# PATENT SPECIFICATION

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Complete Left: Nov, 16, 1926.

Complete Accepted: March 31, 1927.

PROVISIONAL SPECIFICATION.

## Calculator for Readily Determining the Relationship Between Wavelength, Inductance and Capacity in Electrical Circuits.

I, FREDERICK HENRY HAYNES, 38, Sittingbourne Avenue, Enfield, Middlesex (British subject), do hereby declare the nature of this invention to be as follows:—

This invention relates to a device for readily determining the relationship between the wavelength, inductance and capacity of oscillating electrical circuits such as are generally employed in wireless apparatus.

The principle of the device is based upon the wavelength formula in which wavelength is proportional to the square root of the product of the inductance and capacity of the circuit. In practical units expressing wavelength in metres, inductance in microhenries and capacity in microfarads, the wavelength is given by multiplying the square root of the inductance and capacity product by 1885. Calculations involving the determination of wavelength with given inductance and capacity values can therefore be solved by a simplified process in which the sum of half the logarithm of the capacity and inductance values is added to the logarithm of 1885.

It is well known that problems involving the relationship between wavelength, inductance and capacity are solved by reference to slide rules making use of logarithmic scales. It is also well known that wavelength slide rules have been devised for revealing in practical units the resultant given any two of the factors and in which straight line logarithmic scales representing inductance and capacity are assembled side by side but reversed one against the other so that the displacement of the moving scale is equal to the arithmetic mean of the logarithms of inductance and capacity.

In carrying this invention into effect a particular form of construction has been adopted to render the steps in the process of calculation easy, the scales being arranged as concentric circles in preference to the straight line logarithm scales employed in the usual form of slide rule. The revolving scales are devised in a manner to provide the logarithm of the capacity, the logarithm of the inductance and a scale of twice the logarithm of the wavelength displaced by an amount equal to the logarithm of 1885.

This invention may be carried into effect in one form by providing three concentric scales, two of which are set out logarithmically with condenser and inductance values extending over nearly half the circumference, whilst the wavelength indicator being set out on twice the scale of that of the logarithms of inductance and capacity would occupy almost the entire circumference. These scales would be marked out in practical units of inductance, capacity and wavelength or if applied to particular calibrated apparatus the scale divisions of that apparatus might be incorporated in order to give direct readings.

An application of this form of calculator is that the scales can be incorporated in the tuning dial of a wireless receiver so that direct readings of wavelength can be obtained and the relationship between the inductance and the capacity employed readily revealed. Assuming that tuning is effected by means of a variable capacity it would be necessary to adopt a variable condenser having specially shaped plates so that the capacity change from minimum to maximum varies logarithmically. By fitting the dial with a narrow rim so that

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it can be independently rotated and marked on its outer edge with a suitable logarithmic wavelength scale then the relative position of the adjustable rim and the condenser dial proper when tuning to a given wavelength will indicate the value of the inductance, which if desirable, may be set out logarithmically between the main dial and the rim.

The particular purpose aimed at is to provide an instrument dial which may be fitted with an adjustable rim and locking screw so as to predetermine wavelength settings when used in conjunction with a tuning condenser arranged to vary logarithmically with the capacity. By adjusting to a known wavelength the auxiliary dial can be set to indicate that wavelength and secured in position so that the adjustments for other given wavelengths are indicated on the wavelength scale.

Dated the 21st day of October, 1926.

F. H. HAYNES.

## COMPLETE SPECIFICATION.

# Calculator for Readily Determining the Relationship Between Wavelength, Inductance and Capacity in Electrical Circuits.

I, FREDERICK HENRY HAYNES, 38, Sittingbourne Avenue, Enfield, Middlesex (British subject), 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 a device for readily revealing the relationship between capacity, inductance and wavelength or frequency in tuned electrical circuits such as are generally employed in wireless apparatus.

The principle of the device is based upon the wavelength formula in which wavelength is proportional to the square root of the product of the inductance and capacity of the circuit. In practical units expressing wavelength in metres, inductance in microhenries and capacity in microfarads, the wavelength is given by multiplying the square root of the inductance-capacity product by 1885. Calculations involving the determination of wavelength with given inductance and capacity values can therefore be solved by a simplified process in which the sum of half the logarithm of the capacity and inductance values is added to the logarithm of 1885.

It is well known that problems involving the relationship between wavelength, inductance and capacity are solved by reference to slide rules making use of logarithmic scales. It is also well known that wavelength slide rules have been devised for revealing in practical units the resultant given any two of the factors and in which straight line logarithmic scales representing inductance and capacity are assembled side by side but reversed one against the other so that the displacement of the moving scale is equal to the arithmetic mean of the logarithms of inductance and capacity.

In carrying this invention into effect a particular form of construction has been adopted to render the steps in the process of calculation easy, the scales being arranged as concentric circles in preference to the straight line logarithm scales employed in the usual form of slide rule. The revolving scales are devised in a manner to provide the logarithm of the capacity, the logarithm of the inductance and a scale of twice the logarithm of the wavelength displaced by an amount equal to the logarithm of 1885.

This invention may be carried into effect in one form by providing three concentric scales, two of which are set out logarithmically with condenser and inductance values extending over nearly half the circumference while the wavelength scale is set out on twice the scale of that of the logarithms of inductance and capacity and occupies almost the entire circumference.

To readily understand the arrangement reference is made to the accompanying drawing Sheet 1. The scales A, C and E which in this instance are only approximate are logarithmically plotted to represent capacity in micromicrofarads, inductance in microhenries and wavelength in metres. An additional scale might be traversed by the wavelength pointer to indicate frequency in kilocycles and would be set out alongside the wavelength scale, though advancing numerically in the opposite direction of rotation.

The centre disc as bounded by the thick line F is secured to the back card

which carries the capacity scale and does not rotate. The edges of the two rotatable discs are also shown as thickened lines. The centre parts of these two discs are cut away so that they can drop over another disc which serves as a bearing, and is of a diameter approaching that of disc F.

Several additional scales may be provided. B, represents the actual dial settings in divisions of condensers having plates following a straight line wavelength law with maximum capacities of 0.0003 and 0.0005 microfarads and are read against the arrows on the left and right hand side respectively. The scale D carrying the identification numbers of particular inductances is read against the pointer marked "coil numbers" and may be used instead of the inductance scale. Scale F is read from the pointer marked "stations" and indicates particular wireless transmitting stations. Additional scales if required may be provided on the underside of the rotating discs and viewed through holes in the back card. Such scales might serve as an alternative to the capacity scale A for approximately setting the larger disc from scale division readings of variable condensers of various maximum capacities and following different tuning laws. A pointer is shown for revealing the actual capacity values obtained with a calibrated condenser for given dial settings.

An application of this form of calculator is that the scale can be incorporated in the tuning dial of a wireless receiver so that direct readings of wavelength can be obtained and the relationship between the inductance and the capacity employed readily revealed. Assuming that tuning is effected by means of a variable capacity it would be necessary to adopt a variable condenser having specially shaped plates so that the capacity change from minimum to maximum varies logarithmically. By fitting the dial with a rim which can be independently rotated and marked on its outer edge with a suitable logarithmic wavelength scale the relative position of the adjustable rim and the condenser dial proper when tuning to a given wavelength will indicate the value of the inductance. Inductance values may be set out logarithmically on the main dial.

The particular purpose aimed at is to provide an instrument dial which may be fitted with an adjustable rim and locking screw so as to predetermine wavelength settings when used in conjunction with a tuning condenser arranged to vary logarithmically with the capacity. By adjusting to a known wavelength the auxiliary dial can be set to indicate that wavelength and secured in position so that the adjustments for other given wavelengths are indicated on the wavelength scale.

Constructional details of a tuning dial embodying this principle are shown in the drawings of Sheet 2. The dial G together with the operating knob is locked on the shaft of a variable condenser having plates shaped to follow a logarithmic law, actual capacity values K being marked around its edge and read against the pointer L. The adjustable logarithmic scale of wavelengths M is carried on the plate H and is rotatable on G. A tightening screw J or other form of fixing is provided to clamp the plate H in position.

The method of operation consists of tuning to a transmission of known wavelength and by retaining the condenser scale at the position of resonance rotating the wavelength scale to read the wavelength of the transmission and then locking it in position. The wavelengths obtained at other settings of the tuning condenser are now indicated around the dial.

A small error may be present due to stray parallel capacities which would have the effect of changing the logarithmic scale of capacity the error being greatest near the minimum end of the scale as well as slightly displacing the readings of the wavelength scale. For practical purposes these errors may be neglected whilst by making two readings to transmissions of known wavelength capacity in parallel with the tuning condenser can be calculated. When used for tuning an aerial circuit in which the capacity of the aerial increases the capacity across the tuned circuit, the capacity of the aerial can be determined by taking readings on two transmissions of known wavelength.

The process adopted for setting the dial will reveal the inductance value of the coil and a scale N may be provided reading against pointer P.

It is obvious that this wavelength indicating dial may be used with a condenser comprising several independent sections which may be arranged to simltaneously tune several circuits. A usual arrangement comprises several tuning condensers driven from a common shaft, independent adjustment of the individual condensers being provided to allow for small differences in the inductance values of the coils. By using condensers with plates shaped to follow a logarithmic law differences in the inductance values

of the tuning coils can be compensated for by independently adjusting the condensers to tune to a given transmission and then locking them in position on the common shaft. If this shaft is rotated by the adjustable dial herein described the wavelengths to which the circuits simultaneously tune will be indicated, though the inductance scale may be ignored.

I do not limit myself to the precise form of construction shown as it is obviously open to modification within the scope of the invention hereinafter claimed. For instance, the concentric scales on both the calculator and the dial may be transposed or may be driven through pinions changing the actual form of the scales.

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

1. A device for calculating the wavelength or oscillation frequency produced by given values of capacity and inductance in a tuned electrical circuit or equally for determining any one of these factors given the other two and in which concentric circular scales are employed plotted logarithmically for ascertaining directly in practical units as hereinbefore set forth the solution of problems according to the wavelength formula.

$$\lambda = 1885\sqrt{LC}$$

2. A device for calculating capacity, inductance or wavelength in a tuned electrical circuit, comprising logarithmic scales arranged in the form of concentric circles and to revolve with respect to one another substantially as described and illustrated in the annexed drawings.

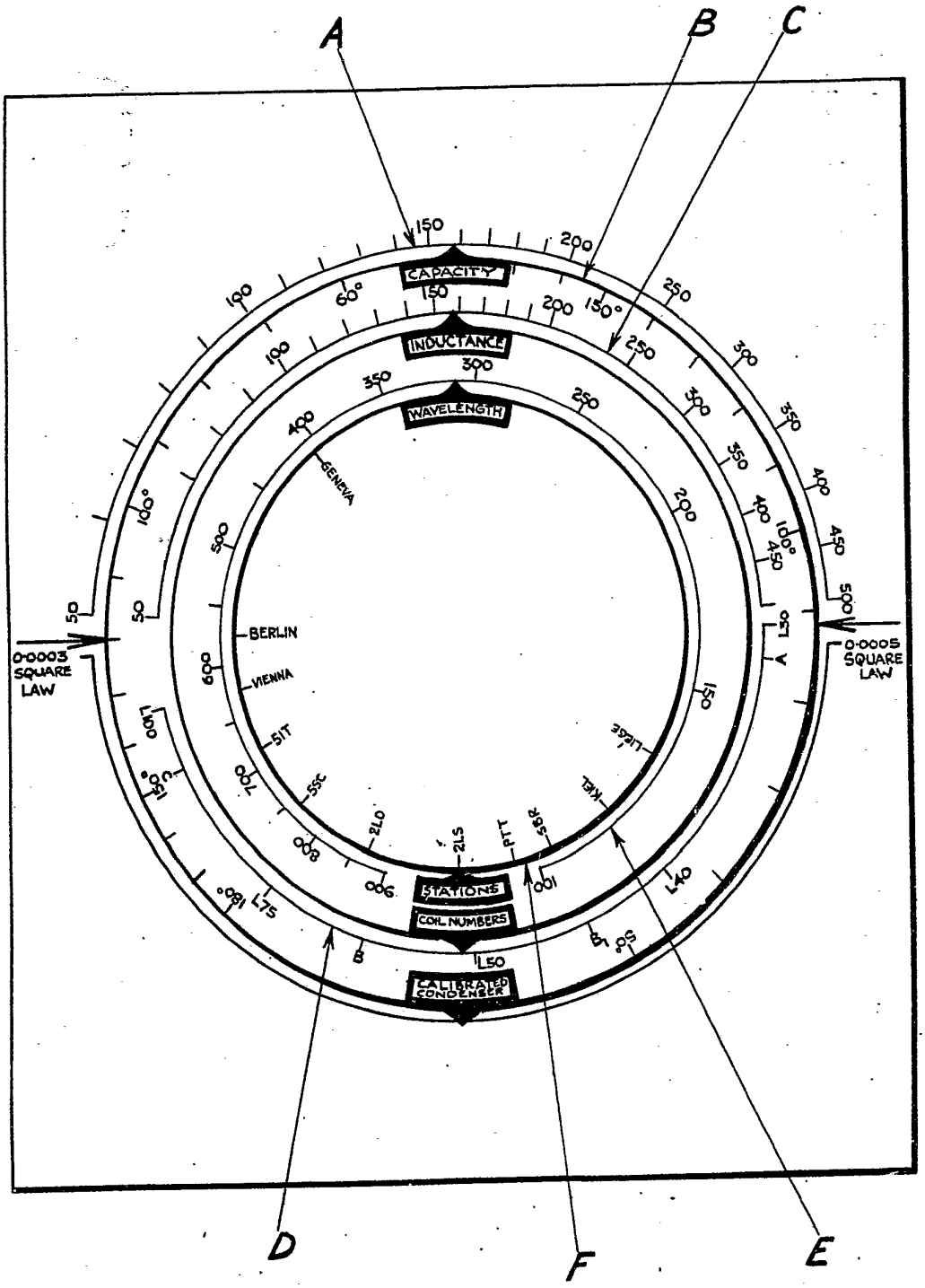
3. The combination of one or more condensers having a scale following a logarithmic law with an adjustable indicating dial for giving direct readings showing the relationship between the inductance capacity and wavelength or oscillation frequency of a tuned electrical circuit.

4. An adjustable dial for giving direct readings of wavelength or frequency when used with a tuned electrical circuit or more than one tuned electrical circuit when such are simultaneously controlled substantially as described.

Dated the 16th day of November, 1926.

F. H. HAYNES.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1927.

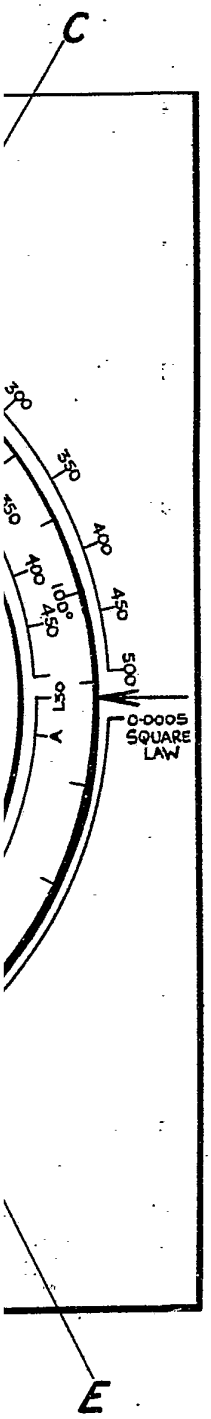


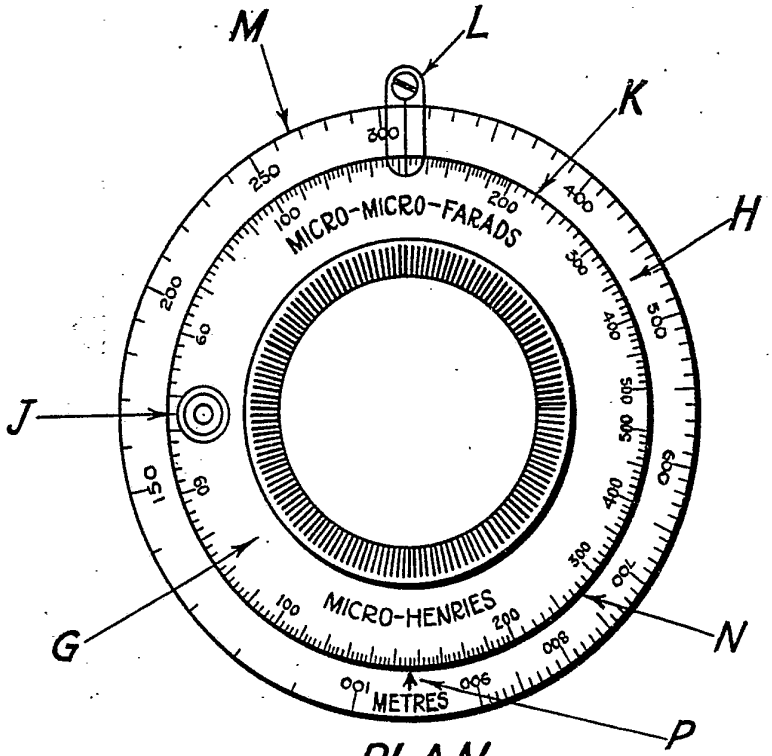

[This Drawing is a reproduction of the Original on a reduced scale.]

2 SHEETS

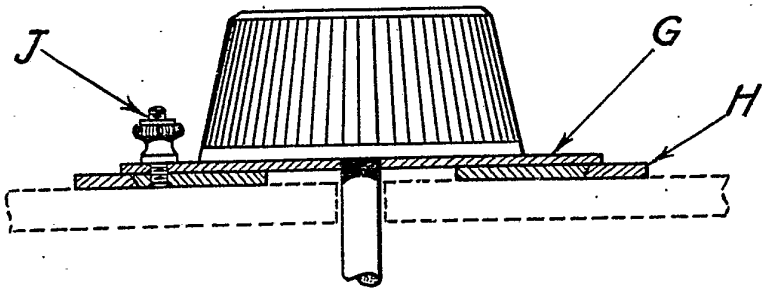
SHEET 1

SHEET 2




PLAN

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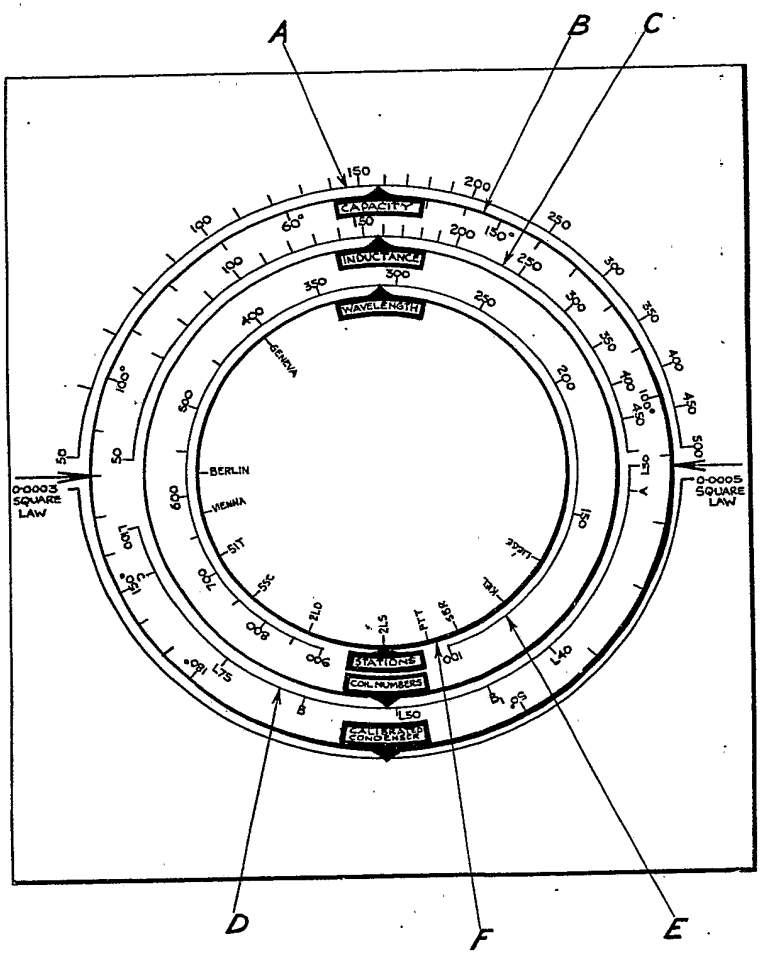


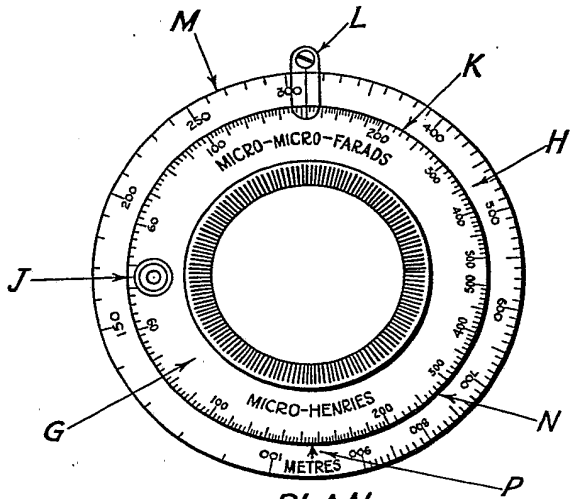


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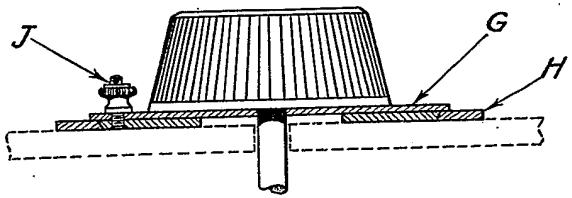


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