If we now consider that an amplifier which generates such a high proportion of second harmonics, will seldom be quite free from third harmonics and that the initial harmonics are diminished in proportion to the applied degeneration, it is hard to imagine a practical case in which negative feedback would do more harm than good.

These practical observations do not, of course, affect the value of Mr. Sloane's statement, which I denied in my first letter, and I am much indebted to him for having pointed out my error.

In conclusion it can be stated that: negative feedback diminishes all harmonics approximately in the proportion in which the sensitivity of the amplifier is diminished, but owing to distortion and crossmodulation of the back-fed harmonics, this relation is not exact. Fortunately in ordinary amplifiers the difference is only negligible.

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To the Editor, The Wireless Engineer.

SIR,—Considering the literature which has been written on negative feedback, some of which appeared recently in your esteemed journal[1, 2, 3] I should like to point out some facts which as far as I know have been neglected.

The negative feedback amplifier was treated alone without considering the harmonic distortion of the preceding valve amplifier. The application of negative feedback to a valve circuit decreases the amplification of the valve. Therefore to obtain the same output from the valve with feedback as without, we must increase the amplification of the preceding stage—the corresponding increase in the harmonic distortion may exceed the decrease obtained by providing negative feedback, so that the total harmonic distortion may be increased.

Let e be the e.m.f. of the input of the preceding stage, u, the p.d. of the output of the same, U, the p.d. of the output of the final stage, again e', u', V', the correspondong values for the negative feedback case. Using the conventional method of deriving u, from e, V, from u, we may write :

$$u = a_1 e + a_2 e^2 +$$
$$U = \alpha_1 u + \alpha_2 u^2 + \ \ldots = \alpha_1 a_1 e + (\alpha_2 a_1^2 + \alpha_1 a_2) e^2 + \ldots$$

and for the negative feedback case :

$$u' = a_1 e' + a_2 e'^2 + \ldots .$$
$$V' = \frac{\alpha_1}{1 + \alpha_1 \beta} u' + \frac{\alpha_2}{1 + \alpha_1 \beta} u'^2 + \ \ldots$$
$$= \frac{\alpha_1 a_2}{1 + \alpha_1 \beta} e' + \left(\frac{\alpha_1 a_2}{1 + \alpha_1 \beta} + \frac{\alpha_2 a_1^2}{1 + \alpha_1 \beta} \right) e'^2 + \ldots$$

If the output (without harmonics) is to be the same in both cases : $e' = (1 + \alpha_1 \beta) e$; therefore :

$$V' = \alpha_1 a_1 e + \left(\alpha_1 a_2 (1 + \alpha_1 \beta) + \frac{\alpha_2 a_1^2}{1 + \alpha_1 \beta} \right) e^2 + \ldots$$

To take advantage, as far as harmonic distortion is concerned, from negative feedback, we must have:

$$\alpha_1 a_2 (1 + \alpha_1 \beta) + \frac{\alpha_2 a_1^2}{1 + \alpha_1 \beta} < \alpha_2 a_1^2 + \alpha_1 a_2$$

finally :

$$\frac{\alpha_2}{\alpha_1} > \frac{a_2}{a_1} \Big/ \frac{a_1}{1 + \alpha_1 \beta} ;$$

Beyond a certain limit given by the above relation, negative feedback no longer improves the harmonic distortion of the system. I cannot discuss here in more detail this relation. It would be interesting that such curves as those given in previous works [2, 4] giving harmonic distortion of current against output watts, with and without negative feedback, should be traced taking into account the total harmonic distortion as explained above.

I must point out here that in some previous works of mine [5, 6, 7] concerning a non-linear positive feedback, I have obtained better results than those given in the references mentioned above, results that are not restricted by the above considerations. I also have obtained [8] very good results concerning frequency distortion, with positive feedback (negative impedance method).

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1. *Wireless Engineer*, Vol. XIV, p. 259.
2. *Wireless Engineer*, Vol. XIV, p. 409.
3. *Wireless Engineer*, Vol. XIV, p. 597.
4. *Philips' Technique Rundschau*, Sept., 1936, p. 269.
5. *L'onde Electrique*, Vol. XV, p. 469.
6. *Wireless Engineer*, Vol. XIII, p. 131.
7. *Comptes Rendus*, Vol. 201, p. 193.
8. *Wireless Engineer*, Vol. XII, p. 375.

The Battery Book

By H. H. U. Cross. XII + 196 pp. 92 Figs. The Technical Press, Ltd., 5, Ave Maria Lane, London, E.C.4. Price 5/-.

This is an excellent little book. Its subtitle is a Practical Manual on the construction, charging, care and repair of automobile, motor cycle, aviation, electric vehicle, medical and other similar batteries, and there is a foreword by Mr. J. Y. Fletcher, a Director of the General Electric Co. The author states in the preface that the book is written from the popular angle, but that scattered throughout the pages will be found a measure of scientific information, so stated that the general reader may assimilate it without effort. The arrangement of the material is based upon the author's book in French on the same subject which was recently published in France and Belgium. The first chapter deals with dry and other primary batteries and the subsequent chapters deal with various types of cells, lead, zinc, halogen and alkaline, their construction, operation and applications. The author is evidently an authority both on the practical and theoretical sides of the subject, and the material is arranged and presented in a very readable form. It is a book which may be recommended not only to all those who are primarily interested in accumulators, but also to every student of electrical engineering. G. W. O. H.