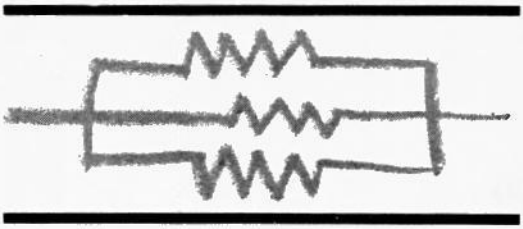
PARALLEL RESISTANCE SHORTCUT



By A. K. QUINN

Simple arithmetic replaces cumbersome calculations for determining needed shunts, finding other values.

AS THE SERVICE shop owner often puts it, "How can I find the value of a blasted resistor which, in parallel with some other blasted resistor, will give me the value of a blasted resistor I need but don't have on hand?" More plainly, suppose you need but don't happen to have a 500-ohm resistor. Nor do you have a pair of 250-ohm units to put in series or a pair at 1000 ohms each to shunt.

Trying to find a series pair from a random collection is not the toughest job in the world, but looking for a parallel pair is another matter. You already know what resistance you want, R_t, but the trouble is that you are looking for two unknowns, R_1 and R_2. From those on hand you pick a likely (you hope) resistor for R_1 and use the parallel resistance formula to derive R_2. But you don't have the latter value in the shop either. Trying several possible combinations in this way with the formula is a messy, time-consuming business. However, there is a short cut, based on simple arithmetic, so easy that you can work out several possible parallel combinations quickly before looking for suitable resistors.

To find the first resistor, R_1, simply multiply desired value R_t by any simple number. To find the matching value of R_2, divide R_1 by a number that is one less than the first number chosen. If you want 500 ohms, for example, multiply that value by, say, 5. This gives 2500 ohms for R_1. Dividing 2500 by 4 now gives you 625 ohms for R_2. A multiplier of 7 and a divisor of 6 gives you another pair, 3500 and 583. Using 4 and 3 yields 2000 and 666. You now have several possibilities before checking your stock.

Tolerances being what they are, converting your answers to the nearest standard values will give little trouble. In the last pairing cited, for example, suppose you shunted a 2000-ohm resistor across a standard, 680-ohm unit. You would theoretically have 507 ohms instead of 500. Is this error of slightly more than 1 per-cent significant in the light of available tolerances and actual requirements? Also, while the use of simple, whole numbers as factors is convenient, you can get as fancy as you like. You might use 7.5 and 6.5 as factors, for example, to get more possible pairs.

So far, so good; but there is still more to the basic technique. Suppose you have such a limited resistor assortment on hand that you can't find a parallel pair, even now, and you have to try it with three units in shunt. Let's say you need 60 ohms. You have multiplied by 7 to give you 420 ohms for R_1 (which you have) but you can't find a matching R_2. You take your second factor (7 minus 1 equals 6) and split it up into any two numbers that add up to it. For example, 4 and 2 make 6. Divide each of these new numbers separately into R_1. The two answers will be the values for R_2 and R_3. In this case, 420/4 gives you 105; and 420/2 gives you 210.

Sure enough, 420 ohms, 105 ohms, and 210 ohms in parallel will come down to 60 ohms exactly. Using standard values, 430, 100, and 220 would provide 59.3, less than 2 per-cent off. This method can be extended for any number of parallel units. If it is not practical to do so, neither should it be necessary.

Finally, a variation of the method works wonders in reverse; that is, when you start out with a number of resistors and wish to determine what they will come to in parallel. It is much simpler than using the reciprocal formula. (Oh, those least common denominators for large numbers!) Assume you want to know what four resistors, whose ohmic values are 540, 270, 180, and 90, will come to in parallel.

First divide each resistor's value into that of the largest one in the group. You quickly find that $540/540=1$, $540/270=2$, $540/180=3$, and $540/90=6$. You add up your four quotients as follows: $1+2+3+6=12$. Now divide the highest value by this sum. This division, $540/12$, gives you an answer of 45 ohms. If you don't think this works, you can test it for yourself by working out a combination in the recommended manner and trying the same set of values with the reciprocal formula. What you accomplish will be more than the confirmation of this method's validity by getting the same answers both ways. You will also find out why this method is easier. ▲