The Technician Explains

Design of Inductance Coils

By "CATHODE"

We commence this week a section which will be conducted by "Cathode" for the more advanced. While attacking radio from its fundamentals, the articles are yet simple and readily understandable. They are drawn up for the reader who wishes to secure a scientific knowledge of radio.

THE three questions which usually exercise the mind of one who essays to design a coil are as follows:

(1) What inductance will be required?

(2) How many turns on a former of given diameter will be necessary to provide this inductance?

(3) What gauge of wire will produce the most efficient coil?

In addition, definite information regarding the high-frequency resistance of different coils will be useful, not only as a basis of comparison, but also at a later stage when the problem of designing a primary winding to complete an intervalve coupling transformer comes up for solution. It will be seen that all these matters, together with certain pertinent incidentals, are treated in some detail.

Firstly, what inductance is required? It is well known that a "coil" with its associated tuning condenser and incidental capacities is a resonant circuit; that is to say, it will respond more readily, or present a greater impedence (according as it is a series or parallel circuit) to an alternating or high-frequency current having a particular frequency to which it is said to be tuned.

The phenomenon of resonance is utilised in a radio receiver to differentiate between signals of the desired frequency (or wavelength) to which the system is "tuned' to resonance and therefore responsive, and the host of signals or other frequencies which have but a small, in most cases a negligible, effect on the tuned system.

It will be clear that the frequency or wavelength to which the system will respond may be varied by alteration of either the inductance or the capacity of the system. The variometer which was popular for tuning some years ago and is still sometimes used in crystal sets is an example of a variable inductance; the modern tendency, however, is towards the use of a fixed inductance and a variable capacity or condenser, and the mechanical construction of this latter component has attained a high standard of precision.

The frequency or wavelength to which a combination of inductance and capacity is resonant may be calculated from the equation

$$W = 1884.96\sqrt{LC}$$

where W is the wavelength in metres, L the inductance in microhenries, and C the capacity in microfarads. Normally, however, the designer is already aware of the wavelength to which the system is desired to respond and of the approximate value of the capacity in circuit; the unknowr quantity is the inductance. The equation must therefore be restated in the form

$$L = \frac{W^2}{3{,}553{,}225 \times C}$$

the symbols having the same significance as before.

The determination of the required inductance now presents little difficulty. Assume that it is desired to tune over the broadcast band (say, 250 metres to 550 metres) using a variable condenser of maximum capacity .00035 mfd. Then, solving for the minimum inductance which will, in combination with the maximum capacity of the condenser, tune to 550 metres, the following result is arrived at:

$$L = \frac{W}{3{,}553{,}225 \times C}$$

$$= \frac{550^2}{3{,}553{,}225 \times .00035}$$

$$= \frac{302500}{1243.62875} = 243 \text{ microh.}$$

Solving next for the maximum inductance which will permit tuning down to 250 metres (it is unsafe to assume that the residual capacity will be less than about .00005 mfd., while it may easily be more) with the variable condenser "all out" the following is the result:

$$L = \frac{250^2}{3{,}553{,}225 \times .00005}$$

$$= \frac{62500}{177.66} = 352 \text{ microh.}$$

It is evident that a variable condenser of maximum capacity .00035 mfd. will cover the required range of wavelengths in combination with a fixed inductance having a value anywhere between 243 microhenries and 352 microhenries; a value of about 280 microhenries would be very suitable.

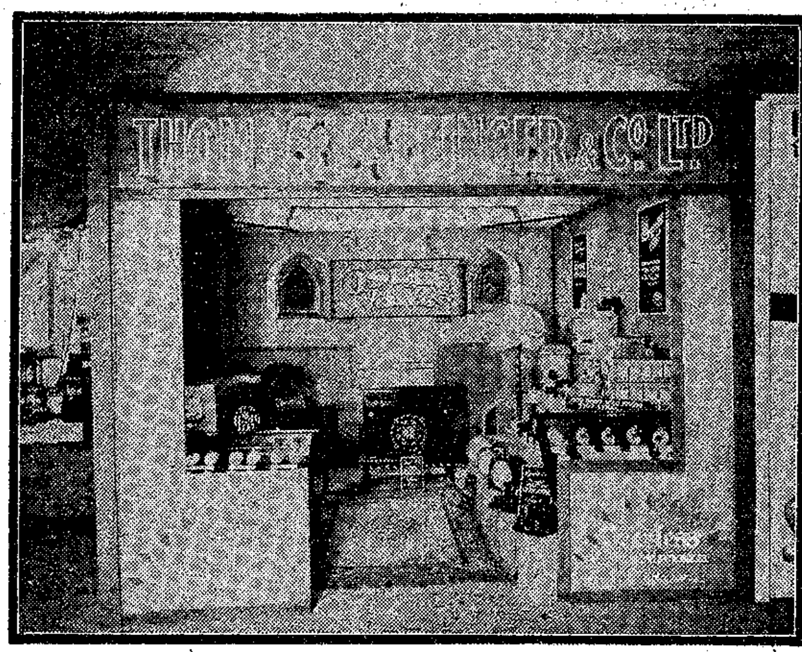
It is equally evident that if a variable condenser having too small a maximum capacity were chosen, it would be impossible to cover the required band.

At first sight there might seem to be no temptation to use a condenser of small maxi um capacity and the high inductance necessitated thereby. When it is remembered, however, that the maximum amplification obtainable from a high-frequency stage depends on the magnitude of the factor

$$\frac{L}{CR}$$

(where R is the effective series high-frequency resistance of the coil in ohms), it will be seen that, as regards amplification, there is every reason for increasing the inductance L (and reducing the capacity C correspondingly), provided the resistance is not unduly increased as a result.

Thus the real limit to increasing the ratio of inductance to capacity is imposed by the necessity of covering a given band, although some designers do not go as far in the direction of in-



Display of Thos. Ballinger at Wellington Radio Exhibition.