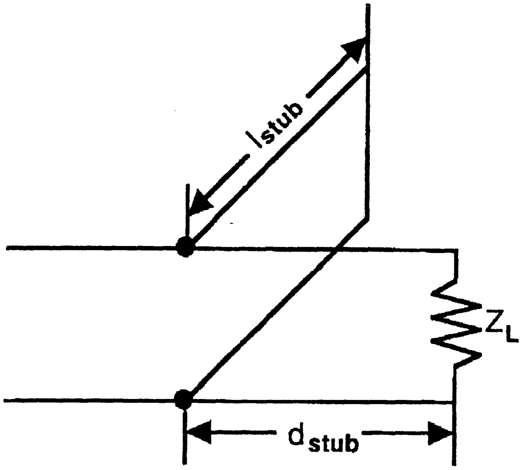

Figure 6-14. Single stub matching of a load impedance to a transmission line.

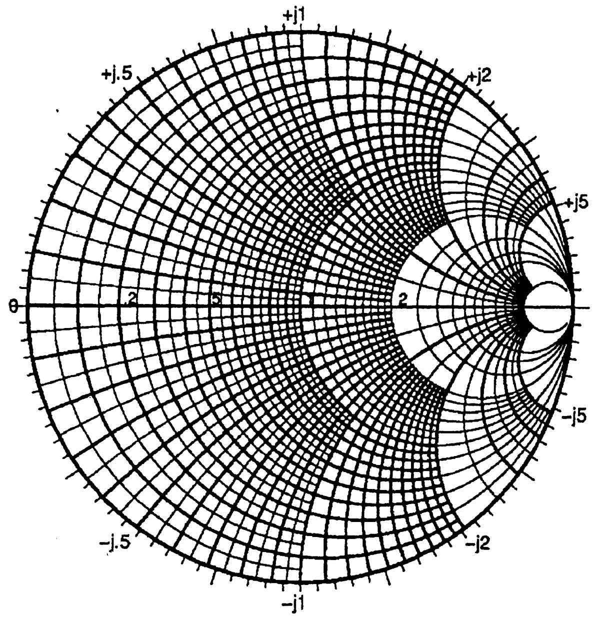

Figure 6-15. The Smith chart created with MATLAB.

tuning stubs are separated by fixed distances along the transmission line. Each adds a certain amount of susceptance that could be specified by a complicated circuit analysis program.

A Smith chart that shows more detail than we have given in our simple sketches is shown in Figure 6-15. The MATLAB programs that are used to create it and the simplified Smith charts are given in Appendix E. Smith charts are omnipresent in high frequency laboratories. Larger Smith charts are available also. In addition, certain oscilloscopes and network analyzers have Smith charts embedded in the screen.

Transient effects

The study of transmission lines that are excited with a sinusoidal voltage generator could continue for many more pages and all possible nuances would still not be uncovered. The reader may wish to explore this topic still further and this writer does not want to discourage these efforts. However in the limited time and space available to us, we should travel on a slightly different path, the path that integrated circuit designers regularly travel in designing chips for computers. As we enter this path, we must be cautious so that a passing zero or one does not strike us and knock us over. The knowledge that we have gained from the time-harmonic analysis should fortify us in our attempt to gain an understanding of transient effects and pulse propagation.

Consider the transmission line shown in Figure 6-16 in which a battery is connected to a transmission line. The battery has an internal impedance Z_b, the transmission line is represented with a characteristic impedance Z_c and the transmission line is terminated in a load impedance Z_L. We will assume that they are pure resistances at this stage and that the signal will propagate with a velocity c. The voltage wave is governed by the Telegraphist's equations (6.11) and (6.12) and the ratio of the voltage wave to the current wave is given by the characteristic impedance Z_c of the transmission line. Since the load impedance is located a distance L from the battery-switch, it will take L/c seconds before the signal arrives at the load impedance.

The voltage V_1 that appears at the terminals of the transmission line is given by a simple voltage divider rule between the battery impedance and the characteristic impedance of the transmission line

$$V_1 = \frac{Z_c}{Z_c + Z_b} V_b \tag{6.56}$$

After a time $= L/c$ seconds, the voltage step arrives at the load impedance Z_L. A portion

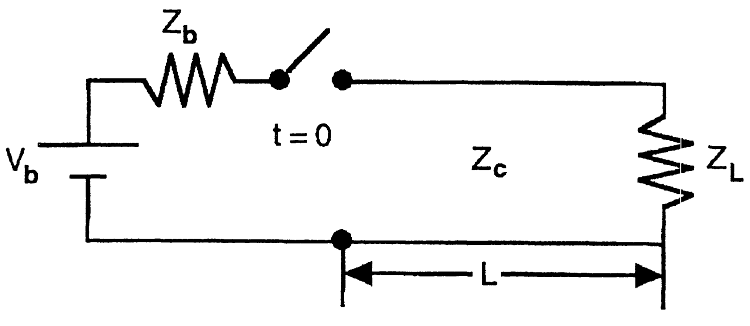

Figure 6-16. The battery is connected to the transmission line with a switch that is closed at $t = 0$.