The History of the Twentieth Century
Episode 52
"TUOBGN"
Transcript

[music: fanfare]

At the beginning of the twentieth century, news and communication could travel around the world instantly by telegraph, and that was a marvel. But there were limitations. Telegraphs could only send text. And the messages could only go where the cables went, and laying the cables was an expensive investment.

The invention of radio heralded a radical change. First telegrams, and later sound, could be sent to any radio receiver, wirelessly. Radio would trigger a revolution, first, in safety and navigation, then in news and information, and later on, in entertainment, the first tentative step toward what we now call mass media.

Welcome to *The History of the Twentieth Century.*

[music: opening theme]

Episode 52. TUOBGN.

We've already talked quite a bit about telegraphy here at *The History of the Twentieth Century,* beginning all the way back in episode one. Telegraphy was invented in the nineteenth century, and most people in the developed world took it for granted by the beginning of the twentieth century that you could send news and information around the world in an instant. Telephones were in use by this time, too, but they had a range limit. You could call across town on a telephone, but long distance telephone calls were not yet a thing. Long distances belong to the telegraph.

The first practical telegraph was patented in Britain, but here in the United States, we prefer to give credit to Samuel Finley Breese Morse, an American portrait painter. One day in 1825, Morse was in Washington, DC, working on a portrait of the Marquis de Lafayette, when he received news by letter that his wife was ill. The next day, he received another letter informing him that she had died, so he headed back to his home in New Haven, Connecticut. By the time he arrived, his wife was already buried.

Distraught by the fact that he had missed what could have been his last opportunity to see and speak with his wife because of the slowness of postal communication, Morse began studying the problem of how to send a message using electricity, potentially a much faster mode of communication. He patented a telegraph in 1837, unaware that the British inventors Cooke and Wheatstone had patented a similar invention the same year. Their version used multiple wires so that messages could be sent a letter at a time, but Morse's simpler two-wire on-and-off device was more reliable, and so it became more popular. At first.

Morse and his assistant, Alfred Vail, developed what came to be called American Morse Code, as a system of sending messages telegraphically over a single wire. Other countries, notably Germany, experimented with modified or adapted codes, but in the end, American Morse Code would evolve into International Morse Code, or, simply, Morse code. Morse code requires only one wire because the message is sent as a series of short and long pulses, or dots and dashes. The interesting thing is that Morse code in an eerie way anticipates our modern digital world that reduces all data to ones and zeroes. Individual letters are encoded as combinations of one to four dots and dashes. Common letters generally get shorter codes. The letter E, for instance, the most commonly used letter in English, is coded as one dot. T, the second most common letter, is one dash.

Morse code is hardly used in our day, but I bet even you know a little bit of Morse code. I bet you know what letters dot-dot-dot and dash-dash-dash represent, and I'm sure a few of you know that the letter V in Morse code is dit-dit-dit-dah, which is just a coincidence, as Beethoven composed his fifth symphony some forty years before Morse invented his code.

[music: Beethoven's Fifth Symphony]

In its simplest form, the telegraph requires an operator to read a message and encode it as dots and dashes by clicking a key. On the receiving end, a live operator can listen to the clicks of the machine and decode the message on the fly, although from a very early stage, everyone preferred to use a moving paper tape machine when possible. The machine made pencil marks on the moving paper tape, which operators could then look at and decode at their leisure. You won't be surprised, I'm sure, if I tell you that in those early days of telegraphy, when telegraph operators sat over their keys, clicking out dots and dashes for hours at a time, some of them developed what was known then as a "glass arm." Today we would say repetitive motion injury or carpal tunnel syndrome, but the problem is still with us, especially among us computer jockeys, who spend hours and hours each day pointing and clicking and dragging.

As the nineteenth century progressed, and the technology was perfected, the British Cooke and Wheatstone form of telegraphy, with multiple wires, came to the fore. Telegraph operators had keyboards now, on which they typed the message with ordinary letters. Each letter corresponded to voltage applied to particular wires in a particular pattern. At the other end, a printing machine would automatically type out the letters on a strip of paper. Not only was this faster, but now telegraph operators don't have to learn Morse code anymore.

As we have seen, by the early twentieth century there were undersea cables that could send messages across water. There were even transatlantic cables by this time, so that telegrams or “cables” could be sent instantly between Europe and the Americas. The British took the lead in laying telegraph cables and controlled most of the network, which was very valuable strategically to the British. During the Russo-Japanese war, for example, the British could, and did, eavesdrop on and decode Russian military communications that used their cables, and passed on anything interesting to Japan.

We’ve already seen that nineteenth century science had identified electromagnetic radiation, and how James Clerk Maxwell’s amazing equations described electromagnetic waves. A German-born professor at the University of Karlsruhe, Heinrich Hertz, built a practical apparatus for generating and detecting standing electromagnetic waves, waves of about 4 meters’ wavelength, in the 1880s. Hertz himself understood his work merely as providing experimental confirmation of Maxwell’s equations, and when asked what practical application his work might have, he said, “It is of no use whatsoever.” Sadly, Professor Hertz would fall ill with some nasty infections and would pass away in 1894, at the too-young age of just 36, a little too soon to find out how wrong he would turn out to be.

Hertz may not have seen the practical potential of what were then called Hertzian waves, but would soon be called radio waves, but several others did. Ironically, his death led to obituary articles reviewing his work, which in turn stimulated new interest in it. Several researchers began experimenting with them, including an Englishman, Oliver Lodge, an Indian, Jagadish Chandra Bose, and a Russian, Alexander Stepanovich Popov.

But the guy who gets the credit for the first practical radio was the first one to the Royal Patent Office, an Italian inventor named Guglielmo Marconi. Marconi was born in Italy in 1874. His father was Italian, and his mother was an Irish woman, Annie Jameson, granddaughter of the founder of the distillery of the same name. He spent part of his childhood in Britain, and learned English at an early age.

Marconi was a poor student, whose only real interest was electronics. He earned the wrath of his father repeatedly for the former, but his mother was indulgent with regard to the latter. At the age of 20 in 1894, the same year Hertz died, he was able to construct a radio device in the family attic, where he could tap a telegraph key on one side of the attic which would make a buzzer sound on the opposite side of the attic, about 30 feet away, with no connection between them. In 1896, Marconi would travel to London with his mother, and with the help of her family, would patent his invention. He would eventually receive a Nobel Prize for the invention of radio in 1909.

To make this device truly practical, the range had to be increased. Early experiments led many to conclude that radio had a range limit of less than a mile. But Marconi, through patient and methodical experimentation, was able steadily to increase the distance. By March 1897, he could transmit messages across Salisbury Plain, about three miles. Two months later, he transmitted a message across the open waters of the Bristol Channel, about ten miles. And in 1903, radio communication truly came of age when US President Theodore Roosevelt and the British King Edward VII exchanged greetings across the Atlantic via radio.

Of course, those greetings were sent and received using Morse code. By this time, others were beginning to experiment with modulated carrier waves, which would allow for transmission of sound, but at this time, the equipment required was expensive, bulky, and the sound quality was poor. So it would be another fifteen years or so, and a couple more technical breakthroughs before sound transmission became practical.

Marconi was not merely the first person to patent radio transmission. He was an adroit businessman, organizing the Wireless Telegraph and Signal Company in Britain in 1897. It would later be known as Marconi's Wireless Telegraph Company, and it would dominate the field for years to come. It's only serious rival in those days was the German company Telefunken. Marconi's company name probably has something to do with *wireless* becoming the preferred term for radio in the United Kingdom and the British Empire. The word *radio* was originally used as a prefix, as in *radiotelegraph* or *radiotelegram,* apparently beginning in France, and quickly adopted in Germany and the United States, where the word *radio,* by itself, was in common use by 1910. As the twentieth century progresses, the British will gradually give in, and *radio* will eventually become the most common term everywhere in the English-speaking world.

Marconi seems to have envisioned his company primarily as a competitor to the transatlantic cable companies. But as radio developed, it became clear that its real strength was that it could be installed on a ship, and that ships at sea could now communicate with each other and with shore-based radiotelegraphers. The United States Navy took an early interest in radio, and tehey called it "radio," which may be part of the reason *radio* became the preferred term in the United States. We have already seen how wireless communication gave Admiral Togo crucial information about the arrival of the Russian Second Pacific Squadron during the Russo-Japanese war. And Marconi Wireless, with their powerful transmitters on both sides of the Atlantic, were well-positioned to bring radio to ocean vessels.

The men who operated the radios aboard civilian ships were not part of the crew. They were Marconi Wireless employees. The typical radio operator was a young man in his twenties. In order to get hired, he would have to pass a physical and a hearing test and a written examination. He would then undergo extensive training by the company until he could send and receive messages over the radio at the rate of at least 25 words per minute.

At first, radio equipment was installed on the ship's bridge, but noise was too much of a problem. The radio equipment was distracting to the bridge crew, and the other sounds on the bridge made it hard for the operator to listen to the code. So the radio and the operator were sson moved to their own small room, which came to be called the “radio shack,” and the radio operator often was referred to by the rest of the crew as “Sparks.”

These young men were the computer geeks of their day. Typically, there was only one of them aboard the ship, maybe two on a big ship, and he was the only one who understood this complicated—maybe even a little bit spooky—technology. They tended to be undisciplined, even cocky, because no one else aboard could do what they did, and everyone else knew that, which meant they were untouchable and could pretty much do as they pleased. They often remained aloof from the rest of the crew, bonding more readily with their fellow Marconi Wireless operators on other ships, with whom they communicated regularly.

Most of the demand for their services was during the day, and often messages would accumulate that would take until evening to work through. Now, late at night, radio travels farther than it does during the day, although the reason for this was not well understood at the time. So, when the day’s work was done and most everyone else on the ship was asleep, the radio guys would chat with each other across the ocean night.

I bet it won’t surprise you if I tell you that a lot of these conversations were puerile. Marconi and Telefunken men would insult each other, if they deigned to talk to each other at all. Among their own, typical nighttime conversations might be about what everyone was having to drink that night, or about girls and sex.

There was no privacy in these early radio communications. Anyone who owned a radio and understood Morse could listen in, but the radio operators did have their own insider code. The letter C, for instance, meant “yes” and N meant “no.” Radio men referred to each other as OB and OM, short for “old bean” and “old man,” which were 1910 ways of saying “dude.” When they started hiring women radio operators, it became common for a guy to signal to her the number “88” which, for some reason, was supposed to represent, “I love you.” TU meant “thank you,” GTH meant “go to hell,” and so on. So you might end a late-night conversation with one of your buddies by signing off with TUOBGN, meaning, “Thanks, dude. Good night.” or maybe “k thx bye.”

Yes, these radio operators were history’s first texters, and they were doing it a hundred years before *you* discovered it.

During the day, the radio operators were expected to communicate with the ship’s owners. For the first time in maritime history, a ship’s owners could track its progress across the ocean, and the crew of the ship could keep their bosses up to date on their position, the weather, the ship’s condition, and whatever else they might want to know.

Wikipedia has a modern simulated recording of what an old-style Morse code radio message might sound like. I have speeded up this recording to 25 words per minute, which, remember, is the minimum speed at which a Marconi Wireless operator was expected to send and receive.

[sound effect: Morse radio signal]

Aboard passenger ships, wireless telegraph services were made available to the passengers, for a stiff charge: typically 12/6 for the first ten words and 9d per word thereafter. In modern currency, call that about US$85 for the first ten words, and around US$5 per word thereafter. Needless to say, this was pricey, and only the wealthiest passengers indulged in the sending of radiotelegrams, and when they did, it was as much about showing off as anything else. Typical messages from the period were brief and indulged in the special kind of terse English used in telegrams. Messages like ARRIVING NYC ABOARD OLYMPIC THURSDAY PM SEE YOU THEN ROBERT. Ten words exactly. Of course, the real message here is “Hey, I’m sending you a telegram from right aboard the ship!!”

Because these telegrams were so expensive, there developed a line of codebooks for sale to the public, in which single words were suggested as shorthand for a whole phrase or sentence. Naturally, the sender and the recipient would have to agree on a codebook ahead of time from the many available, and buy a copy each. The company didn’t mind its customers using code, since these customers otherwise presumably wouldn’t be sending messages at all.

The potential for radio to transmit not just dots and dashes, but actual sounds would be a technical leap analogous to the leap from telegraphs to telephones. The path to broadcasting sound was becoming clear by the beginning of the twentieth century. In order to broadcast sound, you need to modulate the amplitude of the radio carrier wave, hence the term “amplitude modulation” or “AM” radio. In order to convert a received AM radio signal into sound, you need a device that will allow electricity to flow through it in one direction, but not the other. Such a device is called a “rectifier” or a “diode.” On the face of it, this sounds like a simple enough thing. But it isn’t.

At the beginning of the twentieth century, diodes were crystals. You attached a thin metal wire to the crystal—you had to find just the right spot—but if you did, you could use your crystal as part of an electrical device that would allow you to pick up AM radio waves and hear the sounds being transmitted in a pair of headphones.

What’s cool about crystal sets is that they don’t require a power source. The energy of the radio waves themselves is all that they need. What’s not cool about crystal sets is that you have to wear headphones, because the radio waves don’t carry enough energy to make a sound loud enough for anything bigger, and also, that thin little wire—sometimes they call it a “cat’s whisker”—has to touch the crystal at just the right spot. Bumps and shakes will move it and force the operator to recalibrate, so the equipment is delicate and requires a trained operator to keep it working. This is not a consumer-ready technology, although the various militaries of the time were interested, for obvious reasons, and there were hobbyists, who tinkered with these devices for their own entertainment. People still make and sell and build crystal sets to this day, for educational purposes and as a hobby. I built one when I was a kid.

But two more breakthroughs were needed in order for radio to be truly practical: reliable diodes and some way to amplify sound. Both of these problems would be solved in the first decade of the twentieth century, and the solution to both of them would be the same invention: the vacuum tube.

All the way back in episode 15, I talked about cathode tubes, which were a scientific curiosity in the late nineteenth century. You'll recall that these were sealed glass tubes with no air inside. There were metal plates at both ends, and electric charge can be made to pass from one plate to the other, which led to the discovery of the electron in 1897. I hadn't mentioned it before, but typically, one of the two plates is electrically heated with a filament. The heating facilitates the electrons' leaping off that plate and onto the other one.

A heated filament in a closed glass tube with no air inside is what an incandescent electric light bulb is, the invention of which is usually credited to Thomas Edison in 1879, although the story is, of course, more complicated than that. But for our purposes, I'll just note that incandescent lights and vacuum tubes are related technologies and that improvements in one often carry over to improve the other.

But since the electrons in a heated cathode tube, or vacuum tube, only travel from the heated cathode to the unheated one (more properly called an anode), a vacuum tube is functionally a diode, only allowing electricity to flow in one direction. Edison noticed this in the course of his light bulb experiments, and it is sometimes called the "Edison effect," even today. Edison wasn't actually the first person to notice this, but he was the most famous one. So it goes.

This means that a vacuum tube diode is the answer to the problem of sending sound signals over AM radio. The first person who had this insight was a British electrical engineer named John Fleming, who had previously worked for Edison. He was consulting with the Marconi Wireless Company in 1904, when he developed the first practical vacuum tube diode, which were called "Fleming valves" in the UK.

On the down side, a vacuum tube requires a heated filament, which requires a source of electricity, meaning that a vacuum tube radio receiver is not going to be as lightweight and portable as a crystal set. On the other hand, a vacuum tube is more rugged and doesn't require constant fiddling like a crystal set does, making it more consumer friendly.

But even with a vacuum tube diode, the sound signal you get is still so quiet you need headphones to hear it. What the world needs next is a device to *amplify* sound signals. Something like that would revolutionize not just radio, but also phonographs.

Thomas Edison also gets the credit for inventing the first phonograph, in 1877, just two years before the light bulb. The word "phonograph" was coined by analogy to "photograph" and "telephone." (Both of which were already in use.) The roots come from the Greek words meaning "written sound" or "written voice." "Phonograph" was Edison's name for the thing.

Edison’s early phonographs recorded sounds mechanically, as grooves on a metal or wax cylinder, and then played them back by running a stylus through the groove.

The phonograph may have been the first trade good in history that could literally sell itself. Again from Wikipedia, here is a 1906 phonograph recording that was created and used to sell the machine.

[sound: Edison phonograph advertisement]

In Britain, the Gramophone Company used similar technology to record and play sounds as a long spiral on a flat disk, and “gramophone” quickly became the preferred term in the UK and the British Empire. Flat disks would quickly replace cylinders everywhere, as they were easier to use and store.

In these early machines, the stylus would be used to vibrate a small diaphragm to make sounds. Like early AM radio, this technology couldn’t produce sounds that were very loud. Early machines either used tubes to bring the sound to your ear, kind of like a doctor’s stethoscope, a forerunner of today’s earbuds, or else the diaphragm was connected to a horn, so what sound there was could be directed to one part of the room, since there wasn’t enough of it to fill the room. You’ve probably seen pictures of early machines with those characteristic horns.

And in 1898, a Danish engineer named Valdemar Poulsen developed magnetic recording and playback of sounds on a metal wire. Wire recorders, and later tape recorders, would compete with phonographs. The main advantage of magnetic recording for a consumer is that it’s fairly easy to package magnetic recording and playback into one device, and the recording medium, first wire, and later tape, can be used over and over again. In the first half of the twentieth century, phonographs were the preferred technology for the manufacture and distribution of commercial recordings, most often music, while magnetic recording was the preferred technology for dictation—the so-called “Dictaphone”—as well as making recordings from radios and telephones.

Valdemar Poulsen demonstrated his machine at the 1900 Paris Exposition, and a recording survives from that time. It happens to be a recording of our old friend, the Austrian Kaiser Franz Josef. It is believed to be the oldest magnetic recording still in existence. And thanks to Wikipedia, I can bring it to you right now. Here it is:

[sound: wire recording of Kaiser Franz Josef]

The Emperor seems to be saying “Erfindung hat mich sehr interessiert, und ich danke sehr für die Vorführung,” or, “This invention is very interesting. Thank you for the presentation.” Memorable words from an inspiring leader.

But what all these technologies needed to be truly useful—radio, phonograph, magnetic recording, even the telephone—was the ability to amplify the sound and make it louder.

The technology to convert sound into an electrical signal was already well known. It's the basis for the telephone, an invention usually credited to the Scottish-born American Alexander Graham Bell in 1876, although again, it's complicated. But for our purposes, the point is that amplifying sound comes down to the ability to amplify an electric signal.

As it would turn out, this was accomplished by what in hindsight seems a simple modification to the Fleming valve, the triode, which was first made practical by the flamboyant American inventor Lee de Forest in 1907. A triode vacuum tube is just like a diode vacuum tube, with the addition of a wire grid between the cathode and the anode. When you apply a negative voltage to the grid, it repels electrons, blocking their passage from the cathode to the anode. Increasing and decreasing the negative voltage on the grid shuts off and opens up the flow of electrons from the cathode to the anode, in a manner similar to the flow of water through a faucet as you turn the handle one way or the other.

Which is the explanation for the British habit of referring to what we Americans call vacuum tubes as "valves." While "vacuum tube" is a fair physical description of the gadget, "valve" is really a better functional description, at least in the case of triodes. So I have to concede that to those of you in the UK and Commonwealth who call them "valves." Well played.

But the practical upshot of the triode is that, if you apply a weak signal to the grid, the flow of electricity through the triode matches the weak signal, and gives you a much stronger copy of the same signal. Strong enough to connect to a loudspeaker, and make into a much louder sound.

The full potential of the triode became apparent by 1913. One of its earliest adopters was Alexander Graham Bell's American Telephone and Telegraph Company, which began using triodes to amplify phone calls, which eliminated the range limit on long distance telephone calls. The dramatic culmination was the first transcontinental telephone call in the United States, on January 25, 1915. The call was placed by none other than the now 67-year old Alexander Graham Bell at the Telephone Building in New York City to San Francisco, where waited none other than the now 60-year old Thomas Watson. Bell recapitulated his famous first phone call of 38 years earlier, saying, "Mr. Watson, come here. I want you." Watson replied, "It will take me five days to get there now!"

Further consumer development would have to wait until after the Great War, but the invention of the vacuum tube marks the beginning of what we now call "electronics." It opened the way for a slew of amazing devices that would revolutionize life in the twentieth century, including radio, television, phonographs, sound recording and amplification, talking motion pictures, long distance telephones, radar, computers, and microwaves. Vacuum tubes themselves would be superseded by semiconductor devices in the 1960s and 70s, but for those of us who are over a certain age, well, we can still remember a day when our radios and TVs and phonographs and amplifiers all had vacuum tubes in them. We just called them "tubes" back then, and everyone knew what you meant. And when you switched on your electronics, there would be a delay of 30 to 60 seconds before the device began working, because it took that long for the filaments in the tubes to get red hot, as was required. We would say the device was "warming up."

And yes, they generated a lot of heat. Electronic devices of the time typically had a masonite back cover which could be removed to access the tubes when they burned out and needed to be replaced, which was frequently, and the back cover had a lot of holes or slots cut into it to allow the heat from the tubes to escape. You checked to make sure your device was turned on and working properly by peeking through the little holes in the back to check for that dull red glow that meant everything was a-okay.

Radio and phonographs would eventually allow information and entertainment to be delivered directly to individual consumers in their own homes, assuming the consumer could afford the proper equipment. But the cost of this equipment would decline by orders of magnitude over the course of the twentieth century, and the quality of the content delivered would increase. First sound, then stereo, then images, finally data itself. Radio signaled the beginning of mass media; information and entertainment chosen by the consumer, with a corresponding decline in the influence of mediators such as newspaper editors, theatrical producers and impresarios. And so it would go for the rest of the twentieth century, profoundly changing the nature of news and information, arts and entertainment

We'll have to stop there for today. I'd like to thank all of you who listen and subscribe to *The History of the Twentieth Century.* I appreciate all my listeners and I don't thank you as often as I should. And if you like *The History of the Twentieth Century,* I invite you to visit the website at historyofthetwentiethcentury.com, where I sometimes post pictures and graphics on the topics of the podcast, and where I continue to expand the recommended reading section, which highlights the books and other resources I use to create this podcast, and which I recommend to those of you interested in delving deeper into some of the topics we've discussed. And, of course, there's a "donate" button, which I invite you to use if you have a few extra bucks or pounds or pesos or yen or sheckels or euros or kroner to contribute to help keep the podcast going, and help convince Mrs. History of the Twentieth Century that I'm something more than just a deadbeat husband.

There's also our Facebook page, and we're on Twitter @history20th, that's history-two-zero-t-h, and you can email me at historyofthetwentiethcentury at gmail dot com. Let me know what you like or don't like about the show, and let me know what topics you might like to hear about in future episodes. And I hope you'll join me next week on *The History of the Twentieth Century* as we return to the United States. The last time we were there, we bid Theodore Roosevelt *au revoir,* and it's time to check in and see where America goes from there. That's next week, on The History of the Twentieth Century.

Oh, and one more thing. If you'll indulge me for a moment, I'd like to share a bit of family history. My grandmother was an ethnic Polish immigrant from Austria-Hungary, and she was living with my mother when my mother bought her first television set in 1955. My mother reports leaving the TV on for her mother to watch while she went out. When she returned, the TV was off. She asked her mother why she had turned the TV off, and my grandmother explained that it was because she looked into the back of the set and saw that it was on fire.

[music: closing theme]