still compatible with measurements at variable frequency taken with fixed loads.

Another practical recommendation is to use more than four loads in order to increase the precision by some averaging. This also makes it possible to choose for the construction the points that show the best configuration; for instance, to avoid the use of points that are too close together.

Finally it should be noted that at a single frequency and when the wavelength is known, the quarter-wave spacing leads to a simpler construction. For variable frequency the measurements take less time when fixed short-circuit positions are used, but the interpretation is slightly complicated.

An obvious requirement when using this method is to have a good control on the frequency. In regions where the measured reflection coefficients vary rapidly with frequency, it may be advisable to go back to a measurement where the frequency is set and the short circuit moved.

Correspondence

WESCON Papers' Deadline Set for May 1

Authors wishing to present papers at the 1957 WESCON Convention to be held in San Francisco, Calif., on August 20–23 should send 100–200 word abstracts, together with complete texts or additional detailed summaries, to the Technical Program Chairman, D. A. Watkins, Stanford Electronics Laboratories, Stanford University, Stanford, Calif., for consideration by the Technical Program Committee. Authors will be notified whether or not their papers have been accepted by June 1.

For the first time this year, an IRE WESCON Convention Record will be published. It will include every paper presented at the 1957 WESCON and will be published immediately following the convention, for national distribution.

The IRE "Affiliate" Plan—A New Venture in Engineering Society Structure and Service

On January 4, 1957, the IRE Board of Directors arrived at a decision which may in time prove to be one of the most far-reaching in its 45-year history. On that date the Board adopted a plan which will enable non-IRE members whose main professional interests lie outside the sphere of IRE activities to become affiliated with certain of the IRE Professional Groups *without* first having to join the IRE itself.

This plan is aimed at those specialists in other fields of science and technology whose work touches upon our own electronics and communications field only in specialized areas. In effect, the IRE is extending the specialized services of its Professional Groups to every field of science and engineering.

An outstanding example of where these services are needed may be found in the case of the medical and biological sciences. At the present time some 1400 IRE members enjoy the privileges of membership in the Professional Group on Medical Electronics. And yet there are hundreds, perhaps thousands, of medical doctors, biologists, and others to whom the activities of this Group would be of interest and value. Both they and the Group would benefit from their participation. To require these persons, who have no interest in radio engineering, to join the IRE in order to join the Group is unreasonable, and probably futile as well. In fact, it was largely to provide an answer to this particular problem that the "Affiliate" Plan was first conceived, although it pertains to other fields as well, such as Computers, etc.

The "Affiliate" Plan is admittedly an experiment. So far as is known, no other society has ever tried a similar scheme. The Board of Directors feels strongly that the benefits afforded by the plan justify the risk that some persons who should join the IRE will instead become Affiliates. To minimize this risk, the plan has been carefully worked out along the following lines:

1) Participation in the Plan is at the option of each Professional Group. It is not expected that all Groups will adopt it; only those which feel it serves a need in their particular field.

2) Each Group interested in initiating the "Affiliate" Plan must submit to the Chairman of the Professional Groups Committee a list of accredited organizations which has been selected and approved by its Administrative Committee, for official approval by the IRE Executive Committee.

3) To be an Affiliate of a Professional Group, a person must belong to an accredited organization approved by that Group and the IRE Executive Committee. Moreover, he shall not have been an IRE member during the five years prior to his application. He may affiliate with more than one Group, provided the accredited organization to which he belongs is recognized by the Groups concerned.

4) The fee for Affiliates shall be the assessment fee of the Group, plus $4.50. The latter covers IRE subsidies to the Group, Professional Group overhead expenses borne by IRE Headquarters, and 50 cents which is to be rebated to IRE Sections for mailing and meeting costs.

5) An Affiliate will be entitled to receive the TRANSACTIONS of his Group and that part of the IRE NATIONAL CONVENTION RECORD pertaining to his Group. He will be eligible for a Group award, and may attend local or national meetings of the Group by payment of charges assessed Group members.

6) An Affiliate cannot serve in an elective office in the Group or Group Chapter, nor vote for candidates for these offices.

7) An Affiliate may hold an appointive office in the Group or Group Chapter.

8) An Affiliate may not receive any IRE benefits that are derived through IRE membership.

The "Affiliate" Plan is a bold and far-sighted venture; one that recognizes and provides for the rapidly spreading influence of electronics in every walk of scientific and technological life, and one that enables the IRE to further its aims as a professional engineering society—the advancement of radio engineering and related fields of engineering and science.

W. R. G. BAKER, *Chairman*
IRE Professional Groups Committee

Matching the Sides of a Parallel-Plate Region*

One of the simplest forms of electromagnetic wave is a TEM wave propagating between parallel conducting planes which extend laterally to infinity. It is perhaps not

* Received by the PGMTT, December 27, 1956.

widely known that a TEM mode may be sustained in a parallel plane region of finite width by closing the sides and including dielectric slabs as in Fig. 1. The field in

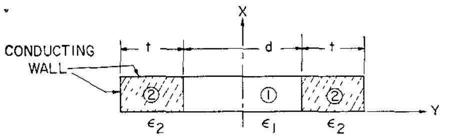

Fig. 1.

the dielectric-free region is strictly identical with a TEM mode at a single frequency (f_0) only; the curves of Fig. 2 have been prepared to show the bandwidth which may be achieved by permitting a given departure from a pure TEM mode.

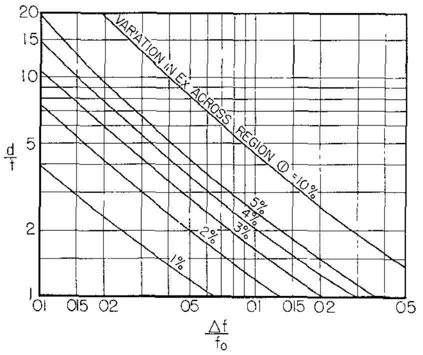

Fig. 2.

In region 1 of Fig. 1, the dependence of E_x on y may be expressed as

$$E_x \propto \cos \beta y. \quad (1)$$

The solution to Maxwell's equations for the case of Fig. 1 and assuming no variation with x is well known.

It is found that as the frequency is increased, β, which is real, decreases to zero and then becomes imaginary. The field which is identical to a TEM mode in region 1 is the degenerate case where $\beta=0$. In this case it may be shown that

$$\frac{t}{\lambda_1}\sqrt{\frac{\epsilon_2}{\epsilon_1}-1} = 0.25 \quad (2)$$

where the following nomenclature is used:

λ_1—Wavelength of a plane wave in an unbounded region of relative permittivity ϵ_1, *i.e.*, free space wavelength if region 1 is air-filled
ϵ_1—Relative permittivity in region 1
ϵ_2—Relative permittivity in region 2
t, d—Dimensions, in same units as λ_1
E_x—Electric field in x direction.

For a given wavelength and given value of ϵ_1 in region 1, (2) shows that there is a single infinity of pairs of t and ϵ_2 which are satisfactory, while d may have any value. If in a practical case, region 1 is the useful region, it would be desirable to minimize the width "t" of region 2. Eq. (1) shows that in this case the permittivity of the dielectric in region 2 should be as high as possible.

The above remarks apply only at a single frequency. To consider operation throughout a range of frequencies, the bandwidth may be defined in terms of allowable nonuniformity of E_x throughout region 1. This has been done in Fig. 2, which shows the amount of dielectric which must be used to obtain a given bandwidth. Curves are drawn for various allowable percentages of variation in E_x across region 1. At the low frequency end of the band the departure of E_x from uniformity across region 1 takes the form of a maximum at $y=0$, while at the high frequency end of the band E_x has a minimum at $y=0$.

For a given bandwidth (Δf) and permissible variation of E_x across region 1, Fig. 2 will give the parameter (d/t). By a slight rearrangement of (2):

$$\frac{d}{\lambda_1}\sqrt{\frac{\epsilon_2}{\epsilon_1}-1} = 0.25\frac{d}{t}\cdot \quad (3)$$

Using this relation, and assuming λ_1 to be known,

$$d\sqrt{\frac{\epsilon_2}{\epsilon_1}-1}$$

is established. It is interesting to note that regardless of how large d is, the bandwidth requirement may be met in practice merely by reducing ϵ_2/ϵ_1 toward unity. In some cases this may imply the use of drilled or expanded dielectrics. There is no lower limit to d either, since if ϵ_2 becomes inconveniently large, it is merely necessary to choose a *better* condition, *i.e.*, smaller per cent variation in E_x, from Fig. 2.

The following explanation may help to provide a physical picture. The TE_{01} mode of a rectangular waveguide of width a has a wavelength longer than the free space wavelength of a plane wave. If the waveguide is now filled with dielectric, the wavelength will be reduced. Hence there must be some dielectric constant for each value of a which restores the wavelength to its free space value. This is identically the relation given by (2) if we consider: 1) "free space" has been generalized to any dielectric medium of permittivity ϵ_1; 2) $a=2t$; and 3) $d=0$.

If now we reintroduce region 1 by splitting the waveguide and tapering it outward as in Fig. 3, it is at least plausible

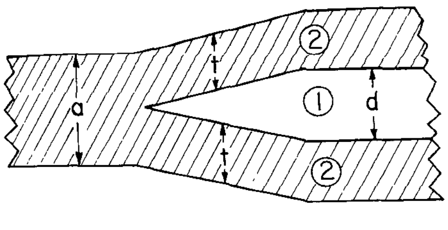

Fig. 3.

that the field in region 1 will resemble a TEM mode.

In practice, the configuration of Fig. 3 provides a possible method of setting up such a mode.

For completeness, it may be mentioned that the values of t and ϵ_2 could be different in each part of region 2.

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A Method of Analysis of Symmetrical Four-Port Networks*

The following errors appeared in the above article.[1] On page 248 the C term in the matrix for Fig. 11 should be $j(-a^2c^2+2ac+a^2-1)$. Also, on page 249 the term for T_{+-} for the rat race ring should be $T_{+-}=-j/\sqrt{2}$.

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* Received by the PGMTT, November 25, 1956.
[1] J. Reed and G. J. Wheeler, IRE TRANS., vol. MTT-4, pp. 246–252; October, 1956.

Miniature Waveguide Flanges Unpressurized Contact Type*

I would like to call attention to the fact that RETMA Standard RS-166 with the above title and dated October, 1956, has been released. Copies of the Standard can be obtained through the Engineering Department of the RETMA, 11 West 42nd Street, New York 36, N. Y.

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* Received by the PGMTT, November 29, 1956.

Criteria for the Design of Loop-Type Directional Couplers for the L Band*

We have noted several errors in the above article[1] and the corrections are as follows:

Eq. 5(b) should read:

$$V_B \cong +\sqrt{\frac{Z_{20}}{Z_{01}}}\left(\frac{k_L-k_C}{4}\right)\cdot[1-\cos\beta_0(k_C+k_L)l\epsilon^{-j2\beta_0 l}].$$

Eq. (7) should read:

$$D = 20\log_{10}\left|\frac{k_L-k_C}{k_L+k_C}\right|\frac{\sin\beta_0 l}{\beta_0 l}\cdot$$

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* Received by the PGMTT, November 1, 1956.
[1] P. P. Lombardi, R. F. Schwartz, and P. J. Kelly, IRE TRANS., vol. MTT-4, pp. 234–239; October, 1956.