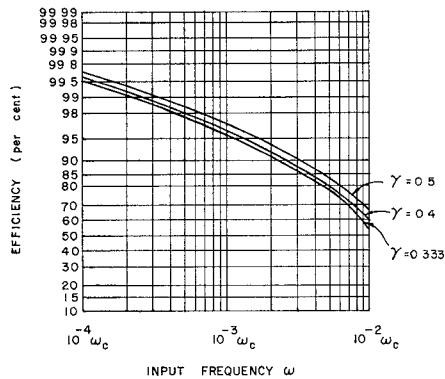
Fig. 4. $h(\gamma)$ as a function of γ .Fig. 5. Efficiency as a function of ω for several values of γ .

of the conversion efficiency as a function of input frequency ω for several values of γ . The conversion efficiency varies linearly with frequency and is quite near 100 per cent at low frequencies.

CONCLUSIONS

The results given in this analysis indicate that the highest efficiency would occur with a varactor nonlinearity γ lying in the range 0.5 to 0.7 assuming the same cutoff frequency for all values of γ . The power handling capability with γ 's in the range 0.6 $< \gamma < 1$ is much higher than that in the range 0 $< \gamma < 0.6$ with the same conversion efficiency. However, the power handling capability of varactors has been shown to depend strongly on breakdown voltage and series resistance R_s .

The above equations can be extended to a cascade of multiplier stages considering that the load impedance of each stage is the input impedance of the following stage and that the output power of each stage is the input power of the following stage.

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REFERENCES

- [1] Page, C. H. Harmonic generation with ideal rectifiers, *Proc. IRE*, vol 46, Oct 1958, pp 1738-1740.
- [2] Lesson, D. B., and S. Weinreb, Frequency multiplication with nonlinear capacitors—a circuit analysis, *Proc. IRE*, vol 47, Dec 1959, pp 2076-2084.
- [3] Utsunomiya, T., and S. Yuan, Theory design and performance of maximum-efficiency variable-reactance frequency multipliers, *Proc. IRE*, vol. 50, Jan 1962, pp 57-65.
- [4] Hyltin, T. H., and K. L. Kotzue, A solid state microwave source from reactance-diode harmonic generators, *IRE Trans. on Microwave Theory and Techniques*, vol MTT-9, Jan 1961, pp 73-78.
- [5] Breitzer, D. I., R. Gardner, J. C. Greene, P. P. Lombardo, B. Salzberg, and K. Siegel, Third quarterly progress report on application of semiconductor diodes to low-noise amplifiers, harmonic generators and fast-acting TR switches, Rept No 4589-1-3, pp 10-22, Airborne Instruments Laboratory, Mineola, N. Y., March 1959.
- [6] Chang, K. K. N., Harmonic generation with nonlinear reactance, *RCA Rev.*, vol 19, Sep 1958, pp 455-464.
- [7] Diamond, B. L., Idler circuits in varactor frequency multipliers, *IEEE Trans. on Circuit Theory*, vol CT-10, Mar 1963, pp 35-44.
- [8] Grandchamp, G., Theory, design and application of harmonic generators using varactors, Rept No BT-39, Bomaic Laboratories, Inc., Beverly, Mass., Sep 1962.
- [9] Leonard, T. C., Prediction of power and efficiency of frequency doublers using varactors exhibiting a general nonlinearity, *Proc. IEEE*, vol 51, Aug 1963, pp 1135-1139.
- [10] Penfield, P., and R. Rafuse, *Varactor applications*, Cambridge, Mass.: MIT Technology Press, 1962.
- [11] Manley, J. M., and H. E. Rowe, Some general properties of nonlinear elements—Pt I. General energy relations, *Proc. IRE*, vol 44, Jul 1956, pp 904-913.
- [12] Morrison, J., Maximization of the fundamental power in nonlinear capacitance diodes, *Bell Sys. Tech. J.*, vol 41, Mar 1962, pp 677-721.

CORRECTIONS

Intrinsic Attenuation

In the above paper,¹ on page 180, (4) should have read:

$$I_{TM} = \frac{B}{2A} \left[1 \pm \sqrt{1 - \left(\frac{2|A|}{B} \right)^2} \right].$$

It will then be in agreement with (2) of a previous correspondence item,² where it appeared correctly.

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¹ Beatty, R. W., Intrinsic attenuation, *IEEE Trans. on Microwave Theory and Techniques*, vol MTT-11, May 1963, pp 179-182.

² —, Maximum efficiency of a two arm waveguide junction, *IEEE Trans. on Microwave Theory and Techniques*, (Correspondence) vol MTT-11, Jan 1963, p 94.

Electromagnetic Wave Propagation in Lossy Ferrites

In the above paper,¹ the following corrections should be made:

1) Equation (6) should read:

$$\omega_c^2(\rho^2 - \rho_0^2)^2 + \omega_M \omega_c (\rho^2 - \rho_0^2)(\rho^2 - 2k_0^2) - \omega^2(\rho^2 - \rho_0^2)^2 + \omega_M^2 k_0^2 (k_0^2 - \rho^2) = 0$$

2) Page 518, second column, first paragraph, first line reads: $\omega_c = \omega_M + j\omega_R$, should read: $\omega_c = \omega_H + j\omega_R$.

3) Page 519, first column, second paragraph, first line reads: "radial" should read "radical."

4) Equation (18b), coefficient of last term reads:

$$\left(\frac{\omega \rho_0 k_0}{\rho_0^2 \omega H_1 + k_0^2 \omega_M} \right)^2$$

should read:

$$\left(\frac{\omega \rho_0 k_0}{\rho_0^2 \omega H_2 + k_0^2 \omega_M} \right)^2$$

5) Page 523, second column, first paragraph, third line reads: $(\omega_M, \omega_R = 0)$; should read: $(\omega_H, \omega_R = 0)$.

6) Equation (26a), reads:

$$\left| \frac{P}{P_0} \right| = \frac{4\beta_0 \epsilon_f \rho'}{(\beta_0 \epsilon_f)^2 + |\rho|^2 + 2\beta_0 \rho' \epsilon_f}$$

should read:

$$\left| \frac{P}{P_0} \right| = \frac{4\beta_0 \epsilon_f \rho}{(\beta_0 \epsilon_f)^2 + |\rho|^2 + 2\beta_0 \rho' \epsilon_f}$$

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¹ Rosenbaum, F. J., *IEEE Trans. on Microwave Theory and Techniques*, vol MTT-12, Sep 1964, pp 517-528.

Internal Reflection in Dielectric Prisms

In the above,¹ on page 584, the membership status of the authors are incorrect. Dr. Fellers is a Fellow and Dr. Taylor is a Senior Member of IEEE.

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¹ Fellers, R. G., and J. Taylor, Internal reflection in dielectric prisms, *IEEE Trans. on Microwave Theory and Techniques*, vol MTT-12, Nov 1964, pp 584-587.