Losses in Early Telephone Lines.

Updated: 10 June 2001

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The first telephone lines were naturally based on existing telegraph circuits; these proved not well adapted to telephony.

The normal telegraph circuit consisted of iron or steel wire suspended on poles, with a common ground return through the earth. The series resistance of the wire was high, and there were predictable problems with corrosion and noisy connections. The crosstalk resulting from the common ground return resistance was not a problem with telegraphy, which is basically a digital or on/off system, but it was soon found to be intolerable for telephony. The only solution was the use of 2-wire "metallic circuits" which used another metal wire to complete the circuit. This removed the ground return problems, at the cost of doubling the number of wires in the system.

The obvious solution to the problem of wire resistance appears to be the use of copper which is both more conductive and resistant to corrosion; however it is always dangerous to assume that our ancestors were stupider than we are. Copper was not used because the processes of embrittlement and annealing that were part of drawing the wire left it too weak to support its own weight over a practical distance. It was not until Thomas B Doolittle evolved a method for making "hard-drawn" copper wire in 1877 that copper circuits became feasible. The process changed a metal with a tensile strength of 28,000lb/sqin at elongation of 36%, to one with a tensile strength of 65,000lb/sqin at elongation of only 1%.
The first recorded conversation over such a circuit was between New York and Boston in 1884.

A few more salient events:

1881. The first demonstration of 2-wire metallic circuit. 1892. The New York - Chicago circuit runs for 900 miles.

1897. Service begins New York - Omaha, over 1300 miles. Even with very large copper wires, the service was just barely acceptable.

1900. Pupin and Campbell introduce loading coils. Loading a line with series inductance raises its impedance, so the energy is transferred at a higher voltage and a lower current; this reduces losses in the series resistance. In May 1900 experimental loading coils were used on two 24-mile circuits in Boston.

There are other losses apart from series resistance. If the line impedance is raised with inductance then parallel leakage becomes more important. Insulators were therefore improved, primarily by adding "skirts" to increase the path length over the insulator body. Insulators of clear glass became popular because the light discouraged insects from establishing themselves under the skirts.

Acknowledgement: This article draws heavily on the book "Engineering and Science in the Bell System". All speculation is mine.

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