

As suggested before⁶ we assume the following relation

$$dn = \frac{\psi}{ckT} F \Delta \tau$$

where ψ is the free energy, F the partition function, the form of which is not known, $\Delta \tau$ the elementary phase volume. Consider a mixture of n_A and n_B molecules of substances A and B forming a regular solution in which x molecules of each are present as A-B pairs. We then have

$$\psi_A = kT \ln (n_A - x) - \ln \int F \Delta \tau$$

$$\psi_A' = kT \ln x - \ln \int F \Delta \tau$$

where ψ_A and ψ_A' are the free energies of A molecule present as A-A pair and as a component of A-B pair respectively. Hence the change of free energy

$$\Delta \psi_A = \psi_A - \psi_A' = kT \ln \frac{n_A - x}{x}$$

Similarly we have

$$\Delta \psi_B = kT \ln \frac{n_B - x}{x}$$

Now the total change of free energy is equal to the increase of potential energy of the system

$$2(2w_{AB} - w_A - w_B)r = 2\lambda/r$$

as defined by Guggenheim. r is the number of molecules surrounding each pair. Hence

$$\Delta \psi = kT \left(\ln \frac{(n_A - x)}{x} - \ln \frac{(n_B - x)}{x} \right) = 2\lambda/r$$

from which we have $\frac{(n_A - x)(n_B - x)}{x^2} = e^{2\lambda/rkT}$

which on transformation reduces to Guggenheim's relation. Hildebrand's relation follows as a special case for $\lambda = 0$, i.e., when the total change of free energy is zero.

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March 25, 1935.

¹ Ganguli, *Curr. Sci.*, 1933, 2, 212.

² Ganguli, *Koll. Z.*, 1931, 67, 304.

³ Guggenheim, *Proc. Roy. Soc.*, 1932, A135, 181.

⁴ Guggenheim, *Ibid.*, 1935, 148, 304.

⁵ Hildebrand and Wood, *J. Chem. Phys.*, 1933, 1, 818.

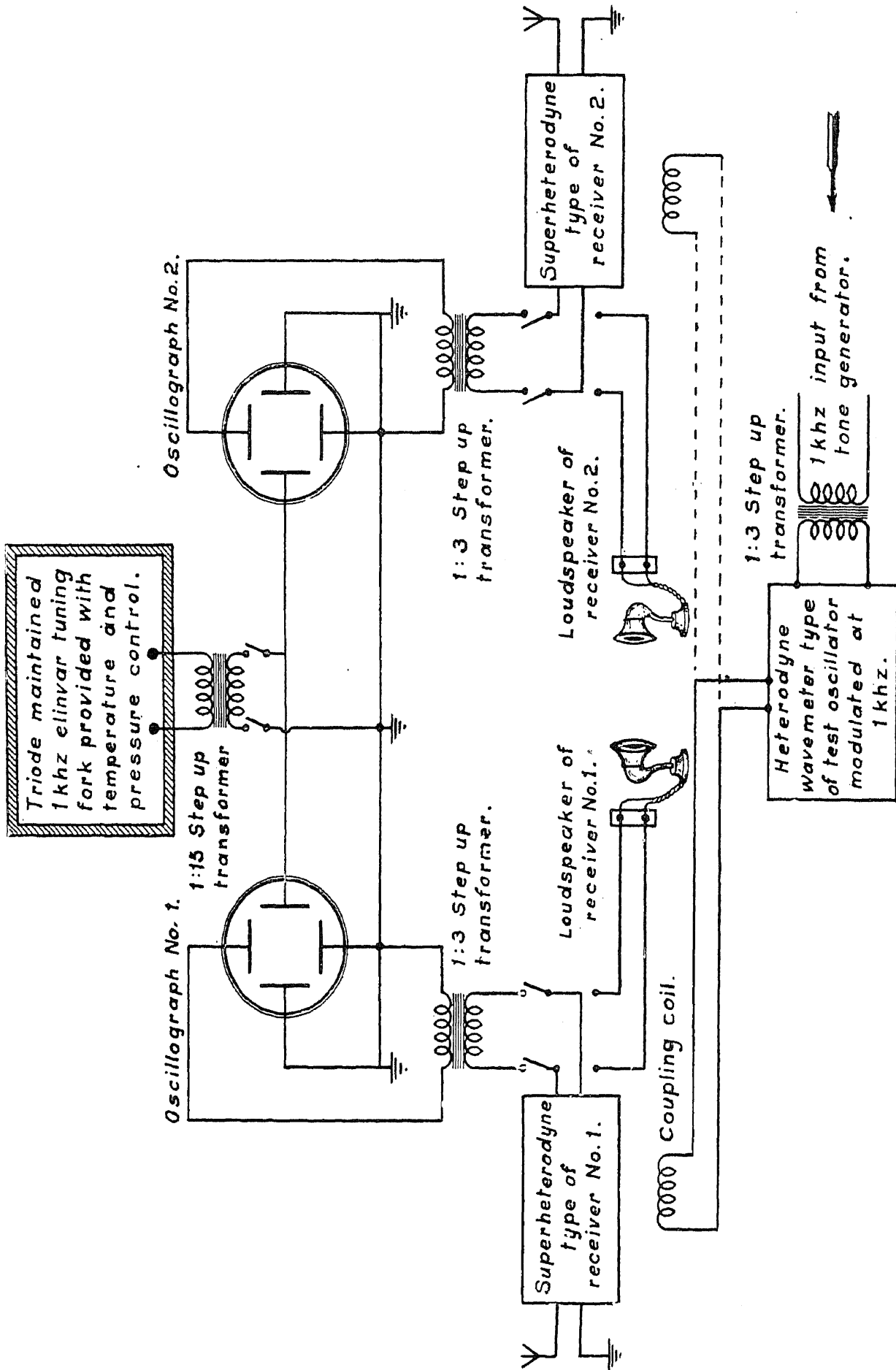
⁶ Ganguli, *loc. cit.*, ref. 2.

Special Radio Test Transmissions on 12th and 13th March 1935.

UNDER the auspices of the Union Radio Scientifique Internationale (URSI) and in continuation of the practice of the last two years, a frequency of 1 khz of high precision and stability obtained from the 1 khz standard tuning fork at the National Physical Laboratory in England was radiated in accordance with a previously notified schedule, as a modulation of the carrier frequencies of the broadcast transmitters, Droitwich (200 khz, 150 kw), Scottish Regional (801 khz, 50 kw) and Scottish National (1050 khz, 50 kw) of the British Broadcasting Corporation, England. These emissions took the form of a preliminary emission programme for adjustment purposes on 12th March between 0545 and 0615 IST; the main schedule of emissions of 13th March lasted from 0600 to 0845 IST. These emissions have the two-fold object (a) of inter-comparison of national standards of frequencies or of calibration of local apparatus where primary standards do not exist; and (b) of making observations of a physical nature such as fading, etc., characteristic of the transmission path.

Recently, a multivibrator type of wave-meter equipment of up-to-date design and driven by a 1 khz elinvar tuning fork, maintained at a temperature varying little from 50°C and at a pressure of 75 mm. has been installed in the laboratories of the Department of Electrical Technology of the Indian Institute of Science, Bangalore, to serve as the reference standard for India. The frequency of this fork had been accurately measured at the National Physical Laboratory prior to shipment of the apparatus to India. But the measurement on 13th March of the frequency difference between the two 1 khz signals—either by the phonic wheel or by the beat note method—was found to be out of question on account of (a) the rapidly diminishing signal intensities at Bangalore of the incoming 801 and 1050 khz signals from early morning hours onwards, (b) fading and (c) atmospheric disturbances in relation to the signal strength. Comparatively speaking, the disturbances were far more severe on 200 khz, the frequency of Droitwich, and it was not without difficulty that the 1 khz modulating note could be heard. This station could not therefore be used.

For visual observations (Fig. 1), the output from each receiver was impressed across



13-3-1935. 804 khz.

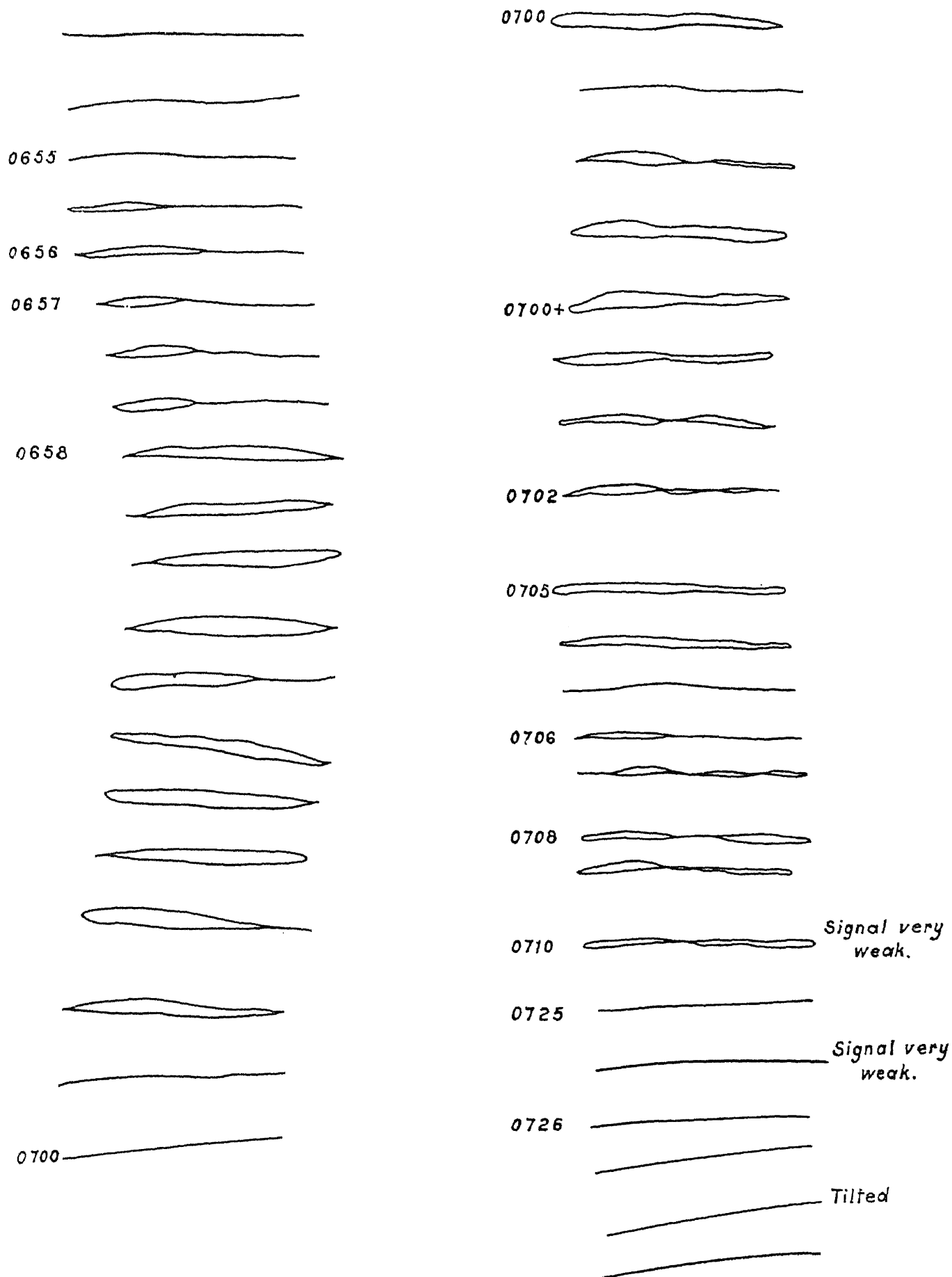


Fig. 2.

13-3-1935, 1050 khz.

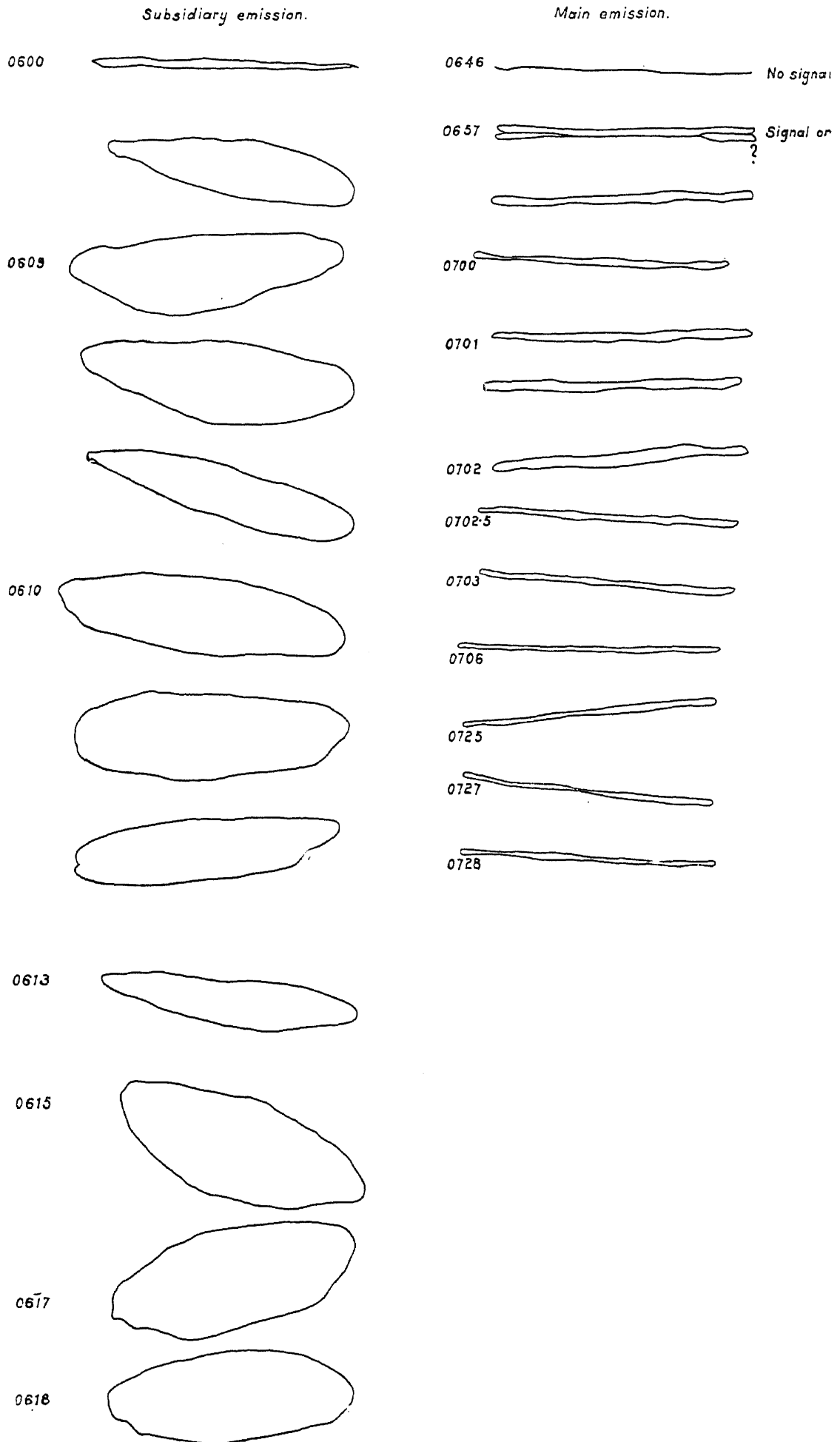


Fig. 3.

the vertical plates of its cathode ray oscillograph, while the horizontal plates were connected in common to the output of the local 1 khz fork apparatus; the resulting image on the screen was quickly traced by hand on a piece of clear tracing paper. Observations were hampered considerably by a rather unexpected source of trouble in the form of a continuous current motor used for pumping water. The announcements could not be made out at all.

The test oscillator modulated at 1 khz from a local tone generator was used in gaining experience in adjustment.

The pattern on the screen was, in general, a somewhat distorted ellipse on both 804 and 1050 khz; neither its shape nor its size was constant for more than a few seconds at either frequency (Figs. 2 and 3). The variations were more pronounced and rapid at the higher frequency than at the lower, particularly on 12th morning. In view of the location of the two transmitters at the same site in Scotland and the accuracy and high stability of the frequencies of the Institute and the NPL forks, the above would indicate that the variations in the figures observed on the oscillograph screen were due to the ionospheric transmission path in respect of intensity and of phase, that is, path difference. The local 1 khz voltage across the horizontal plates of the oscillograph with the 1050 khz receiver output across its vertical plates was replaced by the output from the 804 khz receiver; but the signals were so feeble that no clear diagram was obtained on the screen. The modulating frequency for the subsidiary emissions earlier in the morning on 13th March differed from that of the main emissions by only a few points in a million or less.

In spite of the distance of Bangalore from the transmitters and of the severity of electrical disturbances, more satisfactory observations and even measurements would probably have been possible if the programme of transmission had started about an hour earlier. Alternatively, modulation of some of the short wave transmitters might have enabled useful observations notwithstanding severe fading at these hours.

At the southern end of Bangalore, about 4 miles from the Institute Mr. N. Srinivasa Row "listened in" on 1050 khz using the excellent super heterodyne receiver owned by Sir M. N. Krishna Row. Atmospheric disturbances and fading were present but

little of any "man made" disturbances. The announcements could be made out but somewhat incompletely. The 1 khz emission was heard; but as the morning proceeded, the signal got weaker; after about 0730 IST, nothing came out of the receiver except disturbances.

Grateful thanks are due to Dr. E. H. Rayner of the National Physical Laboratory, Teddington and present Chairman, Commission 1, Standards, of the URSI for kindly forwarding all relevant information and literature relating to the transmissions and to apparatus arrangements; to Mr. Evans of the Gramophone Company and to Mr. K. S. Ramamurthy for kindly lending the necessary broadcast receivers for the tests; and to Mr. N. Srinivasa Row for his accurate report of what he heard.

The apparatus arrangements and the observations were all made by Messrs. B. V. Baliga, T. D. Chatterji, T. Krishnaswamy Rao, S. N. Mukerji, K. Raghunatha Rao and T. V. Rama Murthy of the Electrical Communication Engineering Section of the Department of Electrical Technology of the Indian Institute of Science, Bangalore.

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Densities of Aqueous Solutions of Formaldehyde between 20° and 40°.

AUERBACH AND BARSCHALL¹ have determined the densities of formaldehyde solutions in water at 18°. As these solutions of different concentrations are now extensively used in photography in India, their densities have now been determined at temperatures between 20–40°. Thus, with the aid of an accurate hydrometer, the data given in Table I can be readily employed for determining the concentration of a given solution of formaldehyde at the usual laboratory temperatures in India.

For these determinations pure formaldehyde gas was obtained by passing a current of pure nitrogen over trioxymethylene contained in a retort heated to 180°. The gas was absorbed in distilled water kept in an ice bath and the most concentrated solution containing 42 per cent. of formaldehyde by volume was obtained. The amount of formaldehyde in the solution was estimated by the usual iodine method.

Densities were determined by a specific gravity bottle (Regnault type) which was