Resistance Decade Box

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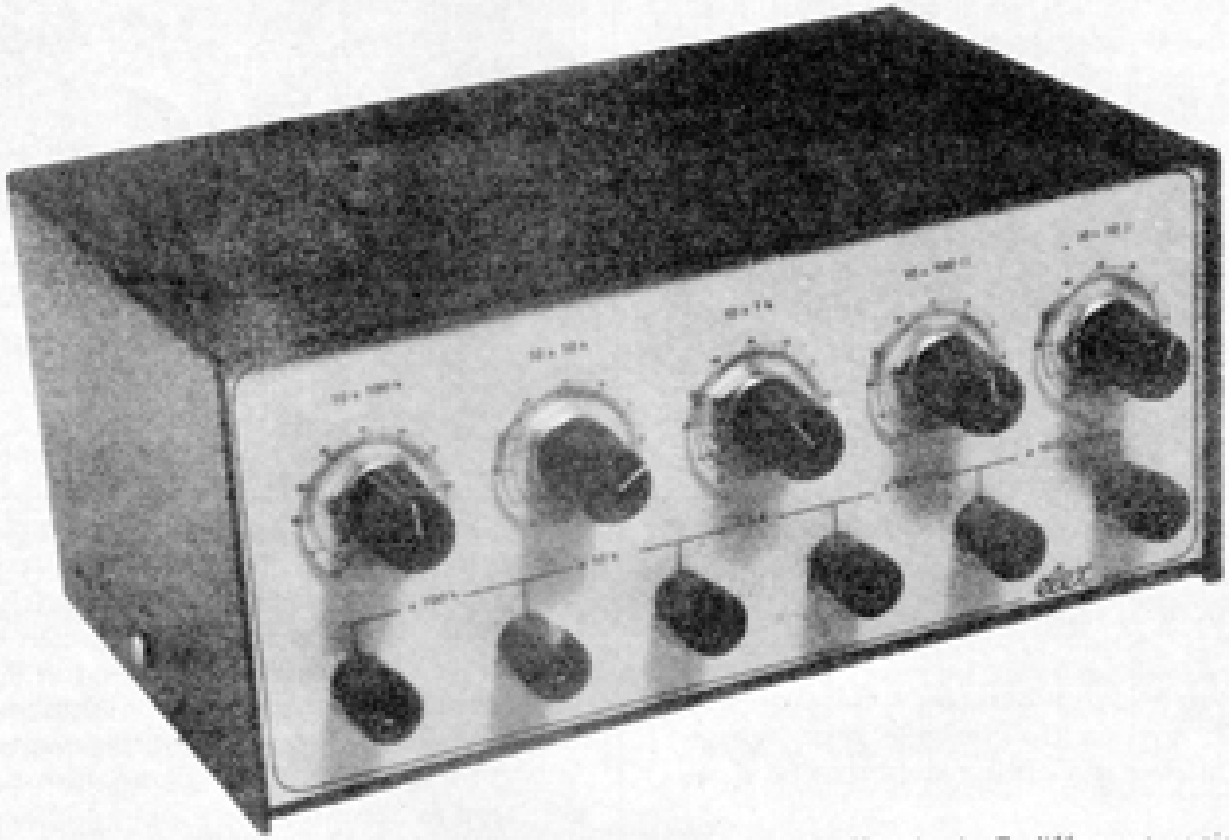

Even though the resistance decade is not a very sophiticated circuit, it has very great practical utility. The resistance decade box can be used for experiments, testing, bridge balanceing, voltage dividing and many other priactical applications. The values available being adjustable from 10Ω to more than 1MΩ.

The circuit is shown in figure 2. This is a selectable series connection of total 50 resistors, Individual resistors are added in to the series combination by selecting the switch positions. Each switch selects the number of resistors from a group of 10 resistors from a group of 10 resistors of equal value. The total resistance of equal value. The total resistance comprise of effectively 5 different resistance values selected by the 5 switches, as shown in figure 3. The individual values of resistors used in each group are selected in such a way that each switch represent a decimal place in the final effective combination of the five groups.

The series combination of five groups R1 ..... R5, added up to make the total resistance Rg = R1 + R2 + R3 + R4 + R5, lies between the external sockets A and F of the decade box. It is not essential that sockets A & F must be used as the two ends of the effective resistance from the decade box. Any pair of

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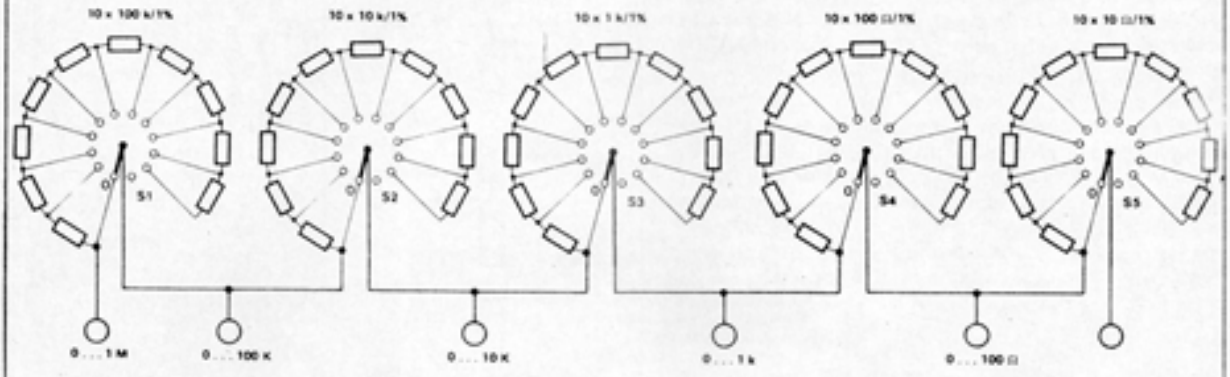

sockets can be used for this purpose, depending on the required resistance value, as shown below :

R (A-C) = R1 + R2
R (B-D) = R2+R3
R (C-F)= R3+R4+R5

As the 5 groups of resistors covered by the 5 switches have 10 resistors of equal values each - the switch position multiplied by the individual resistor value gives the effective values of R1 ..... R5.

For example, switch 1 controls a group of 10 resistors of 100KΩ each. Thus the switch 1 set to position 3 will give a value of 300KΩ for R1. Switch 1 set to positions 0 to 10 will give values of 0 to 1MΩ is steps of 100 K ∩ each.

The individual values within each group are selected as multiples of 10. Group 1 has 10 resistors of 100KΩ each, group 2 has 10 resistors of 10KΩ each and so on, group 5 has 10 resistors of 10Ω each.

Advantage of this selection of values is that each switch represents one decimal place.

Every switch is connected with an external socket, so that any of the 5 groups can be used to make up the required value of resistance. Using all five decimal places may turn out to be ineffective due to the individual tolerance vlaues of resistors. For instance, let us examine a setting of switches in the sequence 51381 (513810Ω). As we have used resistors with 1% tolerance, the error on the 1st switch itself can build up to 5Ω (1% of 500kΩ) thus making the setting of 4th and 5th switches superfluous. In spite of this drawback, the decade box is provided with five switches, so that the full range of vlaues is available to the user.

Construction Details :

The construction of resistance decade box mainly consists of soldering work and mechanical fitting work. The 50 individual resistors must be soldered onto the lugs of the 5 different switches as shown in figure 6. The final fitting into a standard enclosure is simple, as shown in figure 4.

1% Metal Film Resistors must be used if a good accuracy is to be achieved. Even 5% Carbon Film Resistors will work equally well if the accuracy aspect is neglected.

Applications :

This resistance decade box can be used as an adjustable resistor, or as a voltage divider.

When using this as a adjustable resitance, only 3 digits (switches) can be used at a time due to the accuracny consideration we have already seen. The remaining two switches can either be set to zero or

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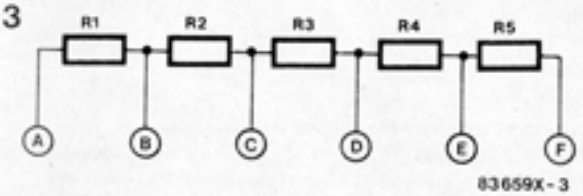

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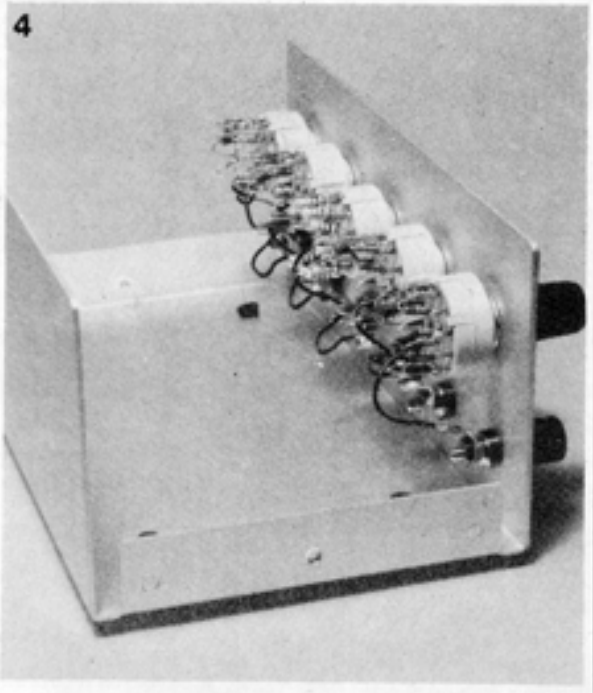

we can use only the sockets relating to the switches of interest.

When using the circuit as a voltage divider, any one of the sockets B, C, D, E can be used as the output socket for the divided voltage and the switches can be set to suitable positions to achieve the desired voltage division.

A more useful application of this circuit is as a decimal voltage divider. For this the switch settings must be in the sequence 9, 9, 9, 9, 10 on the five switches from left to right. The effective distribution of resistors is as shown in figure 5. By conecting a voltage V across sockets A and F we are able to get the following voltage outputs on the sockets :

A = V
B = V/10
C = V/100
D = V/1000
E = V/10000
F = 0

This has been achieved by the fact that the resistance between the pairs of sockets are distributed as follows.

R (A-F) = 1 MΩ = Rg
R (B-F) = 100 KΩ = Rg/10
R (C-F) = 10 KΩ = Rg/100
R (D-F) = 1 KΩ = Rg/1000
R (E-F) = 100 Ω = Rg/10000

Using this circuit it is possible to obtain very small voltages. For instance, a 4.5V battery connected across sockets A and F will give a voltage of 450 micro volts at socket E.

Figure 1 :

A good sturdy sheet metal enclosure gives a professional appearance to the decade box. The front panel graphics has been designed for ease of understanding the operation.

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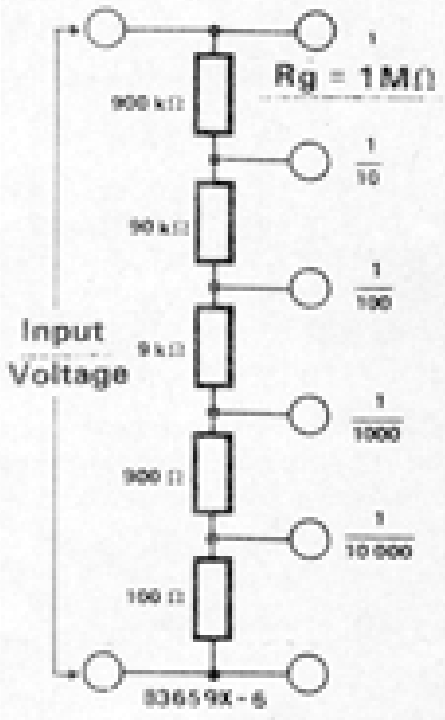

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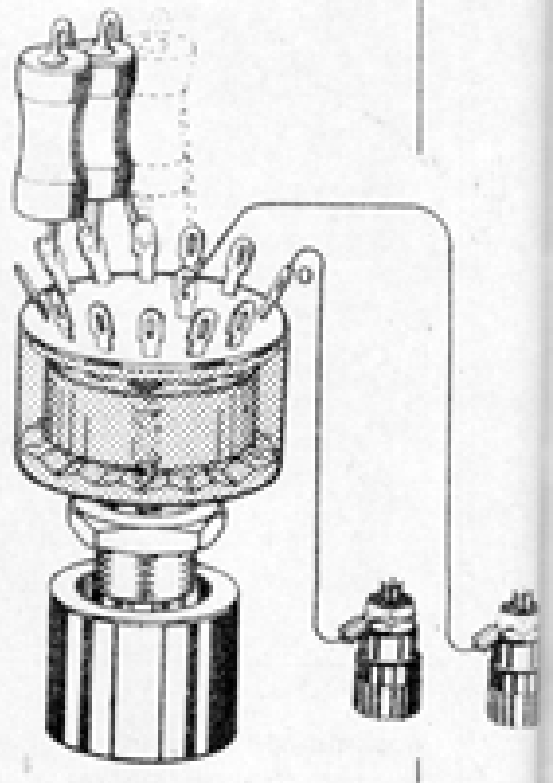

Figure 2 :

The resistance decade contains 50 resistors. They are divided into 5 groups. Each group has one selector switch for selecting the individual digit value of that decimal place.

Figure 3 :

The effective combination of the resistances. R1, R2 ..... R5 are selected by the switch positions. A,B,C ..... F are the sockets on the front panel.

Figure 4 :

Inside view of the assembled decade box. The switches are mounted on front panel.

Figure 5 :

Use of the resistance decade box as a decimal voltage divider. Voltage divisions available are from 1/10 to 1/1000