CORRESPONDENCE

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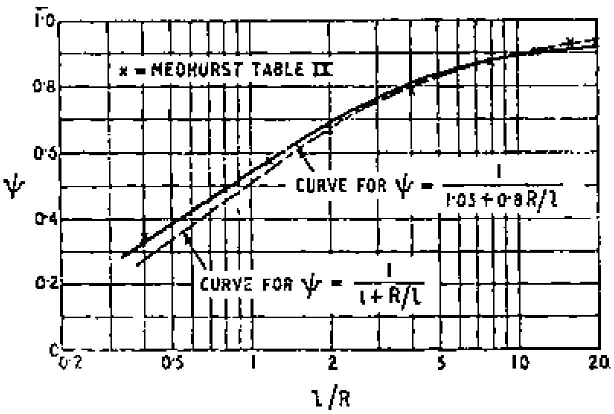
Q of Solenoid Coils

To the Editor, "Wireless Engineer"

SIR,—From Mr. Medhurst's paper in *Wireless Engineer* for March, one concludes that the results of his careful measurements on solenoid coil Q should be taken as superseding Butterworth's formulæ which have for so long been taken by engineers as a practical basis for coil design.

Mr. Medhurst's results for the Q of coils wound with the optimum gauge of wire are contained in his formula $Q = 0.15R\psi\sqrt{f}$ and his curve for ψ shown in Fig. 13. It is interesting to note that the latter curve agrees to an accuracy of a few per cent with the simple empirical equation $\psi = 1/(1.03 + 0.8R/l)$ as shown in the graph. Thus we arrive



at the following simple and practical formula for the Q of a properly designed solenoid, using plain copper wire, at high radio frequencies:—

$$Q = \frac{\sqrt{f}}{(6.9/R + 5.4/l)}$$

where R and l are the radius and length of the coil in centimetres. In a majority of practical cases we can use the even simpler formula

$$Q = 0.15\sqrt{f}/(1/R + 1/l)$$

which follows the data to a few per cent, provided $l > R$.

The range of conditions under which this formula applies is the same as that to which Mr. Medhurst's data refer: in particular—

(*a*) The ratio of wire diameter to wire spacing must approximate to the optimum (i.e., this ratio should lie between 0.5 and 0.7 for short coils ($l < 2R$) or 0.6 to 0.8 for l order of $4R$, and 0.75 to 0.9 for very long coils).

(*b*) The formulæ apply strictly only for very high frequencies, but (from Sect. 10) the accuracy will be better than ± 10 per cent provided $z > 7$; i.e., provided frequency in Mc/s exceeds 0.5 divided by (wire diameter in mm)^2.

Solenoids are chiefly used in current practice on frequencies above about 3 Mc/s, and here Litz wire is of little or no advantage; the following table, giving the thinnest gauge for which the formula applies to ± 10 per cent, shows that most practical solenoids will be covered.

freq.	1 Mc/s	4 Mc/s	16 Mc/s
wire ..	22 S.W.G.	28 S.W.G.	37 S.W.G.

(*c*) The formulæ do not hold for coils of very few turns (or extremely short coils). Mr. Medhurst gives us little guidance as to how far Butterworth's correction factor for coils of few turns can be relied on. Further experimental work seems indicated in view of the practical importance of coils of very few turns on v.h.f. and u.h.f.

(*d*) Dielectric loss is not, of course, allowed for. This is unlikely to be material except where the coil has a rather poor dielectric (bakelite or worse) and is used in a circuit having a low parallel tuning capacitance.

M. V. CALLENDAR.

E. K. Cole & Co. Ltd.,
Southend-on-Sea,
Essex.

Absolute Rotation and a Rotating Magnet

To the Editor, "Wireless Engineer"

Sir,—There are two aspects of the old rotating magnet problem: one is the absolute property of rotation, and the other is the electromagnetic reaction on the magnet itself. Various suggestions have been put forward by different authors to explain absolute rotation and from them to interpret the electromagnetic reaction upon the magnet.[1]

The problem is, however, as fundamental as it is hoary. We should especially notice that the questions of absolute acceleration and absolute rotation, which were sanctioned in the special relativity and which signify a return to the Newtonian Hypothesis of absolute space and absolute time, served, in fact, as the genesis of Einstein's theory of general relativity. Einstein's "principle of equivalence" asserts that, for the description of physical processes, we may take either the view-point of an observer A, at rest with an inertial coordinate system or that of another observer B, on a constantly accelerated coordinate system who measures the physical processes by means of the coordinates of observer A and, in addition, assumes the presence of a homogeneous gravitational field.[2] This principle, properly applied here for any particular instant, gives us a simple way of explaining so-called "absolute rotation". The electromagnetic reaction upon a rotating magnet and the resultant electric field distribution in it can then be obtained from Maxwell's equations modified for the relativity effect.

1. *Absolute Rotation*

Consider an inertial system Σ, in which the position-vector of any point is given by

$$\mathbf{r} = \mathbf{i}x + \mathbf{j}y + \mathbf{k}z \quad \ldots \quad (1)$$

and another coordinate system Σ', with its $\mathbf{k}'$-axis and origin coinciding with the $\mathbf{k}$-axis and origin of the first system, and rotating about the $\mathbf{k}$-axis with constant angular velocity ω. The position-