Television Standards Conversion

REMOVING THE 10C/S FLICKER IN 50C/S-60C/S FIELD CONVERSIONS

CONVERSION of television pictures from one standard to another has been common practice for a number of years, and has made possible the Eurovision link. However, conversion of European standards, which all employ a 50c/s field frequency, to the 525-line 60c/s system in use in North America, and *vice versa*, has set a new problem. In addition to the relatively easily removed moiré pattern, caused by the interaction of closely related line-structures, a new type of picture deformation becomes apparent. The different field frequencies interact one with the other to produce a 10c/s amplitude modulation of the video signal, which appears as a flicker at this frequency, and which renders the converted picture intolerable to the viewer.

Equipment designed to overcome this problem has been developed by the B.B.C. Engineering Division and has already been used to handle recordings, for translation to the American standard, of the Paris Summit Conference and the wedding of H.R.H. Princess Margaret.

The principle of a standards converter is shown in diagrammatic form in Fig. 1. The incoming video signal is amplified and displayed on a high-quality cathode-ray tube which has an afterglow time constant of 7msec. A lens focuses the displayed picture on to the storage mosaic of a camera tube scanned at the rate corresponding to the new standard, the output of which is processed in a sync-pulse insertion and blanking unit. The signal emerging from this unit is the converted signal.

As has been mentioned, when the number of lines per field of the two standards under consideration are closely related the picture on the new standard is subject to moiré interference caused by the fact that the lines of the two systems will be at very slightly different angles to the horizontal. In practice this effect is removed by the addition of "spot wobble" to the displayed incoming picture of such an amplitude as to camouflage the line structure of each field.

The mechanism producing the 10c/s flicker is indicated in Fig. 2. The top curve is a graph of the brightness of a single displayed picture element plotted against time and it is assumed that the signal at this point is peak white. It will be seen that the brightness increases to peak white as the element is scanned, once every 16.6msec, and that it then dies away exponentially. The time constant of this decay is, with the cathode-ray tube used, 7msec. The middle curve is the charge on the C.P.S. Emitron camera tube target, which in this case is being scanned at a 50c/s field frequency. The charge would increase linearly with time if display brightness were constant, but as the brightness of the display tube decays exponentially the charging curve of the target is also exponential.

The target charge increases in this way until the display tube element is rescanned. The camera tube element has not yet been neutralized by its scanning beam and continues to increase for a further 3.4msec, when it is discharged. It now commences to charge again, but at a lower rate, as the display tube element brightness has decayed from its peak level. The action continues in this manner until the fifth camera tube scan, when the two scans are once more coincident. If the peaks of the target charging curve are joined, a sawtooth type of waveform is obtained at a frequency of 10c/s, and this is proportional to the output of the camera tube. The signal is thereby amplitude modulated at 10c/s.

Removal of this flicker is effected by a pulse-sampling, manually adjusted amplitude compensator, followed by an automatic compensator which removes any flicker remaining after the signal has been subjected to the effect of the manually set circuit. The system, which is the subject of British Patent 801140 (T. C. Macnamara and A. M. Spooner), operates in the manner indicated in Fig. 3. The incoming video signal is passed through a low-pass filter which is switch-selected to pass the band of frequencies used by the incoming standard (3Mc/s for 405-line 50c/s standard). The next process is the insertion at the end of each line of the picture of a reference pulse which has a width of about 2% of the line period, and an amplitude of about 85% peak white. The pulse slightly overlaps the right-hand edge of a line of video signal and is apparent as a bright vertical stripe on the picture. The video signal with the reference pulse added is now amplified and displayed on the cathode-ray tube. The conversion process referred to earlier

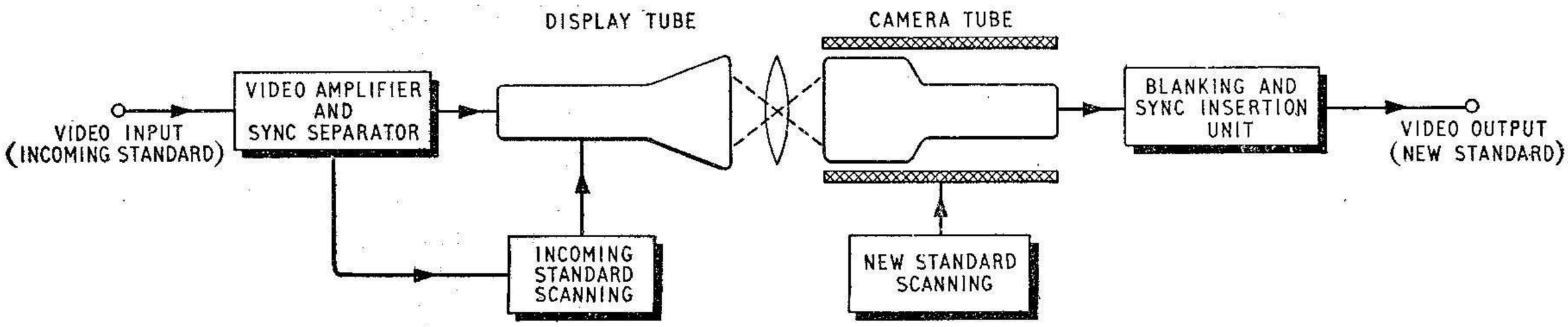


Fig. 1. The basic principle of a standards converter.

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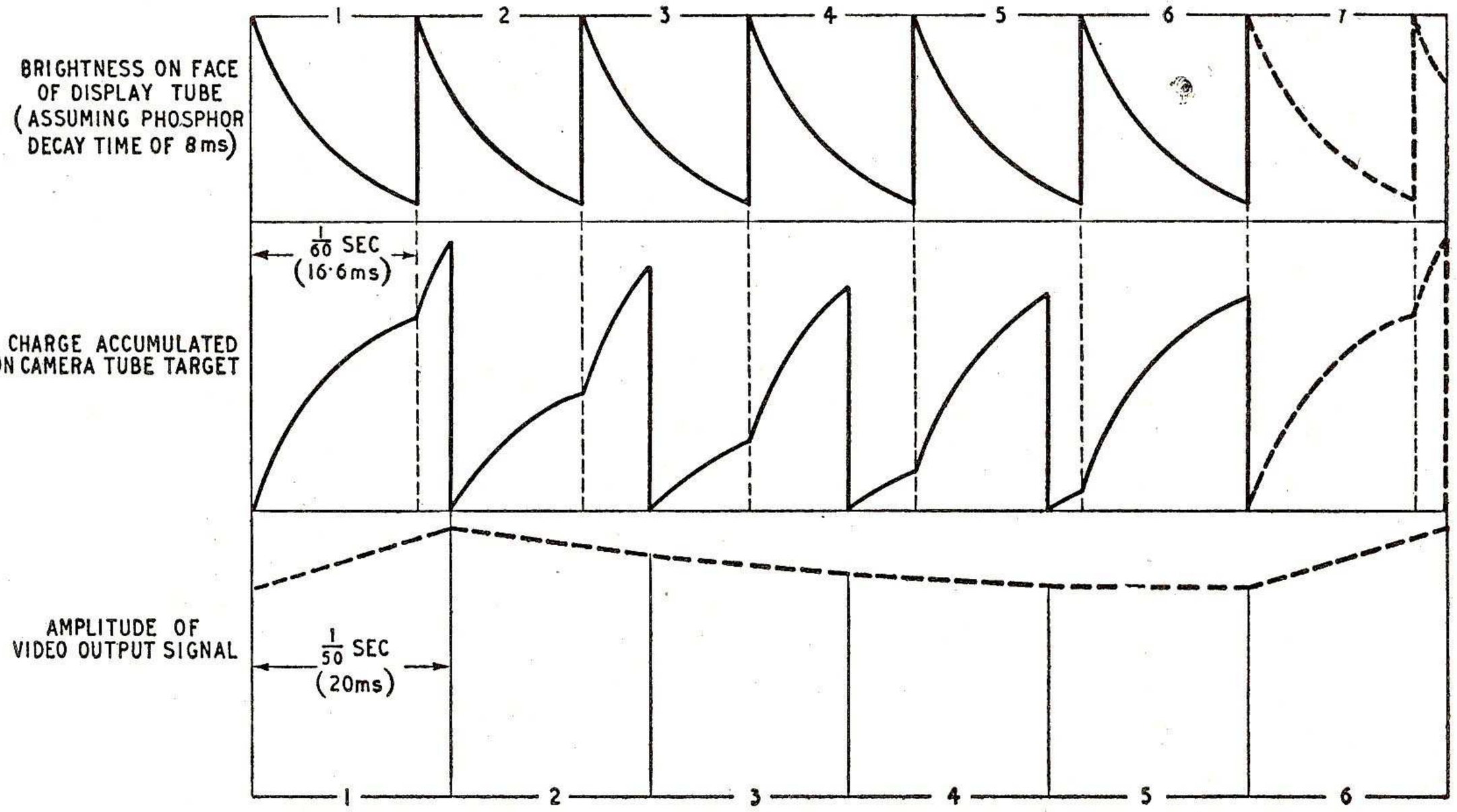
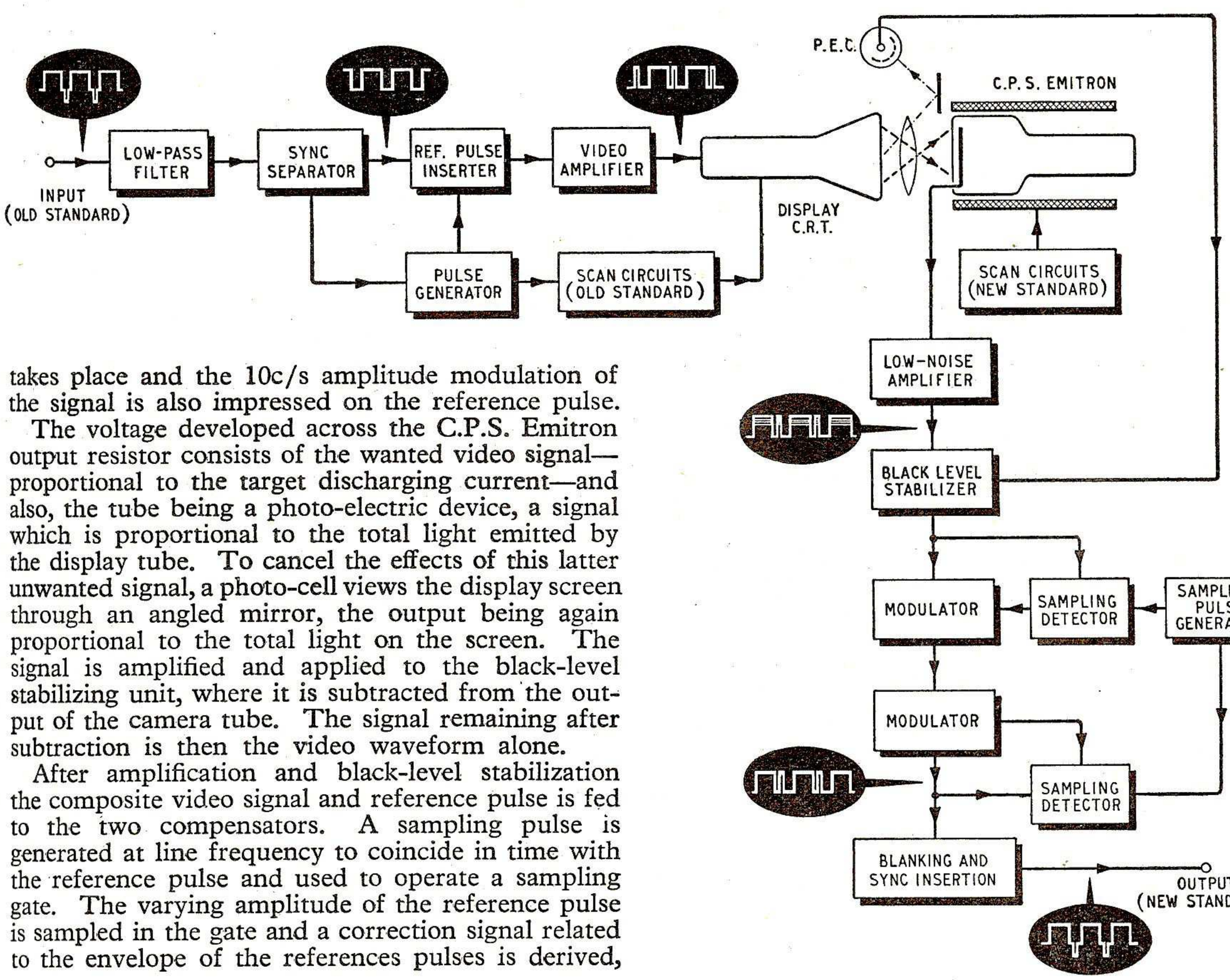


Fig. 2. The mechanism producing the 10c/s amplitude modulation of the video signal, in a conversion from 525 lines 60 fields/sec to 405 lines 50 fields/sec.

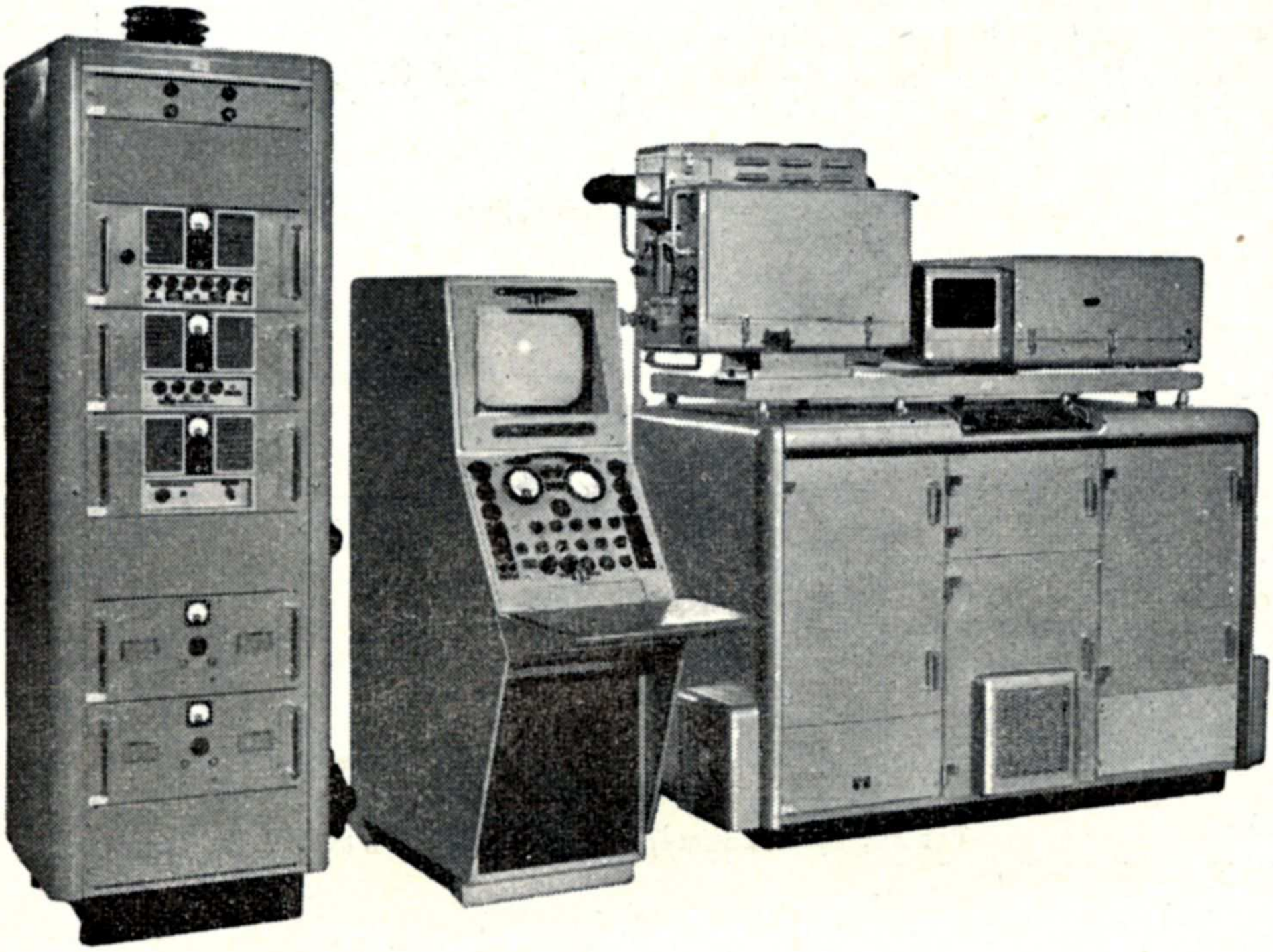
Fig. 3. Block diagram of B.B.C. 50c/s-60c/s converter, showing units concerned with 10c/s flicker removal. Waveforms shown are of peak white lines.



takes place and the 10c/s amplitude modulation of the signal is also impressed on the reference pulse.

The voltage developed across the C.P.S. Emitron output resistor consists of the wanted video signal—proportional to the target discharging current—and also, the tube being a photo-electric device, a signal which is proportional to the total light emitted by the display tube. To cancel the effects of this latter unwanted signal, a photo-cell views the display screen through an angled mirror, the output being again proportional to the total light on the screen. The signal is amplified and applied to the black-level stabilizing unit, where it is subtracted from the output of the camera tube. The signal remaining after subtraction is then the video waveform alone.

After amplification and black-level stabilization the composite video signal and reference pulse is fed to the two compensators. A sampling pulse is generated at line frequency to coincide in time with the reference pulse and used to operate a sampling gate. The varying amplitude of the reference pulse is sampled in the gate and a correction signal related to the envelope of the references pulses is derived,



The B.B.C. standards converter. From left to right: the flicker correction bay, the camera and display control unit with monitor, and the display pedestal including the camera and display tube.

this being used to drive a modulator which is in series with the signal path. The manual gain control adjusts the amplitude of the correction signal until the flicker is at minimum level. After this compensator the signal passes through a similar circuit which functions as an a.g.c. After passing through a modulator the signal feeds the sampling gate, which then applies the derived correction signal to the series modulator. The whole circuit is a feedback loop and is capable of reducing amplitude variations at 10c/s from 30% to less than 1%. The signal, then, first passes through a manually adjusted compensator, which reduces the level of modulation to a value which is within the range of control of the automatic circuit.

On leaving the two compensating circuits the signal is processed in a unit which inserts sync pulses and blanking intervals, and in which the reference pulses are removed. The signal is now converted to the new standard and ready for use.