

K & E
ROYLANCE ELECTRICAL SLIDE RULE

No. 4133

A SUPPLEMENTARY MANUAL

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PRINTED IN U.S.A.

PUBLISHED BY
KEUFFEL & ESSER CO.
NEW YORK, 127 Fulton Street, General Office and Factories, HOBOKEN, N. J.

CHICAGO 516-20 S. Dearborn St.	ST. LOUIS 817 Locust St.	DETROIT Concorde, Gen'l. Motors Bldg.
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Drawing Materials, Mathematical and Surveying Instruments, Measuring Tapes.

K & E

Reg. U. S. Pat. Offr.

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A Supplementary Manual

NOTE: This booklet explains only the application of the special scales and gauge marks to problems in the electrical field. It is a supplement to the instructions covering the Poly-phase Slide Rule No. 4053. Be sure that you receive the manual for 4053, which explains the general use of this slide rule.

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The *Roylance Electrical Slide Rule* consists of the standard Polyphase Slide Rule, with the addition of several special scales; hence, the manual furnished with it is that covering the Polyphase Rule, which completely explains the operation of all the scales of the Polyphase Slide Rule.

This supplementary manual covers only the proper methods of operating the special features of this rule.

ELECTRICAL SCALES

The B scale is graduated fully, as in all Polyphase rules, but that portion of it between 9.6 and 20 also serves as a *temperature scale* in figuring *resistance* of copper wire. The red numbers on the scale indicate degrees Centigrade. Between 0 and 10 degrees the temperature scale is subdivided to 2.5 degrees; the remainder of the temperature scale being subdivided to 5 degrees. It is possible to estimate to 1 degree, should this prove necessary.

Near the right-hand 3 on the A scale is an extra graduation marked W. This is the constant .003027 employed in calculating *weight in pounds per 1000 ft.* of bare copper wire.

On the C and D scales the extra division 746 has been inserted, and numbered in red on the C scale. This is used in converting *Horse Power* into *Kilowatts*, and *vice versa*.

On the square edge of the rule is a scale of gauge points. The numbers marked at these points stand for B. & S. standard wire gauge. Forty-four different wire sizes are shown ranging from size No. 0000 to size No. 40. They form the basis of the special electrical calculations made on this slide rule.

On the body of the rule under the slide is a scale of values which relates to the scale on the square edge of the rule. It gives the *allowable current-carrying capacities of conductors in amperes*, based on room temperature of 30° C. or 86° F.

Two groups of values are given, the upper three rows labeled "WIRE" are for solid wire while the lower three rows labeled "ROPE" are for wire ropes or cables whose effective area in circular mils is 100,000 times the gauge of wire designated at the corresponding mark on the square edge of the rule.

The first and fourth rows "RW, R" are for moisture resistant and code conductors.

The second and fifth rows "RU, RPT, RP" are for RU (90% un-milled grainless rubber), small diameter building wire and performance conductors.

The third and sixth rows "SB, W" are for slow burning and weatherproof conductors.

This scale of carrying capacities is based on the standard adopted by the American Institute of Electrical Engineers, as given in the National Electrical Code 1940, National Board of Fire Underwriters, and refers to copper wire of 98% conductivity.

OPERATION

Special Scales

With one setting of the slide and indicator, it is possible to read directly for any size of copper wire, the diameter in mils, area in circular mils, area in square inches, weight in pounds of 1,000 ft. of bare wire, and the resistance in ohms per 1,000 ft. at any temperature in degrees Centigrade. After these values are read the slide may be moved clear of the indicator, and the carrying capacity of the wire may be read directly under the middle hairline of the indicator.

EXAMPLES: Find the diameter in mils, area in circular mils, area in square inches, weight in pounds per 1,000 ft. of bare wire, resistance in ohms at 35 degrees and 20 degrees Centi-

grade, of No. 14 B. & S. standard gauge wire.

Refer to the illustration at the left.

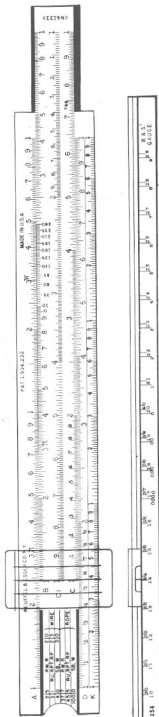
To the graduation marked 14 on the square edge of the rule, set the hair-line on the edge of the indicator. To the middle hair-line on the glass face of the indicator, set the left-hand I on C.

- To find the diameter in mils: Over the right-hand I of scale D, read 64.1 mils diameter on scale C.

Note: If it is considered that scale C is graduated to read from 1 to 10, the correct placing of the decimal point is obtained as follows: For Nos. 0000 to 10, multiply the reading on C by 100; from 11 to 30, multiply by 10; while for Nos. 31 to 40 the reading on scale C is the actual diameter in mils. For No. 10 wire the reading on C is made opposite the left-hand I on D.

- To find the area in circular mils: Under the right-hand I of scale A, read 4110 circular mils on scale B.

Note: If it is considered that scales A and B are graduated from 1 to 100, the correct placing of the decimal point is obtained as follows: For Nos. 0000 to 10, multiply the reading on B by 10,000; for 11 to 30, multiply by 100; while for Nos. 31 to 40 the read-



A

ing on scale B is the actual area in circular mils.

3. To find the area in square inches: Under the gauge mark .7854 on scale A, read .003225 square inches area on scale B.

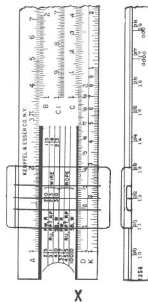
Note: If it is considered that scales A and B are graduated from 1 to 100, the correct placing of the decimal point is obtained as follows: For Nos. 0000 to 9, divide the reading on B by 100; for 10 to 30, divide by 10,000; and for Nos. 31 to 40, divide by 1,000,000.

4. To find the weight of 1,000 feet of bare wire: Under gauge mark W = 0.003027 on scale A, read 12.43 lbs. per 1,000 ft. on scale B.

Note: If it is considered that scales A and B are graduated from 1 to 100, the correct placing of the decimal point is obtained as follows: For Nos. 0000 to 4, multiply the reading on B by 100; for Nos. 5 to 24, use the scale reading; and for Nos. 25 to 40, divide the reading on B by 100. For Nos. 5 to 9, and Nos. 25 to 29, the right hand I of the slide must be brought to the middle hair-line of the indicator.

5. To find the resistance of 1,000 ft. of No. 14 wire at 35 degrees Centigrade: Over 35° on the temperature scale (on B), read 2.675 ohms on scale A.
6. To find the resistance of 1,000 ft. of No. 14 wire at 20 degrees Centigrade: Over 20° on the temperature scale (on B), read 2.53 ohms on scale A.

Note: If it is considered that scales A and B are graduated from 1 to 100, the correct placing of the decimal point is obtained as follows: For No. 40, multiply the reading on A by 1,000; for Nos. 20 to 39, multiply by 10; for Nos. 0 to 19, divide the scale reading by 10, and for Nos. 0000 to 00, divide the scale reading by 1,000. For some wires the left-hand I of the slide must be set at the middle hair-line of the indicator for some temperatures, and the right-hand I for other temperatures. The correct placing of the decimal point can be determined by considering the resistance, found as above



described, for wires of higher and lower gauges. In general, the left-hand I of B is set for Nos. 0000 to 00, for Nos. 10 to 19, and for Nos. 30 to 39. In general, the right-hand I of B is set for Nos. 0 to 9, for Nos. 20 to 29, and for No. 40.

EXAMPLE: A field coil containing 1,000 ft. of No. 16 B. & S. magnet wire shows a resistance of 4.10 ohms. What is the temperature?

To 16 on the square edge of the rule set the indicator. To the middle hair-line of the indicator, bring the left-hand I of C. Under 41 on A, read 25° on B.

EXAMPLE: Find the carrying capacity in amperes of a No. 12 wire.

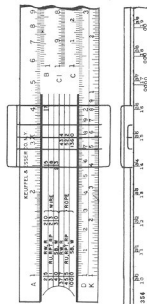
Refer to illustration "X" at the left.

To gauge point 12 on the square edge of the rule, set the indicator. Move the slide clear of the indicator. In the recess behind the slide, under the middle hairline of the indicator, read 20 amperes (1st row) for code wire; and 23 amperes (2nd row) for performance wire.

EXAMPLE: Find the carrying capacity in amperes for a cable of a total effective cross-section of 1,500,000 circular mils.

Refer to illustration "Y" at right.

To the gauge point on the square edge of the rule representing 1,500,000 circular mils set the indicator.



This is $\frac{1,500,000}{100,000}$ or 15. Move the slide clear of the indicator. In the recess behind the slide, under the middle hair-line of the indicator, read 434 amperes (4th row) for moisture resistant cable, and 1360 amperes (6th row) for weather-proof cable.

EXAMPLE: Find the carrying capacity in amperes of a cable with a total effective area of 800,000 circular mils.

$\frac{800,000}{100,000} = 8$. To 8 on the square edge of rule, set indicator. Move the slide clear of the indicator. In the recess behind the slide read 340 amperes (4th row) for moisture resistant cable, and 840 amperes (5th row) for weather-proof cable.

HORSE POWER AND KILOWATTS

The scale C is provided with a special graduation at point 746, through the use of which horse-power can be converted into kilowatts and *vice versa*. To operate:

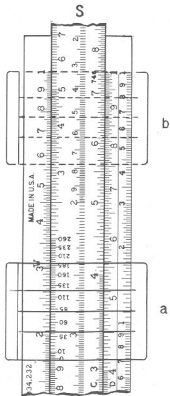
To 1 on D set gauge 746 on C. Then opposite any horse-power read on D will be found the equivalent number of kilowatts read on C; or, below any number of kilowatts read on C will be found the equivalent number of horse-power read on D.

EXAMPLE: Find in K.W. the equivalent of 48 horse-power.

Refer to illustration "S" at right.

To right-hand 1 of D set gauge point 746 on C. Over 48 on scale D, read 35.8 on scale C.

The indicator (position a) shows where the answer is read. See illustration "S".

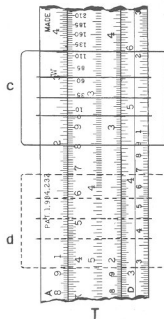


EXAMPLE: Find in H.P. the equivalent of 65 K.W.

To right-hand 1 of D set gauge point 746 on C.

Below 65 on C, read 87.2 on scale D.

The indicator (position b) shows where the answer is read. See illustration "S".



AREAS OF CIRCLES

If the right-hand hair line on the indicator is set to the diameter of any circle on the D scale, the area of the circle may be read directly on the A scale under the left-hand hair line.

EXAMPLE: Find the area of a circle whose diameter is $5\frac{1}{2}$ inches.

Refer to illustration "T" at left-- (position c).

To 5.5 on D set the right hair line of indicator.

Under left hair line of indicator read 23.75 square inches on scale A.

EXAMPLE: Find the diameter of a circle whose area is 11.2 square inches.

Refer to illustration "T" at left - (position d).

To 11.2 on A set the left hair line of indicator.

Under right hair line of indicator, read 3.78 inches on scale D.