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develop a correcting signal across the condenser C_2 in the grid circuit of V_2. The correcting action is required to take place only during those time intervals when it is known that the signal should be at the black level, and control pulses are used to select the required times. This action is shown symbolically in the diagram by a switch, which is closed by each pulse. The voltage across C_2 can be changed only while this switch is closed.

When the switch is closed a loop is formed having a very high negative feedback, so that any error in the black level disappears in the few microseconds required for C_2 to take up its required voltage. The correcting effect does not stop here, however. Even after the switch has opened, C_2 retains its voltage, and correcting current continues to flow through R_2, C_1 and R_1 which results in a further correcting voltage building up across C_1. The time constant R_1C_1 is approximately equal to the time interval between pulses, so that the additional correcting voltage developed across C_1, in this time, is approximately equal to the original correcting voltage across R_1. The result of this action is that the circuit not only corrects the black level line by line, it also puts in the required slope to correct for a rate-of-change of black level. This is a feature which, I believe, has not been achieved before, and it results in a much improved accuracy.

This control circuit was developed in the first place for use with the gamma corrector, but the principle should also have other useful applications. For example, it should be useful for controlling the black level in the modulated output stage of a television transmitter. For this purpose a sample of the transmitter output would be taken, and any error in the observed black level would be used to develop a correcting signal to be applied to an early stage of the modulator. This method should overcome many of the difficulties caused by the impedances of power supplies.

The combination of gamma corrector and black level control works very well in practice and the reproduced picture is very similar to the original. The film used is quite standard, as normally supplied to cinemas, and is not specially processed in any way. Such film contains many sudden changes in brightness from one scene to another, and the total range of contrast is very great. The circuits handle this quite automatically and the best results are obtained without the necessity of any manual adjustments during the running of the film. Engineers with experience of other types of film scanning equipment will appreciate the significance of this result.

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I have tried to explain to you some of the advantages to be gained by phase correction and gamma correction. My arguments and explanations on both subjects have had to be strictly limited by the time available, but I hope I may have succeeded in imparting to you some of my own belief that these subjects are both worthy of more practical attention than they have received in the past.

All my experimental work has been done in the course of my employment with Cinema-Television Ltd., of London. Thanks are due to a number of my colleagues for practical assistance, and to Cinema-Television Ltd. for permission to publish the results and for making possible my visit to this Conference.

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Diskussionsbeitrag

Von *T. Vellat*, Mailand

Die Trennung der Einflüsse von Amplituden- und Phasengang einer Schaltung auf Einschaltvorgänge ist physikalisch nicht gerechtfertigt. Beide Einflüsse nehmen an der Verformung des Eingangsimpulses teil. Allerdings bestehen Zusammenhänge zwischen Amplitudenkurve und Phasengang eines Netzwerkes, so dass man zu einer vorgeschriebenen Dämpfungskurve nicht einen willkürlichen Phasengang wählen kann. Zum Beispiel führt das so oft zitierte Beispiel einer Schaltung mit rechteckiger Durchlasskurve und linearem Phasengang im Durchlassbereich zum Paradoxon, dass der Eingangsimpuls sich am Ausgang der Schaltung noch vor dem Einsetzen des Impulses bemerkbar macht.

Auf den Phasengang einer Schaltung wird man aber nur schliessen können, wenn man die Feinstruktur der Amplitudenkurve in Betracht zieht.

Solange man die Einschwingprobleme mathematisch durch Zerlegung der Impulse in Fouriersche Integrale löste, war es naheliegend den Einfluss des Netzwerkes in Amplituden- und Phaseneinfluss aufzutrennen. Heutzutage, wo man derartige Probleme vermittels Operatorenrechnung (Laplacesche Transformation) löst, ist auch mathematisch kein Grund vorhanden zwischen amplituden- und phasenbedingten Verzerrungen zu unterscheiden.

Das Vorhergesagte gilt für Einschwingvorgänge, also für typische Fernsehprobleme. Unberührt davon wird man für akustische und Frequenzmodulationsprobleme den Dämpfungsverlauf bzw. den Phasengang getrennt heranziehen.

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Contribution to discussion

By *T. H. Bridgewater*, London

In my opinion Mr. Nuttall has rightly stressed the importance of giving attention to phase and amplitude correction. Indeed twenty years ago there was probably more awareness of phase displacement as a factor in television than at the present day, since in the early days the frame repetition frequency of $12^1/_2$c./s made it difficult to reproduce the lower frequencies without any evident distortion.

With a view to clarifying one's concepts I would like to suggest to Mr. Nuttall that there is, philosophically at any rate, no real difference between phase and frequency distortion. Frequency distortion results in the presence of a component at an unwanted frequency or the absence of a wanted one: phase distortion is the appearance of a component where it is unwanted, or the loss of another where it should be.