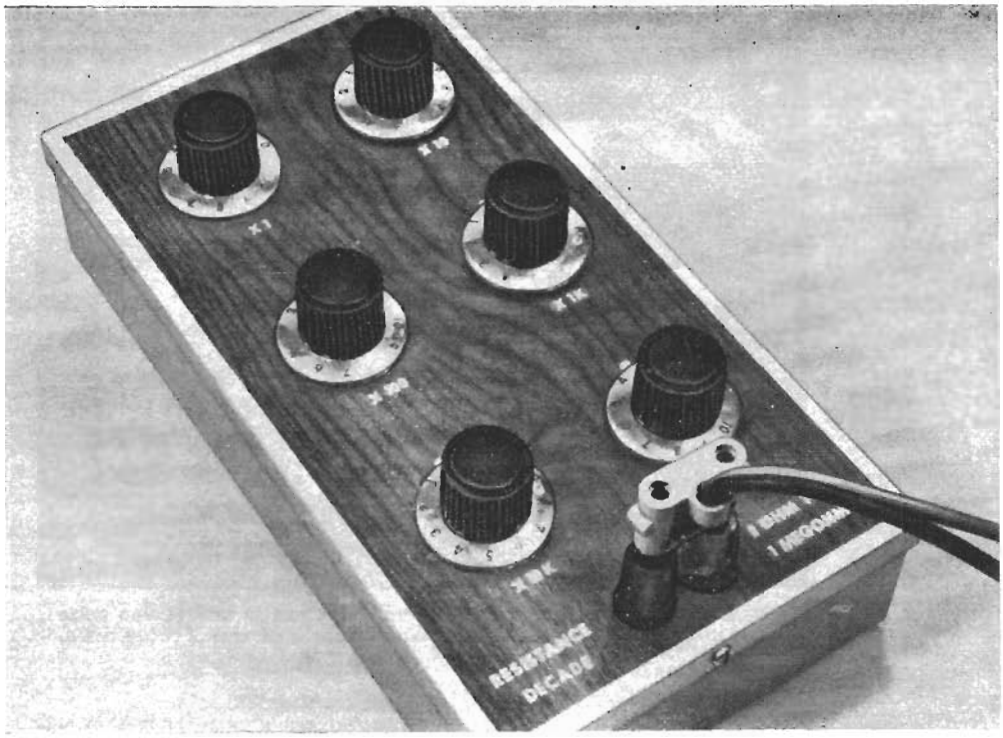


The Different Resistance Decade

Unusual, economical switching arrangement

BY JAMES A. FRED

THERE ARE several different approaches that can be taken to the design of a resistance decade box. One simply switches increasing values of resistors, while others use tricky switching arrangements that add four values of resistance (1,2,3, and 4) to make 10 units per switch.

All of these schemes have their drawbacks —from either a cost, production, or use standpoint. Take the case where four resistors are used to add up to 10. There are bound to be switching irregularities in this process since it is impossible to switch out the one and two units and switch in the four unit at the same time. The total resistance jumps during switching either a value below three or above four. Such a condition may not be important in many cases, but it may cause damage to a highly sensitive galvanometer or a delicate piece of electronic equipment.

Described here is a switching scheme for a resistance decade that solves many of the problems mentioned above and is simple and inexpensive to build. Six identical resistors are used in each decade to provide 10 smooth equal steps. A schematic of one decade switch is shown in Fig. 1. The secret of the scheme is in the values of the resistors and in the switch arrangement. The rotors on the two wafers of the switch are offset by one place to provide smooth operation. The resistors are twice the value that would ordinarily be used for a particular decade. That is, for the ×1 decade the resistors are all 2 ohms; for the ×10 dec-

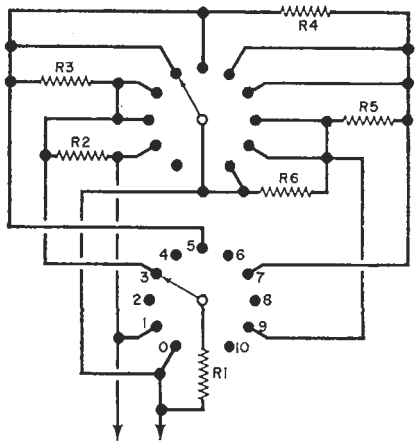
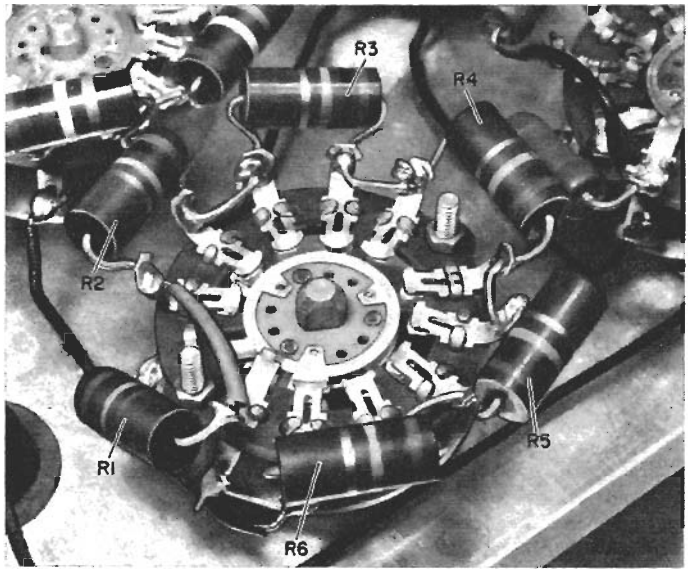


Fig. 1. Any number of decades can be made using this same circuit. Note that the two rotors are displaced one position apart.

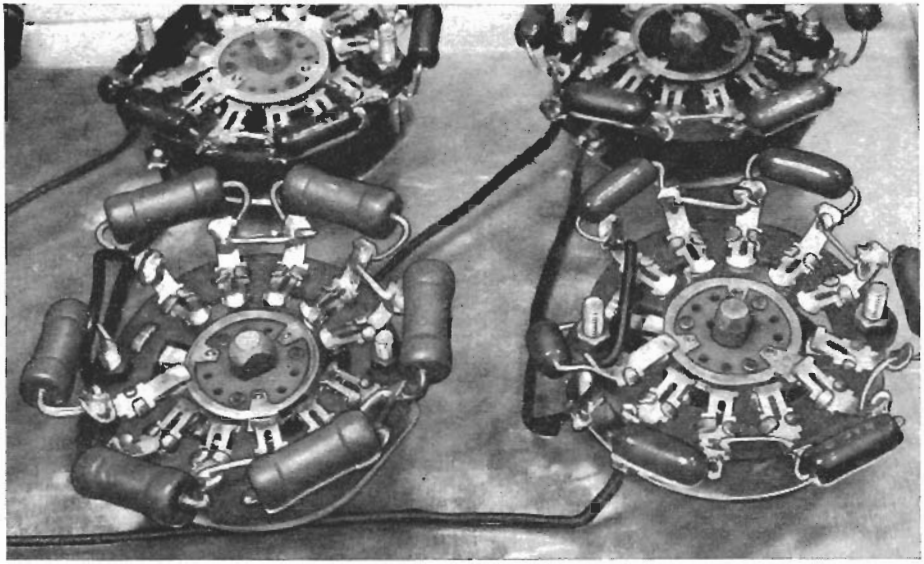
PARTS LIST

For X1 decade:
R1-R6—2-ohm resistor (Mallory 3AE or Ohmite 995-3A)
For X10 decade:
R1-R6—20-ohm resistor (Mallory 3AE or Ohmite 995-3A)
For X100 decade:
R1-R6—200-ohm resistor (Mallory 3AE or Ohmite 995-3A)
For X1K decade:
R1-R6—2000-ohm resistor (Mallory 3AE or Ohmite 995-3A)
For X10K decade:
R1-R6—20,000-ohm resistor (Mallory 2MOL22k or Ohmite 995-5B)
For X100K decade:
R1-R6—200,000-ohm resistor (IRC RC2)
*S1—Two-pole, 12-position rotary switch (one per decade)**
Misc.—Suitable chassis, knobs, five-way binding posts (2), wire, solder, etc.
**Available as JMSW1 from J & M Electronics, Rte 1, Box 28, Cutler, IN 46920 at $3 each, $2.50 each in lots of 6, postpaid. Indiana residents add 2% state sales tax.*

ade, they are 20 ohms; etc. To provide the even values (2, 4, 6, 8, and 10), the resistors are connected in series. To provide the odd values, the sixth resistor "floats" from one position to another so that it is in parallel with one of the other five, thus giving a resistance value equivalent to 1. Several factors must be taken into consideration when planning the decade box. First, the wattage of the resistors must be decided. This, of course, depends on where you are going to use the instrument. Then, the overall range of resistance must be determined. Six switches will produce resistance values in one-ohm steps



Typical switch showing how the associated resistors are mounted directly to the contacts. Make sure that each resistor is isolated from each of the others and from the chassis to insure against accidental shorts.



When building up several decades, use resistors having the same tolerance and wattage. Certain terminals on two wafers of each switch are stapled together. Note decade interconnections.

from one ohm to one megohm. Eight switches will allow coverage from 0.1 ohm to 10 megohms.

The accuracy of the decade box must also be considered. Low-tolerance resistors cost more than higher tolerance types. However, 5% tolerance should prove adequate for general work.

Construction. The six-switch decade box shown in the photographs was constructed in a 5″ × 9½″ × 2″ aluminum chassis having a removable top. The chassis size is not important as long as it can comfortably support the selected number of switches and the output five-way binding posts. Construction and operation will be greatly improved by the use of the special switch specified in the Parts List. This switch has its two sections staggered as required and has the proper terminals on each wafer stapled together to make the necessary electrical contact.

Wire the switches as shown in Fig. 1. Test each switch after completion with an ohmmeter. Connect the switch outputs in series. Make sure that resistors are not touching each other or the chassis. If high-wattage resistors are used, it is advisable to make several ventilation holes in the chassis. Mark the switch positions and the multiplication factor with press-on type. Once complete, use an ohmmeter to check the overall operation of the box.

To use, connect the decade box binding posts to the required external circuit and position the switches to obtain the total value of resistance required. The zero position of each switch forms a short across that switch, thus effectively removing it from the circuit.

—30—