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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.

If this hypothesis can be accepted it seems to me therefore that graphs which may express the phase and frequency characteristics of a particular amplifier are capable of being combined to yield a resultant curve which expresses the over-all effective distortion (or the «goodness» factor). Such an assessment would be far more valuable to operating engineers than the separate curves of phase and frequency whose sum effect cannot readily be visualized. I would be interested to know if Mr. Nuttall can see any practical way of effecting a combination of this sort.

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Wide Band Systems for Television

By *E. Labin*, Nutley, USA

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Introduction

The purpose of this lecture is to consider the bandwidth requirements of various components of television networks and to describe some results obtained in this field. I intend to handle this problem from the point-of-view of a transmission, rather than a television engineer. In transmission, we are interested in reproducing faithfully, at a distance, a message which is not exactly known. The message is generally defined as part of a certain category of signals; such as, television signals, speech signals, etc. The main characteristics of a group of signals of this kind are known only on a statistical basis. The importance of the concept of bandwidth of a given message is due to the experimental fact that messages of a given family have generally the same bandwidth in spite of possible large variations in wave shapes. The usefullness of the bandwidth concept has been often criticized by television engineers who prefer to study signals as time functions. These criticisms are not justified from the point-of-view of the transmission engineers because bandwidth is the most permanent characteristic of a series of messages of the same family.

What are the bandwidths we are likely to meet in television? Present American television standards call for a video bandwidth of 4,5 Mc./s. This is adequate for the screen sizes which are now popular, or which are likely to be used in the average home. It corresponds to a quality comparable to what 16 mm home movie projectors will supply.

Many years will elapse before, in a commercial network, including home receivers, full advantage will be taken of the existing standards. If television pictures shall compare with movie pictures as projected in ordinary theatres in size and quality, a more ambitious standard probably up to 12 Mc./s video will be necessary. If, in addition, color is desired we might arrive at a video standard of 30 Mc./s. The message so defined has to be transmitted from the camera to a distant broadcast transmitter and from there to the home receiver, or eventually to the theatre projector. This represents a complex series of transformations of the message which are outlined in Fig. 1.

We intend to follow the message through this complex network and to indicate how broad a band can now be achieved for the various components. The message at the output of the camera has to be amplified within suitable video amplifiers, from there it has to go either through a coaxial line or through a radio pick-up link to a fixed relay station.

From there, the signal might be transmitted through radio relays, or again through a coaxial line to a distant city. In that distant city, the signal will be restored to its video form, amplified again by video amplifiers and finally applied to an AM transmitter which will broadcast the message. The intermediary coaxial cable links will normally use the video spectrum directly, or the same spectrum translated into another frequency range, but essentially it will be the same bandwidth.

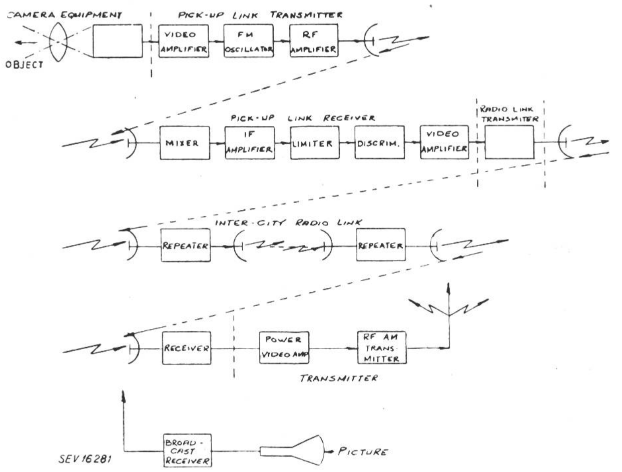

Fig. 1

The radio links will not normally use FM, meaning that the bandwidth at radio frequencies will be at least twice and normally three times the video bandwidth. It might be found useful in the future to transform the video signal before it is applied to the radio link. Such transformation could further increase the bandwidth. All this means that we need various tools; such as, frequency modulated oscillators, RF amplifiers, IF amplifiers, limiters, and discriminators with bandwidths which have to extend, depending upon the video standards referred to above, essentially from 10 to 100 Mc./s. The broadcast transmitters using vestigial side band AM modulation do not have to be that broad, but would still have to operate with a bandwidth of 6 to 60 Mc./s.

I do not intend to determine, on theoretical grounds, what the possible limits might be, but to describe briefly what has been done in our Laboratories in terms of independent components; such as, video amplifiers, IF amplifiers, limiters, discriminators, etc. I would like to stress before I start to show you the results obtained in these various