

# PATENT SPECIFICATION



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## COMPLETE SPECIFICATION.

### Improvements relating to Logarithmic Calculating-apparatus.

I, PHILIP RAY COURSEY, a British subject, of Stamford House, Marchmont Road, Richmond, Surrey, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to calculating apparatus of the so-called "slide rule" type designed to facilitate numerical computations to a certain mathematical formula. The object of the invention is to provide a simple calculating apparatus to perform the desired functions and that shall be easy to operate and will avoid the necessity of reference to numerical tables etc.

In calculations relating to the design and use of certain electrical circuits, particularly those carrying high-frequency alternating currents, and containing an electrical condenser as part of the circuit, it is frequently desirable to be able to determine quickly the voltage across the condenser when the current flowing through it is known, and vice versa.

Particularly in radio frequency circuits it is comparatively easy to measure the current flowing through the condenser by means of an appropriate ammeter, and also to measure the frequency or wavelength. It is usually difficult however, to measure the voltage across the condenser terminals, but yet a knowledge of this voltage is very desirable from the point of view particularly of providing adequate insulation for it in order to prevent breakdown.

The mathematical relationship between the various quantities may be expressed as follows:—

$$I = \frac{1885CV}{\lambda}$$

[Price 1/-]

wherein I = the current in amperes flowing through the condenser, 45

C = the capacity of the condenser in microfarads;

V = the voltage across the condenser terminals in volts,

$\lambda$  = the wavelength of the alternating current in metres. If  $f$  = the frequency of the current, the wavelength  $\lambda$  is expressible in terms of the frequency by the relation  $\lambda \times f = 300,000,000$ . The above quoted relationship between the current and voltage may also be turned into the following form 55

$$\frac{V}{I} = \frac{1}{1885} \cdot \frac{\lambda}{C} = 0.000531 \lambda / C$$

and in this form, consisting of an equality of two ratios, it is utilised in the calculating apparatus forming the subject matter of this invention. 60

The accompanying diagram illustrates the preferred form of the calculator and is drawn to illustrate the relative arrangement of the scales. The calculator is preferably constructed in the well-known form of a calculating slide-rule, on which the necessary special scales are engraved, and having a fixed part or body carrying some of the scales and a movable slider carrying the remainder and coacting with the fixed scales. The scales are logarithmic in character. 70

Referring to the diagram the scale marked A is graduated from 20 to 20,000 metres reading from left to right, and the wavelength values are read off on this scale. It is logarithmic in character covering three "periods" viz. 20—200; 200—2000; and 2000—20,000 metres, this scale is engraved on the body of the calculating rule. A similar type of scale marked B is engraved on the upper edge of the movable slider S so as to co-operate with the fixed scale A. This 85

second scale is engraved in capacity between 0.00005 microfarad and 0.05 microfarad reading from left to right, covering three logarithmic "periods".

5 Similarly at the lower part of the rule there are provided two co-operating logarithmic scales marked C and D, one engraved on the edge of the slider, and the other on the body of the rule. Scale  
10 C is engraved for three logarithmic periods from 0.5 to 500 amperes reading from left to right to provide the scale for the current flowing through the condenser. The co-operating scale D is  
15 graduated from 0.1 to 100 kilovolts to read from left to right, the voltage across the terminals of the condenser.

To operate the rule the slider is moved along in its guides until the point on the  
20 scale B representing the known value of the capacity coincides with the point on the scale A representing the known (or measured) wavelength. This setting of the slider determines the ratio of these  
25 two quantities  $\lambda/C$  in accordance with the well-known principles of slide-rule calculations. The corresponding ratio of  $V/I$  is thus automatically obtained by this  
30 setting of the slider, and the proper value of the voltage corresponding to the known value of the current can thus be obtained by direct inspection of the scales.

With this preferred arrangement of the scales engraved on the rule it is necessary to displace one or more of the scales  
35 longitudinally in order to satisfy the mathematical equation connecting the various quantities. One way of carrying this into effect is to displace the capacity  
40 scale B so that the extreme right hand end mark of the scale which is engraved with the numeral 0.05 coincides with the reading 18,850 on the upper or A scale instead of with 20,000 on that scale, when  
45 the movable slider is closed up so that the ends of the C and D scales are in alignment. A displacement to the same extent of any one of the other three scales could likewise be employed. A fifth  
50 logarithmic scale E engraved so that its readings increase from right to left instead of from left to right as in the case of the other four scales, may be placed on the body of the rule so that frequencies  
55 may be read off instead of wavelengths. With the preferred arrangements of the scales as herein described the engraving on scale E is arranged to run from 15 kilocycles at the right hand end  
60 to 15,000 kilocycles at the left, this scale covering three logarithmic "periods" similarly to the others.

A movable index mark or "cursor" M, may be provided to assist in making  
56 readings across from the E scale to the others on the rule.

A substantial advantage may be gained by engraving the scales of the slide rule with the actual numerical values of the  
70 five quantities concerned as above described, since by this means errors due to estimation of the decimal point etc. may be eliminated, and the facility of use of the calculator materially increased.

A further advantage of the use of  
75 logarithmic scales covering three periods is that the range of usefulness of the calculator can be doubled by the exercise of a trifling mental effort. Thus if the fifth scale marked E in the diagram is  
80 read as "cycles" instead of "kilocycles", and the third scale C is read as "milliamperes" instead of "amperes" the other relationship given by the calculator will still hold good, while by this  
85 means the upper end of the new frequency scale E viz. 15,000 cycles, becomes identical with the lower end of the engraved scale viz. 15 kilocycles, thus extending  
90 the range of the rule to cover a frequency range of fifteen to fifteen million cycles.

The same calculator can by this means be employed for frequencies in the tele-  
95 phone, or audio range, as well as in the radio range.

It will be evident that the improvements above described are also equally applicable to other forms of slide-rules,  
100 such as the circular or annular form, which may be employed for the same purposes.

An especial advantage of the rule is that four of the elements are so disposed  
105 collectively that they read in what may be called the natural order viz.:—from left to right, and of the five scales given only the topmost one reads in the reverse direction. This arrangement will be  
110 found to be most convenient to the eye in reading.

It should be understood that the international symbols for electrical calculation may be used in place of words and  
115 signs or abbreviations for figures if so desired.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is  
120 to be performed, I declare that what I claim is:—

1. A mathematical calculating apparatus of the slide-rule type comprising four logarithmic scales so disposed as to  
125 solve the equation  $V/I=0.000531 \lambda/C$ .

2. Calculating apparatus of the slide-  
130 rule type as claimed in Claim 1 provided with a fifth logarithmic scale coacting with the other scales to enable corresponding values of frequency and wavelength to be read off the scales.

3. Calculating apparatus as claimed in  
Claims 1 and 2 wherein the logarithmic

scales are engraved with the actual numerical values of the five quantities concerned.

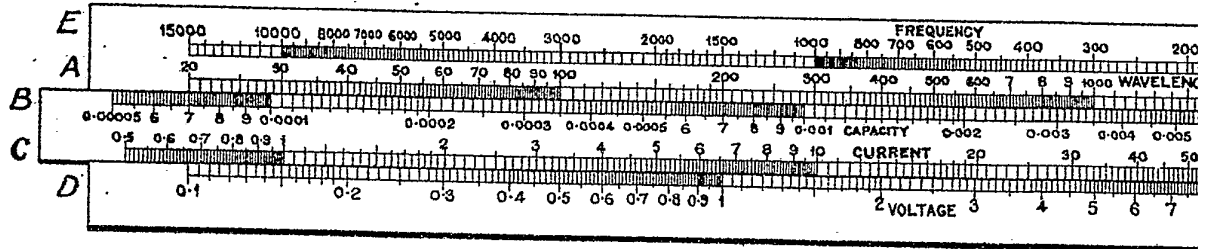
5 4. Calculating apparatus as claimed in any of the preceding claims wherein each of the logarithmic scales covers three logarithmic periods substantially for the reason and purposes described.

5. Calculating apparatus arranged and operating substantially as herein described with reference to the accompanying drawing. 10

Dated this 26th day of September, 1925.

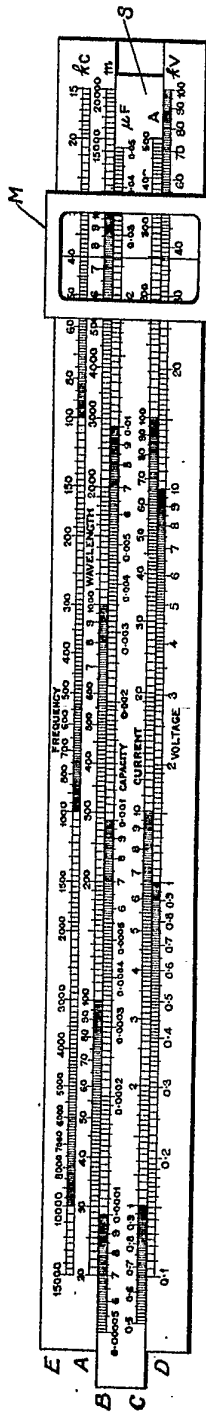
PHILIP R. COURSEY.

[This Drawing is a reproduction of the Original on a reduced scale.]





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POOR QUALITY