cases dealing with electrical communication. The first, naturally, is the telegraph, and in it are examples of telegraph instruments going as far back as Samuel Morse's first days. There's a very early telegraph register here, the one with the curlicues. There's a clockwork motor that winds a tape. A pen marks the dots and dashes on the paper, and then the operator reads it afterwards.

If you look down here, you see the little miniature set on the small mahogany board. When they celebrated Morse's fiftieth anniversary, they had a big banquet in New York, and all of the important people in industry were at the banquet, particularly the people in the telegraph business. Each place setting at the head table had one of those little miniature sets. They were wired under the linen tablecloth. The whole length of the table was on an open circuit so that anybody could talk to anybody up and down the table. And the interesting thing to us today is that the Morse Code was pretty much universally understood by people in business, because they would hear it chattering away in offices all the time, and they decided it would be better to learn it than to just listen to the noise. As a consequence, these big shots were able to talk to each other up and down the table.

The "Crow's Foot", hanging on the pegboard, is from the bottom of a gravity cell battery.

Copper sulfate is the electrolyte. The virtue of this type of battery was that it could run on closed circuit for a long time without discharging. It was a reliable source of juice

Fred – "But didn't they keep a continuous circuit going?"

Yes, particularly in the case of railroads. The whole railroad would be looped together from one end to the other. And you'll notice, if you look at these keys, you see a little lever switch just to the right of the key handle? That closes the circuit on this particular set, so the signal would go right through it, on to the next station, down through the other line, so, it was never interrupted by breaking the circuit. The gravity cell needed a continuous current to prevent the two solutions from mixing.

Fred – "Now, I remember you told us before that the telegraph really paralleled the expansion of the railroads, or maybe the railroads paralleled the expansion of the telegraph."

Yes, it was the most fortunate thing that the development of the telegraph and the railroad were simultaneous. They developed together, and one supported the other, particularly when they had one track and they had trains going both ways. And, of course, in the early days, one track was the rule. It cost money to put in a second track.

Fred – "What is that one in the back with the needle?"

Oh, that's a galvanometer for testing. The technician would use that to check the circuit.

Loose Couplers

Jumping ahead to wireless, the early receivers were frequently referred to as loose couplers. A loose coupler is where the primary coil can be varied in coupling to the secondary coil by sliding it in and out. That whole cylinder with the taps on the end can go in and out. A fixed coil is in the box, and the coupling is variable by pulling the secondary coil out. The looser the coupling, the sharper the selectivity. So, if you have very tight coupling, that is, with the coil jammed all the way in, it would be loud, but it would not be selective for a particular frequency.

Crystal Receivers

Moving ahead to the early 1920's when the broadcast radio boom began, here are some examples of early crystal sets. After World War I, almost everybody had a crystal set. There were all kinds of pet ways to build them and there were literally thousands of different manufacturers.

Fred – "What's the basic principle of a crystal set?"

Nothing but a tuned circuit, an antenna feeding the tuned circuit, antenna through the coil to ground, the rectifier, which is the detector, or crystal, which changes the alternating current radio frequency to direct current so that the direct current can actuate the diaphragm of the earphone. So all there is to it is antenna, tuning coil, crystal, tuning condenser, and earphones…and a ground. There's nothing more. And there were literally thousands of makers. The Quaker Oats Company was sharp enough to realize that their oats box made a very practical coil form, and so they actually sold Quaker Oats in a box with a crystal set built on the end of it. You could buy that in a grocery store.

Fred – "And kids grew up making these things. You did, I suppose?"

Oh, absolutely. I made one with a single earphone, that is, half of that pair of earphones. And I unscrewed the top, and inside there was room enough so that I could put a crystal in there with a cat whisker, and I had a little wire with an alligator clip on the end, and another little wire that I could clip to the school desk. My desk was by the window at Rhodes School in Edgewood, and I used to sneak over and clip the clip on the radiator pipe, and clip the other clip on the frame of my desk and listen to the radio. It was easy to do because there was a broadcast station at the end of Shaw Avenue, WDWF, Dutee W. Flint. He was Henry Ford's champion automobile salesman, and he had a big mansion on Allen's Avenue in Edgewood, down at the end of Shaw Avenue, right next to Edgewood Yacht Club. So, obviously, he had a strong signal. It didn't take much to listen to WDWF.

Fred – "Now, some of these look much fancier, you see, in a fancy box. Were those professional?

Yes, well, like anything, they try to gussie it up. Also, they change wavelengths. This one on the right, you can see, has three separate coils. You can plug them in to tune a different band.

Earphones

Jumping from crystal sets, one has to realize there were no such things as loudspeakers. So, when you listened you used earphones, of which there were many varieties. Also, the transmitting was not voice originally, it was all telegraph, so this particular window shows a few earphones and a variety of different keys. You'll notice this one right by my finger is a one-kilowatt and has a contact about that big around, and it's heavy duty. And that's designed for keying a big spark transmitter. The company in Boston made electronic equipment, and they favored using marble for the insulation. You have to

realize, modern plastics had not yet been developed, and so, proper insulators were hard to come by, and marble was pretty good as long as there was not a streak of metal in it, which could be very bad.

Fred – "Now, I remember companies, when I first started work, would have big catalogs of spare parts for a machine. And each had a code word, a wireless code word, so they didn't have to type out the long explanation of the part. They would have a few quick symbols to indicate that part. I suppose so they could transmit a lot of data over these telegraph keys."

The world was much simpler in those days.

This is a Navy key for a high-power transmitter, something like a 10,000 watt job. You can see the fin coolers on the contacts.

Fred – "So, all the power went through the key!"

Absolutely. The operator was sitting there with 10,000 watts in the contacts right here. He had better keep his hooks off it!

Fred – "They never made them with relays?"

Oh, they did, but they did it both ways.

Tubes

Going here, this is the beginning of the vacuum tube era. Not starting at the beginning, looking in the left hand corner is a 212-D triode vacuum tube, which happened to have been the actual final amplifier tube of WEAN, Providence, which was in a penthouse on top of the Biltmore Hotel. You probably can't see that card next to that big bottle, but that's the Biltmore Hotel with the antenna towers on its roof. The transmitter was in a little building on the roof.
Now, there are some very significant things in this particular window. Professor E. Leon Chaffee, who was one of my teachers at Harvard Engineering School, was an eminent authority on radio in the early days. And in the Cruft Laboratory at Harvard he had the distinction of building the highest-power triode up to that time…and there is the actual triode on the pegboard to the left of the letter from Professor Chaffee to me. He gave the museum that 50-watt triode in 1966. And that is the world's first 50-watt triode, so that's quite an important, historic critter.

Fred – "Now, who developed, or is "invented" the right word, the radio tube?

Oh, well, that subject comes back at the far end down there…Armstrong's window. We'll talk about that.

Of course, Lee de Forest is the guy that actually put the grid…and he's the gentleman in that picture…put the grid between the filament and the plate, making the triode vacuum tube. So, nobody's arguing with Lee de Forest on that particular point. But the generation story is quite different, and that comes to Armstrong at the far end.
In World War I, vacuum tube radio exploded into use, and the VT-1, those little tubes that are leaning against the cartons, was the first military triode vacuum tube. And there are two in those two unopened cartons right there. The cartons are covered with signatures of eminent, early wireless people who came here at one of our first meets, and they signed these boxes.

Jumping around, there are all kinds of interesting things in here. In a radio receiver you need a high resistance in the grid of the detector tube, and that high resistance had the name of a grid leak. And the grid leak was always bypassed with a little capacitor. And some wag, some amusing guy years ago, decided to make a grid leak drip pan (chuckle) …and down here, I don't know as you can see it, but there's the grid leak on the top with the drip pan hanging from it, and the capacitor that it bridges beneath.

Fred – "What's this one over here with the liquid in it?"

No, there's no liquid in there. That's a Myers tube. The man that made that was here at one of our early wireless meets back in the 1960's. He was an interesting guy.
There's another Myers tube in the little carton on its side behind it.

There are so many interesting things here.

Fred – "Tell me a little bit about those wireless meets. Those were people who weren't just hobby collectors…they knew what the electrons were doing in the instruments, right?"

Oh, absolutely. They were important people of history of radio. They would come up in those days…unfortunately those early guys are practically all deceased now. But most of them at one time or another came here, and they reveled in the things that they saw here.

Fred – "Because they knew what they were..."

Yes.

Fred - "…and understood their importance."

The spherical objects in the front here are Lee de Forest audions. They are the original

triode vacuum tube, and de Forest, rightly, has claimed that invention.

Fred – "When was that?"

1906. The date is somewhere around there. 1912-13, is when Armstrong discovered regeneration and de Forest went to war with Armstrong, saying, "Hey, you stole my idea…", but history has shown that Armstrong was the originator, not de Forest. And de Forest lost quite a bit of face after that.

Vance Phillips Collection

Well, moving along…
This is a collection made by Vance Phillips, who is the gentleman in the picture on the right. He was a W6GH. De Forest retired to Los Angeles, which was not very far from where Vance lived. Vance looked him up and had him come up to his place, and that's a picture of de Forest in his late years visiting at Vance Phillips's place.

Detector Collection

Now, this is the range of detectors going all the way from coherers…you see coherers up there at the top…Marconi started off with coherers.

Fred – "Are these powder…"

Iron-powder coats.

There's a little glass tube…there are lots of different varieties. The rest of these are different kinds of crystal detectors.

Fred – "Would they detect a particular frequency or just anything?"

Well, they were broadband…it didn't matter what frequency, but they didn't go very high in frequency. And they had liquid detectors. They would dip a so-called Wollaston Wire in the little carbon crater of acid, usually nitric acid, and that made a detector, too.

Fred – "That's the equipment on that box?"

Yes, that's a liquid detector.

An English physicist discovered the principle of the detector with the moving wire. The soft iron wire belt is around those two wheels, which are driven by clockwork, and it

travels through the coil that has the radio signal in it. And the horseshoe magnets magnetize the wire…the wire is soft iron…it detects the radio signal. The antenna goes into one end of one coil and grounds the other, and the second coil in that little spool is the secondary coil, which connects to the earphone for the listening person.
And, that little thing about two-and-one-half inches long, on the right corner, is simply a miniature moving wire detector that somebody made.

Locally, there is an amusing incident to me, because this is the museum of wireless and steam, and the George Corliss Steam Engine Company was in pretty hard shape at the beginning of this century, in fact, they were essentially out of business…nobody was buying steam engines anymore…at least of the Corliss type…and so they tried to diversify into the radio business, and they changed the name of the company to the American-British Company, and experimented with wireless. And according to the father of one of our early volunteers here, the American British Company hired Tesla to come up here and experiment on radio, and that hunk of galena back in the corner…there's a picture of it here…supposedly was acquired by Tesla to carry on his experimentation.

Fred – "Were they successful?"

No, the American British failed very quickly.

Murdock Clapp-Eastham

Clapp-Eastham and Murdock were two noted Boston area manufacturers before World War I…I'm reading the nameplate up there…and that sign is out of date because General Radio doesn't exist anymore…

Fred – "You liked General Radio, didn't you? You thought they were a good company and they made good equipment?

They made excellent equipment, the finest kind of stuff. But they liked using marble for the bases. These are different products of those two companies.

This is a rotary spark-gap. A little motor spins the wheel around and it gives a picket fence effect to the note that you hear on the receiver from that spark transmitter.

Fred – "Why was that good?"

Well, one of the reasons that was good is, if there were more than one on the air at the same time, and they had different notes, you could read one through the other.

Fred – "You had to be a good telegrapher to be able to do that!"

Well, they were all pretty good telegraphers, because, after all, they were doing it all the time, and they got so fast, they could do all kinds of funny things. I used to be impressed with these professional telegraphers who would be talking to somebody with the key, and turn around and shoot the breeze with you while they were sending. They were well trained. And it's a lost cause. It's most unfortunate.

Fred – "Have they changed the Morse Code?"

Not that I know about. There was a Continental Code, and there's American Morse Code. There always was more than one, but most of the characters are the same. If you know one, you basically know the other.

Fred – "What was the Fidelity Amateur Radio Club? Does it still exist?

Yes. One of the founding directors of the New England Wireless and Steam Museum was Merrill Budlong. And Merrill Budlong had founded the Fidelity Amateur Radio Club way back in the early 50's, and they have supported the museum for years and they donated that Murdock two-slide tuner. The two-slide tuner is so that you can have a lower number of turns active between the antenna and the ground, and a higher number of turns on the detector side where you can select the frequency…in other words, the tuner is on the one that has the higher number of turns.

And I mentioned the loose coupler…there's a little loose coupler up there, and I showed you one, way down here. By loosening the coupler between the primary coil and the secondary, you sharpen the resonance curve and increase selectivity.

Moving over here is a display of Geissler tubes. There are also Geissler tubes up on the back…those squiggly things, which are essentially the same thing as neon signs today. They date almost back to the Civil War time. It could be even before the Civil War. Those particular ones are very early. They were done for demonstrating peculiar effects. They had no other purpose.

Straight spark gaps…there's a variety of them in here…there are also induction coils… and this is a Crook's tube. This is a cold cathode-ray tube. There's no filament in it, and the screen is the white metal plate. I can exercise, or energize this with high voltage. The curving of the beam is caused by the horseshoe magnet in the rear. The poles are facing this way. If I turned that around, the beam would go the other way.

Fred – "Some of this stuff is on the transmitting side…all these sparks, is that right?"

Yes, but many of them are just demo sparks, but otherwise, transmitting sparks.

There's a quenched-gap plate…

Fred – "Whereas this cathode ray tube was on the receiving side?"

That was a laboratory curiosity. That's very early. That's the first example of a cathode-ray tube, and we should really carry from there, across the hall, because the evolution of the cathode-ray tube is in this Braun tube. Everywhere in the world, at least in my younger years, everywhere in the world, the cathode-ray tube was known as a Braun tube…the Braunschen Röhre, and that's in honor of Karl Ferdinand Braun, who was the inventor of the Braun tube.

Professor Chaffee at Harvard, who I mentioned before, also gave us this tube, which he had ordered specially from Germany, I believe in 1913. And that's a very rare article, and it's quite impressive because it has all of the same elements as the 1930 Western Electric equivalent. You see the X and Y deflection plates here, on the Western Electric, they're much smaller, but they do the same thing. The focusing electrodes…they're all the same, but Western Electric made these…and that's an oscilloscope, obviously…

Hugo Gernsback

We move to Hugo Gernsback. Hugo Gernsback, to me, was a giant and to many other radio bugs he was a giant, also. He was a most imaginative individual. He came from Luxembourg to New York in the early 20th century, and went right to work building wireless equipment in downtown Manhattan. He called the company, Electro Importing Company, and then he got into publishing, and these are all different magazines that Hugo published in his time.

Fred – "Radio was so new and popular then, these were all popular magazines about it?"

Yes, well, electronic, modern stuff, you know…scary type stuff…and Hugo retailed equipment from Electro Importing…these are all catalogs of the Electro Importing Company sold by Hugo Gernsback.

Fred – "What are the medals here?"

Oh, he formed different clubs…before the American Amateur Radio League was formed, Hugo tried to form an amateur radio club. And he formed these clubs and these are the pins that people would wear when they were members of the so-called clubs.

Fred – "Was he respected by the scientists?"

Not really, no. He was strictly a popular guy, but he was immensely talented…and as a personal matter that probably doesn't belong on here, when I was a teenager or even earlier, my father had a good friend who subscribed to Short Wave Craft, and he had a stack of them and he didn't know what to do with them. So, he mentioned them to my father, and my father said Robert would probably enjoy those. And I still have that stack, and I've read every lousy written word in them. The English was terrible, so I had trouble when I got to Harvard, with my English composition. But I still…I don't actually worship Hugo, but I certainly admire him.

Fred – "Well, that's how kids get interested in something, right?"

Oh, absolutely. He was a very positive influence.

Meters

This is just a window of various kinds of electrical measuring instruments. Nothing particularly special to be noted here.

Fred - "Well, who came up with the first ones, Volta?"

Well, I think way back in the very beginning, the pocket compass with a coil under it, like this one here…see the little compass? That was an electrical indicator. Then they evolved into more elegant forms.

I went to a prep school in Northern New Hampshire, and the road to get there went through Penacook, New Hampshire, which is a tiny little town. And in Penacook were a couple of manufacturers, which made these meters. There's nothing more to the story, except that these Hoyt meters were made in these little towns…small Yankee industry.

Fred – "Okay. Now, Weston, that was a division of Bell Telephone, wasn't it?"

Yes, yes. I can't tell you all about Weston, but he was quite a noted engineer back in those early days.

That's an ammeter that obviously carries a lot of amps. See the binding posts on top?

Cable Equipment

Moving over here, as the label says, this is cable equipment, and Cyrus Field, of course, is the guy who started the cable business, stretching the first cable across the Atlantic… and you can see, 1858. Tragically, the first cable only lasted for about a day, but Cyrus

Field didn't give up, and he arranged to lay another cable. To raise money for the laying of the cable, he had Tiffany's of New York, package sections of the old cable, and strapped them in brass, and sold them at a good dollar to collectors. Those are several versions of the Tiffany cables that were sold to raise money for the second transatlantic cable.

Fred – "This is a French telegraph. Is that Field?

This is just Cyrus Field here. We have more that just Cyrus Field here. The French telegraph came ashore at Orleans (Massachusetts) on Cape Cod…

Fred – "That was a separate cable altogether."

Oh, completely, and many years later. They had an office in New York. It came ashore on the outside of Cape Cod, and was carried across Cape Cod to Orleans, and from Orleans it was carried on pole lines to New York City, where their headquarters was, on this side of the Atlantic.

Cable communication in the early days of course was all telegraph. Telephone hadn't come around. Alexander Graham Bell was not in the picture yet.

But, in order to maximize the signal over thousands of miles, they had to use a double-key system, plus and minus 150-volts or a difference of 300 volts. You see this little telegraph key here with two paddles? One of them puts a negative polarity on the conductor. The other one puts a positive polarity on the conductor, so you had to key it in this manner. That was to achieve long distance all the way across the Atlantic. Because, what you wound up at the end with was a small fraction of milliamperes. A very, very faint signal. Now, as time progressed…

Fred – "Well, being under the ocean, did sunspots or lightning storms affect transmissions?"

Well, sunspots in particular, because they would change the potential from one end of the Atlantic to the other. You'd have a potential difference, and they could cause drastic problems, superimposed on the feeble signal.

There are pieces of other people's cables. That thing that looks like an ice cream torte there, sliced off, is a piece of the English cable. This came across at Plymouth, Massachusetts.

Here's a coaxial cable, single-conductor coaxial cable, and by advancing to, more or less contemporary, on the pegboard in the back, the gift of Ed Rooney…you see a piece of the modern fiber optic cable. And if you read that label, "This is a piece of MCI's Gemini

North Transatlantic Cable which connects Charlestown, RI with Brest, France. It carries three pairs of fiber optic strands which can carry six million telephone conversations at once."…as well as television pictures.

In the center of that…these fiber optic strands…see them hanging on the pegboard? That's what's in the middle of that cable. Each one of those strands can carry a separate signal.

Fred – "And just think, for however many thousand miles, that can't have any imperfection in it."

You have to be very, very careful about injuries to it.

That cable, which is the Verizon cable, goes to Bermuda, and from Bermuda it goes over to France.

Edwin H. Armstrong

Edwin Howard Armstrong was a giant in many respects. That picture was given to us by the gentleman on the left, who was Mr. Charles R. Underhill. He started Armstrong on his distinguished career because Armstrong lived in the neighborhood of Mount Vernon, in New York. And Underhill live a couple houses away… and very quickly, young Armstrong found out that Underhill was the man to go to find the answers to questions that bothered him. So, as Underhill's son has told it to me, that's the fellow, the younger guy on the right we knew…Armstrong would come over and sit in Underhill's office while Underhill was at the drafting board pushing his slide-rule, and he would ask him questions, and Underhill would answer the questions. This would go on for hours. Underhill was very impressed with the staying power of the young fellow, because he was just a kid. He would ride over on his bike. Anyway, that's how we happen to have that picture.

The other interesting thing is that Underhill was a friend of Massie…Walter Massie. And we have the Massie Wireless Station next door, the world's oldest surviving, fully-equipped wireless station. (National Register)

Fred – "What was Armstrong's achievement?"

Armstrong's first major achievement gave him the nickname of "Feedback Armstrong". He's the guy that suggested using a tickler coil in the plate circuit of a radio receiver, so that a little of the output energy would be coupled back into the input, to cause the circuit to oscillate. And this would elevate the sensitivity of the circuit tremendously. It is called regeneration.

Fred – "Is that a drawing of the circuit there?"

Armstrong got involved in many patent disputes with Lee de Forest, and that is a coil that Armstrong had made when he was a younger fellow, but it was an exhibit in the federal patent dispute. So, that's the real McCoy from Armstrong's patent dispute…and Harry Houck worked with Armstrong in France as a soldier…Armstrong was a Major in the Signal Corps in World War I, and Harry Houck worked with him…and we were honored to have Harry come up here and bring one of Armstrong's early feedback radios with him and talk about it.

The windows behind Harry Houck (in the photo) are actually this building. We're standing in the same building.

The four major inventions of Armstrong are there, listed, Regenerative, Super-Regenerative, Super-Heterodyne, and FM…Frequency Modulation. And those are the fundamental radio circuits to this day.

Fred – "Nancy mentioned that Armstrong gave some of these patents to the government?"

Oh, yes. In World War II…this comes to me because I was in the Signal Corps and used an awful lot of stuff based on his patents.

Our equipment for short-range field radios by the infantry, the tank people…everybody… was Frequency Modulation. And Frequency Modulation is immune to static interference, unlike AM, where static can drive the signal to pieces. Armstrong recognized the value of this patent, and he gave to the United States government the free use of his patent, which was worth literally billions of dollars in World War II, and then the poor fellow died broke.

Fred – "Really!"

Yes.

Fred – "Because of a fight with..."

…Because of RCA, which cheated him. His estate won the patent back again. Sarnoff… David Sarnoff was the rogue.

But while I'm talking about Armstrong, the Columbia University…he had his own laboratory at Columbia University for years, and Columbia, thank goodness, thought about us when they cleaned out his laboratory, and they gave this woofer-tweeter

speaker…of course, Armstrong is known as the man of high-fidelity, and the woofer-tweeter was one of the earliest hi-fi speaker systems. And supposedly…I have no proof of this…Armstrong, himself, built this particular enclosure. He had it in his office at Columbia.

Amos Emerson Dolbear

1880 was the same year that Edison perfected the light bulb. Also, the evolution of electrical signaling engineering was ignited about that time, mostly by Edison. But there were other prominent people, like Amos Emerson Dolbear, who was a professor at Tufts College, and neither Edison, nor Dolbear, nor anybody else understood the electromagnetic wave. That waited on Heinrich Hertz's research, which came a decade or so later. But these guys knew the effects, and they were experimenting with it. And Dolbear had an elevated antenna, and essentially what he was doing was exciting the area around his antenna electrostatically, and the electrostatic field went out. This is not radio waves, it's just an electrostatic field, and Dolbear was able to signal over a mile away from Tufts College. Dolbear's patented receiver was nothing but an electrostatic receiver…basically two metal diaphragms very close to each other, so that as the voltage varies on them, the electrostatic attraction moves the diaphragms and makes sound. This is an actual Dolbear 1881 wireless receiver. That has to be one of the earliest wireless devices around. It's described here in this 1881 Scientific American.

Dolbear, naturally, tangled with Marconi. Marconi had a lot of money because his mother was a very wealthy woman, and he ran to the courts immediately…he was a very action-minded guy. He would sue you at the drop of a hat. Anyway, all of these newspaper clippings are about Dolbear's difficulty with Marconi.

Anyway, Dolbear was a pioneer, but a forerunner-type pioneer.

Thomas A. Edison

Now we come to Edison, who was the most remarkable guy, with over a thousand patents. I don't know if anybody else has that many…it's possible today they do with the spewing out of patents.

This brings up the conflict with Marconi's professor, Sir Ambrose Fleming, who worked for the Marconi Wireless Telegraph Company, and he patented an electron tube…the diode tube. This was around 1905. The interesting thing is that our I-Triple-E (IEEE, Institute of Electrical and Electronics Engineers), I guess in hands-across-the-sea friendship with the English, has not argued with the English patent, but in fact, Edison made a diode tube, and there is an original Edison diode tube, and he measured the

current flow between the filaments of the plate…the electron had yet to be identified and discovered…so Edison, of course, hadn't the foggiest idea why he was getting current between the filament and the plate…but he did…and it was known as the Edison Effect for a long time. That's kind of unfortunate that people don't really give Edison (credit).

Fred – "Are these similar here?"

No, these are light bulbs. These are just lights. See the plate in there? Inside? The English call that the Fleming Valve. I've always considered it a giant fraud. Because, here we have it, you know…thirty years before! But, unfortunately, Edison…the electron hadn't been identified yet…that came just before Fleming's experiments.

Also, Edison realized, much the same as Dolbear, that electrostatic fields, whether they be stationary or alternating, radiated some distance. And Edison patented a wireless system in 1892. That's three years before anybody ever heard of Marconi. This was way in advance of Marconi.

Here are the two schooner's with the elevated antennas, and the shore stations with elevated antennas, and ground plates and everything…and that's 1892, and Marconi didn't hit the scene until late 1895, and so when Marconi succeeded in crossing the Atlantic with the letter "S" in 1901, from Poldhu, England to Newfoundland, he came to New York City to be wined and dined. And all the big shots congratulated him, and so forth, among whom was Edison. And Edison was noted for a very friendly personality, and he was full of funny stories. He had a tremendous repertoire of funny stories. He was not a stiff guy at all. Anyway, the story is…that when he met Marconi…I think it was on the street in Manhattan, he slapped him on the back and he said, "Well done, young man! By the way, I have something that might be of interest to you." And he showed him this patent. And he wound up selling it to Marconi for something like $30,000, allowing Marconi to clinch his claim. But here's Edison anticipating:

He experimented with etheric force for quite a while, and Colin Leath, if you'll remember, made a replica of this, and what's inside is a micrometer-adjustable carbon arc, and you can set it to a very fine gap…almost down to nothing. And if you have a strong field in the area, whether it be radio, or electrostatic, or whatever, the little arc would light up. Edison first discovered this at Menlo Park (New Jersey). The Menlo Park building was about twice the length of this building, and Edison had an organ at the end…he liked to play the organ to amuse the guys because they worked night and day… there was no start and finish to working hours…but anyway, he experimented with etheric force from one end of the building to the other. He had an induction coil making a spark at one end of the building, and he would walk this shadow box down the other end of the building watching the arc in there. So that's why we gave it this name. Of course, Heinrich Hertz had not done his mathematical work yet, and nobody knew anything more about electromagnetic radiation. But Edison was ahead of it all right

there.

Anyway, these are probably replica light bulbs that they made to celebrate Edison's invention some years ago.

Guglielmo Marconi

Moving, now, over to this stiff aristocrat, Bill Marconi. What Marconi was, was a powerful organizer and a business man, and a pretty grabby guy, if you come right down to it, and he succeeded in building giant wireless stations all over the world…tremendous stations…the most famous one in this area, of course, was the one down at Wellfleet. And what with the ocean rising and the storms, the land that it was situated on is all gone and washed away into the ocean. And it was what they called MCC, for Marconi Cape Cod originally…it later became WCC when RCA took over the Marconi interest. WCC was a very famous shore station for ships. In the early days, radio was mostly a very useful tool for steamers going to sea, so they could communicate to the shore, messages for the passengers, both directions, and also they could send SOS and other necessary things. And they could warn other ships of ice flows like the problem on the Titanic, and unfortunately, as everybody knows these days because of the big centennial of the Titanic thing, that the steamer, California, was within sight of the Titanic, and it wanted to advise the Titanic to go slow because there were ice flows all over the place. And the operator on the Titanic was sending "CQD, CQD" distress signal, but the California's operator had gone to bed because it was midnight. The captain came down…he saw the rockets going up…and he came down to the wireless room and found the operator asleep, so he didn't want to bother him. He didn't understand the Morse Code, so he didn't understand the messages. He assumed that all the rockets…was just the Titanic celebrating their maiden voyage. And tragically, he steamed right along, and he could have rescued most of the people, but that's part of the tragedy.

Well, to go along to the next window, it's curious that Marconi…

Fred – "Is this a Marconi patent?"

Yes…or one of them. This is a copy of the Nobel Prize, which he won in 1909, and so did Karl Ferdinand Braun…the same year. I should point out one more thing. There is a coherer that is attached to a piece of that whale bone, and a coherer is nothing but fine metal particles between two electrodes, and if one end is connected to an antenna, and another is to a ground, they will tend to cohere when a wireless signal arrives. Basically, the microscopic particles weld together a little bit, allowing current to flow, and they have to be tapped to be ready for the next message.

These are all authentic things. That's a very early Marconi instrument. This is a very

early Marconi wave meter to measure the wavelength that you are sending on or receiving on.

Karl Ferdinand Braun

Karl Ferdinand Braun was a giant. He died in New York in 1918. He was, as a young man, a professor in Alsace University, and he had a class of women…this is pioneering in itself…these were physics students and Braun was their teacher. He went on to be one of the founders of the Telefunken Company. And Telefunken was, of course, a giant competitor of Marconi.

Anyway, he also invented the cathode ray tube, and this is an original Braun cathode ray tube, which was a gift of Professor Chaffee at Harvard, whom I knew when I was a student there. And that is how come he gave it to the museum as a friendly gesture.

In Europe, and most of the rest of the world, up until recently, these were known as Braun Röhres. "Röhre" is the word for "tube" in German. It's curious that that cathode ray tube, in all its parts, is identical to this Western Electric one, which was built in 1930. That's a lot of years between them. But, they're identical in detail. Braun was in New York throughout World War I, and in the days before MIT's benefactor, George Eastman, of the Kodak Company appeared, many people carried a sketchpad to make a little sketch of where they've been as a souvenir of the trip. This is Braun's sketchpad, and it shows the Palisades of New Jersey on the Hudson River, and the next picture shows Bannerman's Island, partway up the Hudson River with a steamboat in the middle. And here…Tesla was a friend of Braun's…and this is a personal note from Tesla to Braun, and it has Tesla's personal card here.

Braun taught physics and mathematics, and several people…trained mathematicians, have come in and commented that there's an error on this work. I wish you could copy that, Fred, and analyze it for me and tell me what the mathematical error is! I doubt it.

Fred – "He started an electronics company, right?"

Yes.

Fred – "Was it Telefunken or Blaupunkt?"

Telefunken.

This came from Braun himself…this paper knife.

Fred – "Talk a little about his Nobel Prize."

Well, he wrote a paper on directional antennas. This is phased-array antennas as far back as 1909, which is very early for that type of science…extremely early. But it's an erudite paper, and he won the Nobel Prize for this work. The story is, and I have this from his daughter-in-law, who was a good friend of ours…that when Braun, and this gentleman, Marconi, walked up on the stage to receive the Nobel Prize, Braun put his hand out to congratulate Marconi…of course they got the prize for different subjects…they weren't competing on the stage…Marconi absolutely snubbed Braun, and wouldn't even speak to him…which reflects exactly what kind of a snob he was. Of course, he was of minor nobility because his mother was a Jameson, and he had an entrée in all society in London for that reason.

Fred – "You'd be interested to know, we built the latest distillery for those people."

Really?

Fred – When I was in London, we built it.

Son of a gun, that was in Ireland?

Fred – "Yes."

I think Marconi was critical of Telefunken barging into Marconi's business. Telefunken also made superior equipment, far better than Marconi's stuff.

Fred – "Because it was more science-based."

Absolutely.

Fred – "Tell us about your dinner jacket…your tux."

Oh. Well, the reason we have this wonderful collection of Karl Ferdinand Braun things is that Jackie Braun, who is this lady in this picture, lived in Kingston, Rhode Island, and her husband was Karl Ferdinand Braun's son. And they were quite wealthy people. He was in the textile business in Manhattan. When he was, oh, I don't know…in his fifties or so, he had a magnificent tuxedo tailor-made for himself. She gave me that tuxedo. And I was almost a perfect fit for it. I went to the local tailor and he doctored it a little bit, and I'm going to a classy meeting tomorrow night, which calls for the wearing of that tux. So, I'll be wearing it tomorrow night!

Reginald Aubrey Fessenden

Reginald A. Fessenden, very, very early, was experimenting with electrostatic effects… wireless, if you will. And he was doing it really before Marconi started doing it. He had a wealth of patents also. I'm very fortunate in that…I've lost count of the number of times I've been to Bermuda…literally…and I got to know about Fessenden's in-laws. He married a Bermudian lady, and his house is this one right here, which still stands in Bermuda.

Fred – "Was he an academic?.. Or a business man?"

Well, he was nobody's fool, but he didn't have a lot of college degrees behind him. He grew up in a little English enclave in Quebec. His father and grandfather were Church of England ministers. He put up this tower at Brant Rock, Massachusetts, which was designed out of smokestack sections, and it was just big enough so he could get his somewhat portly body up the inside. He had ladder rungs up inside…there was a trap door at the bottom…and he could climb up there.

Fred – "So that was a huge thing!"

Oh, well, you can see the scale of it there. Anyway, he put that up in 1906, and he is the guy that said spark is nonsense, we should go to continuous wave. He was way ahead of the world in this regard. And so he made continuous waves, mechanically, with high-speed alternators. They were dealing with frequencies that were well under a hundred kilocycles. And that's why the size of the tower.

Anyway, on Christmas Eve, in 1906, he sang hymns and played musical instruments and so forth on a program from Brant Rock. Nobody expected to hear sound on the radio, you know, or the wireless as it would be, but a number of military ships and steamers reported that they heard his signals, and on Christmas Eve, he put on a program. I think they had a piano somebody played, and so forth, and they were going to repeat the performance. They built a duplicate station in Ardrossan, Scotland, in the wintertime up there. And tragically, a Scottish storm blew the tower down before they were able to complete the experiment, and they didn't have the funds to replace the tower…they never did…it's kind of sad…but a number of people in England did report that they heard the signal.

Fred – "This was in 1906?"

Yes, very early. Everything else was spark but this was continuous wave. He was ahead of his time.

This is what remains of the base of the tower today, and those are a couple of shards… insulators that supported the different layers…several layers of concrete about six-inches thick, separated by these porcelain insulators. It provided high-voltage separation.

Nancy and I, actually, on our honeymoon, went over to call at this house, and Fessenden's wife's sister was living there at the time and she was very gracious and invited us in and gave us a tour all over the house. Of course, Bermuda has a social strata in the people there, so they always have maids and house servants, and so forth. This is the call box so that you can push a button in and a flag would denote which room needs the help, you know, and the maid would come running to that room in this house.

Fred – "Well, here he styles himself, "Professor, in his book there, see?"

Yes, well, he did teach in a few places when he was starting out. Anyway, he was very stuffed with his own importance, so people would put a moniker like "professor" in front, but it was a valid thing.

There is this tower in a post card, down at Brant Point, Mass, and you see the magnitude of it…oh, by the way, see the smokestack? They made their own electricity with a little power plant there…steam power…I don't know if commercial electricity was available yet at that time out in that isolated area.

Fred – "Now here you've made a display with a picture of one of those rotary…"

He made this rotary gap…I'm not sure if that is correct. I-Triple-E (IEEE) prepared these posters….this was out at the Ford museum last I knew. And this is what this pedestal base looked like. All these ceramic bottles were in here, separating it. Good ol' Fessenden.

When I was a student at Harvard, I was already interested in this kind of thing…and I would prod them for comments on this subject…and they all kind of had the attitude that Fessenden was a bit of a buffoon, you know. He used to come over and walk the halls of Cruft Laboratory, which is the physics lab at Harvard, and he would poke his nose into different rooms to see if he could get an idea that he could patent. That's what they said, anyway.

Communications Receivers

What we have beyond here are simply communications receivers of various kinds made by various manufacturers.

Fred – "These are all receivers?"

Yes…well there are Handi-Talkies which are transmitter/receivers, but most of them are just receivers. These are World War II Handi-Talkies. These are my age in the Army.

These are vacuum tube devices, and they're quite heavy…push-to-talk, you know…

Fred – "Being tubes, are they delicate?"

Yes. They were ruggedized. Motorola made them, and of course, over evolution, this is the same thing later.

Down here…various kinds of receivers…that's a military two-way thing…it really is not important to talk about…these are all communications receivers along here…RME was a manufacturer that I rather liked when I was a young fellow. This row is all RME…from here…down to here…Radio Manufacturers Engineers.

Fred – "Now, do these seem to get better over time?"

Oh, absolutely…with evolution…Hallicrafters, known to most hams as "Halli-Scratchy's"…Bill Halligan was a Boston radio guy in the 1910's, and he went out to Chicago and founded Hallicrafter Company. And he wound up making television sets and all kinds of stuff toward the end, and these are all Hallicrafters.

Fred – "So this top row is…what did you say they were? RME?

Radio Manufacturers Engineers.

Fred – "Okay, so the top row is that, then this second row is Hallicrafters except for that couple of World War II walkie-talkies?"

Right. And down here is National. National was in Waltham, Massachusetts, and their SW-3 is a classic. It is a three-tuber.

Fred – "Now, these don't look like you'd have them in your living room

No, these are communications receivers…this is a three-tuber.

Fred – "What do you mean by communication receiver versus a radio receiver?"

Well, it's all-wave, not just broadcast band…short waves, and so forth. And, as a matter of fact, Admiral Byrd…do you remember he wrote a book called, "Alone"? He spent the winter down on the ice at the South Pole. His means of reaching out was with the SW-3 as a receiver. Richard Byrd…Admiral Byrd…made the SW-3 pretty famous.

Fred – "Didn't he nearly kill himself from carbon monoxide?"

Carbon monoxide, absolutely. And they could detect…everything was telegraph, you

know, communicating with a key…and I think they detected that his sending was getting all blurred and screwed up, so they mounted a rescue team and got him.

National was a famous company…this is the FB-7. That's another National…all various types of National receivers. Hallicrafters, you see, goes all the way down to the end.

And then, of course, you had classic…in the 1930's, with the depression, and people not having much money, they would build their own sets. And there would be startup companies that would make simple receivers…and this is a typical 1930's receiver made in New York.

And we have here…I made a little set, a little bit smaller than that, when I was going to be shipped overseas in the army in World War II…and of course, it was strictly verboten to have a radio on a ship because a sub of the day could detect the regeneration. Anyway, I tried to sneak this thing in my duffle bag, but you go through different stages of inspection, and I finally came to an inspection station and somebody took it out and threw it away. I never forgave them.

This is a classic of simplicity and high performance. The nineteen has two triodes in it… I don't know if you can see that…but it's got two tubes in one. So, what you need for a simple regenerative receiver is a detector and an amplifier. One of the tubes is the detector, the other's the amplifier. And it's a regenerative receiver, plug-in coil to change the band…you can see how cheap it was…it was just a piece of tin, but it was very, very popular. My cousin, Dick Day, down in Maryland, built one…not from the kit, but from the description, and I was amazed how well the darn thing worked. He and I went to the same prep school together many years ago.

Pilot was in Brooklyn, New York, and they were a big time manufacturer for quite a while, and these are the Pilot Wasps. They were a famous set. It's a super-duper Pilot Wasp.

Getting higher and higher in frequency…like today, they are way, way up past visible light…doing things, but…5 meters was the rage for a while, and this is a little 5-meter receiver.

Merrill Budlong, who was one of our founding directors in this museum, W1QLD… during the war he was exempt from the military…he was too old, I guess, and he had a bunch of kids and so forth, so he didn't go to war but he got very active in the Civil Air Patrol, another quasi military group…he designed this little radio, and they must have made about thirty of them…so that the different stations around the state could communicate in emergencies.

Fred – "That's a transmitter and receiver, it says, right? A transceiver."

Yes.

Fred – "Now, there's another one over here…it says, "Make: Merriam"

Well, the Doerle…I don't know anything about him…never could find much about him, but he was from San Francisco, and he wrote an article in "Short Wave Craft", describing the Doerle receiver.

This just a joke…when Paul was young, I made this with him to get him interested in it. But it's absolute rudimentary, you see, the chassis is nothing but wood, the front panel is masonite with aluminum foil on the back for shielding. You know, it couldn't be cheaper, but it's a two-tube blooper and a super performer. They were very popular…"Short Wave Craft".

This is World War II military…that radio is a BC-191 that was mounted in the rear end of jeeps with a big whip antenna…World War II…piece of junk, designed about 1930 by General Electric, absolutely replaced by Motorola's frequency modulation…this is a Motorola frequency modulation…that's a backpack set…but it would sail circles around that one, but that's pretty darn heavy to carry.

In the North Room, here, are simply broadcast receivers of the period 1920 to 1925, starting with the Atwater-Kent down at the far end, and running down to Zenith on this end, alphabetically arranged. These are all nothing very special, just broadcast receivers of that period.

North Room –South Side
Electrical Experiments Before 1900

Benjamin Franklin

Looking at the South side of the North Room, the length of the counter is arranged chronologically, starting with the earliest devices, the Benjamin Franklin period, and so forth. Probably one of the curious objects here is the so-called "plunge battery". These are carbon and zinc electrodes, and to turn it on, you put the electrodes in the electrolyte, and to turn it off, you pull them out.

What is next to it is a bank of Leyden jars…it's named for the town in Holland where they were first used…and they are a form of capacitor with the tin foil on the outside of the bottle, and the tin foil on the inside of the bottle…the two electrodes of an electrostatic capacitor. And they put in a bank of them…there are…

Fred – "And they just used the glass as the dielectric between the two plates…"

Exactly. There are nine of them here and they're all in parallel to get a larger capacitance. I don't know how many microfarads this is, but it's probably pretty high.

Down here is a collection of various types of batteries and Leyden jars…there's a little Leyden jar right here, for example…but here's a wet battery…here's another wet battery…these are more wet batteries…actually, there was a certain battery called the "Edison-Leland Battery", and that porcelain one right there is an Edison-Leland Battery. Those were the kind of batteries used in the Massie Wireless Station next door, originally. You wouldn't run to the hardware store and buy a number-six battery, you know. You know the number-six battery, like this. I played with those when I was a kid. I could run down to Pawtuxet Paint and Hardware, you know, and buy these things pretty cheap in the depression.

There are ancient instruments here. That's a little Wimshurst Generator up there… electrostatic…up on the shelf.

Wimshurst Generater

This is a glass disk electrostatic generator. There should be leather pads on those springs…you rub the glass and I guess you rub the electrons off it and it charges things up.

Fred – "This looks like it was in a physics class…a demonstration in a physics class."

Well, as a matter of fact, quite a bit of this stuff came from Brown University. They were just junking it…and they gave it to us. This Wimshurst generator was made by Thorn Mayes, for whom the Mayes building is named. Two wheels turn in opposite directions. One is positive and one is negative, and this little bell will go back and forth between the two.

Franklin's Bells

Fred – "That was a Benjamin Franklin idea, wasn't it?"

Yes. Benjamin Franklin was so intrigued by this…this is in his apartment in London…he installed such a system. This one went to a rod that was sticking out the roof with a sharp point on the end of it, and this one went to a chain hanging in a well in the back yard. World's first antenna, world's first ground…Benjamin Franklin…approximately 1752, although this is later, this is 1770, or so, in London. It was sort of a weather predictor for him, because when a storm develops, the electricity in the atmosphere charges, and he would see these things start to move…you know…the variation on a barometer, if you

will.

Fred – "Now, you've got one in the Massie Building, right?

Yes, Colin built that.

Fred – "Does it work?"

Yes, as a matter of fact, the day that Colin made it…it was a Thursday…and I had an amateur radio net on Thursday evenings…and I went out that evening, and I was sitting at the ham station with my back to the…Franklin's Bells. And I was talking to somebody on the…it could have been Colin I was talking to…on the radio. Anyway, it was a stormy night, and all of a sudden…"ding…ding…ding…ding"…right behind my head. So I can testify that it works! And thanks to Colin who built it.

Fred – "Didn't you also tell me Franklin had one in his house…that he got his wife to charge up batteries?"

Oh…yes, she wasn't altogether tickled about the idea.

Fred – "I can imagine!"

Here is just a collection of little motors and generators and things of that kind, but this is quite fascinating…you know, potentiometers are designed with a different curve of variation and resistance as you rotate the knob. Some are linear, some are logarithmic… some are various things. This one, I think, is logarithmic. You see the carbon on here, and the contact plate…it starts off high resistance…as you go around you're hitting more carbon, so you get a lower and lower resistance. Over here it's a short circuit. So that's a pretty early version of a potentiometer with a variable resistance.

Unfortunately, this…this is another Wimshurst generator…but things don't travel very well…and this one got broken in transit sometime. It's a Wimshurst…only one is turning…I've never made that work.

This is mostly the way Franklin made his electricity…you rub the glass wand…and it builds up a charge.

Here is an X-Ray tube. Very high voltage between them, and the X-Ray beam fires out this way, off the 45-degree angle.

Fred – "X-Rays are shorter wavelengths?"

Yes, X-Rays are beyond the visible light.

Fred – “They were pretty dangerous originally, when people didn’t really know what they were getting themselves into.”

Well, isn’t it the way with every discovery we make? Look at the chemicals we make… they’re awful things…some of them…and, unfortunately, it make a lot of unknowing people excessively cautious about things they don’t really understand.

Little magnetos, little motors…there’s a strain insulator for a high-power radio transmitter.

Fred – “And this big variable coil here…”

Yes, this came from Brown University, also.

Oh, this is the world’s first snap-acting switch.

Little motors like that, were the great toys. This particular type was common with Erector Sets.

Here is a wireless receiver…these are the antennas…this is the coherer right here, and the bell is the tapper. The transmitter is over there…a spark coil connects to it.

This is a very early Marconi Jigger…Marconi used the term “Jigger” to describe an induction coil. It has taps for different amounts of induction. And it’s built…you see these little pins here? You can stack a second and third coil on and make transformer arrangements. That’s very early. Marconi Wireless Telegraph Company, London. Circa 1900.

This is a coherer receiver, gift of Vance Phillips, who was a great collector of detectors. The Phillips collection of detectors is in the other room, in one of the glass cases.

This is kind of cute. It’s a portable wireless set in a box. And apparently…well, here are the earphones…here is the crystal detector, the galena detector…this side is the receiver…that’s the key…this side is the transmitter…induction coil…spark gap…this is the antenna changer switch…so, some proud kid in 1910-ish had a two-way radio… spark, of course.

This is a high-voltage mica condenser. What is interesting is that Cardwell was a famous manufacturer of such things in the old days, and the fact that it came from his estate is significant.

Just more induction coils…induction coils. This is a high-voltage transformer with a

protection gap at the top, so the voltage doesn't go too high and burn the coil out.

This is an induction coil with a vibrator here.

Fred – "Oh, is that a bit like a Model T ignition coil?

Same thing, exactly. Even a modern automobile has a spark coil, you know.

Fred – "Of course, one of the things that inhibited them greatly was having good enough insulation. In most of this old equipment, has the insulation stood up, or is that a common problem with old equipment?"

They didn't do much better than varnished oak wood. See here? This is a spark gap here, and there's nothing insulated beyond the wood. This is the on/off switch. And of course, it vibrated…spark coil type thing.

Years and years ago, when amateurs were doing things by spark, they would get a big transformer…high-voltage spark gap, and just put a key in there, make a lot of static, and…it's surprising…

Fred – "Try not to electrocute themselves…"

Well, they learn a lot.

This…Clapp-Eastham is the company that evolved into General Radio. Was General Radio still there when you were in Cambridge?

Fred – "I don't know. I think it was, actually."

They were right behind MIT. Anyway, they made nice equipment in Cambridge, Mass.

Material On Display At Floor Level

This stuff along the floor here is all from my cousin, who was in Japan in World War II, and he brought all this Japanese stuff…Japanese gas masks, and so forth. The insulators are not part of it. And this Briggs & Stratton engine is also not part of it.

Fred – "It goes on with a bicycle?"

Yes, I had one of those, and I made a car out of it.

This is a pack set for the Navy, as it says…1917 Quenched-gap…spark gap set.

Fred – "So, this is still spark-gap transmission?"

Absolutely…World War I. Here's the key, and there's the quenched gap up there. These are the tuning coils for the transmitter. Unfortunately, we did not succeed in getting the receiver, which connected to those contacts in that section. The receiver was here.

Fred – "Now, how tight a frequency could they get in the transmission so one transmission didn't interfere with another? Or they did?"

It depends how close they were, you know, I mean, if you were from here to the Mayes building, it didn't do any good to try to select anything. You'd be blotted out by the other guy.

Army Transmitter

Some poor mule carried that on his back, slung over the top was a mating box which had a Briggs & Stratton engine in it driving the generator. The poor mule…I mean, it was a big load, and that's why this Briggs & Stratton is here, just to show that they made those generators for the military in World War I. And up on the pegboard is an assortment of rotary gaps. The idea of the rotary gap was to give a picket fence effect to the note as the different contacts go by…gives it an almost musical tone. And also, the other idea is that, spinning around it would be air-cooled and wouldn't melt the contacts.

Rotary Gap Spark Transmitter

Anyway, Dick Smith, who is this gentleman here, built this transmitter…he was a Navy Commander. He was also an amateur. He was a good friend of ours for a while, until he died, which was unfortunately pretty soon.

Anyway, this rotary gap spark transmitter…this frame is made out of a shaving mirror… the whole thing is homemade…and the vacuum motor is in the back…and it's either 500 watts or 1000 watts, depending on what you wanted to do. This is a thousand watts. And Thorn Mayes made this little Tesla coil, and it's hooked up to the output of this, just for the amusement of it. (Demonstration of keying.)

If you notice, there's ozone in the air…smell the ozone?

World War I

Now, we're in World War I, beginning with this row of elegant communications receivers. This is a 106-D, a much sought after collectors item…long wave…all waves. This little century buzzer…the cover doesn't come off, but…this little buzzer…you push this button, and it gives you a local source of radio static so you can adjust your detector…here's your crystal detector…and you can tune it…so they mostly had a buzzer, see, here's another one on this one.

The sets on the counter are somewhat of an evolution of these communications receivers. The IP-501 is also much sought after collectors item. You see, we jump from this version with a separate box…with a detector in a separate box…to self-contained, with a detector in the same box.

This is a 501 and this is a 501-A. See, this one has one tube. This one has three tubes. This is another 501-A right here. See the tubes in there?

This box is a long-wave adapter. Many of those early wireless stations had tremendously long waves and low frequencies and huge towering antennas, you know…they had antennas a mile long to resonate. And most of the ships…well, when I was younger, the typical shipboard receiver would be a 501-A. Military people would use the…these straps would connect here to extend the wavelength longer to have a wider frequency range…by putting this on, but most of the commercial people in my lifetime…this was before my activity in radio…most of the commercial people were happy to have this only. These are quite rare as a consequence.

This is a typical water-cooled triode vacuum tube for a transmitter. These are the filament connections.

This combination of equipment is receiver and transmitter, and, curiously enough…it's called the CW-924…this, as far as I know, is the world's first push-to-talk…push the button and talk, let it up to listen…

These are various microphone arrangements, most of them military…

These are marine type…commercial and military…all telegraph.

Testing For A Radio License

What we have down at the end…I knew the FCC man-in-charge in Boston quite well. Nathan Hallenstein was his name, and he was a good friend of mine. I got my various radio licenses in the Custom House building…I think the 20th floor, and I was shaking in my shoes, you know, trying to remember the code, because that was the big thing, you

had to know the code. You know a little theory, but the code was the important thing. Anyway, the FCC office had gathered all of these various testers for their purposes, and when they moved out of the Custom House tower, Nathan Hallenstein called me up and he said, "Hey Bob, come on up, we're cleaning out. So, this bonanza I acquired in one swoop. I should have a testimonial to the FCC here.

And what is particularly close to my heart…in an evil kind of a way…this instructor graph…this is a tape…clockwork drive…various messages on here by the little indentations…they can make and break the circuit into dots and dashes, and that's what they used to subject you to, to copy the code. And I got my first ham license by listening to that stupid thing. So that has meaning to me but nobody else.

Some of these things…radio stuff was made all over the world…see the CE CO, Providence, Rhode Island…do you remember where Big Chief Market used to be on Eddy Street in South Providence? Well, Big Chief Market was in the CE CO factory. When CE CO went belly up, the market moved in, during the depression.

Various types of tube testers, and so forth…

North Side of North Room

I think it might be worth commenting about a few things here. As I said at the other end of the room, these are broadcast receivers…Adams-Morgan, Amrad, Atwater-Kent, Clapp-Eastham…Clapp-Eastham was the beginning of General Radio company, Crosley, and so forth. When I speak about Crosley, Powel Crosley was quite a character, and down underneath is one of the…I think there were eight of them in WLW's transmitter… that's a water-cooled transmitter…I forget what the power of the transmitter was… something like 200,000 watts…maybe it was 500,000 watts…anyway, there was an international tussle between Mexico, Canada, and this country, because Crosley's transmitter was so powerful that he was wiping out the Mexicans and the Canadians. And the state department got involved, and they finally decided that there is no sense in the super high-power stuff, so the federal government knocked the power down to 50,000 watts as the max. To this day, you can't build a transmitter higher than 50,000 watts. But that's one of the water-cooled amplifiers, and you see, the anode is inside that copper tube which is immersed in water for cooling.

We were told that the…when that transmitter was on the air…Jack Gray was the Chief Engineer of WLW…and he gave us that tube. He drove it all the way from Ohio in the back of his car…and he told us that a wag living close to the transmitter, built a model railroad track around his house, and, on the locomotive, he stuck an antenna, fore and aft, inline with the tracks so that the locomotive went along with this antenna, and it was able to suck enough power out of the air to run the little model train!

So, these are all Crosley's…in tribute to WLW. Powel Crosley was a real character. He had the ability to make something practical, and he charged about a third of what everybody else charged, so it became very prosperous. And these are typical Crosley sets.

Lee de Forest, who has forever claim for putting the grid in the vacuum tube way back.

De Forest didn't really understand what he was doing…he was kind of a clown…and come the twenties, he was kind of broke, and went into business making little shortwave sets of which this is. It's a very rare shortwave receiver.

Here's another de Forest.

Federal…Federal was out in Buffalo, New York.

Freed-Eisemann was in downtown New York City…yes, Mike Thompson rigged this up with a transistor receiver.

Here are some roof antennas.

Grebe, located in Brooklyn, New York, had a reputation for excellent equipment, particularly to amateur radio operators, so…this is a Grebe CR-18, which had plug-in coils so you could get short waves on it.

Comical things were done (picking up a shell)…this is a loudspeaker…clever idea.

That's the output amplifier of WPRO, and that's WFCI…Frank Crook, Incorporated.

Fred – "Have you ever been in a factory where they made tubes?"

I can't recall that I have.

Fred – "It must have been quite an operation."

Yeah. Well, they made them by the skillions."

That's cute (opening top of box in Kennedy display)…the batteries go in here…one tuber. Here's another little one-tuber.

Magnavox were the world's first high-fidelity people…because this is is a push-pull amplifier, not a single-ended amplifier…and push-pull means that the sine wave…has an amplifier up, and another amplifier down, so you don't have a distorted shape to the wave

form. So, Magnavox…well, that's a long time ago, but they also have another claim to fame. Marconi, in his pushy way, the company brought suit against all the American Wireless people in 1910…this is the British Marconi company…and an English judge concluded that they were all infringing Marconi's patent. So, that put Massie out of business, it put de Forest out of business, it put basically all of the American manufacturers…basically shut down because of this law, but coming to Magnavox here, reminds me that Magnavox reversed that patent case. In 1942, the Supreme Court decided that the 1910 British decision was in error. The whole history of radio would have been changed, but all of the principals were dead by then. Massie, in particular, was riding very high…he had a big yacht, you know…Commodore of the Rhode Island Yacht Club, and he was doing great…all of a sudden…off the cliff. But if the English judge had not decided erroneously, who knows what Massie would have become! Much more than just PJ.

RCA made some pretty nice stuff…and Westinghouse made it for them…see, this is Westinghouse Radiola. This little set…this is a self-contained…I had this as a kid, and obviously…kids take things apart…but this used to have D-cells in here for the filaments, and "B" Batteries in here for the plates…and I thought this was the cat's mustache when I was a kid. We'd take it out in the bay when we went on these camping trips, and we'd have radio, you know?…Hooray! But that's got nothing to do with what you're recording here…I shouldn't talk…

Fred – "To ask a really dumb question, what does Heterodyne mean?"

It's not a dumb question. I should go back to the Greek roots. "Dyne" is power, and "hetero" meaning, "mix". All those radios down there have…two-men-and-a-boy number of knobs to twiddle on the front. You had to line up all these knobs together to synchronize it. See, super-heterodyne, which was an invention of Armstrong…was that you would mix the incoming signal with a local oscillator signal, and all you'd have to do is vary the local oscillator signal so that the mixture would come out to a fixed frequency. No matter what the incoming station is, you would amplify it all on the same frequency so you wouldn't have a bunch of knobs. So, a super-het has basically a control for the local oscillator and the antenna coil at the beginning. And all the amplifier stages were of the same frequency, so you didn't have to have a knob on each one. And they peaked up and it simplified the whole thing. This is another one of Edwin Armstrong's inventions… the super-het.

So, as we go in evolution…you see, I don't know if this is a super-het…maybe it is, I'm not sure…well, that's a super-het…radios start getting simpler with the super-het, you see you don't have a bunch of knobs…but we're not moving in time along this counter… we're moving alphabetically.

Jeff Berry's mother was a Donle, and he's related to this guy, who manufactured a line of

receivers in Providence.

East Wall, North Room

Now we come to television. This is a scanning-wheel television, where there's a pinhole here. The size of the picture is about an inch-and-a-quarter by an inch-and-a-quarter. These pinholes spiral in toward the center, see, they're going down, so you get all the way around, and all of a sudden they snap up to the top again. So, they scan the picture as it spins. It has to be synchronized with the transmitted signal.

Fred – "And what year is this?"

1928, that sort of time…National got into it.

Fred – "Did it exist in Rhode Island? Was there a broadcast in Rhode Island?"

I don't think there was any TV in Rhode Island, but there might have been…I don't know. But there were quite a few stations around Boston. In fact, I had a wealthy relative of a relative of mine who gave us a number of things.

This, by the way, is a scanning-wheel television here…there's a picture…it's inside this thing…this drum has the pinholes in it, but he used a National receiver with one of those scanning wheels.

I'm getting cold, Fred.

Fred – "I think we should quit, Bob."