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Theory of phasochronous devices...

The motion of the electrons in the presence of the field is described by:

$$\dot{v}_x = -\eta E_x + \eta v_y B_y - \eta v_z (B_z + B_o)$$
$$\dot{v}_y = -\eta E_y + \eta v_x (B_z + B_o) - \eta v_z B_x$$
$$\dot{v}_z = -\eta E_z + \eta v_y B_y - \eta v_x B_z$$

The solutions of Eqs. (4a) are in the form:

$$x = \tilde{X}(z, \alpha) + x_1(z, \alpha)$$
$$y = \tilde{Y}(z, \alpha) + y_1(z, \alpha)$$

where:

$$\tilde{X}(z, \alpha) = X(t(t_0', z), t_0)$$

The magnitudes for the alternating components \(\tilde{X}\) and \(\tilde{Y}\) produced by the different transit times of the electrons are much higher...
than the components \( x_1 \) and \( y_1 \); the latter can therefore be neglected. An equation for the starting current of the system is derived and it is shown that this is similar to the small signal scattering equation of a travelling-wave tube or a backward-wave tube. If the spread of the electron velocities \( \Delta v_z = \delta \) is taken into account, the scattering equation becomes:

\[
(x + ib)(x^2 + 4QC) - i = 0
\]

where

\[
\left( \frac{\delta}{2Cv_0} \right)^2 = 4QC
\]

The following notation is adopted in Eq. (21):

\[
\begin{align*}
\epsilon/C & = b \\
\delta/C & = \mu \\
\mu - ib & = \chi
\end{align*}
\]

where \( \epsilon \) is the detuning parameter. Eq. (22) is similar to that of a travelling-wave tube with space charge. The effect of the variations in the magnetic field is also taken into account and it is found that a 1% variation can lead to the doubling of the starting current.

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SUBMITTED: April 10, 1962 (initially)
May 14, 1962 (after revision)