Two Rich Minds - One Poor Invention

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An early patent by legendary inventors Edwin Armstrong and Michael Pupin confirms the former's long-time interest in reducing radio static. Though the application of regeneration to antenna circuits as a noise limiting technique was a dead end, it did foreshadow Armstrong's eventual development of Frequency Modulation. Writer Bill Denk was a long-time author of The OTB's book review column.

Even before the founding of the first organizations devoted to the preservation of the wireless history and equipment, this writer had started his collection of patents having special significance in the early development of the communications technologies. The collection includes Edison's patent on the phonograph, Bell's patent on the telephone, the Morse patents on the telegraph, Marconi's earliest patents on his wireless transmitting and receiving system, Fleming's patent on the vacuum tube diode detector, the early crystal detector patents of Bose, Dunwoody, and Pickard, the Hazeltine Neutrodyne patent--hundreds in all. Collecting patents is an area of our hobby that requires very little space, and it can be most interesting and revealing.

One of the early patents in my collection, added because of the eminence of the named co-inventors, might have been later discarded had the inventors been a pair of unknowns. One of the inventors was Michael I. Pupin, Professor of Mathematics at Columbia University. He was the inventor of the telephone repeater, or Pupin coil, which greatly improved long-distance land-line telephony. His patent covering that development was acquired by Bell Telephone Company in 1901. Other Pupin patents, on tuning systems, were licensed to the Marconi Company.

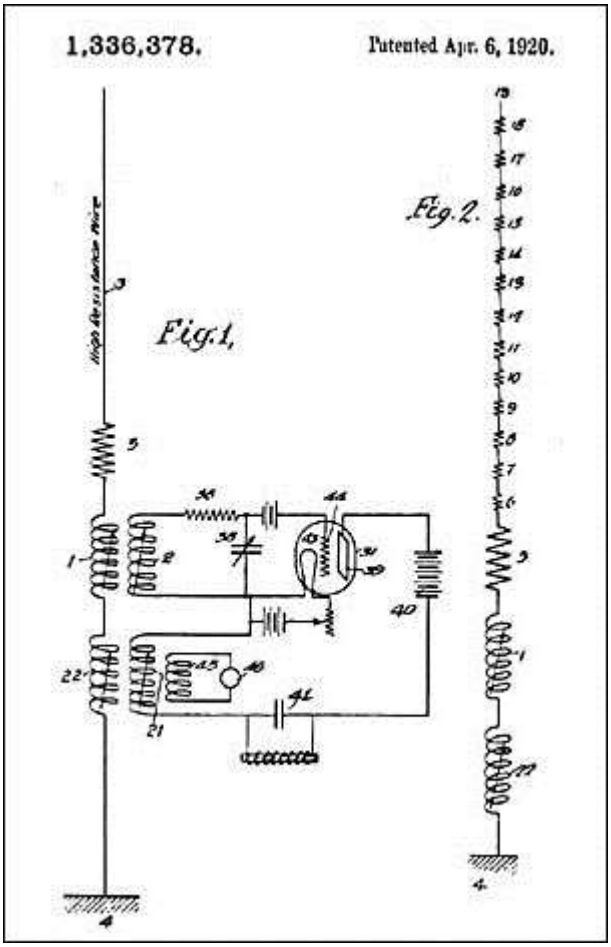
The other co-inventor was Edwin H. Armstrong, who needs no introduction to radio historians. Armstrong studied under Professor Pupin while at Columbia University, where he received his Electrical Engineering degree in 1913.

The patent here in question is U .S. Patent No. 1,336,378, "Antenna with Distributed Positive Resistance." The application was filed October 1, 1915, and issued April 6, 1920. The single page of drawings is reproduced here in its entirety. To place this patent in historical perspective, note that DeForest filed his patent application on the triode on January 29, 1907; Armstrong filed his application on the regenerative detector on October 29, 1913, and that on the superheterodyne receiver on February 8, 1919.

For an understanding of the objective of Messrs. Pupin and Armstrong which, broadly, was to reduce the effects of static on radio reception, the second paragraph of the patent specification is reproduced below in its entirety:

The invention relates to receiving wave conductors which are loaded with resistance in order to screen them against the disturbing effects of electrical waves, and particularly those waves which have the character of electrical pulses of short duration, known in the art as "atmospherics" or "strays." A resistance introduced into the receiving conductor, called the receiving antenna in wireless transmissions,

will diminish the effects of disturbing waves and pulses, but it will also diminish to the same degree the effect of the waves which are to be received, ***unless the introduced resistance is properly placed****.. (emphasis added) This invention gives definite rules which enable one skilled in the art to distribute the introduced resistance so that it will diminish the effect of disturbing waves more than of the waves which are to be received.*



Referring to Figure 1 of the drawing there is an antenna (3) of high-resistance wire (as much as 300,000 ohms). This is connected to ground (4) by way of primary inductors 1 and 22. A series resistor (5) is included the antenna primary circuit; it may equal about "a quarter of the total introduced resistance."

Figure 2 is included merely to show that, instead of using high resistance wire in the antenna (quite a practical problem!), it would be easier to use a large number of lumped resistors (6 through 18). The inventors note that such an antenna would "act like a perfectly uniform wire of the same total resistance, if the lumps are so spaced that there are several per wavelength of the waves to be received." According to the inventors, the function of resistor 5 "is to dissipate the electromagnetic energy during its passage from the antenna to the receiving apparatus."

For the moment, ignore the entire vacuum tube circuit and notice only that detector 46 is coupled to antenna primary coil 22 by way of coupling coil 45. Ignore also the interposed coil 21 which is part of the vacuum tube circuit. In describing this arrangement, the inventors make the unsupported statement that "we find that in such an antenna the effective resistance for waves to be received is a fractional part of the total resistance, whereas for electrical pulses of short duration the effective resistance is substantially equal to the total resistance of the antenna." Their "pulses of short duration" are, of course, the static against which the inventors desired to discriminate.

Claim 1 of the patent broadly covers an antenna of the type described so far. It reads:

1. A receiving conductor for wireless wave transmission having a resistance load sufficiently high to screen the system effectively against disturbing electromagnetic waves impressed upon the conductor, the said resistance load being distributed

along the conductor with substantial uniformity with respect to the wavelengths developed upon the conductor by the received signals.

Now to the vacuum tube circuit -- and here the patent becomes more interesting, though no more convincing. The inventors describe the circuit as "a resistance compensator... employed for the purpose of compensating a large resistance introduced into an antenna." This compensator is, simply, a regenerative system that reintroduces energy, taken from the antenna and applied to the grid circuit, back into the antenna circuit, via plate coil 21, in such phase as to introduce a negative resistance into the antenna.

In the words of the inventors, "This produces in the antenna a negative resistance reaction capable of reducing the resistance (of the antenna) to any predetermined limit for waves of selected frequency." The inventors seem to have believed that the high, built-in antenna resistance would be greatly diminished for the desired signals, while remaining very high for atmospherics, thus discriminating strongly against static interference.

Claim 2 of the patent is like claim 1, reproduced above, but adds the following:

. . .and a resistance compensator connected to the conductor and adapted to reduce its effective resistance to any predetermined limit for received signals.

The writer found no reference to this patent in Maclauren's fine book *Invention and Innovation in the Radio Industry* (Macmillan Co., 1949), and didn't really expect to, but the following significant statement appears on page 184. "One of the major problems which Armstrong had been eager to solve was the elimination of static. His first work with Pupin had been in this field, and for eight years (1914-1922) he had wrestled with the task without making significant progress." Maclauren adds that, in an interview, Armstrong stated, "My early failures here were a chastening experience and it was two years before I regained sufficient confidence to tackle this particular problem once more."

As we all know now, Armstrong's new approach to static reduction was use of the UHF spectrum, higher power, wide-band frequency modulation, and amplitude limiters, or clippers, at the receiver.

On balance, it seems fair to conclude that the Pupin & Armstrong patent does not belong my the discard pile. Instead it will be retained as an interesting but unproductive step in man's long effort to minimize the effects of atmospherics on radio reception. And for us more ordinary toilers, it has to be reassuring to know that occasional failure need not preclude ultimate success.

[1] *The Antique Radio Gazette was the official publication of the Antique Radio Club of America. ARCA merged with The Antique Wireless Association in the spring of 1994, and the content that appeared in the Gazette during its 1972-1994 publishing history is now part of the AWA archives. Though edited to conform to The OTB's current standards of style, this article appears essentially as originally published.*