The attached is a summary of a talk given at the YCARS program meeting in March of 2002. The facts are based on historical record, folklore and practical knowledge.

Enjoy!

Wireless History, part III

Initially, wireless transmission was accomplished via a spark gap transmitter. In its simplest form, steal a Ford model "T" ignition coil (perfect, 'cause they ran (sparked) all the time), connect one end to earth, t'other to an aerial (the high voltage end), turn it on and off via a momentary switch (a KEY!!) in series w/ a battery and voila!, a very wide band transmitter.

Why wide band you ask? Well, without getting too deep in Fourier equations, consider the spark. It is a very short duration of high energy. Yeah, so what? Well consider the extreme opposite case, a pure sine wave (we have to assume something is remembered from the exam preparation). A sine wave consists of on single, pure frequency. To hear, or detect, this frequency, you have to have equipment capable of tuning to its range, be it the human ear, which is fairly wide band in a very narrow range (what?), or a radio receiver tuned to this single frequency. Depending on the Q or selectivity of the tuned circuit, it hears this frequency alone and no others around it.

Again, so what? Well, consider another fundamental wave shape, the square wave. A square wave is simply created by applying and removing energy to a circuit (light bulb an' a battery). A square wave also just happens to be mathematically the summation of the odd harmonics of some frequency based on the on and off rate (and the slope of the sides but lets not get too complicated). Don't believe me? I'll whip out a sketch on the chalkboard and demonstrate that the more odd harmonics you add in, the more "square" the wave becomes.

Any body still awake?

So, we see that the odd harmonics of pure sine waves can create square waves. Well consider another extreme case, an impulse. In its purest form, an impulse has infinite amplitude and infinitely short duration. Kind of like a spark (ah haaa!) To create an impulse mathematically requires an extremely large amount of odd harmonics of sine waves. Yeah, but we create a spark by keying the spark gap transmitter, no math required. Absolutely! But, the harmonics gotta be somewhere. And they are, in the form of a very wide band signal. QED. That's why lightening causes interference in radios, no matter which station you are tuned to.

Jeez, I'm like James Burke of "Connections" fame here.

SOOOO, we have a spark gap transmitter, very wide band, very noisy. Well, how do we get a pure sine wave to clean this up? Well, what runs off single frequency sine wave in your homes? Every AC motor! In the early days, the

opposite of a motor was used. (a generator, come on people!). Early CW transmitters were AC generators, operating at extremely high frequencies of up to 42 kilocycles. WoW! Pretty fast for a mechanical rotating device. No, the shaft speed was not 42,000 rps. These generators had several poles, such that the shaft speed was some fraction of the output frequency, similar to modern (since the teens) power generation rotating machines.

OK, so we now got single freq generators, and with out resorting to tubes and oscillators and what all! Kwel!

Yeah, but, just like with modern hams, CW got boring. Well, how do you un bore it? Music of course! More on that later!

What were some other black magic devices in existence at the same time period? How about Alexander's invention? A telephone (still) takes audio pressure modulation and converts it to electrical (voltage or current, depending on who's system, but hey, modulation is modulation) modulation that can be converted back to audible pressure modulation at some distance. That's nice, but how do it work, an' what's that got ta do wid RF modulation? Patience, dear reader (captive audience, etc.)

Until the introduction of the electret mic in telephones about 25 years ago, the fundamental components had not changed since the late 1800s. The transmitter of a telephone was (is) a carbon microphone. The carbon mic is easy to construct (hind sight IS everything) by taking a conductive cup, about the size of an 1/8 teaspoon (something for the ladies, indeed), filling it with carbon granules, about the size of #3 sand, placing an electrode in the middle of the surface of the granules and securing it and the granules in place with a film or tape, or mica sheet as in the old days. This insulates the center electrode from the cup while keeping it in contact with the carbon granules and keeping them in place. This electrode is mechanically connected to a much bigger flat-ish diaphragm, such that when the diaphragm moves, the electrode moves also.

Getting intrigued yet?

When the diaphragm moves, the electrode moved correspondingly. This movement causes mechanical pressure fluctuations that correspond to the diaphragm movement. These mechanical pressure fluctuations are impressed upon the carbon granules such that they are compacted and loosened according to the applied pressure. So, for example, you were to speak at the diaphragm, your voice pressure fluctuations would be translated to carbon granule fluctuations. Everybody (should) knows that carbon is a somewhat conductor, so if you apply a voltage across the 2 electrodes, because of the mechanical fluctuations, the resulting resistance would change accordingly, causing the current passing though the carbon granules to match the speech imposed on the

diaphragm. Well lookey here, we've described converting voice into electrical signals, just like the original patent did 100 years ago.

What happens on the far end? Ehh, that's simple! If you place a coil of wire (10-20 loops) around a magnet such that the coil is free to move, it WILL move when current is passed through it. Kind of like a motor. Well instead of rotating, suppose the coil is mechanically attached to a diaphragm (hey that sounds like a speaker) you get a speaker. So, this device will convert (translate, whatever) the modulated electrical signals back into modulate pressure, something the ear can decipher.

So now you know the secret of the telephone, and I don't even have to kill you now, 'cause the patent has long since expired. But even better, you now can transmit sound (phone) to a distant (tele) place!! Man this IS cool!

All right all right, back to the original discussion.

So we got a cw transmitter, and we got a device that will modulate electrical signals. What happens if you place the carbon microphone between the generator and the aerial? Any signal, voice, music, etc, used to make the carbon mic do its thing, will impress this modulation in the current going through it, be it DC current (I know, redundant) or RF current. The purely sine wave being transmitted is still a pure, single frequency, but the amplitude of the CW signal now varies with the information impressed via the carbon mic. Hey, that sounds like Amplitude Modulation!

Imagine if you were some poor ole wireless telegrapher on a ship listening to ship to shore traffic in the early part of this century and all you had ever heard and all you expected to ever hear was " click-clickclick-click", and one night you heard MUSIC coming from the headphones. What the Hell would you think! Neat, huh?

In future sessions I'll discuss the construction of the spark gap generator (Ford ignition coil, mechanical buzzer, etc), passive receiver fundamentals, tuning systems, etc.

Dave
WB4OZU
Rock Hill, SC