are both evident. Many observations have first been made without the photographic paper bridging the gap, and it can be stated beyond doubt that the presence of the paper makes very little difference, if any, to the appearance of the discharge. Details of the corona playing over the surface of the emulsion are far superior to any details which can be photographed through a lens: indeed, with a lens, practically only the leader-strokes would have been recorded.

I am certain now that the missing 'pilot streamer' is corona discharge similar to that shown in the photograph; that the leader-stroke develops behind this faint corona and is in the nature of a 'core' to the voluminous corona shower, a trunk and a few main branches in relation to the tree with its innumerable small branches and twigs. Why this is stepped in the lightning flash is still a matter for study; that it is stepped in the laboratory may be due mainly to the circuit; the terminal voltage may be diminished by the current taken by the leader-stroke, but the present experiments do not elucidate this, so further experiments are in progress.

I wish to thank Dr. F. J. Miranda and Mr. F. E. Chivers for assistance in these experiments, and the Metropolitan-Vickers Electrical Co., Ltd., for the loan of the portable impulse generator: also Dr. W. A. Berry, of Messrs. Ilford, Ltd., for the photographic papers selected for use.

Note added in proof. The printed record is inferior to the photographic record, which shows the corona bridging the gap.

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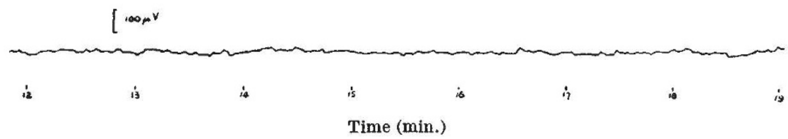
[1] Allibone and Schonland, *Nature*, **134**, 736 (1934).
[2] Allibone, *J. Ind. Elect. Eng.*, **82**, 513 (1938).
[3] Allibone and Meek, *Proc. Roy. Soc.*, **166**, 97 (1938).
[4] Schonland's most recent review, *Proc. Phys. Soc.*, **55**, 445 (1943).
[5] Bruce, C. E. R., *Proc. Roy. Soc.*, **183**, 228 (1945).
[6] Schonland and Allibone, *Nature*, **128**, 794 (1931).

Low-Frequency Noise from Thermionic Valves Working under Amplifying Conditions

ALTHOUGH there is a great deal of information concerning the noise produced by thermionic valves at radio frequencies, there do not appear to have been published data for the low-frequency noise intensity they produce under amplifying conditions. It has long been known that the noise intensity increases as the frequency to which the observational system is tuned is diminished, and a theory of the origin of this so-called 'flicker' noise has been given by Schottky[1] and modified by Macfarlane[2]. One of us (E. J. H.) has made measurements of valve noise and found that the intensity of the low-frequency noise varies approximately inversely as frequency in the range 10–1,000 c./s. At 1,000 c./s. it was not observable above the 'shot' noise. If expressed as an equivalent fluctuation E.M.F. at the grid, the low-frequency noise was remarkably constant from valve to valve.

Those observations, however, do not suffice to allow calculation of the performance of a direct-coupled amplifier covering a band of zero to (say) 1,000 cycles, as it is the very low-frequency fluctuations which set a limit to the useful amplification. It is, of course, difficult to distinguish between fluctuations arising in the valves, and those resulting from irregularities in the external circuits; but the figure for the low-frequency noise which we have obtained using a particularly well-stabilized direct-coupled amplifier sets an upper limit to the valve noise integrated over the band zero—1,000 cycles. A balanced system using 6*J*6 valves with input shorted produces fluctuations having a maximum amplitude equivalent to 20 μV. (peak to peak) when observed on an oscilloscope over a period of several seconds. Using a moving coil pen recorder it has been possible to obtain an accurate record of the low-frequency fluctuations over a period of 30 min. (see record above). The maximum peak-to-peak fluctuation in the record was about 60 μV. One result of the concentration of the noise of the zero frequency end of the spectrum is that extending the band-width to cover 0–5,000 cycles does not appreciably increase the total valve noise.



PORTION OF THE PEN RECORDER TRACE COVERING THE 12TH TO THE 18TH MINUTE OF A 30-MIN. RECORDING.

ORDINATE: E.M.F. EQUIVALENT AT INPUT TERMINALS TO THE VALVE UNBALANCE

When a 2·2 megohm resistance was connected across the input the thermal agitation noise (6 μV. r.m.s. for a 1,000-cycle band-width) of the resistance could be seen to increase the mean noise-level (observed in a short period) by some 50 per cent.

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[1] *Phys. Rev.*, **28**, 74 (1926).
[2] *Proc. Phys. Soc.*, **59**, 366 (1947).

A Correlation between Molecular Vibrations and Bond-forming Orbitals

IN a recent letter, Heath and Linnett[1] suggested for the treatment of molecular vibrations a new force field, the orbital valency force field. This is based more closely on modern ideas of directed valency than is the simple valency force field. We decided to test the orbital valency force field on methane, which is a convenient molecule to use, since all the deuterium-substituted methanes have been studied[2]. The first result obtained was that the original theory failed in this case. In particular, for CH_4 and CD_4, it was found that, to explain the frequencies of the doubly degenerate bending vibrations, a bending constant (k_H/r^2) of $1{\cdot}35 \times 10^5$ dynes/cm. was required, whereas the triply degenerate bending vibrations needed a constant of $0{\cdot}86 \times 10^5$ dynes/cm. Bending motions which are members of these two degenerate sets are shown in the accompanying drawings.

The relative values of these two bending constants indicate that it is easier to bend the molecule in the sense of Fig. *b* than in the sense of Fig. *a*.