ADDITIONAL INSTRUCTIONS

For using the "Simplon" Electro Slide Rule (SE10).

1. **THE EFFICIENCY SCALE.**
The upper of the two electrical scales—at bottom of channel—marked DYNAMO is for finding the efficiency of dynamos and electric motors, and for ascertaining the Kilowatt output, or the effective horse power with a stated efficiency.
2. These calculations may be obtained with a single setting of the slide. Note the two special marks 746 on scales "A" and "B." The scale itself performs the division by 746. (See Paragraph 8.)

3. **THE VOLTAGE LOSS SCALE.**
By means of the lower scale (marked volt), the loss of potential in an electric circuit may be calculated by the automatic application of the common mathematical formula comprising the quantities: Strength of current, length of lead in yards, and cross section of lead in circular mils.
Thus— Where I = current in amperes.

$$E = \frac{I \times L}{C \times a}$$

L = Total Length of conductor in yards.
C = 0·0327 mho. conductivity of copper (mil yard) at 60°F.
a = Area of cross section of conductor in circular mils.

4. It matters not which of the four factors (excluding "C" which is a constant) specified is the unknown quantity. The scales are applicable to direct current calculations or to inductionless alternating current circuits. (See paragraph 17).
5. For brevity in practice, the Dynamo efficiency scale is referred to as the D.E. Scale when working the examples, and the motor efficiency scale as the M.E. scale.
6. The divisions to the left of the 100 mark (inclusive) comprise the D.E. scale and the divisions to the right of the 100 mark (inclusive) comprise the M.E. scale.
7. The voltage loss scale will be referred to as the V.L. scale. The capitals, K.W. at the extreme right end of the normal scale "A" stand for Kilowatts, and the letters H.P. on scale "B" signify horse power.
8. The D.E. scale is placed so that when the index 1 (B) of the slide is set to the constant 746 on scale "A" (using the cursor line to locate 1 (B) in alignment with the 746 watts mark) the indicator edge of the left end of the slide registers 100 (%) on the **D.E. Scale.**
9. The special mark 10 amp. on scale "A" indicates that index 1 (A) must be read as 10 amperes, and the special marks 10 yd. and 10,000 Circ. mils on scale "B" mean that the index 1 (B) must be read as 10 yards and also as 10,000 circular mils when using the V.L. scale.
10. The current therefore is read on scale "A" and the length of lead and cross section are taken on scale "B," the loss of potential finally being read on the V.L. scale in the channel.
11. **Example 1.** Find the efficiency of a dynamo with an output of 20·5 K.W. from a 32 H.P. engine. Set 32 on the H.P. scale against 20·5 on the K.W. scale, and read the answer 86·3% efficiency against the indicator edge of the slide on D.E. Scale.
12. **Example 2.** Calculate the K.W. output which can be obtained with 50 H.P. from a dynamo of 87% efficiency. Set the indicator edge of the slide to 87% on the D.E. scale, and over 50 on the H.P. scale (place the cursor line on 5 scale "B") and read the answer 32·45 on the K.W. scale.
13. If the result in this or any other similar problem is not sufficiently satisfactory to meet the case, the electrical output required of the dynamo can be determined by reference to the table which the rule setting now supplies, since for every additional H.P. transmitted to the dynamo shaft, the proportional increase in K.W. output can be immediately read off.

THE MOTOR EFFICIENCY SCALE.

14. **Example 3.** Determine the efficiency of a motor from which with 19 K.W. input is delivering 22 H.P. Set 22 on the H.P. scale directly under 19 on the K.W. scale, carefully observing that the indicator end of the slide really does register within the limits of the motor scale. (See Paragraph 6.) The answer is 86·4%.
15. **Rule.** Set the two numbers which indicate the K.W. and H.P. respectively directly against each other, and read the efficiency against the indicator on the Motor Scale.
16. **Example 4.** What power is derived from an 85% efficiency motor with 460 volts and 15 amperes (*i.e.* 6·9 K.W.). Set the indicator end of the slide to 85% on the M.E. scale, move the cursor line over 6·9 on the K.W. scale and immediately below read the answer 7·86 H.P. on the slide.
17. **The Voltage loss scale.** The loss of potential or pressure drop in a simple copper lead with D.C. (or with A.C. of unity power factor) is determined by the formula as stated above (see paragraph 3) and the V.L. scale indicates directly the pressure drop from 0·05 to 10 volts and by means of the scale the current and total length—in yards—of the conductor are multiplied together on the "A" and "B" scales. The cross sectional area of the lead on "B" is set to the product of I x L on scale "A" and the number which then appears against the indicator end of the slide defines the required loss in Volts. The V.L. scale graduations are so arranged that division by the constant "C" is unnecessary.

18. To find the cross section in circular mils it is only necessary to square the diameter in mils *i.e.* thousandths of an inch.

19. **Example 5.** Find the voltage drop across the terminals of a copper conductor 600 yards long and 45,000 circular mils in area when the current is 15 amperes. **Process**—Set index 1 (B) to 15 on "A"—the left-hand index of scale "A" being taken as 10 amps.—then run the cursor along so that the line is over 600 on "B" (the left-hand index of "B" being taken as 10 yards) in which case 600 yards will be represented by the graduation marked 60, bring 45,000 (circ. mils) on the left-hand "B" scale under the cursor line and the answer, 6·12 volts, will be indicated at the end of the slide on the V.L. scale. (See paragraph 31.)

20. The adjustments of the decimal points, both before and after working out the calculations, are conveniently effected mentally. (See paragraph 31).

21. **Example 6.** Find the voltage drop in a 4,600 yards Tramway trolley wire which has a sectional area of 100,000 circular mils. The current being 27 amperes. The answer is 38 volts.

22. Should the pressure drop obtained be too high, set the indicator end of slide to the permissible drop, without shifting the cursor, and read the required sectional area of the conductor under the cursor line.

23. For instance, were the potential difference to be limited to 30 volts in the last case, set the indicator end of slide to 30 volts (3·0) on the V.L. scale and read 126,500 circular mils on "B" under the cursor line. This is the sectional area of a wire that will carry 27 amperes with a loss of 30 volts. The square root of 126,500 gives the required diameter 356 mils or 0·356 inch.

24. If the indicator be set to the permissible voltage drop (say 30 volts) on the V.L. scale and the cursor line be put over the given sectional area of conductor (126,500 circ. mils) on "B" then if 1 on "B" be brought to any selected current on "A," under the cursor line will be found the corresponding conductor length. Or if any conductor length be brought under the cursor line, the corresponding current will be found on "A" over the left-hand index of "B." This may be more conveniently arranged in the form of a table. When the slide is reversed so that 1 on "B" is under the cursor line; then the conductor lengths and corresponding currents coincide on "B" and "A."
Examples for practice:—45 amps. and 2,760 yds. 22 amps. and 5,650 yds.
55 amps. and 2,260 yds. 24 amps. and 5,170 yds.

25. Instructions for use of the marks on **Scale "D"**—W. (for weight) and R. (for electrical resistance at 60°F.) of copper wires. Set the length of a conductor on the scale "B" above the mark W. and you will find above the diameter of the wire on the scale "D" the weight of the conductor on the scale "B."

Example 7. Set the length, 2,450 yards, on "B" over the mark W. and read the weight, 15·05 lbs. on "B" over the diameter 0·026 inch (26 mils) on scale "D."

Example 8. Set the length, 2,450 yards on "B" over the diameter, 0·026 inch (26 mils) on "D" and read the resistance 111·8 ohms, over the mark "R" on "B" (corresponds to the B.E.S.A. standard for annealed copper).

26. **The three line cursor (cursor for two unequal constants).** The cursor lines are so spaced that when the line to right of the centre line is placed over 100 (A scale) the centre line is on the special mark defining 7854 (A scale) and these two cursor lines—used together—are for simplifying the process of finding the area of a circle and the volume of a cylinder.

27. **Example 9.** Find the volume of a cylinder 1·36 inch in diameter and 6·5 inches long. Set the R.H. Cursor line to 1·36 (diameter of cylinder) on scale "D," then above it on scale "A" read the square of this diameter, and under the middle cursor line on scale "A" the quotient $\frac{1{\cdot}849}{1{\cdot}273}$ the cross section of the cylinder = 1·452 square inches. The figure 1·273 is obtained by dividing 1 by ·7854.

28. Then to complete the calculation, set 1 (B) to middle cursor line, move the cursor line over 6·5 (the length of the cylinder) on "B" and under the same line on "A" read the answer 9·47 Cubic inches.

29. The line to the left on the cursor is so spaced with respect to the middle line that Watts are changed into H.P. and H.P. into Watts at one setting; when the middle line of cursor is set over 10 (1 K.W.) scale "A" the line to the left is on the special mark defining 746 Watts=one H.P.

30. **Example 10.** How many Watts are 25 H.P.? Set the middle cursor line over 25 on scale "A" and under the left cursor line will be found 18,650 Watts on scale "A."

31. The V.L. scale gives answers with the decimal point correctly placed so long as the current, length, and sectional area of the lead are of such size that the left-hand indices can be taken as 10 amps. 10 yards and 10,000 circular mils. When however one or more of the quantities is outside these limits, the decimal points may be moved. For instance to find the voltage required for a current of 4·5 amperes, flowing through 2,500 yards of copper wire, which is 0·041 inches in diameter: take 45 amperes, 250 yards and 168,100 circular mils instead of 1,681. The equation is as follows:—

$$e = \frac{45 \times 10^{-1} \times 250 \times 10}{C \times 168{,}100 \times 10^{-2}} = \frac{45 \times 250}{C \times 168{,}100} \times 100$$

Set 1 (B) to 45 amperes on "A," move the cursor line over 250 yards on "B," bring 168,100 circ. mils on "B" under the cursor line and read 2·05 volts against the indicator end of the slide. This must be multiplied by 100 and the answer is therefore 205 volts.