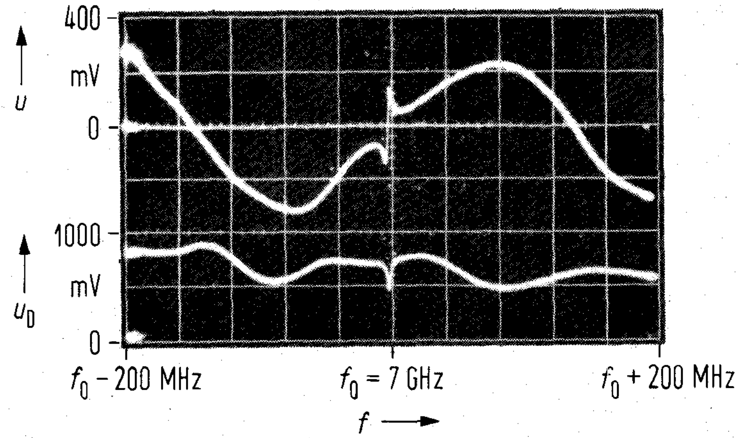

Fig. 2. Discriminator voltage u and diode voltage u_D as a function of frequency.

With respect to Dr. Freude's Figs. 1 and 2, the operation of his attenuator B at greater than zero dB is not desirable for making FM noise measurements. Since the absorption filter prevents the carrier power from overdriving the balanced mixer, attenuator B should have minimum loss to allow the noise sidebands to be as large as possible in order to over-ride the noise in the mixer diodes.

In [3], we called attention to the work of Fikart *et al.* [8], [9] on the effect of resonator detuning in the AM noise measurement. The analysis of noise measurement discriminators has been further advanced by Brozovich [10]. A new result on the bandwidth of the simplest of transmission-line discriminators was given at the 1983 MTT International Symposium by Ashley *et al.* [11].

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[6] W. Freude, "Ein Ratiodetektor im Mikrowellenbereich," *Arch. Elek. Übertragung*, vol. 27, pp. 389–396, Sept. 1973. Erratum: Fifth line after (1), instead of $|S_{12}| \approx |S_{23}|$ read $|S_{21}| \approx |S_{32}|$; (13) and (17), instead of $\sqrt{AB}$ read $\sqrt{AB/(A+B)}$; First line after (13), instead of $\sqrt{AB/(A+B)}$ read $\sqrt{AB}/(A+B)$; (34), instead of S read $2S$.

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Comments on "The Design Parameters of Nonsymmetrical Coupled Microstrips"

V. K. TRIPATHI, MEMBER, IEEE

A recent paper [1] dealt with the subject of the design parameters of nonsymmetrical coupled microstrips for applications as microwave circuit elements. In this brief correspondence, the completeness and consistency of some of the results presented in the paper are examined and the existence of an earlier relatively comprehensive work reported on the same subject is pointed out [2].

First of all, it must be noted that, in general, the nonsymmetrical uniformly coupled inhomogeneous line system has six degrees of freedom, i.e., six independent variables are required to analyze and formulate design procedures for any circuit consisting of nonsymmetrical coupled microstrips [3], [4]. These six variables can be the equivalent line constants, that is, the self- and mutual-capacitances and inductances of the structure per unit length, or the six independent normal mode parameters derived from the line constants. There are eight normal mode parameters defined in [3], of which six are independent, e.g., β_c, β_π, R_c, R_π, Z_{c1}, and $Z_{\pi1}$ or β_c, β_π, R_c, or R_π, and three of the four impedances. The other two variables can be determined from $Z_{c2}/Z_{c1} = Z_{\pi2}/Z_{\pi1} = -R_cR_n$ [3]. It should be mentioned that for certain special so-called congruent cases of coupled microstrips where even-voltage and odd-current modes can be defined, i.e., R_c is nearly equal to 1, only five variables need to be specified which can be the phase constants and three out of four mode impedances [3]. In the article under discussion, [1, fig. 7] representing the design data for a special but useful case of substrate material only gives impedances or three independent parameters. At least one of the mode–voltage ratios and both phase constants must also be specified for any analysis and design of a coupled-line circuit. The normal mode effective dielectric constants are given in [1, fig. 5] only for a special case of $S = 0.4$ mm in connection with the dispersion model.

From the statements made in the article [1] regarding the absence of any design data, it seems that the authors were not aware of an earlier study reported on the same subject [2]. In that

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The author is with the Department of Electrical and Computer Engineering, Oregon State University, Corvallis, OR 97331.

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paper [2], the quasi-TEM parameters of nonsymmetrical coupled microstrips were computed by utilizing the Green's function integral equation method. The computed results for all the normal mode parameters as a function of substrate dielectric constants, nonsymmetry, and geometry of the structure were presented in that paper for several typical cases.

The dispersion model reported in [1] does not appear to be consistent in that the results obtained for a given coupled microstrip system are dependent on whether the wider or the narrower line is referred to as line 1, which, of course, cannot be the case. The problem lies in the derivation of the expressions of the "total" mode impedances which are to be used in Getsinger's parallel coupled microstrip formula [5]. The author's attempt to modify the source and impedance of one line after exciting a given mode with voltage sources [1, figs. 3 and 4] results in modified voltage and power on that line associated with that mode, and the resulting modified circuit is not equivalent to the original one. The total mode impedances in the manner of [5] can, however, be defined for the special congruent case where $R_c \cong 1$ (partially implied in [1] for the π mode value). For this case, the mode voltage and current ratios for the two normal modes are given by [3]

$$V_1 = V_2 \text{ and } I_1 = -I_2 R_\pi \text{ for the } c \text{ mode}$$
$$I_1 = -I_2 \text{ and } V_2 = R_\pi V_1 \text{ for the } \pi \text{ mode.} \tag{1}$$

The two modes can be excited for this case by equal voltage sources for the c mode and equal, but opposite, current sources for the π mode, enabling one to define the "total" mode impedances in exactly the same manner as in [5] leading to

$$Z_{c(\text{total})} = Z_{c1} Z_{c2} / (Z_{c1} + Z_{c2}) \text{ and } Z_{\pi(\text{total})} = Z_{\pi 1} + Z_{\pi 2}. \tag{2}$$

These impedance values can be used to estimate the effect of dispersion if Getsinger's model as given in [5] is to be utilized.

The following example is given to illustrate the above points. For a nonsymmetrical coupled microstrip structure with $W_1 = 0.6$ mm, $W_2 = 1.2$ mm, $S = 0.4$ mm, $h = 0.635$ mm, and $\epsilon_r = 9.7$, the computed normal mode parameters [2] are found to be:

$$\begin{aligned} c \text{ mode} \quad & \epsilon_{\text{eff}} = 7.33, \quad R_c = 1.093, \\ & Z_{c1} = 63.07\Omega, \quad Z_{c2} = 38.8\Omega, \\ \pi \text{ mode} \quad & \epsilon_{\text{eff}} = 5.83, \quad R_\pi = -0.563, \\ & Z_{\pi 1} = 43.73\Omega, \quad Z_{\pi 2} = 26.9\Omega. \end{aligned}$$

In addition to the effective dielectric constants and impedances of the two normal modes, the values R_c or R_π are required to analyze any circuit consisting of parallel coupled microstrips having the substrate material and dimensions given above. If lines 1 and 2 are interchanged, i.e., $W_1 = 1.2$ mm, $W_2 = 0.6$ mm and all the other dimensions are kept the same, the normal mode parameters obtained are the same as those given above with subscripts 1 and 2 interchanged, except for R_c and R_π. The new $R_c = 0.915$ ($=1/1.093$) and the new $R_\pi = -1.776$ ($=-1/0.563$). The structure is *identical* to that considered before with the same network functions, etc., with properly interchanged subscripts. The two structures must have the same eigenvalues, and the normal mode effective dielectric constants must have identical frequency dependent behavior. However, use of the total mode impedance given in [1, eqs. (13) and (14)] gives $Z_{c(\text{total})} = 22.71\ \Omega$ and $Z_{\pi(\text{total})} = 91.47\ \Omega$ for the former case of $W_1 = 0.6$ mm and $W_2 = 1.2$ mm and $Z_{c(\text{total})} = 24.82\ \Omega$ and $Z_{(\text{total})} = 51.52\ \Omega$ for the later case of $W_1 = 1.2$ mm and $W_2 = 0.6$ mm. These parameters lead to two very different sets of dispersion characteristics, particularly for the π-mode which, of course, is not possible. Only for a class of structures for which $R_c \simeq 1$, the application of the total mode impedances as given by (2) results in the resolution of this problem if the model given in [5] is to be used. For this example, we get $Z_{c(\text{total})} = 24.02\ \Omega$ and $Z_{\pi(\text{total})} = 70.63\ \Omega$, and these impedances lead to results that are reasonably close to those obtained by Jansen [6].

Reply[1] *by N. A. El-Deeb et al.*[2]

The authors of the original paper [1] were aware of Jansen's results [6], but were not aware of the results of Tripathi and Chang [2] who used another approach. Therefore, they produced results that can be compared with that of Jansen. In addition, the variation of the modal impedances of the system with its geometric dimensions were illustrated [1, fig. 7] for a reasonable range of dimensions. To determine these modal impedances it is clear, from [1, eqs. (9) and (10)], that the mode numbers (R_c, R_π) and the modes effective dielectric constants ($\epsilon_{\text{reff}c}, \epsilon_{\text{reff}\pi}$) should have been determined. Their variations with the geometric dimensions of the system were not presented in [1] due to limited allowed space. However, they are presented in an easy-to-use manner in an "application" paper recently submitted by some of the authors of [1] to this TRANSACTIONS.

The dispersion model introduced in [1] was clearly claimed to be only an "approximate" model. The involved approximations include almost all of the remarks mentioned in the letter but they were not discussed in detail. The reason is that their influence on the final results, the dispersive modal impedances, is reasonably small, as will be shown, and not so drastic as may be concluded from the letter. Also, the basic Getsinger's model [5] is only an empirical model. Therefore, associating it with an approximate generalization of the intermediate parameter Z_{eq} is, in the authors' opinion, preferable than associating it with the special, but exact, case of congruence.

To illustrate these facts, the data given in the example of the letter were used to determine the dispersive modal impedances at 10 GHz.

For the first case ($W_1 = 0.6$ mm, $W_2 = 1.2$ mm,... etc), the dispersive modal impedances at 10 GHz as determined according to [1] are: $Z_{c1} = 65.60\ \Omega$, $Z_{c2} = 40.36\ \Omega$, $Z_{\pi 1} = 45.05\ \Omega$, and $Z_{\pi 2} = 27.71\ \Omega$. For the second case (where W_1 and W_2 are interchanged), the corresponding impedances, determined in a similar manner, are given by: $Z_{c1} = 40.53\ \Omega$, $Z_{c2} = 65.89\ \Omega$, $Z_{\pi 1} = 27.27\ \Omega$, and $Z_{\pi 2} = 44.33\ \Omega$. Thus, the deviation of the latter results from the former ones is about 0.44 percent for the C-mode impedances and about -1.6 percent for the π-mode impedances, which is reasonably small. However, an average of the above results can be suggested as a good compromise. When using (2) in the latter, congruent case, the corresponding dispersive modal impedances are given by: $Z_{c1} = 65.72\ \Omega$, $Z_{c2} = 40.43\ \Omega$, $Z_{\pi 1} = 44.58\ \Omega$, and $Z_{\pi 2} = 27.43\ \Omega$. These results are in between the results of the aforementioned cases. Therefore, the proposed averaging of these latter results, while still having the sense of generality, should give a better estimate.

Finally, the authors would like to thank V. K. Tripathi for his remarks and for providing [2]. These remarks, together with the present reply, should clarify and prevent any future misinterpretation of the results of [1].

[1]Manuscript received December 5, 1983.
[2]The authors are with the Department of Electrical Engineering, Military Technical College, Cairo, Egypt.

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Patent Abstracts

These Patent Abstracts of recently issued patents are intended to provide the minimum information necessary for readers to determine if they are interested in examining the patent in more detail. Complete copies of patents are available for a small fee by writing: U.S. Patent and Trademark Office, Box 9, Washington, DC 20231.

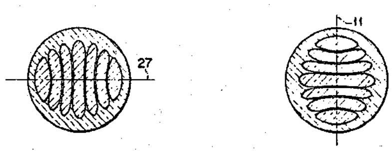
4,400,055 Aug. 23, 1983

Optical Power Distributor and Method for Manufacturing the Same

Inventors: Takeshi Ozeki, Shigeru Ohshima.
Assignee: Tokyo Shibaura Denki Kabushiki Kaisha.
Filed: Mar. 29, 1982.

Abstract—A pair of optical fibers are arranged parallel in contact. A portion of the pair is thermally fused to form a biconical taper waist. The biconical taper waist is cleaved at its thinnest portion, thus dividing the pair of optical fibers into two sections each having a tapered portion at one end. One of the sections is rotated by 90°, and its tapered portion is butted on the tapered portion of the other section, while keeping the axes of both sections aligned. The tapered portions thus butted are then thermally fused to couple the sections together, thus providing an optical power distributor. At the thinnest portion of the waist, one of the cores of one section overlaps both cores of the other section.

7 Claims, 12 Drawing Figures



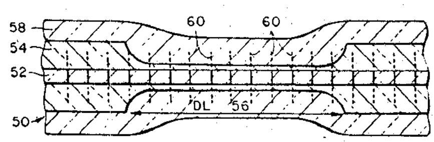
4,400,056 Aug. 23, 1983

Evanescent-Wave Fiber Reflector

Inventor: Paolo G. Cielo.
Assignee: Her Majesty the Queen as represented by the Minister of National Defence of her Majesty's Canadian Government.
Filed: Mar. 17, 1981.

Abstract—A tunable optical fiber reflector is described, together with a method of making the same. A length of optical fiber has a core of a first light transmitting material, and a cladding of a second light transmitting material covering the core. The cladding is etched away to a predetermined thickness over a portion of the fiber. A layer of photoresist material is applied either to the etched away portion of the fiber or to a thin metal blade, i.e., mask, and then exposed to beams of light which optically interfere and generate a standing wave pattern in said material. The photoresist material is then developed to fix said wave pattern therein. An optical discontinuity is formed in one of the core and cladding by that fixed wave pattern, said discontinuity representing a quasi-periodical fluctuation in the refractive index and causing evanescent waves in the cladding to be reflected. Such discontinuity forms a distributed-feedback reflector. In one method, the fiber core in the etched portion is bombarded under a vacuum with a beam of ions passed through openings having said standing wave pattern, thus producing quasi-periodical fluctuations in the refractive index of the core. More preferably, the photoresist material is coated on the etched portion of the fiber, and counter-propagating light beams are coupled into opposite ends of the fiber. These beams expose the photoresist material and generate the standing wave pattern therein as residual quantities of the same. The etched portion of fiber is typically filled with reinforcing material such as an epoxy. Two such reflectors in an optical fiber make up a resonator, and several resonators can be used in a hydrophone line-array.

5 Claims, 5 Drawing Figures



4,400,669 Aug. 23, 1983

Magnetostatic Wave Delay Line Having Improved Group Delay Linearity

Inventors: Michael R. Daniel, John D. Adam, Robert A. Moore.
Assignee: The United States of America as represented by the Secretary of the Air Force.
Filed: Sept. 25, 1981.

Abstract—The linearity of group delay versus frequency in magnetostatic wave delay lines is improved by a linear variation of one of three discrete parameters in the region between the two delay line transducers. The parameter variation is applied to magnetostatic wave delay lines that have a ground