up by the dissociating molecule. The explanation of this very remarkable phenomenon cannot be given with certainty until the results of further experiments are available[3].

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[1] NATURE, **113**, 855, June 14, 1924.
[2] *J. Chem. Soc.*, 1603; 1926.
[3] E Adinolfi (*Atti R. Accad. Lincei*, **8**, 381; 1928) found that the specific heat of bismuth is increased by about 14 per cent and that of tellurium by 8 per cent by exposure to X-rays. D. Coster and A. v. d. Ziel (*Z. physik. Chem.*, B, **20**, 283; 1933) found that irradiation with X-rays of the monoalkyl malonic acids accelerates strongly the transformations taking place in these substances.

Magnetron Oscillations of a New Type

IN a recent issue of NATURE[1] Dr. Megaw suggests that the magnetron oscillations dealt with in my letter[2] should be "dynatron oscillations" of the type described in his fundamental paper: "An Investigation of the Magnetron Short-Wave Oscillation"[3].

One condition that oscillations should be of a "dynatron" character is the presence of a static negative resistance. In our case such a negative resistance could not be measured. Also there was a definite lower frequency limit for every adjustment of anode tension and magnetic field as well as an upper frequency limit, both limits being fairly close together. This fact is not in favour of the "dynatron" theory.

In a paper which has not yet appeared, the generation of the oscillations is shown to be possible under the influence of the tangential alternating electric field, which can be resolved into two rotating fields. As one of these components plays the principal part, the oscillations are called "rotating field oscillations" in this paper.

For the upper frequency limit is derived the equation

$$\omega_{max.} = \tfrac{1}{2} H \frac{e}{m}\left[1 - \sqrt{\left(1 - 8\frac{V_a^2}{r^2H^2}\frac{m}{e}\right)}\right] \text{ or}$$

$$\omega_{max.} = \tfrac{1}{2} H \frac{e}{m}\left[1 - \sqrt{\left(1 - \frac{H_{cr.}^2}{H^2}\right)}\right].$$

$H_{cr.}$ is the critical cut-off field strength, the other symbols are the same as those used in my previous letter. As an approximation, this is transformed to $\omega_{max.} = 2\ V_a/r_a^2H$ in my previous letter, only holding for $H \gg H_{cr.}$, and for a four-plate magnetron the frequency should be twice this value.

Therefore these formulæ yield the upper frequency limit for *every* value of $H > H_{cr.}$, and it would not be clear what proof is to be derived for the identity of these oscillations and the "dynatron" oscillations, when for H is substituted the arbitrary value $H_{cr.}$, apart from the fact that the approximate equation $\omega_{max.} = 2\ V_a/r_a^2H$ is not valid for $H = H_{cr.}$.

The equations are confirmed by experiment. As already stated, there exists also a lower frequency limit, which is found experimentally to be equal to

$$\omega_{min.} = \tfrac{1}{4} \frac{e}{m} H\left[1 - \sqrt{\left(1 - \frac{4}{3}\frac{H_{cr.}^2}{H^2}\right)}\right],$$

this expression being obtained by drawing a straight line through a group of experimental points in a certain diagram.

For $H \gg H_{cr.}$ this can again be simplified to

$$\omega_{min.} = 4/3\ V_a/r_a^2H.$$

In the rotating field theory mentioned above, these limits have the following physical significance. When $\omega = \omega_{max.}$, the radial velocity of the electrons arriving on the anodes equals zero. When $\omega = \omega_{min.}$, the total kinetic energy of the electrons reaching the anodes equals one third of the energy corresponding to the D.C. potential. As formerly stated, this latter limit is found experimentally, and at present I see no reason why this figure should be precisely one third.

From the rotating field theory it is obvious that for four-plate magnetrons all frequencies are twice the values for two-plate magnetrons, which is very well confirmed by experiment. Recently we succeeded in obtaining weak oscillations from an eight-plate magnetron, the frequency being equal to four times the frequency obtained from a two-plate type under similar conditions. However, this was only possible for values of H not much greater than $H_{cr.}$; for higher values of H the electrons are confined to an area where the tangential rotating field cannot become appreciable.

As stated in my previous letter, the output obtainable at about 40 cm. is of the order of 30 watts for a four-plate magnetron, whereas Dr. Megaw states in the summary of his paper[3] "It is concluded that for wavelengths below about 50 cm. electronic oscillations give the greater output", electronic oscillations only giving an output of the order of 1 watt.

In practice, we obtained this type of oscillations on a wave-length ranging from 80 cm. to 5 m. for a two-plate magetron and from 35 cm. to 250 cm. for a four-plate magnetron, whereas Dr. Megaw even mentions measurements on a pure dynatron oscillation of only 600 kc./sec.

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[1] NATURE, **134**, 324, Sept. 1, 1934.
[2] NATURE, **134**, 179, Aug. 4, 1934.
[3] *J. Inst. Elec. Eng.*, **72**, 1933.

Fluorine in Coal

A CASE of severe disintegration of porcelain tower fillings over which hot ammoniacal liquor was circulated in a gasworks, caused me to investigate the source of this somewhat puzzling corrosion.

It was found that the attack on the porcelain was due to fluorine, which was shown to be present in the liquor in appreciable quantities (80 parts per million), probably in the form of ammonium fluoride. After eliminating the possibility of other sources of fluorine, I was forced to the conclusion that this element had been derived from the coal carbonised in the gas-making process. On examining a sample of the coal, which consisted of a mixture of Midland and West Country coals, the presence of fluorine was definitely established by the etching of glass.

The existence of fluorine in coal has, I believe, hitherto not been known, or has at any rate not been mentioned in the literature. I have examined a limited number of other coals and have established the presence of fluorine in all of them, in amounts not exceeding one part per million.

The available methods for the quantitative estimation of small amounts of fluorine have not been found satisfactory when applied to coal, but work in this direction is proceeding. Pending the elaboration of a reliable method, the etching test under