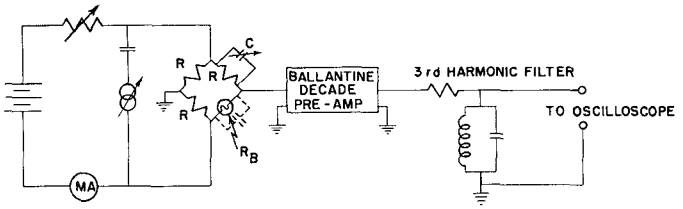

Fig. 6—Experimental arrangement for measuring s/τ by use of a combination of dc and audio power.

$$\Delta R = \frac{\alpha R_0}{c_p} \cdot \text{(pulse energy)}$$

$$\frac{s}{\tau} \equiv \frac{\alpha R_0}{c_p} = \frac{4R^2\omega^2}{7} \cdot \frac{dC}{dP_{dc}}.$$

can be expressed to good approximation as the sum of a steady component

$$P_0 = (I_{dc}^2 + I_{ac}^2)\overline{R} \tag{41}$$

and a time-dependent component

$$p(t) = (2\sqrt{2}I_{dc}I_{ac} \sin \omega t - I_{ac}^2 \cos 2\omega t)\overline{R} \tag{42}$$

By (39)

$$r_b(t) = s\overline{R}\left[\frac{2\sqrt{2}I_{dc}I_{ac} \sin (\omega t - \phi_1)}{\sqrt{(\omega\tau)^2 + 1}} - \frac{I_{ac}^2 \cos (2\omega t - \phi_2)}{\sqrt{(2\omega\tau)^2 + 1}}\right].$$

$$\phi_1 = \tan^{-1} \omega\tau$$

$$\phi_2 = \tan^{-1} 2\omega\tau. \tag{43}$$

Since $\omega\tau \gg 1$ if ω is a sufficiently high audio-frequency,

$$\sqrt{(\omega\tau)^2 + 1} \simeq \omega\tau,$$

$$\sqrt{(2\omega\tau)^2 + 1} \simeq 2\omega\tau,$$

$$\phi_1 \simeq \phi_2 \simeq \pi/2. \tag{44}$$

The voltage $V(t)$ across the bolometer is

$$V(t) = (I_{dc} + \sqrt{2}I_{ac} \sin \omega t)(\overline{R} + r(t)). \tag{45}$$

On carrying through the multiplication and setting aside all dc, second and third harmonic components, the fundamental component $v_f(t)$ is:

$$v_f(t) = \sqrt{2}I_{ac}\overline{R} \sin \omega t + \frac{\sqrt{2}sI_{ac}}{\omega\tau}\left[2P_{dc} + \frac{1}{4}P_{ac}\right] \sin (\omega t - \pi/2), \tag{46}$$

where

$$P_{dc} = I_{dc}^2\overline{R},$$

$$P_{ac} = I_{ac}^2\overline{R}.$$

The first term on the right-hand side of the leading equation in (46) is the in-phase component of voltage that would be generated if the bolometer were purely resistive i.e., not power-sensitive, the second term is a voltage generated by the tendency of the bolometer resistance to follow the applied ac power and lags the applied current by 90 degrees. The total voltage lags the applied current by an angle

$$\psi = \tan^{-1}\left[\frac{s(8P_{dc} + P_{ac})}{4\omega\overline{R}\tau}\right]. \tag{47}$$

If the bolometer were a pure resistance R shunted by a capacitance C, the phase angle of the voltage across its terminals would be

$$\psi = \tan^{-1} \omega CR; \tag{48}$$

accordingly, the effective capacitance generated across the bolometer is

$$C = \frac{s[8P_{dc} + P_{ac}]}{4\omega^2\overline{R}^2\tau}. \tag{49}$$

If the total power is maintained constant but the ratio of dc to ac power varied, C will vary linearly with P_{dc}, and

$$\frac{s}{\tau} = \frac{4\omega^2\overline{R}^2}{7} \cdot \frac{dC}{dP_{dc}}. \tag{50}$$

In practice, the effective capacitance C is balanced out by an equal physical capacitance in an adjacent arm of the bridge. Care must be taken to suppress third harmonic at the null detector by suitable filtering or use of a sharply tuned amplifier.

ACKNOWLEDGMENT

We are indebted to Mr. Leonard Sweet of the Microwave Research Institute who patiently performed many of the measurements and calculations on which this paper is based.[11] Earlier work on this problem was also done by P. Mariotti.[12]

[11] L. Sweet, "A Study of the Error in the Measurement of Pulsed Microwave Power with Bolometers," M.E.E. Thesis, Polytech. Inst. of Brooklyn, Brooklyn, N. Y.; June, 1952.

[12] P. Mariotti, "A Study of Bolometer Errors as a Function of the Pulse Modulation of the RF Signal," M.E.E. Thesis, Polytech. Inst. of Brooklyn, Brooklyn, N. Y.; May, 1948.

Correspondence

Proceedings or Transactions?

Questions frequently arise—in Editorial Board discussions and among the reviewers of PROCEEDINGS papers—as to what should be published in the PROCEEDINGS OF THE IRE and what should be published in the various TRANSACTIONS. This statement will not settle the matter, but it does clarify the present situation and speculate about future possibilities.

One aspect of the current state of affairs is that of the twenty-three Professional Groups of the Institute, twenty-one publish TRANSACTIONS, while only ten of the twenty-one TRANSACTIONS appear regularly. Thus, in some fields of interest the PROCEEDINGS is the Institute's only facility for publication, and in some it is the only regularly published facility. As long as this situation persists, there must be a certain seeming inconsistency

in the publication policies of the PROCEEDINGS. In some fields the PROCEEDINGS will endeavor to publish all papers worthy of publication, and in other fields it will publish only a selected few of these papers. It is to be hoped, of course, that neither TRANSACTIONS nor PROCEEDINGS will publish papers which are not worthy of publication.

We hope that this inequity of coverage by the PROCEEDINGS is a temporary matter. While it continues, the PROCEEDINGS will have to cover some fields in more detail than is perhaps desirable and it may publish too little in the fields of the most active and effective Professional Groups. The remedy for this is obviously a continued expansion and improvement in the TRANSACTIONS, and effective liaison between the editors of TRANSACTIONS and the PROCEEDINGS.

Let us now consider the specific case in which a field is covered both by an active Professional Group with a fine TRANSACTIONS which appears regularly, and by the PROCEEDINGS. Among all papers worthy of publication, which should go to the PROCEEDINGS and which should go to the TRANSACTIONS? Above all, whatever the decision should be, papers should get into the right journal as promptly as possible. While an initial mistake might in some measure be remedied by republishing in the PROCEEDINGS a paper which appeared first in the TRANSACTIONS, this is bad, and papers will be reprinted only under the most unusual circumstances. A technical journal is most valuable and most interesting to its readers when its contents are fresh and new. What about simultaneous publication in the PROCEEDINGS and in the TRANSACTIONS? This is pointless, for the PROCEFDINGS reaches all members of the IRE. The problem, then, is to get the papers into the right journal the first time, and promptly.

It is not easy to lay down rules which will cover all papers. There is certainly a place in the PROCEEDINGS for review papers which summarize recent progress in a field, and for tutorial papers which teach new concepts and techniques of analysis. The PROCEEDINGS asks experts to write such papers.

Most of the material in the PROCEEDINGS is submitted unsolicited. In trying to lay down rules for reviewing papers, the Editorial Board has said that to appear in the PROCEEDINGS papers should be important enough to be of general interest (to a reasonable fraction of the Institute's 40,000 members). This has been further interpreted by saying that papers should represent either a contribution of permanent value, or sound work of great current interest.

In being more specific than this, one can only describe and comment on particular types of papers.

A paper submitted to the TRANSACTIONS or the PROCEEDINGS may constitute a sort of review or tutorial paper if it presents a rational approach to a new field quite clearly or completely, so that one unfamiliar or only slightly familiar with the field can use it. Such a paper may or may not contain important new information. If it is really good, it will be suitable for the PROCEEDINGS.

A paper may describe an important new invention or device. If this device has considerable present or potential importance, and if it has real novelty, the membership of the Institute should know about it promptly in a paper of length adequate to explain it clearly. Perhaps the author will want to treat at length many important details which are of interest largely to specialists; he should do so in the TRANSACTIONS. The PROCEEDINGS paper should, however, be a real technical paper and not a news item; it should be technically sound and complete enough so that a more detailed discussion can be based on it and can refer to it.

A new experimental result, or new theory, should be treated much as is a new invention or device.

Many papers are concerned with calculations of great importance, about, for example, vacuum tubes, networks, antennas, or solid-state devices. If a calculation exhibits a new and important principle which casts new light on important problems, it is suitable for the PROCEEDINGS. If it merely solves a particular difficult problem by ingenious but special methods, it will usually be of interest only to specialists. In such a case, the result, if it is important, can be conveyed to the general IRE membership through the abstracts of TRANSACTIONS papers which appear in the PROCEEDINGS, or through a letter to appear as Correspondence.

In all cases, we should ask, "Should people outside a particular Professional Group be told about the contents of the paper? Why should they be told? How much should they be told to make the telling a real technical communication and not a news note?"

Where should an author send his paper? If he believes that he has something to say to the entire IRE membership, he should send it directly to the PROCEEDINGS. If he is addressing only experts in his field, he should send it to the TRANSACTIONS. To assure the promptest publication the author should make the right choice.

Sometimes the author makes the wrong choice. It is up to the reviewers to be alert about this, and to recommend to the PROCEEDINGS or TRANSACTIONS a paper which they feel has been misdirected. This makes some sort of liaison desirable. Several PROFESSIONAL Groups have named one or more of their members to act as one of the three PROCEEDINGS reviewers on all papers in the field of their Group. This makes available at the time of the review for the PROCEEDINGS the opinion of a representative of the Professional Group.

The relationship between the TRANSACTIONS and the PROCEEDINGS must evolve. During this evolution, it is important that at each stage both the TRANSACTIONS and PROCEEDINGS publish promptly interesting and worthwhile material. The material must be worthwhile in each case, and perhaps the chief distinction must be between what is interesting to a large and heterogeneous group and with what is interesting to a specialized segment.

J. R. PIERCE
Editor, IRE

Impedance Matching

Matching an impedance to a transmission line by the use of a cascaded section of line is a well-known process. However, the range of terminating impedance that can be matched by this method, I believe, is not so well-known. Consider a lossless line of characteristic impedance R_0 to which is to be matched an arbitrary impedance $\bar{Z}=R+jX$ by means of another lossless line of lentgh d and characteristic impedance R_1 cascaded between the first line and the load as shown schematically in Fig. 1. The problem is to determine for what range of values of $\bar{Z}$ a match can be thus obtained for any values of R_1 and d.

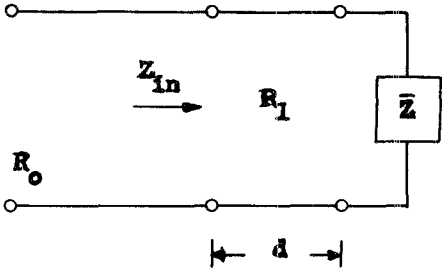

Fig. 1

A match is obtained when the input impedance to the matching line, Z_{in}, is equal to R_0. Thus, the impedance $\bar{Z}$ and R_0 must lie on the same p circle on a rectangular impedance chart. Depending on whether $R_0>R_1$ or $R_0<R_1$, we will have $R_0/R_1=p$ or $R_0/R_1=1/p$, where p is the standing-wave ratio. The equation of a constant p circle is

$$\left[\frac{R}{R_1}-\frac{1}{2}\left(p+\frac{1}{p}\right)\right]^2+\left(\frac{X}{R_1}\right)^2=\frac{1}{4}\left(p-\frac{1}{p}\right)^2. \quad (1)$$

This is seen to be invariant to a replacement of p by $1/p$. Thus, either $R_0/R_1=p$ or $1/p$ can be substituted in (1). If $R_0/R_1=1/p$ is substituted in (1) and the result is solved for R_1, we obtain

$$R_1=R_0\sqrt{\frac{R_0R-(R^2+X^2)}{R_0(R_0-R)}}. \quad (2)$$

Since R_1 is to be real, the radical must be positive. This condition yields

$$R-\frac{X^2}{R_0-R}>0. \quad (3)$$

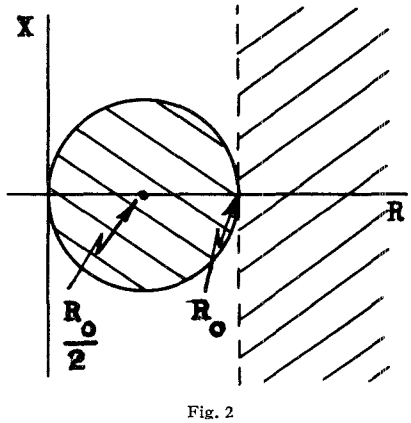

Fig. 2

The values of terminating impedance which satisfy this inequality lie in the cross-hatched areas shown in Fig. 2. For a terminating impedance lying in one of these areas an impedance match may be obtained by this method.

NORMAN BALABANIAN
Elec. Engrg. Dept.
Syracuse University
Syracuse, N. Y.