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the future this same example. Television standards as now used in the United States are probably adequate for home receivers but more ambitious standards will have to be adopted for theatre television.

It gives me a special satisfaction to conclude in favor of theatre television in this place where Prof. Fischer, during his lifetime, and his able successors since have done so much for the promotion of theatre television.

Acknowledgments

The equipment described in this paper have been developed at the Federal Telecommunication Laboratories, Inc. (a subsidiary of International Telephone and Telegraph Corporation) mostly under the sponsorship of Camp Coles, United States Army Signal Corps Laboratories.

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A Comparative Analysis of Certain Television Standards

By L. H. Bedford, Chelmsford, England

389.6 : 621.397.5

Introduction

The British and American television systems have been developed along strictly parallel lines of thought in which a two-way choice of standard presents itself at a number of stages. It is unfortunate that in most cases where the balance of advantage is not absolutely clear the opposite choice has been taken on the two sides of the Atlantic.

In the present paper it is proposed to discuss only two of these divergences, namely (a) The Polarity of Modulation, and (b) The significance of «Equalising Pulses».

Before going into detail we may pause to consider what results may be expected from a comparative analysis. In each case there would appear to be one of two possibilities.

- (1) That one or other party has blundered.
- (2) That the balance of advantage one way of the other is insignificantly small.

In the latter case one may perhaps still consider that a «blunder» has been committed, that of failure to standardise where standardisation was possible.

Polarity of Modulation

One reason for this point being selected for analysis is because it has been the subject of a good deal of loose reasoning. Thus it is argued that with negative modulation the transmitter occupancy at peak power is only of the order of 10% whereas with a positive modulation it can be 85%; therefore a given output valve allows a higher rating of the transmitter with negative modulation. A closer study however reveals that the character of this «advantage» is strictly nominal, the word being used in its literal sense; that is it enables us to name a higher power, but not necessarily to put down a stronger useful signal in any given place.

To determine whether or not we get any advantage (at the transmitter) with negative modulation, we have to take into account two considerations which are conveniently left out in the above «argument». These are:

(a) What constitutes the «useful signal» in relation to peak radiated power?

(b) What parameter constitutes the limitation on the output valve rating, viz. peak current, peak voltage or (mean) anode or grid dissipation? Table 1 shows comparative conditions. We assume a peak carrier amplitude (expressed in amps, volts or field strength at a given place) of unity, and a corresponding carrier power also of unity (arbitrary units). The useful picture signal, E_u , namely the difference of field strength between black and white, is seen to be 0,7 for the case of positive modulation and 0,6 for the case of negative. These figures are not intrinsic to positive or negative modulation as such, but relate to the particular standards that have for good reasons been associated with them in the two Countries; the most significant point here being the low limit of 15% in the case of negative modulation.

For the rest of Table I the following approximations and assumptions have been made:

(1) The two systems have been reduced to comparative terms by the assumption of equal occupancy for sync and equal occupancy for blanking.

(2) The instantaneous efficiency at relative amplitude α has been taken as $\alpha\eta_1$, where η_1 is the efficiency at peak amplitude. The relative anode dissipation D_α at amplitude α is $\alpha^2 \left(\frac{1}{\eta} - 1 \right)$ or $\frac{\alpha}{\eta_1} - \alpha^2$. (η_1 has been taken as 0,5).

Table I

	Rel. Carrier Amplitude	η	Rel. Inst. Watts			Occupance	Rel. Average Watts			Figures of Merit
			Output	Plate Dis.	Grid Dis.		Output	Plate Dis.	Grid Dis.	
White	1 0,15	0,5 0,075	1 0,022	1 0,27	1 0	0,85 0	0,85 0	0,85 0		
Black	0,3 0,75	0,15 0,375	0,09 0,562	0,50 0,94	0 0,32	0,05 0,90	0,005 0,506	0,025 0,845	0 0,29	
Sync.	0 1	— 0,5	0 1	0 1	0 1	0,10 0,10	0 0,10	0 0,10	0 0,10	
Useful picture signal E_u	0,7 0,6									
Total relative Average watts						$\frac{0,855}{(W_a)}$	$\frac{0,606}{(D_a)}$	$\frac{0,875}{(D_a)}$	$\frac{0,945}{(G_a)}$	
$E_u/\sqrt{W_m}$									0,70 0,60	
$E_u/\sqrt{W_a}$									0,76 0,77	
$E_u/\sqrt{D_a}$									0,75 0,62	
$E_u/\sqrt{G_a}$									0,76 0,96	

Note: These Quantities calculated for the Highest Drain Picture, viz. All White or All Black for Positive or Negative Modulation Respectively.

(3) For the grid dissipation (G) we take the descriptive approximation

$$Ga = G_1 \alpha^4$$

We may now complete Table 1 which shows the relative figures for instantaneous output, plate dissipation and grid dissipation. Multiplying these by the occupancy appropriate to the picture of «highest drain» we obtain relative average wattages W_a , D_a , G_a . Finally we define figures of merit $E_u/\sqrt{W_m}$, $E_u/\sqrt{W_a}$, $E_u/\sqrt{D_a}$, $E_u/\sqrt{G_a}$.

These figures of merit apply in order in the event of limiting tube parameters being peak plate current (or voltage), mean plate current, mean anode dissipation and mean grid dissipation. It will be seen that in the likely event of peak output voltage or mean plate dissipation being the limiting parameter, positive modulation shows an advantage of approximately 1.5 db while in the rather unlikely case of grid dissipation being the limiting factor the negative modulation standard shows an advantage of 2 db.

The inference from this is that if there is any dominant advantage for either positive or negative modulation it does not reside at the output stage of the transmitter.

At the receiving end the following aspects may be considered as affected by polarity of modulation:

- (a) Effect of interference on picture.
- (b) Effect of interference on sync.
- (c) Possibilities of A. G. C.

As regards (a) and (b) we may simplify the problem by considering only the most common and objectionable form of interference, namely ignition interference which is stronger than the peak carrier.

(a) This form of interference produces white or black spots on the picture for positive or negative modulation respectively. If no limiter circuit is included the former is vastly more objectionable owing to spot spreading, but very simple limiter circuits are effective in reducing the spots to picture peak white; then it is found that the two effects are about equally objectionable. Thus this point is not a dominant factor.

(b) On sync negative modulation produces much poorer immunity to this type of interference for the simple reason that no amount of limiting can prevent a strong pulse appearing as a false sync signal; this results in a tendency to severe line tearing. In the case of positive modulation strong pulses cannot produce false sync signals, but can obliterate the genuine ones. This means that only pulses in the immediate vicinity of leading edges of the sync signals proper are effective in producing line tearing.

We find this situation expressed in practice by the fact that «flywheel sync» circuits are considered to be a sine qua non in American receivers, whereas they have not appeared in any British commercial receivers to date.

(c) The question of A. G. C. raises some interesting points. In the first place the need for A. G. C. was originally more of a requirement in America than in Britain owing to the contemplation from the outset of multiple programme choice in the American case. In British conditions it is only required in fringe areas where atmospheric fading occurs. In practice we find many British commercial receivers with *preset* gain controls.

It must be said, however, that should the Stratovision project materialise, A. G. C. may become an essential in view of the moving transmitter.

Although it would appear that negative modulation allows the use of simpler A. G. C. circuits, the fact is that in both cases strobed A. G. C. is necessary. The contrary assumption actually led to trouble in the field trial stage of American television owing to the unstrobed A. G. C. circuits being operated by interference. As a result of this A. G. C. had to be removed altogether, and does not appear at the present date on the majority of American commercial receivers. Having regard to the common strobing requirements, the apparent advantage of negative modulation is greatly, but not wholly, reduced.

Conclusion

The technical balance of advantage appears to be insufficient to justify the loss of standardisation.

Equalising Pulses

Figure 1 shows the British and American sync waveforms. They are seen to differ in only one basic point; the inclusion of equalising pulses in the American waveform. The elegant conception of odd line interlacing with double-line-frequency slotted field signal is common. If however a simple integrating circuit is used for separating out the effective field sync pulses,

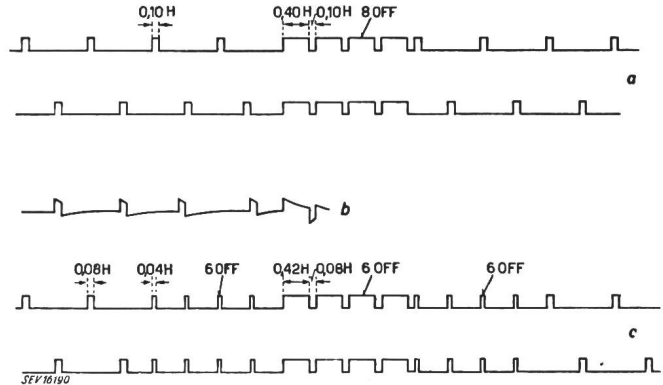


Fig. 1

Different Wave Forms

- a British Standard Wave Form
- H Horizontal period 98.8 μs
- b Fairhurst's Wave Form
- c American Standard Wave Form
- H Horizontal period 63.5 μs

a significant error in interlacing occurs. The error in timing works out to be, approximately

$$\frac{\delta t_f}{T} = \frac{t_s}{t_l} \cdot e^{(t_l - \frac{1}{2} t_l) / T} \cdot \frac{1 - e^{-\frac{1}{2} t_l / T}}{1 - e^{-t_l / T}}$$

where δt_f is the error in timing of the field time base firing point;

- T is the integrating time constant;
- t_s is the duration of the line sync pulse;
- t_l is the duration of the whole line period;
- t_f is the time from commencement of the field pulses to the field firing point.

With reasonable values, errors up to 20% of the line period can occur, sufficient to produce violent pairing.

When equalising pulses are introduced the timing error is reduced by a factor $e^{-t_l / T}$, where t_l is the interval between the first equalising pulse and the first field pulse. This is a very significant reduction.

But this process is in the nature of «patching up» an imperfect method of timing the field firing point, that of integration. Better results are obtained by rather different methods, of which one of the most elegant is due to H. A. Fairhurst (see J. I. E. E. Vol. 83, Dec. 1938, p. 797). It consists of passing the complete sync wave form through a suitably short time constant circuit, thus reducing it to the waveform shown in the third line of Fig. 1. The trailing edge of the first field pulse triggers the field time base. For optimum discrimination between line pulses and field pulses the «differentiating»

time constant T' should be $\frac{t_w - t_s}{\log e (t_w / t_s)}$ where t_w is the duration of the wide field pulses.

The beauty of the method is that the full sharpness of the field pulse is retained so that the necessary high timing accuracy results.

However, even with circuits which give full timing accuracy on the firing point, as also in the case of studio equipment where separate field timing pulses are available, perfect interlacing does not always result. The error arises from the fact that it is not only necessary to secure accuracy of the firing point of the field time base, but also of its extinction point. Provided sufficient field pulses are transmitted to include the whole firing time of the field blocking oscillator, equalising pulses have no bearing on this form of error, which remains the most common trouble in practice.

That equalising pulses were not a panacea for interlacing difficulties was realised when the American system was stan-

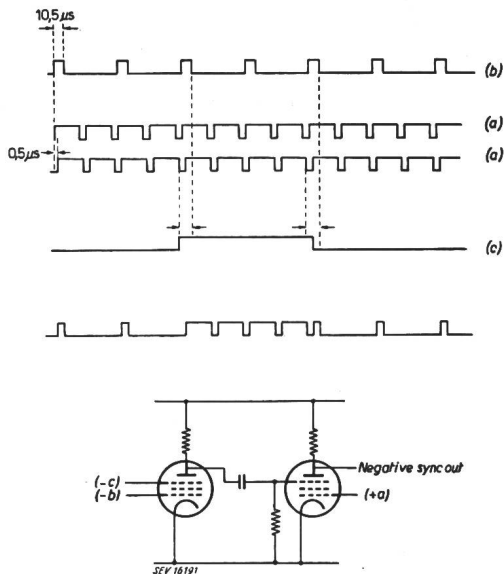


Fig. 2
Sync Wave-Form Generation

ardised. Also the complications introduced at the transmitter were not ignored. But the philosophy was that complications

at the transmitter were well justified if it made for simplicity or flexibility of design at the receiver; no receiver, it was argued, would be any the worse for the presence of equalising pulses.

This last statement is no longer strictly true in view of the trend towards fly-wheel sync circuits. The presence of equalising pulses can, in fact, restrict flexibility of design in this case.

The extraordinary simplification of circuits at the transmitting end which results from abandoning the equalising pulse is shown in Fig. 2 which illustrates one method of arriving at the British standard sync waveform:

Looking at the finally desired waveform we note that it can be made up from the continuously running waveform (a) by quashing out certain parts. The required quashing waveform is shown as (b). As the leading edge of (b) is required to lead that of waveform (a), we sync it from primary waveform (a') from which (a) is derived through a $0.5 \mu\text{s}$ delay line.

Waveform (a) when quashed with waveform (b) produces line sync pulses. To switch over to field sync we «quash the quash»; this latter quashing waveform is shown as (c). Waveform (c) is derived from a multivibrator which is controlled by two counting circuits. The first counts 405 pulses of waveform (a) and opens a gate. As soon as the gate is opened the second counter counts the required number of field pulses (8).

The very simple mixing process is shown schematically in the lower part of Fig. 2.

Conclusion

Equalising pulses would not appear to be justifiable on purely technical grounds.

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Contribution to discussion

By C. G. Mayer, London

Mr. Chairman, since Mr. Bedford has mentioned American television standards I would like to say a few words on this subject of negative versus positive modulation. We have discussed these questions together in the past, and both he and I have also discussed them with engineers on both sides of the Atlantic, with negative results — negative in the sense that since both sides have established standards they naturally endeavour to produce arguments to prove their own system the better. Having said this I will not take up the short time available in this discussion except to point out a new and important factor which affects one's choice in deciding on the sign of the modulation. I refer, of course, to the recent development of the system known as «Intercarrier Sound» which is only made possible by negative modulation of the picture combined with frequency modulated sound. Briefly, with negative modulation the carrier never drops to zero, so that the picture and sound signals can be amplified together in common intermediate and video amplifiers at the receiver. The two carriers beat together to produce a signal having the difference frequency — 4.5 Mc./s in the case of the U.S. standard. This beat frequency will be frequency modulated by virtue of the fm on the original sound carrier, and can be separated from the vision signal at the input to the picture tube by conventional treatment as an fm signal, and passed to the loudspeaker. We are rapidly gaining experience in America with this system, which not only offers real economies in receiver design (sound IF amplifier not needed) but also enables some of the shortcomings of con-

ventional receivers to be overcome, principally in regard to stability, hum modulation, and microphonics of the local oscillator in the receiver. Since both carriers are influenced to the same extent the resultant beat frequency is free from these difficulties, and in fact, an «Intercarrier» receiver requires no fine tuning control. It was thought that the effect of phase or frequency modulation of the picture carrier at the transmitter would be serious, but tests have proved that transmitters having as much as ten degrees phase variation give excellent sound quality on properly designed receivers. In choosing negative modulation in the United States we cannot claim to have had the foresight that has made the development of this system possible, but it is a fortunate circumstance for which we are very grateful, just as we have also to be grateful now for 60 cycle power which enables us to obtain bright pictures free from flicker.

Finally, in regard to Mr. Bedford's remarks on the effects of interference on the picture, our experience — confirmed by others — is that subjectively white spots are certainly much more disturbing to the eye than the black specks obtained with negative modulation.

In view of the widespread interest in this subject I should be glad, Mr Chairman, if you would agree that these remarks be included in the record together with Mr. Bedford's expose.

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Apport à la discussion

Par Y. L. Delbord, Paris

Je voudrais présenter deux remarques:

La première remarque concerne un détail technique. Dans sa très intéressante communication Mr. Bedford a indiqué l'importance d'un double signal de synchronisation verticale, l'un provoquant le retour du spot vers le haut de l'image, l'autre marquant avec précision l'instant du commencement de l'analyse utile.

Dans ces conditions, l'intercalage des trames est en général absolument correct.

Plusieurs brevets ont été pris sur ces questions par des industriels français et quand, il y a un an, j'expliquais au regrettable professeur Fischer l'importance de cette solution, il m'a fait remarquer que dès le début des expériences, un tel dispositif avait fonctionné sur le «Grossprojektor»; je sou-

haite que cette remarque constitue un modeste hommage à l'universalité des connaissances du professeur Fischer.

La deuxième remarque n'est pas du tout technique et je m'en excuse.

Quand le Comité International de Télévision a été créé les fondateurs espéraient que l'accord pouvait se faire sur des normes internationales. Pour cela il était nécessaire que des comités nationaux se constituent et il avait été précisé que des comités devaient être composés non de représentants de «corps constitués», je veux dire de représentants de Sociétés commerciales, de représentants de Services publics, de représentants de l'Administration, etc., mais de personnalités ayant une longue expérience de la télévision et qui, sans distinction d'origine: Laboratoires, industries, services publics, universités, etc., soient capables de faire abstraction de leurs

intérêts particuliers et soient capables de discuter les problèmes de la télévision avec une honnêteté scientifique totale.

L'expérience a prouvé que cet idéal était difficile à atteindre et qu'il était à peu près impossible pour un ingénieur d'oublier ses intérêts personnels, les intérêts de son laboratoire, les intérêts de sa Compagnie, les intérêts de son pays, et c'est très naturel.

Je souhaiterais malgré tout qu'un nouvel effort soit fait et j'espère que bientôt nous apprendrons la création de tels comités techniques dans de nombreux pays et particulièrement aux Etats-Unis et en Grande-Bretagne.

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A Self-Oscillating Line-Deflection Circuit

By J. Haantjes, Eindhoven, Netherlands

621.397.331.2

The line-deflection circuit is one of the most interesting parts of a television receiver. This circuit has to deliver a current of saw-tooth wave-form in a coil. The fact that theoretically this should not require any energy, whereas most types of line time bases show a high energy consumption, has led to the problem how to design a line-deflection circuit with a low energy consumption.

Apart from this there is an earnest desire to build television receivers with a minimum of components in order to make them as inexpensive as possible. This last consideration had already led to the development of a self-oscillating line-deflection circuit such as was applied, for instance, in the German Einheitsempfänger [1] ¹⁾ before the last war. The disadvantage of this circuit was that the energy consumption was high, viz. over 30 W. Moreover it appeared to be difficult to develop a sufficiently durable valve for this circuit, because the control grid of this valve, which in principle had to carry a high current, was very heavily loaded.

Later on L. R. Malling [2] published a paper in which he described a self-oscillating line-deflection circuit employing a combination of a triode and a diode. However, owing to the precautions he had to take to obtain good linearity, the energy consumption was again high. Moreover the energy needed for synchronization was very high, which also has to be considered as a serious drawback.

In this paper it will be explained how it has been found possible to design a self-oscillating line-deflection circuit with good linearity and a short fly-back time while being easily synchronized and needing only a rather small energy supply.

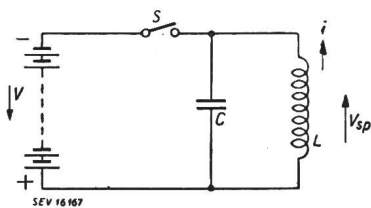
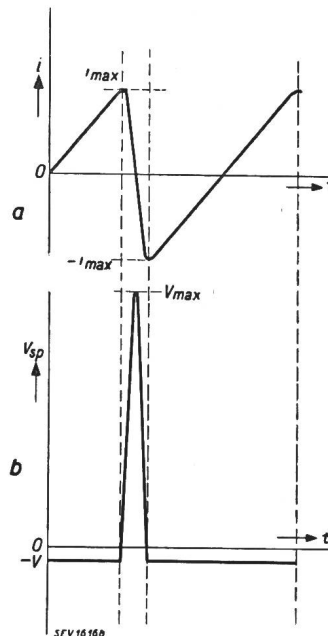


Fig. 1
Ideal circuit for generating linear saw-tooth currents in a coil

First attention will be drawn to an ideal way to generate a saw-tooth current in a coil. The network is indicated in fig. 1. It consists of a coil and a small capacitor in parallel, which are over a switch connected to a battery. When the switch is closed a current will start to flow in the coil, increasing linearly with time. When after some time the switch is opened a certain amount of energy will have been stored in the circuit. Consequently sinusoidal oscillations will start in the resonance frequency of the circuit. After slightly more than a half-cycle of oscillation there will be a situation where the current in the coil has reversed its direction and where the voltage on the condenser is again the same as that on the battery. When at this moment the switch is closed again the current of the coil will charge the battery, whilst the rate of change of the current will be the same as before the switch was opened. Fig. 2 shows the shape of the current in the coil and the shape of the voltage

on the circuit. If the opening and closing of the switch is repeated at the right moments a periodical saw-tooth current will flow in the coil without any energy consumption, since the coil will periodically deliver all the stored energy back to the battery.



The difficulty in trying to build a circuit working on this principle lies in the switch. This switch has to carry current in both directions with a low internal resistance and it will of course be necessary that the switch works automatically.

One might try to realise the switch by means of a combination of a triode and a diode, as indicated in fig. 3. The triode will be able to pass current in one direction while the diode passes it in the opposite direction. In order to make the switch self-operating some kind of feedback

Fig. 2
Wave shape of current and voltage of the coil in the ideal circuit

would be necessary from the anode of the triode to the control grid. As a small internal resistance is needed the triode will have to work in the region of positive grid voltages, thus in the region of grid currents. The internal resistance can be sufficiently low in this region of current take over between anode and grid, but it is preferable to avoid grid currents, for the reasons already mentioned.

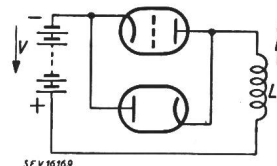


Fig. 3
Circuit in which the switch is realized by a combination of a triode and a diode

In order to avoid these difficulties the triode has been replaced by a tetrode. The circuit is given in fig. 4. The anode current of the tetrode is fed into the primary of a transformer. The tension on the secondary is applied to the control grid in such a sense that a decrease of the voltage on the anode will cause an increase of the voltage on the control grid. To avoid grid currents a capacitor and a resistor are inserted in the grid circuit. The screen grid is connected to a certain fixed positive

¹⁾ Bibliography at the end of this paper.