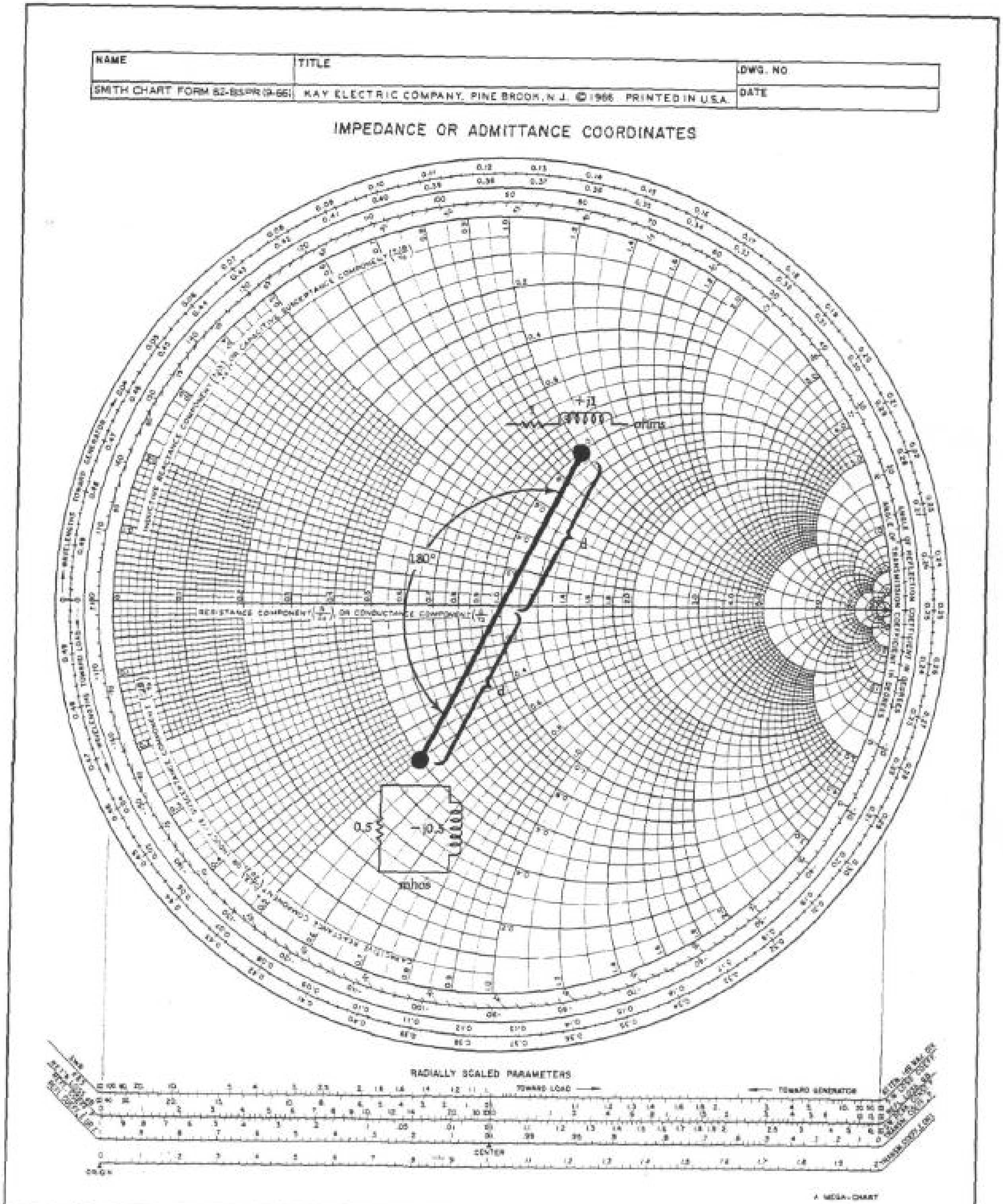

Fig. 4-35. Impedance-admittance conversion on the Smith Chart.

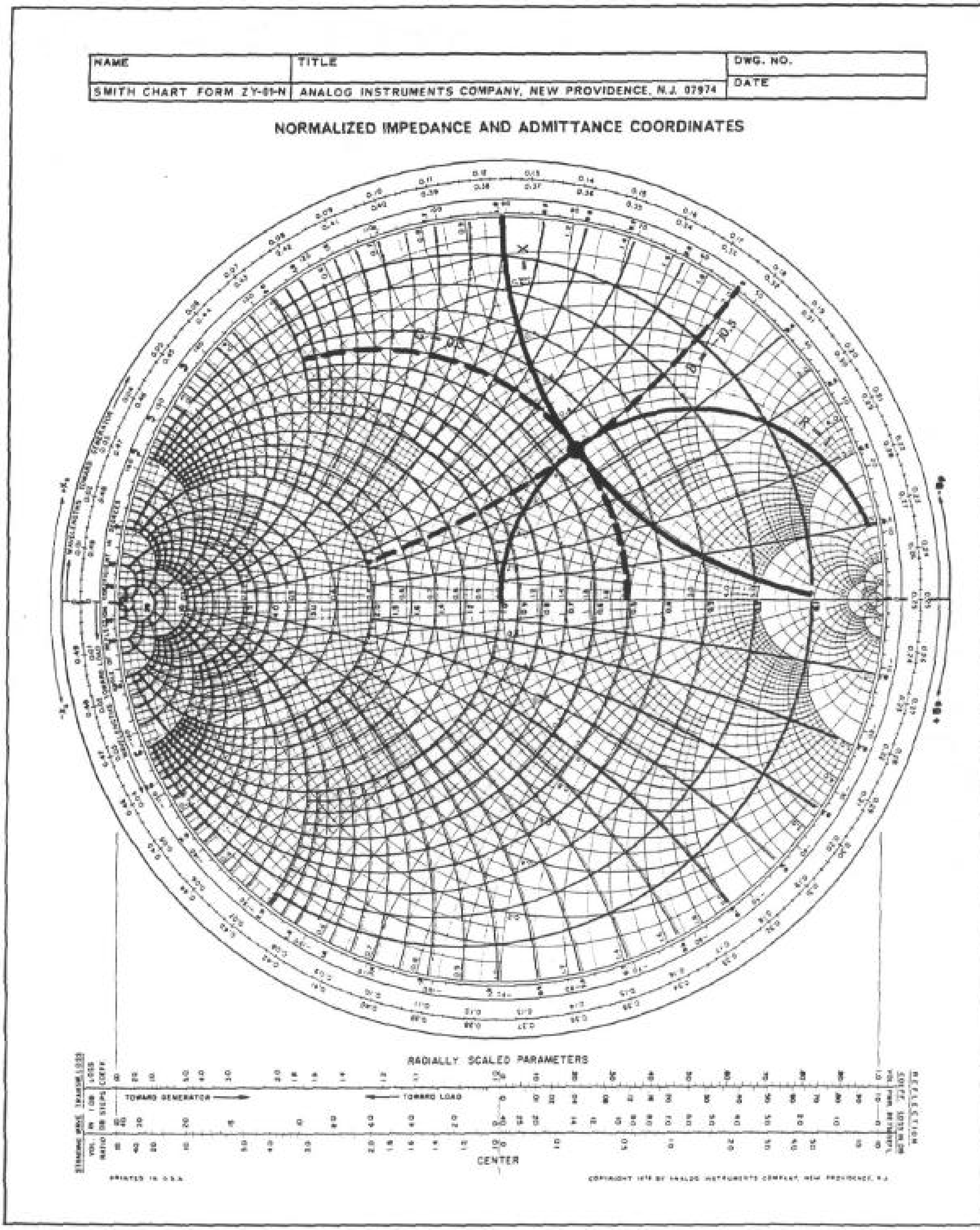

Fig. 4-36. Superimposed admittance coordinates.

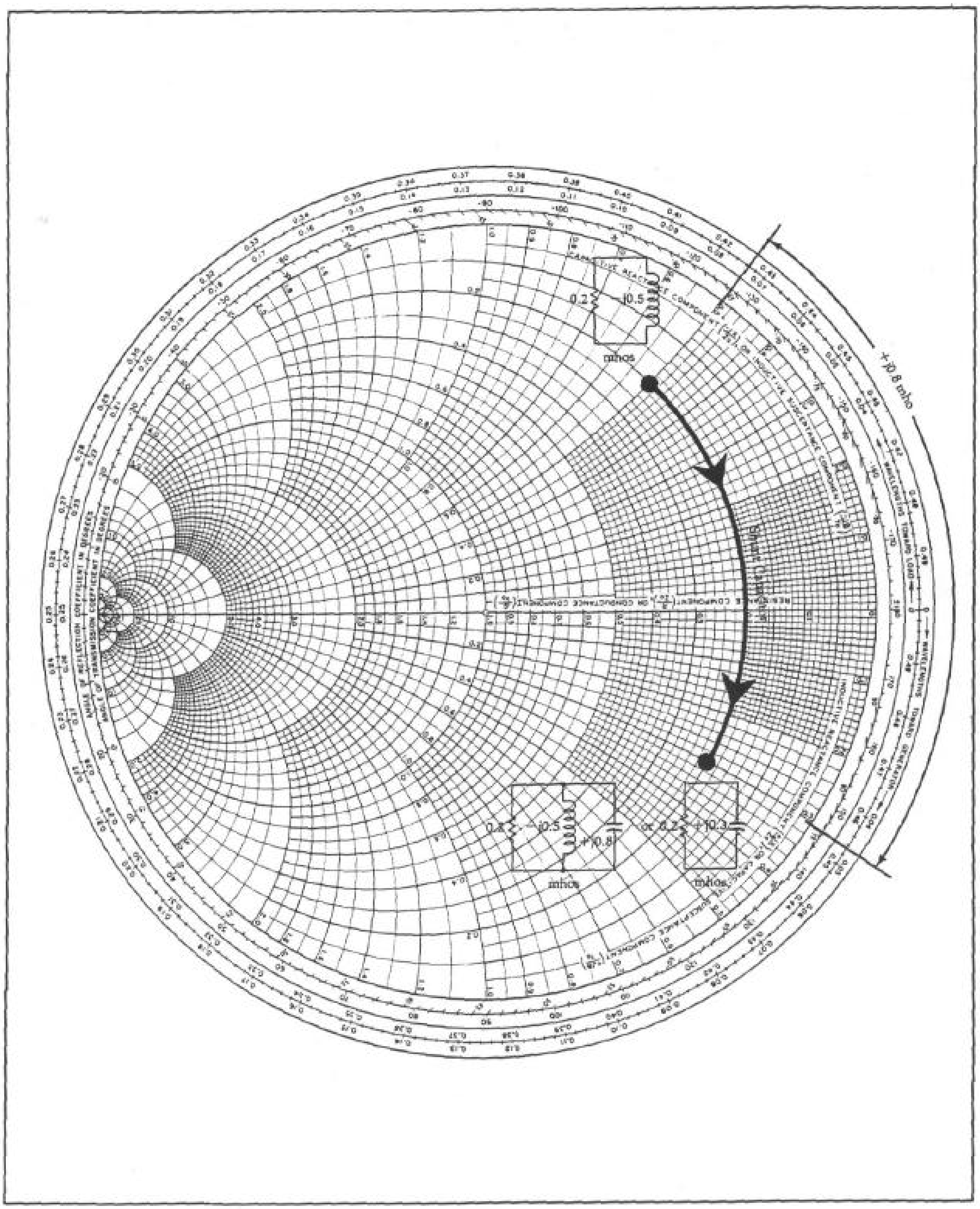

Fig. 4-37. Addition of a shunt capacitor.

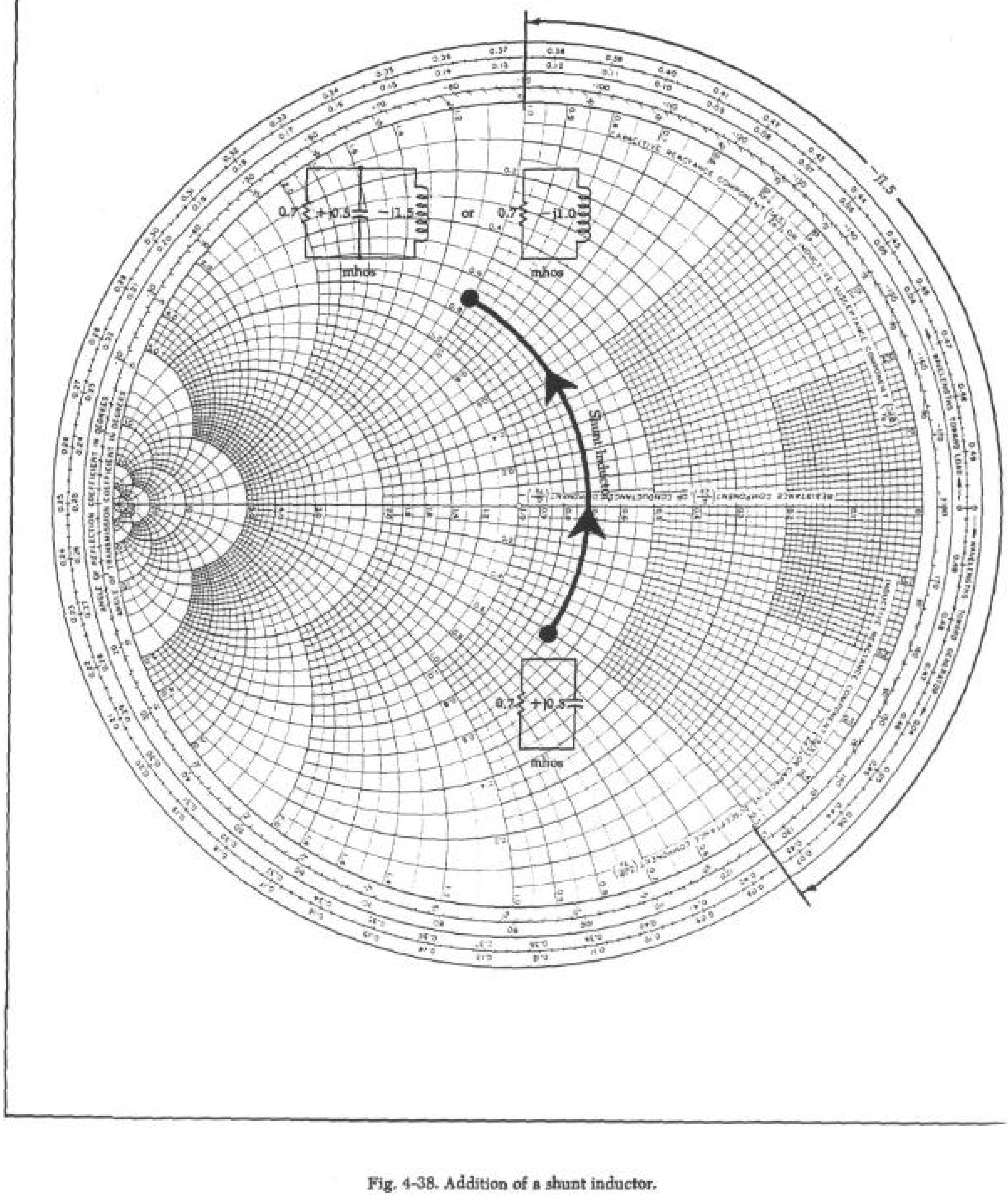

Fig. 4-38. Addition of a shunt inductor.

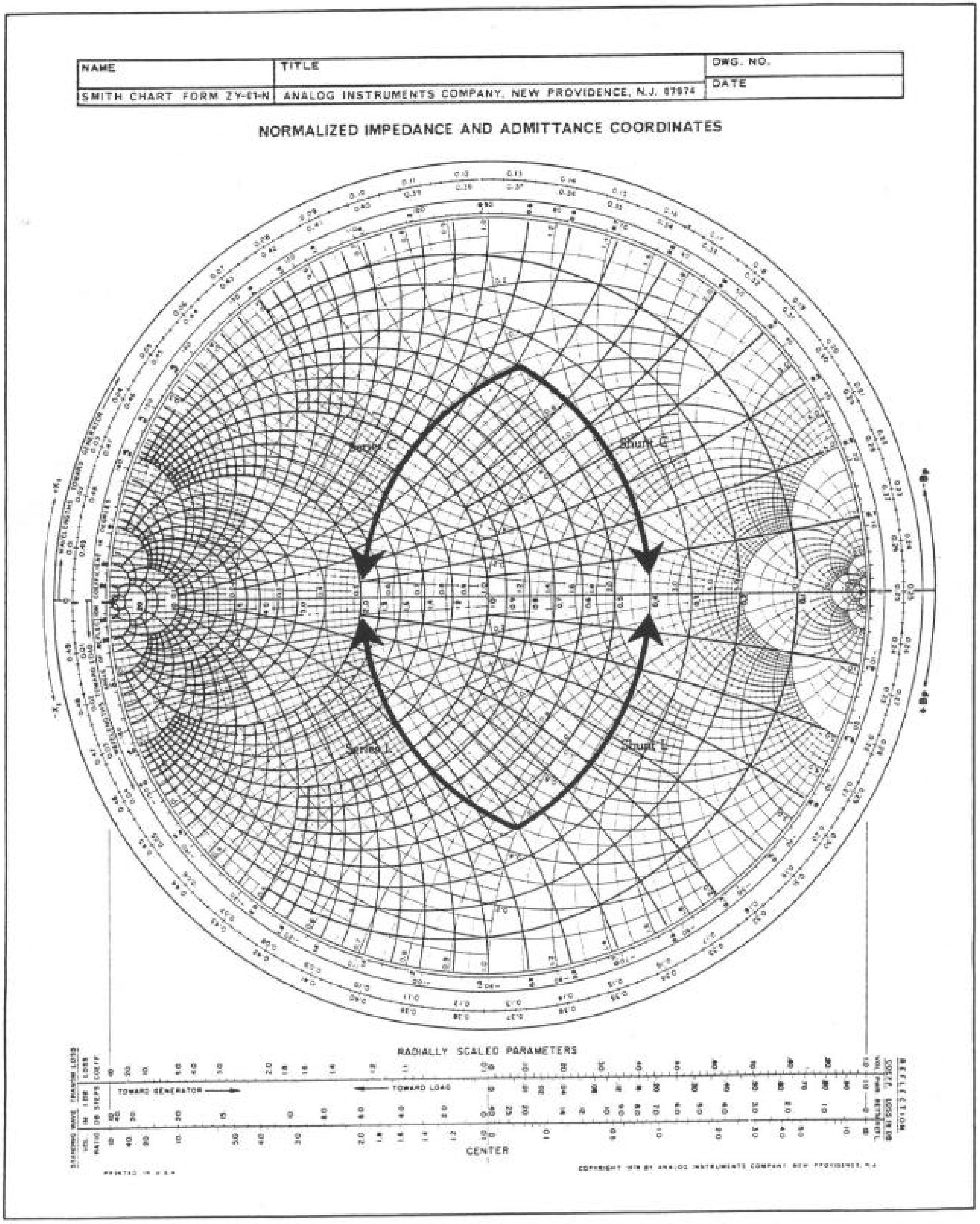

Fig. 4-39. Summary of component addition on a Smith Chart.

B = the susceptance as read from the chart,
N = the number used to normalize the original impedances that are to be matched.

If you use the preceding equations, you will never have to worry about changing susceptances into reactances before unnormalizing the impedances. The equations take care of both operations. The only thing you have to do is read the value of susceptance (for shunt components) or reactance (for series components) directly off of the chart, plug this value into the equation used, and wait for your actual component values to pop out.

Three-Element Matching

In earlier sections of this chapter, you learned that the only real difference between two-element and three-element matching *is* that with three-element matching, you are able to choose the loaded Q for the network. That was easy enough to do in a mathematical-design approach due to the virtual resistance concept. But how can circuit Q be represented on a Smith Chart?

As you have seen before, in earlier chapters, the Q of a series-impedance circuit is simply equal to the ratio of its reactance to its resistance. Thus, any point on a Smith Chart has a Q associated with it. Alternately, if you were to specify a certain Q, you could find an infinite number of points on the chart that could satisfy that Q requirement. For example, the following impedances located on a Smith Chart have a Q of 5:

$$\begin{aligned} R + jX &= 1 \pm j5 \\ &= 0.5 \pm j2.5 \\ &= 0.2 \pm j1 \\ &= 0.1 \pm j0.5 \\ &= 0.05 \pm j0.25 \end{aligned}$$

These values are plotted in Fig. 4-45 and form the arcs shown. Thus, any impedance located on these arcs must have a Q of 5. Similar arcs for other values of Q can be drawn with the arc of infinite Q being located along the perimeter of the chart and the Q = 0 arc (actually a straight line) lying along the pure resistance line located at the center of the chart.

The design of high-Q three-element matching networks on a Smith Chart is approached in much the same manner as in the mathematical methods presented earlier in this chapter. Namely, one branch of the network will determine the loaded Q of the circuit, and it is this branch that will set the characteristics of the rest of the circuit.

The procedure for designing a three-element impedance-matching network for a specified Q is summarized as follows:

1. Plot the constant-Q arcs for the specified Q.
2. Plot the load impedance and the complex conjugate of the source impedance.
3. Determine the end of the network that will be used to establish the loaded Q of the design. For T networks, the end with the *smaller* terminating resistance determines the Q. For Pi networks, the end with the *larger* terminating resistor sets the Q.
4. For T networks:

$$R_s > R_L$$

EXAMPLE 4-6

What is the impedance looking into the network shown in Fig. 4-40? Note that the task has been simplified due to the fact that shunt susceptances are shown rather than shunt reactances.

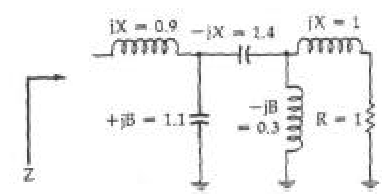

Fig. 4-40. Circuit for Example 4-6.

Solution

This problem is very easily handled on a Smith Chart and not a single calculation needs to be performed. The solution is shown in Fig. 4-42. It is accomplished as follows.

First, break the circuit down into individual branches as shown in Fig. 4-41. Plot the impedance of the series RL branch where Z = 1 + j1 ohm. This is point A in Fig. 4-42. Next, following the rules diagrammed in Fig. 4-39, begin adding each component back into the circuit—one at a time. Thus, the following constructions (Fig. 4-42) should be noted:

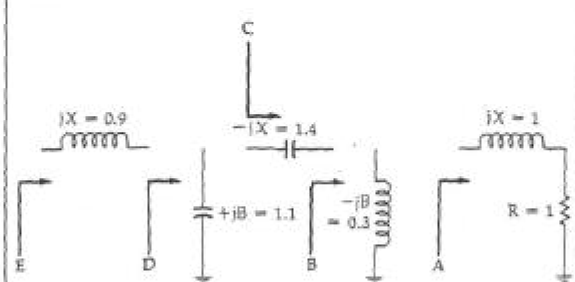

Fig. 4-41. Circuit is broken down into individual branch elements.

Arc AB = shunt L = −jB = 0.3 mho
Arc BC = series C = −jX = 1.4 ohms
Arc CD = shunt C = +jB = 1.1 mhos
Arc DE = series L = +jX = 0.9 ohm

The impedance at point E (Fig. 4-42) can then be read directly off of the chart as Z = 0.2 + j0.3 ohm.

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EXAMPLE 4-6—Cont.

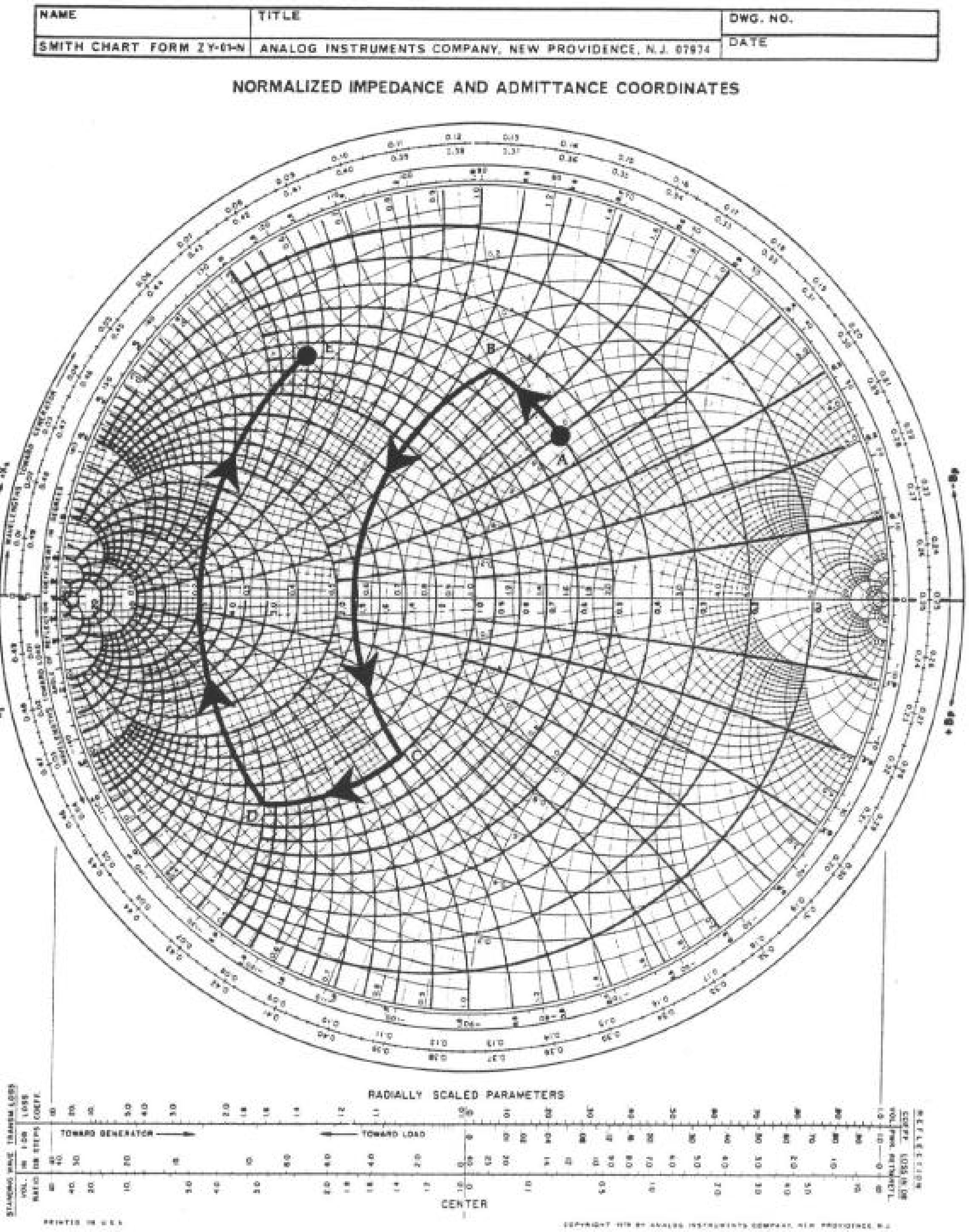

Fig. 4-42. Smith Chart solution for Example 4-6.