and the recommended[2] operating wavelength range is

$$\lambda = F\lambda_c \quad \text{where} \quad 0.635 < F < 0.870.$$

The generalized expression for differential phase shift may be written

$$r(\beta_1 - \beta_2) = \frac{C_2}{F}\left[\sqrt{\left(1 - \left(\frac{C_1 F}{\lambda_{c1}/r}\right)^2\right)} - \sqrt{\left(1 - \left(\frac{C_1 F}{\lambda_{c2}/r}\right)^2\right)}\right] \text{ degrees} \quad (3)$$

where

$$C_1 = 2\pi/1.841184$$

$$C_2 = 360/C_1$$

and λ_{c1}/r, λ_{c2}/r are known for values of d/r where d is the penetration depth of each metal plate

Curves (Fig. 2) of $r(\beta_1 - \beta_2)$ vs d/r have been computed for values of F between 0.63 and 0.88. They may be used for the design of circular polarizers in any circular waveguide operated at a wavelength within the recommended range.

A circular polarizer was constructed us- 0.031 inch plates in 0.986 inch diameter circular waveguide. An elliptically polarized field analyzer (Fig. 3) was used to measure the magnitude and orientation of the polarization ellipses obtained. These quantities suffice to determine[3,4] the actual phase shift introduced by the plate at each operating frequency.

A comparison between computed and experimentally determined phase shift constants is shown in Fig. 4. There is agreement to within 0.2° per inch, this being the maximum deviation of any experimental point about the computed curve.

The percentage bandwidths obtainable with this type of polarizer have been computed for plates from three to fifteen radii in length (Fig. 5). The bandwidth to 3 db ellipticity is approximately constant (27 ±1 per cent) for plates greater than four radii in length. Matching of the plates by some form of stepping is normally unnecessary.

John R. Pyle
Weapons Research Establ.
Adelaide, Australia

[2] "Military Standard Specification MIL-W-23068," Armed Service Technical Information Agency, Arlington, Va., Rept. No. MIL-W-23068; October, 1961.

[3] "Very High Frequency Techniques," Radio Research Lab. Staff, Harvard University, Cambridge, Mass., published by McGraw-Hill Book Co., Inc., 1st ed., vol. 1, ch. 6, 1947.

[4] "Reference Data for Radio Engineers," Internatl. Telephone and Telegraph Corp., published by Stratford Press Inc., New York, N. Y., 4th ed., ch. 23, pp. 666-670; 1961.

Design Curves for Interdigital Band-Pass Filters

Band-pass filters may be constructed using interdigital arrays of quarter-wave stripline resonators as shown in Fig. 1. Interdigital filters are attractive in that they are

1) compact
2) easily fabricated without tight tolerances
3) free of spurious responses at twice the pass-band frequency, f_0 (second passband is at $3f_0$).

Matthaei[1] gives design equations for interdigital filters of prescribed bandwidth and number of cavities N. The low-pass prototype elements are found from tables.[2,3] The widths and spacings of the stripline resonators are determined using Getsinger's[4] charts of capacitance for coupled rectangular bars between parallel plates.

Experience has shown that to design one band-pass filter using the above references may take up to two hours especially if the operator is unfamiliar with the procedure. The author has used an IBM 7090 computer to carry out all the operations necessary for the design of an interdigital bandpass filter. The program[5] consists of about 200 cards and requires 2 seconds execution time per filter.

Figs. 2 to 9 (pages 560-567) give computed widths W_K and spacings $S_{K,K+1}$ of interdigital stripline arrays of N cavities. The curves may be used to design maximally flat and Chebyshev type filters having bandwidths up to ten per cent and values of N between three and eight. Filter parameters are given in inches for the commonly used 0.0625 inch brass strip between ground planes spaced at 0.3125 inch (*i.e.*, $t/b = 0.2$). Designers may use the curves for different ground plane spacings, b provided that $t/b = 0.2$, and the values of W_K and $S_{K,K+1}$ are multiplied by $b/0.3125$.

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John R. Pyle
Weapons Research Establ.
Adelaide, Australia

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[1] G. L. Matthaei, "Interdigital band-pass filters," IRE Trans. on Microwave Theory and Techniques, vol. MTT-10, pp. 479-491; November, 1962.

[2] "The Microwave Engineers' Handbook and Buyers' Guide," p. 95, 1964.

[3] L. Weinberg, "Additional tables for design of optimum ladder networks," *J. Franklin Inst.*, vol. 246, pp. 7-23, 127-138, July and August, 1957.

[4] W. J. Getsinger, "Coupled rectangular bars tween parallel plates," IRE Trans. on Microwave Theory and Techniques, vol. MTT-10, pp. 65-72; January, 1962.

[5] J. R. Pyle, "IBM Programme I.G.4.10.26" Weapons Research Establishment; January, 1964.

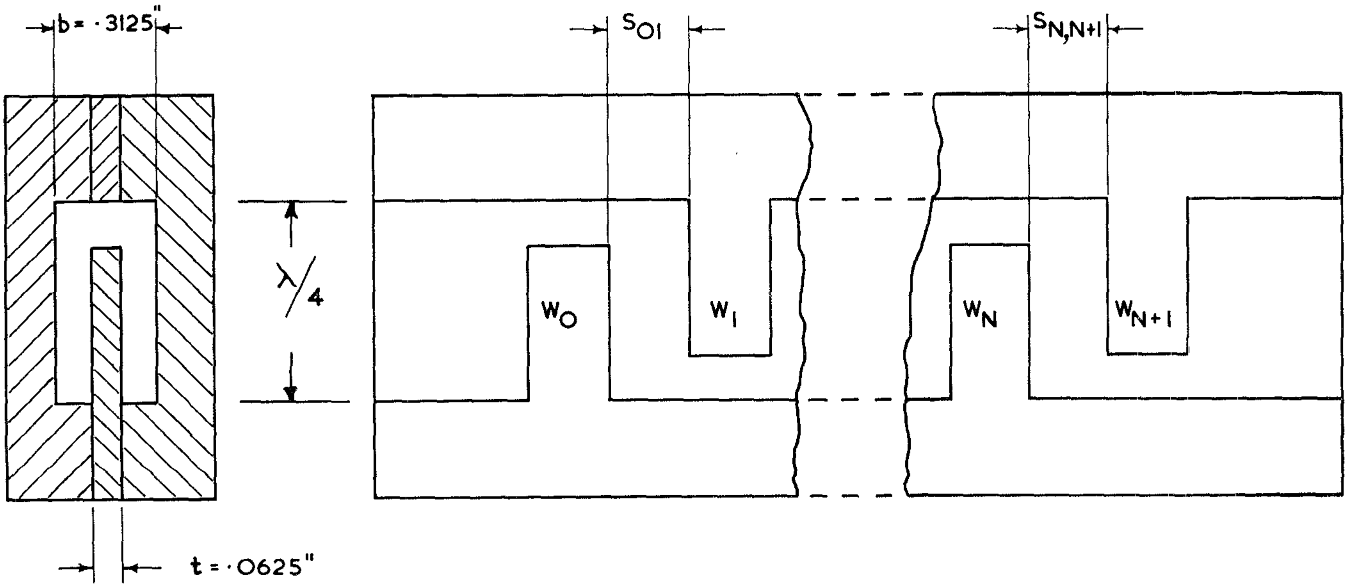

Fig. 1—Construction of an interdigital stripline band-pass filter array of N cavities.

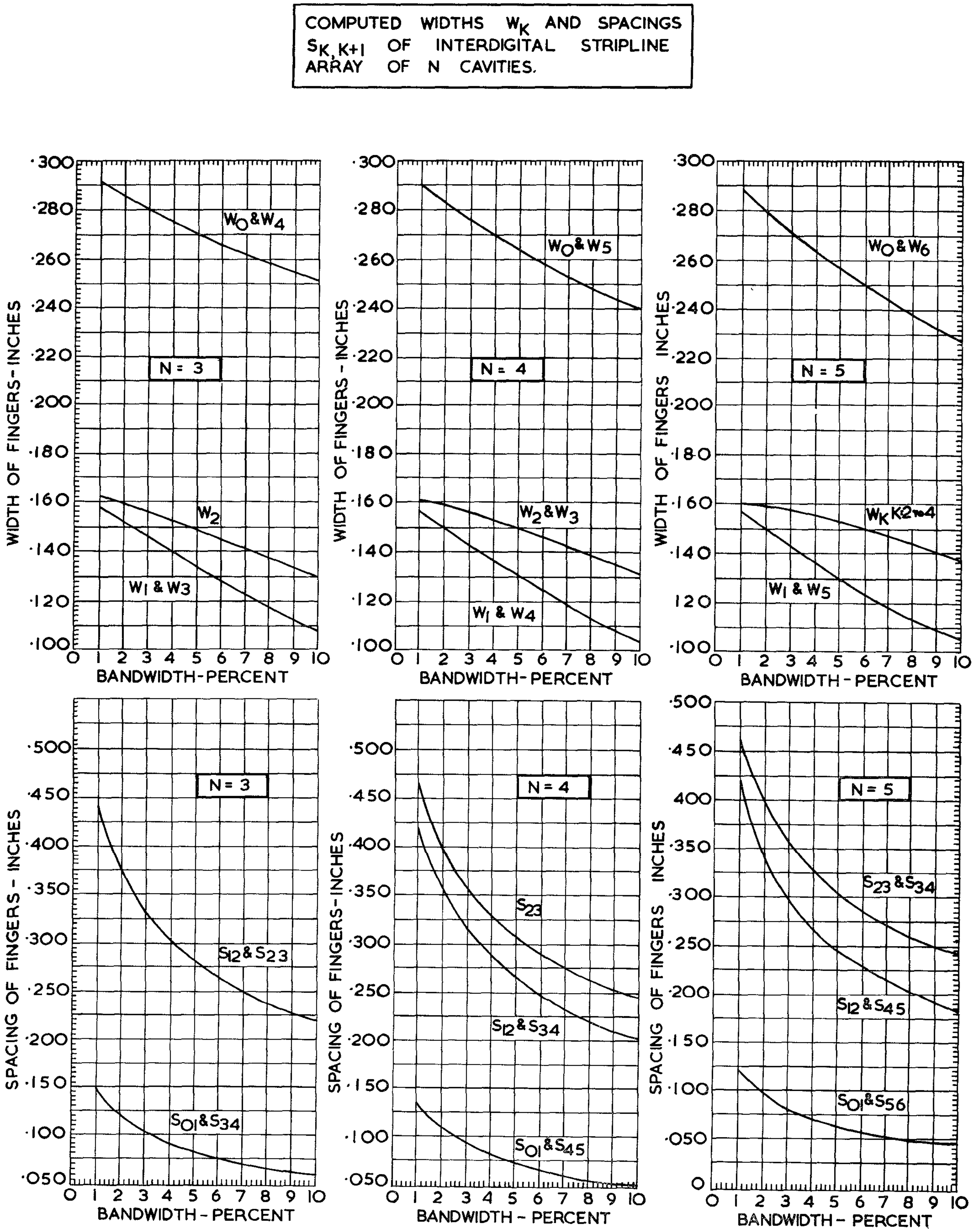

Fig. 2—Interdigital stripline band-pass filter maximally flat amplitude response.

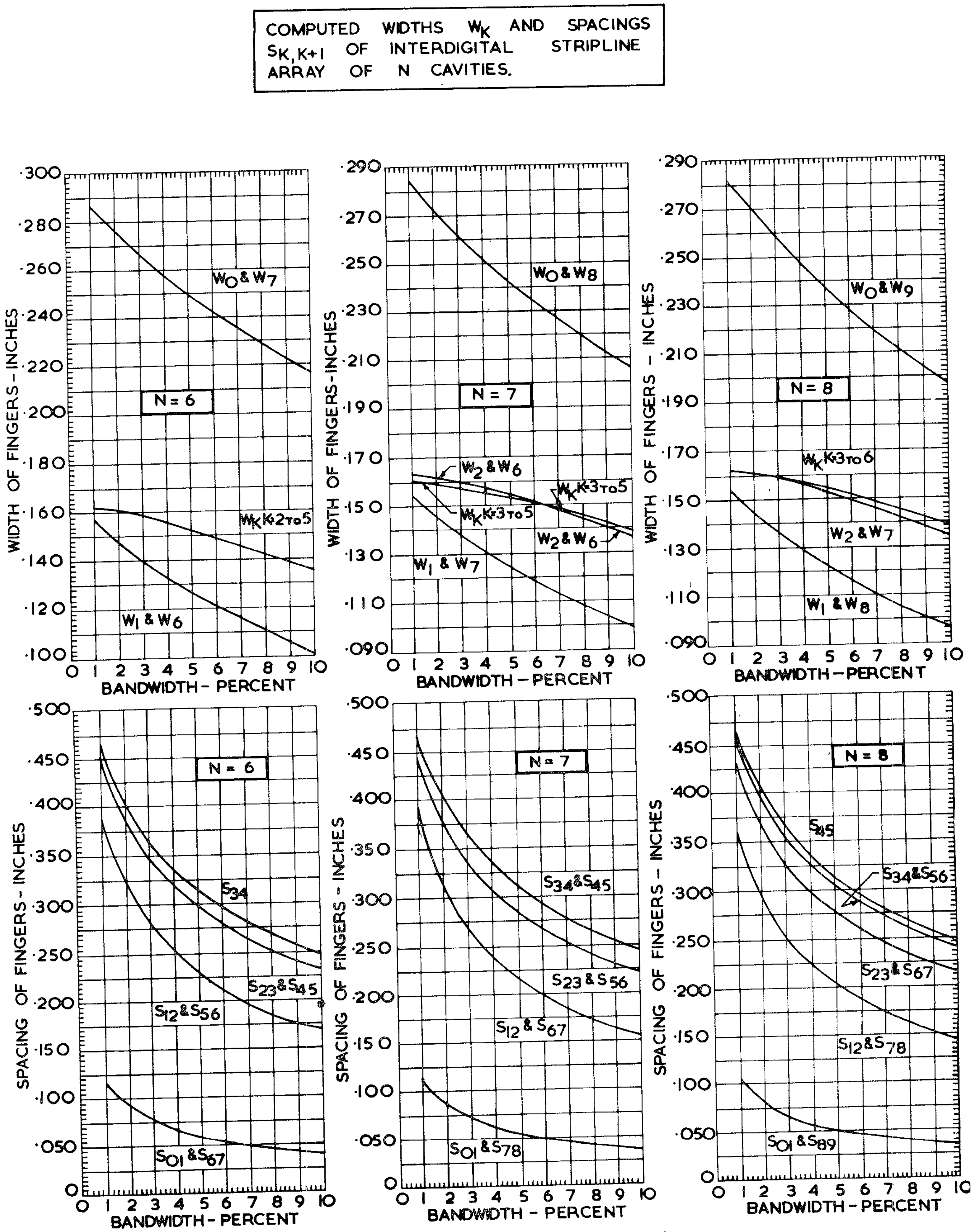

Fig. 3—Interdigital stripline band-pass filter maximally flat amplitude response.

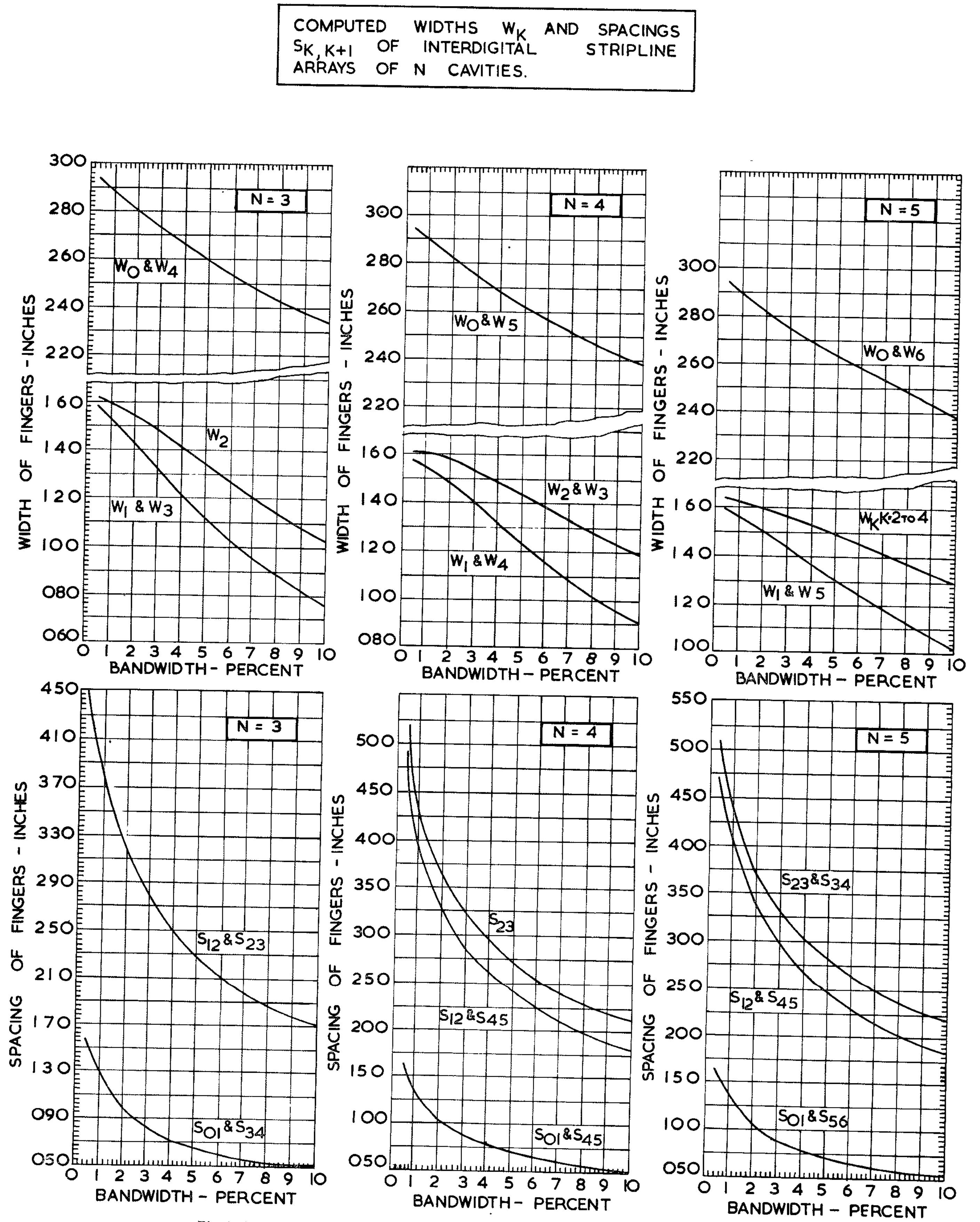

Fig. 4—Interdigital stripline band-pass filter Chebyshev response with 0.01 db pass-band ripple.

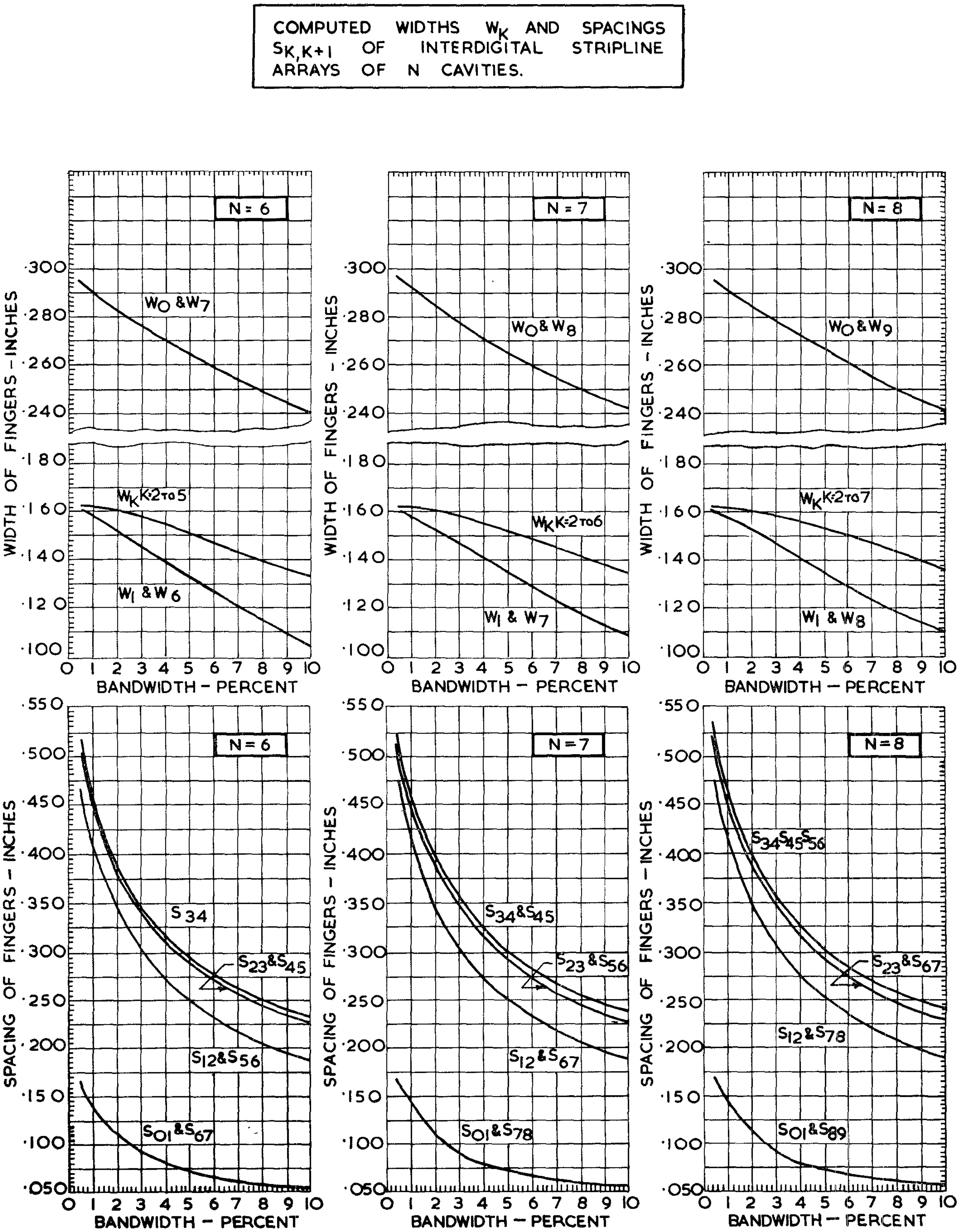

Fig. 5—Interdigital stripline band-pass filter Chebyshev response with 0.01 db pass-band ripple.

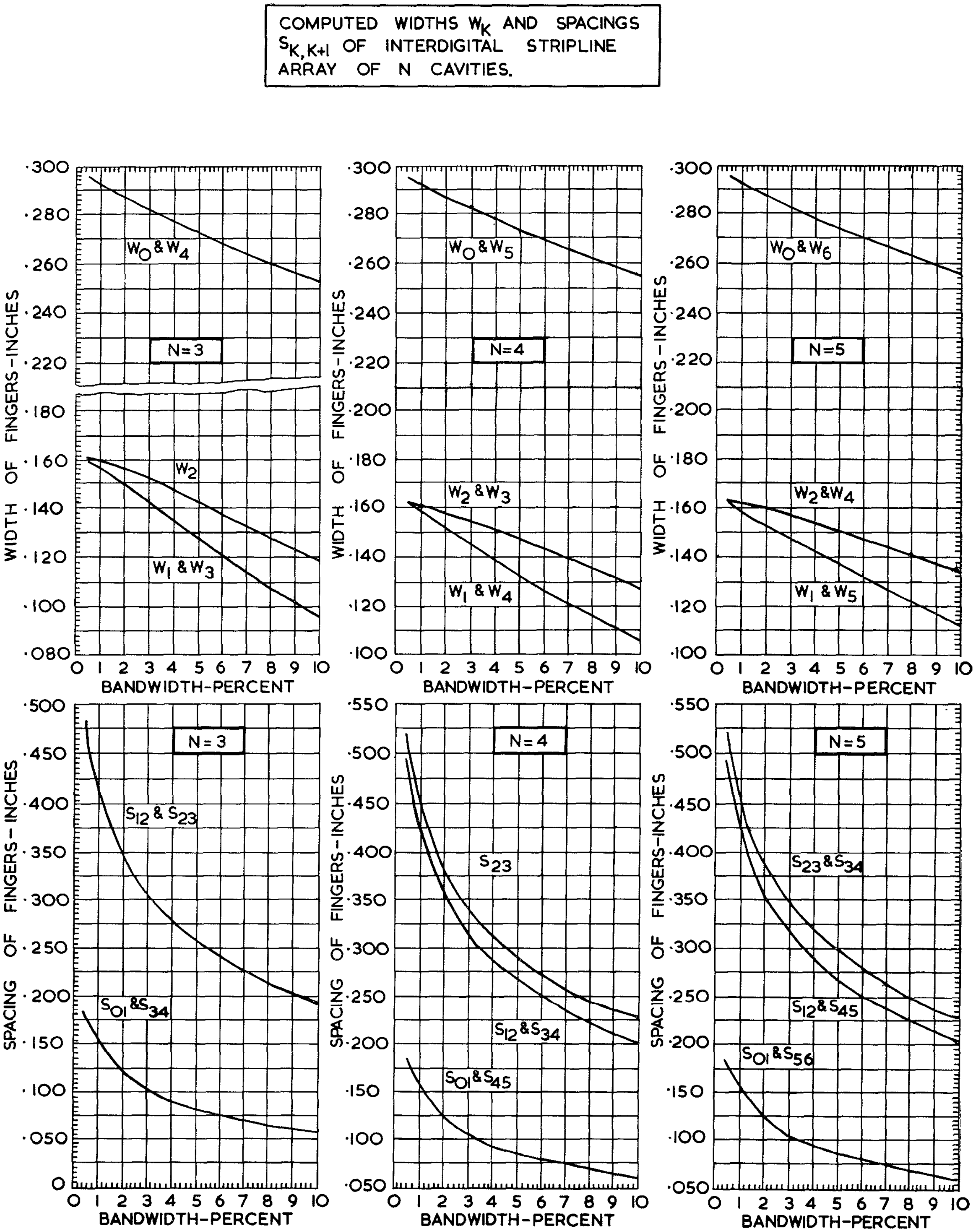

Fig. 6—Interdigital stripline band-pass filter Chebyshev response with 0.1 db pass-band ripple.

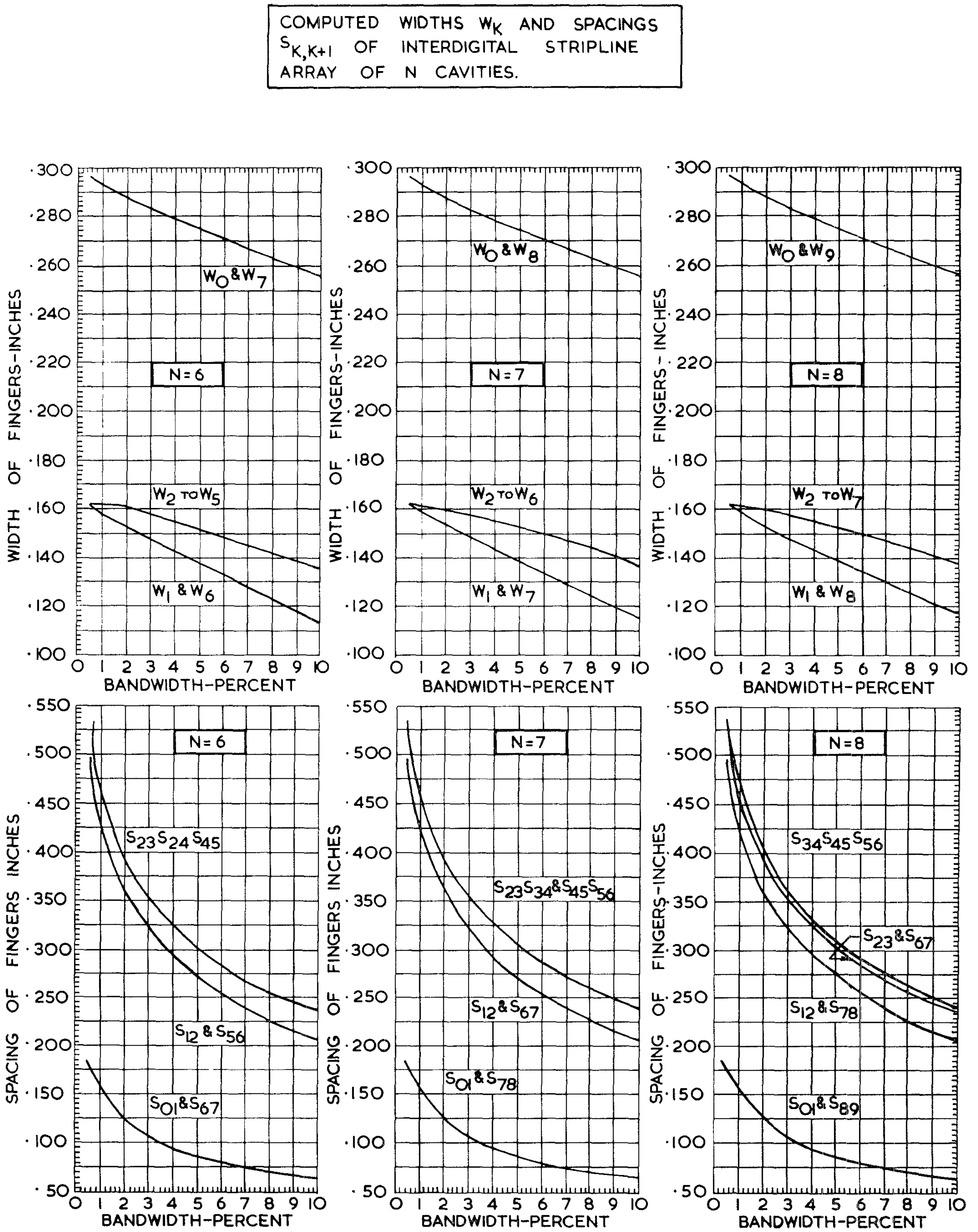

Fig. 7—Interdigital stripline band-pass filter Chebyshev response with 0.1 db pass-band ripple.

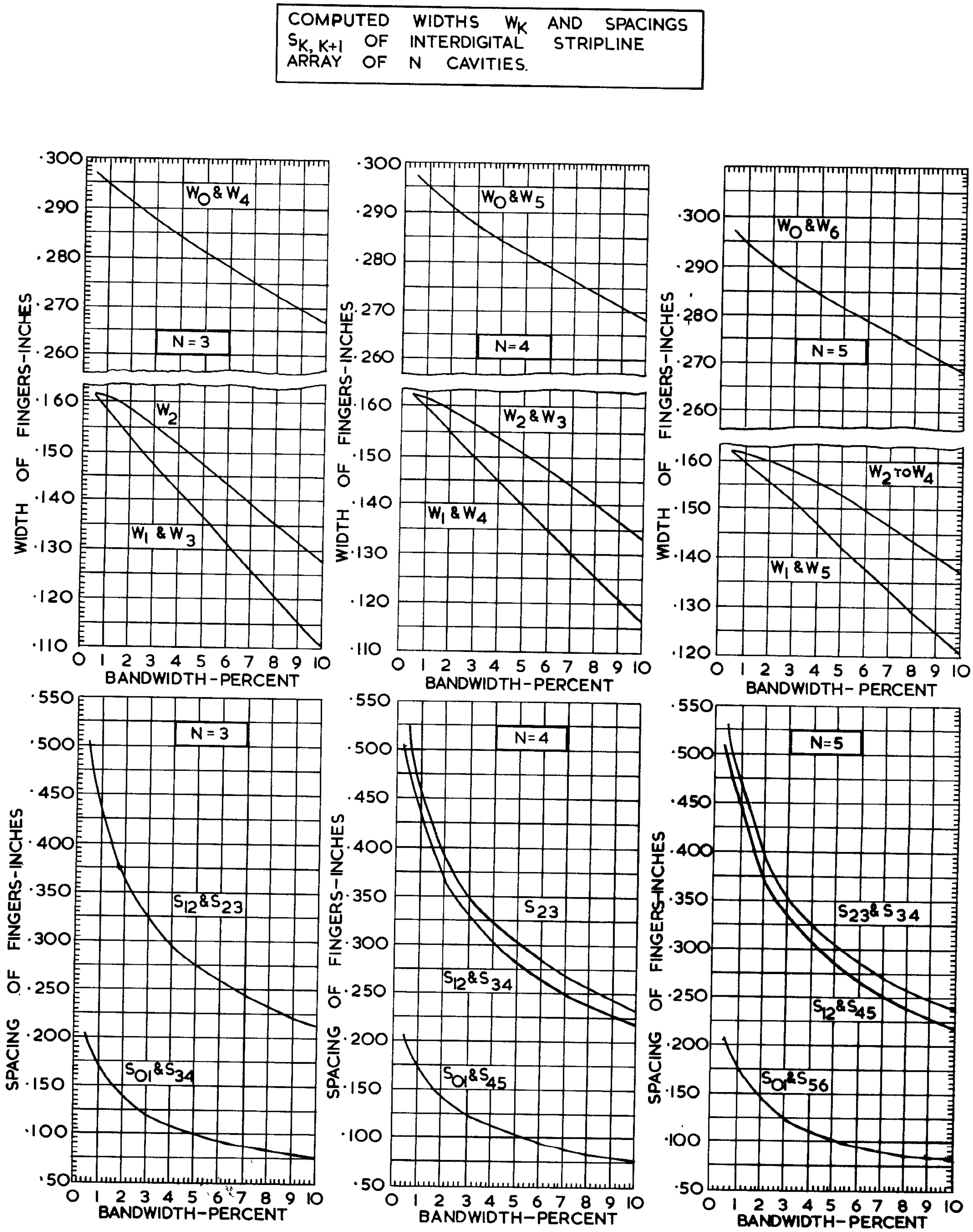

Fig. 8—Interdigital stripline band-pass filter Chebyshev response with 0.5 db pass-band ripple.

COMPUTED WIDTHS W_K AND SPACINGS $S_{K,K+1}$ OF INTERDIGITAL STRIPLINE ARRAYS OF N CAVITIES

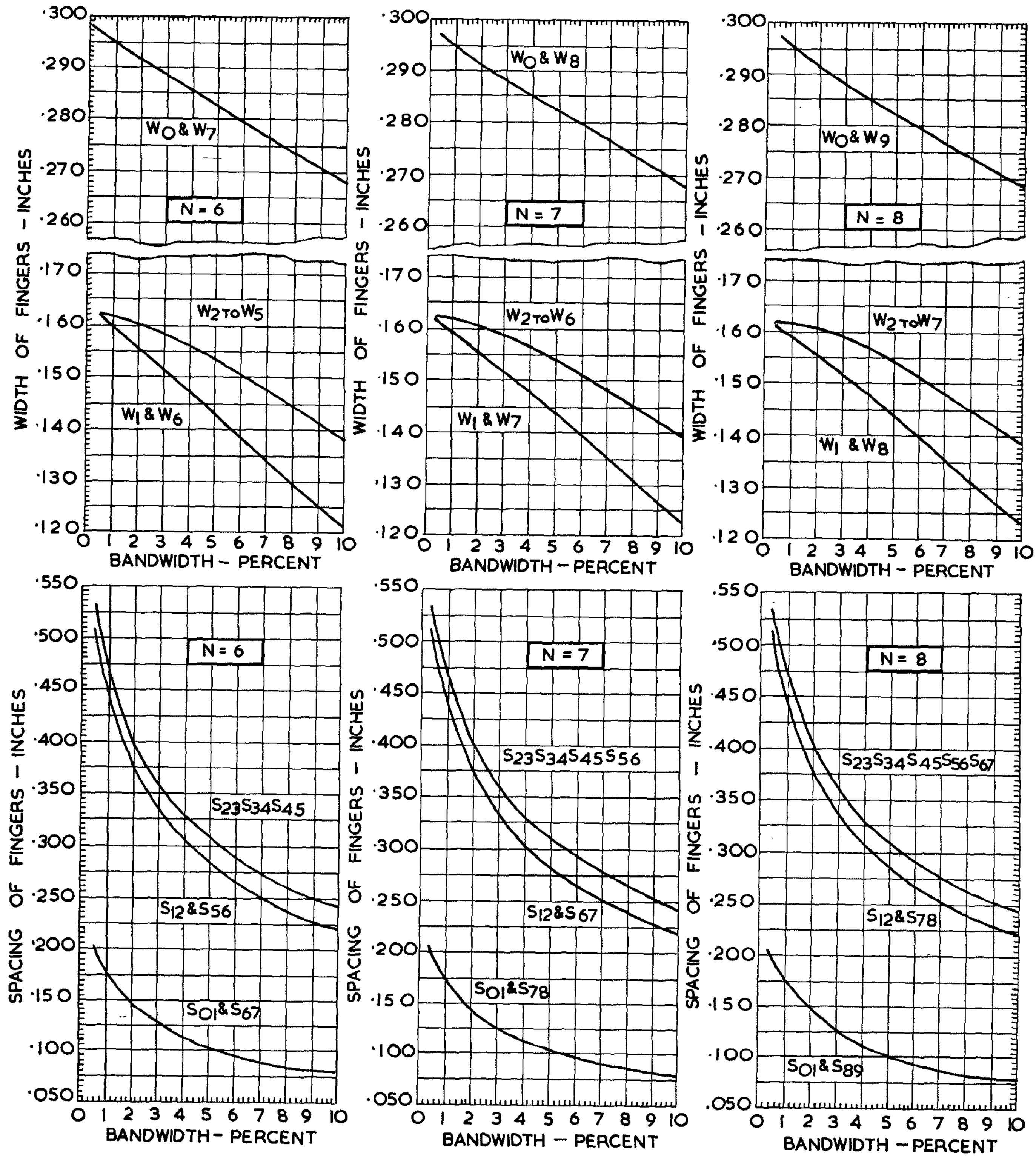

Fig. 9—Interdigital stripline band-pass filter Chebyshev response with 0.5 db pass-band ripple.