CAMERA HEAD

CIRCUIT DESCRIPTION

The camera head comprises the circuits stated on the block-diagram in this chapter. The functions of the circuits are briefly described in this chapter. For a more detailed description of the circuits reference is made to the relevant chapters.

The light entering via the lens is decomposed into red, green and blue light by a prism and these components are projected onto the three plumbicons. The plumbicons CS, CT and CU are supplied via filter p.c. board CP, CQ and CR. The filter p.c. boards comprises a filter circuit C2-R2-R3 to which the static focusing voltage is applied. Via C3 a parabolic signal, arising across C4, is applied to the final anode of the plumbicon for dynamic focusing.

The plumbicon targets receive a fixed voltage of approx. 600 V via the separate filters R1-R2-C1, R3-R4-C2, R5-R6-C3.

The cathodes of the plumbicons are not earthed; to the cathodes the blanking pulses are applied.

The signal currents from the plumbicons are applied to the video amplifiers CJ-CF, CK-CG, CL-CH, which supply signals to the camera cable, so that the amplitude of the signals in the C.C.U. is 0.5 Volt.

The amplifiers contain the adjusting elements for target voltage, gain and streaking correction. A "soft clamp" circuit ensures that interference pulses present in the signal during the blanking interval are strongly attenuated. The blanking and parabola generator, unit CB, comprises a horizontal oscillator which is synchronised by an H-pulse. The oscillator supplies a drive pulse for the horizontal output stage, a pulse for the blanking signal and a pulse for the parabola generator.

A vertical pulse, derived from the "blue" deflection unit triggers a monostable multivibrator. This generator supplies a pulse for the blanking signal and a pulse for the parabola generator. The blanking pulses are added, and applied to the plumbicon cathodes. The parabolic voltages are also added and applied to the plumbicons.

From the horizontal pulse another clamping pulse is derived which controls the soft clamp circuits of the video amplifiers.

The horizontal output stage CC supplies the deflection current to the deflection units CM, CN, CO. The adjusting elements for the horizontal time bases are all accommodated in the CCU.

The deflection units comprise the horizontal and vertical deflection coils, the beam correction coils and the focusing coil. Except for the horizontal time bases all control circuits for the deflection unit are accommodated in the CCU.

The voltage for the final anodes and the plumbicon meshes are supplied by the 600 V generator DE. The voltages for the final anodes are adjustable for static focusing.

Unit DF delivers the supply voltages for the circuits in the camera head except for the intercom circuit for system C.

Unit DC comprises the scanning protection circuit and a sawtooth generator.

The scanning protection circuit receives the signals from the vertical deflection coils and a control voltage taken from the horizontal time base CC.

When the deflection voltages are not correct, this circuit supplies a control voltage. This voltage controls a circuit in the REMOTE module of the CCU, which in turn controls the STANDBY relay and the pilot lamps.

The sawtooth generator is controlled by an H pulse and supplies individually adjustable sawtooth voltages to the inputs of video amplifiers CJ, CK and CL. By means of the sawtooth signals the camera sensitivity can be adjusted and the complete video circuitry of the camera chain can be checked. The sawtooth signal is switched from the control panel on the CCU.

Viewfinder DB is a selfcontained unit. The viewfinder is supplied with 220 V a.c. The video signal is applied via cable compensation unit DG. This unit compensates for a camera cable of 600 or 1000 m, as required. The viewfinder receives a sync signal but can also operate on a VBS signal.

The VB(S) signal can be selected with video selectors SK6-7-8-9 and 10, which control the MON-X module in the CCU. With SK7 the Ext or blue signal is selected; with SK9 the Y or the red signal. With SK11 set to the left the blue or red signal can be selected with SK7 and SK9. With SK11 to the right EXT and Y are selected respectively.

Signalling unit DD receives most of its supply voltages from transformer T1. The signalling voltage "on air" (= actual) is obtained from the CCU; signalling voltage "Call" is obtained either from the CCU or from switch SK10. The +300 V serves for switching on and off the hour counter HOURS.

The +300 V is switched on and off by the STAND BY relay in the CCU. Lamps LA3-LA4 and LA5 can be dimmed with switch SK3. The lamps behind the lens ring are connected to the signalling unit via plug DL of the lens servo. The lamps can be switched off with switch SK2 (F).

From point 6 and 7 of lens servo plug DL a voltage derived from the servo is applied to the iris control on the CCU.

The adjusted voltage returns to the servo amplifier via point 15.

The servo amplifier is supplied with 220 Va.c. Zoom indicator unit DK is connected to the servo amplifier. This unit supplies a voltage which depends on the zoom setting of the lens, to a meter underneath the viewfinder.

Moreover, the voltage is applied to the signalling plug on the CCU.

Filter unit DL switches the control signals for the two motors of the filter revolver. The control voltage is obtained from the CCU. The a.c. supply for the motors is obtained from T1.

Intercom unit DH serves for communication between camera, CCU and production. Three standard systems are available, viz. intercom A, B and C.

In this Manual system C is chosen as standard.

## VIDEO AMPLIFIERS

### CIRCUIT DESCRIPTION

The input circuit is a cascode circuit consisting of TS3 in series with F.E.T. transistors TS1 and TS2. Double gain is obtained by parallel connection of TS1 and TS2. The input impedance is approx. 40 kΩ.
This impedance is obtained by means of feedback circuit R13-C6. L1 serves for compensation of the capacitive load presented by TS4. The target voltage is adjustable with R4.
Via R2 it is possible to apply a test signal to the input. As R2 = 1 M, 1 mV test signal corresponds to a signal current of 1 nA. The collector resistance of TS3 consists of 2 resistors. This is necessary as the voltage drop across the resistor should be restricted on account of the small dimensions.
Via C10 the signal is fed to a second amplifier. The streaking correction is included in the emitter circuit of TS2.
The RC time of R6//R7+C2+C1 is equal to that of the input of the cascode circuit in the first pre-amplifier 40 kΩ (the plumbicon capacitance). TS3 is an amplifier, R11 is the gain control. TS4-6 are amplifiers; C7 serves for adjusting the frequency response. TS5 is a so-called "soft clamp".
The transistor functions as a switch which is closed during the line flyback, Via C9 the signal is short-circuited to earth during this interval. Interference pulses which are capacitively coupled from the deflection coils to the target, are thus strongly attenuated. Via emitter follower TS7 the signal is fed to the camera cable.
The second amplifier is supplied via the first amplifier.

## BLANKING AND PARABOLA GENERATOR

### CIRCUIT DESCRIPTION

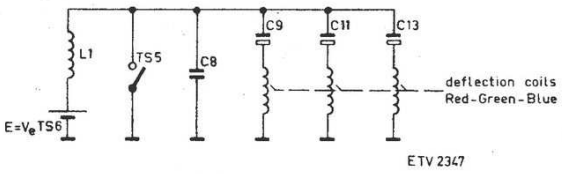
The generator supplies the blanking pulses for the three plumbicons, the parabolic voltages which are used for dynamic focusing, a control pulse for the horizontal output stage and a pulse for the "soft clamp" circuit of the video amplifier.
The H pulse applied to point 4 is obtained from the timing circuit in the control rack. The pulse is differentiated by C1 and serves to synchronise multivibrator TS1-2-3.
The pulse duration can be adjusted by selection of the shunt resistors of R6 and R2. Via emitter follower TS4 the pulses are applied to the horizontal output stage (via point 20), to the parabola generator and the blanking mixer.
Via C7 the pulse triggers sawtooth generator TS5-6. The sawtooth voltage arises across C8; TS5 then functions as a constant current source. With C9 the flyback of the sawtooth is slightly delayed so that the parabolic voltage, which is derived from the sawtooth voltage at a later stage, will have the correct phase with respect to the blanking.
Via TS8 a sawtooth current is applied to the capacitors of the 600 V smoothing circuit of the plumbicons. The sawtooth current is integrated so that a parabolic voltage arises across the capacitors.
The amplitude of this voltage is adjusted with R19. TS9 ensures that the direct current flowing to the capacitive load of TS8 is 0. Thus pure and symmetrical integration is ensured.
The sawtooth voltage from one of the vertical plumbicon deflection coils is applied TS10. This voltage is differentiated by C14-R28.
Via C15 the pulse formed by TS10 triggers mono-stable multivibrator TS11-12, which supplies a pulse with the correct duration for the camera blanking. Via C19 the pulse triggers sawtooth generator TS13-14. The sawtooth voltage arises across C20. Emitter follower TS15 controls Miller integrator TS16 on whose collector a parabolic voltage arises. The amplitude of this voltage is adjusted with R42.
After amplification by TS17 the vertical parabolic voltage is added to the horizontal parabolic voltage via TS18.
The horizontal pulse is amplified by TS19-20. With C4 the duration of the pulse is adjusted to the desired value for the camera blanking. R39 isolates TS19 from TS4; GR1 serves to reduce the switching time of TS19. When the negative pulse appears on GR1, this diode will immediately become conductive and short-circuit R39. C18 is charged and the diode will be cut off again. In TS21 the horizontal and vertical blanking pulses are mixed and amplified by TS22. Via double emitter follower TS23-24 the blanking signal is then applied to the plumbicons. From the collector of TS19 the horizontal pulse is applied to the "soft-clamp" circuit in the video amplifiers.

## HORIZONTAL OUTPUT BOARD

### CIRCUIT DESCRIPTION

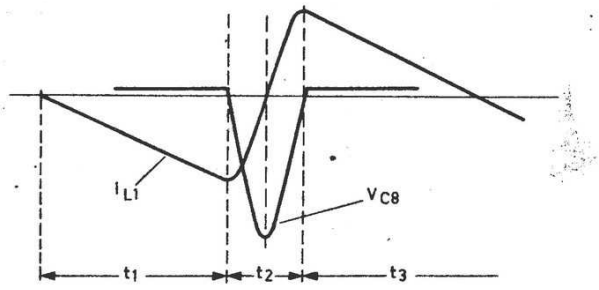
The negative control pulse is amplified by TS1 and applied to driver transistor TS4 via emitter follower TS3. During this pulse TS4 is conductive and C2 is charged by the base current. When the pulse disappears, C2 is discharged via TS4 and R4. However, R4 is short-circuited by TS2 and C2 discharges rapidly so that TS4 is immediately cut off. Via transformer T1 (input impedance of TS5 is very low) the pulse drives output transistor TS5.

Fig. 1 shows the basic diagram of the output stage.




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The battery voltage is the emitter voltage of TS6.
Via capacitors C9-C11-C13, the deflection coils are parallel connected to L1.
When TS5 is bottomed (scan time), L1 is connected to earth.
As a result the battery voltage will be present across L1; through L1 flows a linearly increasing negative current.
C9-C11-C13 also function as batteries for the deflection coils, so that also a linearly increasing negative current is obtained through the deflection coils. At the end of the scan TS5 is cut off. L1 and the deflection coils form a tuned circuit together with C8.




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Fig. 2 shows the voltage across C18 and the current through L1.
Time t2 (flyback time) is determined by C8 and L1 and the deflection coils. At the end of t2, the voltages across C8 will become positive and also the voltage on the emitter of TS5.
The base-emitter diode of TS5 now becomes conductive.
The voltage across the coils is constant again and the current through the coils is again a negative, linearly increasing (T3) current. The amplitude of the deflection current depends on the battery voltage, in this case the emitter-voltage of TS6.
This is the amplitude control for the three deflection coils together (master ampl.).

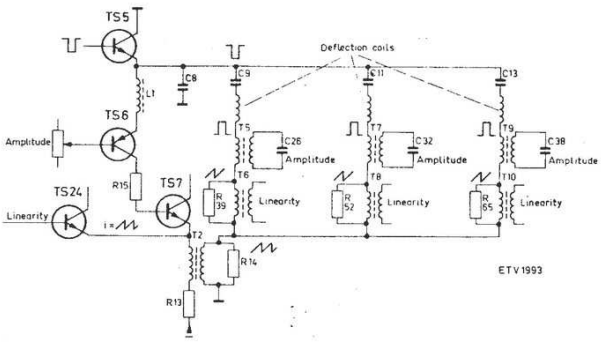



Fig. 3 shows the simplified diagram of the circuit.
Because a deflection coil has an ohmic resistance, the current through the coil will not increase exactly linearly. To compensate for this now non-linearity, a sawtooth voltage is applied in series, which is in antiphase with the voltage drop across the coil resistance. This is effected via T2. The original sawtooth current flows via TS7 through the primary winding of T2 and the sawtooth voltage on the secondary winding is connected in series with the deflection coils. The amplitude of this sawtooth voltage determines the linearity of the deflection current.
Now assume that the deflection current through the three deflection coils increases due to an increase of the emitter voltage of TS6. This is done with the master amplitude control, connected to the base of TS6. As a result, the non-linear sawtooth voltage across the deflection coil resistances increases. However, the increased deflection current also flows through the primary winding of T2.
Consequently the compensating sawtooth voltage across the secondary winding of T2 increases , so that the original linearity does not change.
With the master linearity control, the linearity can be varied over a small range. T5-T7 and T9 are the individual amplitude controls. Via this transformer, adjustable drive pulses can be applied in series with the deflection coils.
T6, T8 and T10 are the individual linearity controls.
Via these transformers adjustable sawtooth voltages can be applied in series with the deflection coils.
Let us now follow the detalis of the main diagram, Fig. 4.
The voltage for overall amplitude control is applied to point 21.

Via TS8 this voltage determines the emitter voltage of TS6. The emitter impedance of TS6 is very low on account of TS7. For, when the current through TS6 increases, the current through TS7 will also increase, viz. with the gain factor. A slight voltage variation on the emitter of TS6 will therefore result in a very strong current variation; consequently the impedance is very low. The sawtooth current which is to be applied to T2 for overall linearity control is supplied by circuit TS24, 25, 26, 27.

Transistor TS27 functions as a switch, which is operated by the pulse on its base. On the other end of L6 the direct voltage from the emitter of TS25 is present. Through L6 a sawtooth current flows: C45 determines the flyback time.

Via TS25-24 the sawtooth current reaches T2. The control voltage on point 3 determines the emitter voltage of TS25 and thus the amplitude of the sawtooth current. TS24 serves to provide a low emitter impedance for TS25. Of the individual controls only that for the red channel is described, as this is identical to those for green and blue.

TS13 is a switching transistor, and through T5 flows a sawtooth current whose amplitude depends on the emitter voltage of TS12.

Transformer T5 supplies the pulse voltage to the red deflection coil and thus determines the amplitude of the deflection current (compare Fig. 3).

TS15 is also a switching transistor. Through L3 a sawtooth current flows whose amplitude depends on the emitter voltage of TS14. The current through T6 is also sawtooth-shaped. R39 is very low ohmic; as a result the voltage across T6 will also be sawtooth-shaped. This voltage is applied in series with the red deflection coil and consequently determines the linearity of the deflection current. The circuits for overall and individual linearity as well as those for individual amplitude, are controlled by a pulse coming from T4.

A tertiary winding of T4 supplies rectifier GR3. This rectifier delivers a low positive voltage for individual amplitude control.

In the base circuits of the various transistors an RC filter has been included (e.g. C4-R8 for TS5). These filters improve the rise time of the drive pulse.

GR1 is conductive during the forward scan so that TS5 will have a low input impedance. R9 serves to discharge C4.

Filters C10-R20-C1-R21, C14-R22, C15-R23 are damping filters. They damp the oscillations arising on account of the flyback of the skew correction sawtooth voltages. The shift current through the deflection coils is supplied by L2, which via points 8, 9, 10 receives direct voltages of adjustable value and polarity. Moreover, sawtooth voltages of vertical frequency are applied to these points for skew correction.

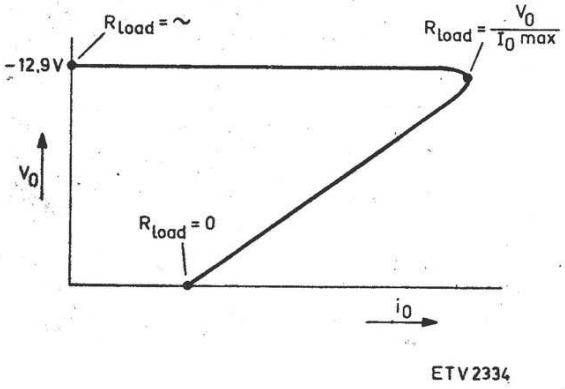
The windings of L2 serve as a choke. To increase their effect, a pulse is induced in three windings via C15-16 and a fourth winding. This pulse is in phase opposition with the pulse on the deflection coil. As a result, there will be no pulse on the sides of the windings to which the deflection voltages are applied; the windings then represent a very high self-inductance.

Protection against too low a deflection voltage is obtained with differential amplifier TS9-10. To TS9 the emitter voltage of TS6 is applied (amplitude control). Transformer T3 supplies a pulse to GR2; the amplitude of this pulse depends on the deflection current. GR2 is a rectifier; the rectified voltage controls TS10. At nominal deflection TS9 is conductive and TS10 is cut off. As a result, there will be a direct voltage of approx. -3 V on C18. When the amplitude is adjusted, both the base voltage of TS9 and that of TS10 will change to practically the same extent. The voltage on C18 remains almost constant. However, if one deflection coil cuts out, the pulse amplitude on GR2 will decrease approx. 30 %. The base of TS10 then becomes less negative so that this transistor is turned on. Via the emitter voltage TS9 is, as a result TS9 becomes cut off and the voltage on C18 becomes 0 V. R19 has been selected so, that at minimum scanning the voltage on C18 remains practically constant ($\geq$ 3 V) on account of the amplitude control.

## -12.9 V POWER SUPPLY

### CIRCUIT DESCRIPTION

Series transistor TS9 is controlled by differential amplifier TS2-3-4-5 via TS1. The differential amplifier is controlled as follows: The voltage on the output of the power supply is applied to long-tail pair TS2 and TS5. The setting of this long-tail pair is such that TS2 is more conductive than TS5, which is achieved with zener diode SP1 and precision resistors R4-R5. At increasing load current the output voltage will decrease. The full change is transferred to the base of TS5 and via the emitter of TS5 to the emitter of TS2. Part of the voltage variation reaches the base of TS2. TS2 and TS3 become more conductive and via TS1 the series transistor receives more current to compensate for the higher load.
As TS2 is more conductive, the emitters of TS2 and TS5 will become less negative so that TS5 and, consequently, TS4 become less conductive. Therefore, TS2 and TS3 will be more conductive at increasing load current, while TS4 and TS5 will become less conductive. The circuit has been proportioned so that when a certain load current is exceeded the output voltage and the output current decrease in such a manner that a certain dissipation is not exceeded.
The charachteristic is shown in the figure.




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The shape of the characteristic is obtained as follows:
At increasing load TS4 and TS5 become continually less conductive. TS2 has a low emitter impedance because it is parallel-connected to the emitter circuit of TS5.
When TS5 is cut off at a certain load the emitter impedance of TS2 is no longer low. TS2 is then strongly fed back by R7. TS3 is strongly fed back by R8 because TS4 is also cut off. On account of the feedback the current control for TS1 and TS9 is greatly reduced cross-over point in the curve.
In this condition the Ic of TS3 is proportional to $V_{R8}$, which in turn is proportional to the Ic of TS2 and consequently to $V_{R4}$. The current applied to TS9 varies linearly with the Ic of TS3, which in turn is a linear function of $V_{R4}$. Consequently, $V_{R4}$ will be a linear function of the output voltage.
In the situation described, the current of TS9 follows a resistance line. The cross-over point is not abrupt on account of the curvature of the Vb and Vce curves of TS5 and TS4.
In the case of a short-circuited output TS3 should be conductive. If this is not the case, TS9 would remain cut off after removal of the short-circuit, because TS3 only supplies current when there is an output voltage. However, this output voltage can only arise when TS9 supplies current. Via R2 transmitter TS3 becomes yet conductive to some extent at short-circuited output so that the above-mentioned effect is avoided.
The value of the output voltage is determined by selection of R14. R13 serves for temperature stabilisation of SP1.
For the heater supply of the plumbicons a voltage of 6.45 V is required (= 6.3 V + 2.5 %). The voltage is derived from the voltage on R4-R5. Via current amplifier TS6-7-8 the required current is supplied to the 6.45 V output. R20 is the common emitter resistor.
GR2 protects the plumbicons in case of a short-circuit between the -6.45 V line and earth. Otherwise 12.9 V would arise across the two plumbicons between the -12.9 and -6.45 V. On account of the short-circuit, amplifier TS6-7-8 is cut off.
Via diode GR2 the base voltage of TS5 becomes practically 0 V, TS4 and TS5 are cut off, TS9 receives a small drive signal and the output voltage of the power supply becomes very low.
If there is a short-circuit in one of the plumbicon heater circuits between the -12.9 V and the -6.45 V, TS8 will become highly conductive on account of its low emitter resistance. This current is limited by GR1. The collector of TS8 becomes strongly negative and so does the base of TS4 via GR1.
The emitter voltage of TS3 rises, TS3 supplies less current and via TS1-TS9 the -12.9 V decreases so that the current of TS8 is reduced.
If on account of a defect in the power supply the output voltage tends to increase, the output voltage will be limited to max. 40 V with SP2-SP3.
The 300 V input voltage is reduced to a voltage of +54 V by SP4-5. This voltage is used as supply voltage for the blanking and parabola generator.

## 600 V SUPPLY

### CIRCUIT DESCRIPTION

The 600 V supply unit delivers a voltage of 600 V to the plumbicon mesh. Three voltages, which are variable between approx. 490 and 590 V, are generated for the final anodes of the plumbicons. These voltages serve for static focusing.
A negative H pulse is amplified by TS1. The pulse on the collector bottoms TS2-4. This means that TS2-4 serve as a switch. The collector voltage on TS2 will consequently vary between +300 V and earth potential. Due to this a pulse will arise with an amplitude of approx. 300 V.
After C12, the lowest level of the pulse is clamped at +300 V by GR10. After rectification by GR9 a direct voltage of approx. 600 V is then obtained on C14. The same procedure is repeated 3 times. However, the bottom of the pulse is then clamped at a variable voltage, so that the direct voltage supplied is adjustable.
The voltage values on the outputs indicated in the circuit diagram, are slightly higher in reality. This is due to the load exerted on the high ohmic circuit (22 M) by the measuring instrument used (20.000 Ω/V).
Diodes GR1-2 limit the $V_{be}$ of TS2 and TS3.

## SCAN PROTECTION CIRCUIT AND TEST GENERATOR

### CIRCUIT DESCRIPTION

The unit comprises a circuit which applies a signalling voltage to the stand-by circuit in the control rack. In the case of failure or too small a deflection current the stand-by circuit is energised. This circuit protects the plumbicons because the +300 V for the camera head is switched off.
The unit moreover, comprises a sawtooth generator which supplies the signals by means of which the video amplifier in the camera head can be checked and adjusted.

1. Protection circuit

The protection circuit consists of a gate circuit with GR1-2-3-4. The cathodes of these diodes are negatively biased with R31-R44. In the normal operating condition the diodes are cut off on account of the negative bias applied to the anodes. For GR4 this voltage is obtained from the horizontal output stage. In the case of GR1...3 the voltages are obtained by rectification of the voltages on the vertical deflection coils. By means of emitter followers TS1-3-5 the rectifiers are isolated from the deflection coils.
During the negative cycles of the deflection signals TS2-4-6 will be conductive because the emitters are then negative with respect to the bases. During the positive cycles of the signals, TS2-4-6 are cut off.
The average current and the collector voltage of TS2-4-6 therefore depend on the amplitude of the deflection signal. The collector voltages are smoothed with C10-12-14.
Normally TS7 is conductive and drives TS8 into saturation. The collector voltage of TS8 is then approx. -12.8 V.
If one of the deflection currents become too small, one of the anodes of GR1-2-3-4 will become positive with respect to the cathode.
The base voltage of TS7 increases, TS7 is cut off and, consequently, TS8. The collector voltage of TS8 then becomes zero. The collector voltage of TS8 controls the protection circuit in the CCU, which switches the camera chain to the STANDBY POSITION. The +300 V for the camera head is then cut off, the anodes of the plumbicons receive no voltage so that the beam current is suppressed.

Test generator

The H pulse is clipped and amplified by TS1. The pulse triggers bootstrap sawtooth generator TS10-11. Through feedback via C4 a linear sawtooth is obtained. Amplifier TS12-13 is overdriven by the sawtooth, so that a flat "white" level is obtained for the sawtooth. The level at which the amplifier is overdriven is determined with feedback resistor R15. Amplifier TS14 applies the sawtooth signal to the inputs of three video amplifiers, (where the signals are fed to the amplifier input).
The signal amplitude is adjustable per channel. The sawtooth signal can be switched off by cutting off TS12. This is achieved by connecting R17 parallel to R11. The value of R13 has been selected so that in position "off" no sawtooth signal is available on the outputs.

SIGNALLING UNIT

This unit comprises a switching circuit and a matrix with the aid of which the individual pilot lamps can be connected to the "call" or to the "on air" system or both. The unit furthermore comprises a switching circuit by means of which the hour counter can be switched on, and a +12.9 V power supply.

1. Signalling

"On air" lamps are connected to TS8 (lamp on top of camera head) and TS10 (lamps behind red ring on the lens).
The "call" lamps are connected to TS11 (viewfinder) and TS12 (rear of camera). The lamps are switched on by bottoming the transistors. The drive voltages are supplied via a matrix circuit. As TS8 and TS10 must deliver a relatively high power, TS7 and TS9 have been included between these transistors and the matrix.
With the aid of the matrix both the "call" and the "actual" control voltages can be applied to one of the four outputs, or a combination of these. The matrix has four junctions, marked in the diagram with AC, AC, AC and AC. If a positive control voltage is applied to one of these junctions, this voltage will reach the output transistors via the diodes connected to that junction. The lamps then light up.
The letter A is for actual (on air) the letter C for call.
A line over the relevant letter means that the relevant circuit receives no signalling voltages. When it is not overlined this means that a signalling voltage is present.
For example, AC means that there is a voltage on point 14 and no voltage on point 8.
The letter combination near a junction indicates that on the relevant junction a voltage of approx. +12 V is present if the requirement given by the letter combination is met.
Consequently, there are four different cases:

a. No signalling voltages on inputs 8 and 14. Junction AC then receives a voltage of approx. +12 V, TS12 is conductive; the lamp in the call switch then lights up to indicate that the camera is switched on.
b. Signalling voltage on 8, not on 14 (call only). Junction AC now receives approx. +12 V. The lamp underneath the viewfinder is lit, the lamp in the call switch is extinguished. When the voltage on 8 disappears (by repeated depression of the call switch e.g. on the control rack) the situation described under a is restored.
c. Signalling voltage on 14, not on 8 ("actual" only). Junction AC now receives the voltage. The red lamps on the top of the camera and near the viewfinder and the lamp in the call switch light up.
d. Signalling voltage on 8 and 14 ("actual" and "call"). Junction AC now receives a voltage. The lamps on top of the camera and near the viewfinder light up. The lamp in the call switch is extinguished.
That junction AC receives voltage in case a can be explained as follows.

When points 14 and 8 are voltageless, TS3 and TS5 are cut off and TS4 and TS6 are turned on. The cathodes of GR6 and 7 are connected to +12.5 V so that GR6 and 7 are turned off. The 12.9 V is then applied to junction AC via R9. The cathodes of GR8-9 are connected to earth via TS4 and 6; point AC receives no voltage.
The cathode of GR11 is connected to earth via TS4.
Junction GR10-11 will carry no voltage and so will AC.
Cathode GR12 is connected to 12.5 V, GR12 is cut off.
GR21 is connected to earth via TS6 so that AC is voltageless.
The situations b, c and d are obtained in a similar way.
By means of a different diode matrix, it is possible to determine which lamps should light up in a certain situation.

2. Power supply

Rectifier GR1-4 supplies a direct voltage of approx. 23 V.
This voltage is used as supply voltage for the pilot lamps.
The voltage is smoothed with R3-C1-R4-C2.
With SP1-2 and TS2 the voltage is stabilised. The stabilised voltage is used for the signalling circuit.
Bridge rectifier GR5 is connected in series with the hour counter. When TS1 is conductive, the bridge rectifier is conductive and the hour counter is switched on.
TS1 is controlled by the stand-by circuit in the C.C.U.

3. Signalling C.C.U.

The signalling voltage for "Actual" is applied via relay RE1.
This relay can be energised in various ways:

a. By means of a voltage between points 4 and 6. This can be effected via the intercom plug (F and G) or via the signalling plug (A and B). The value of R7 (which is connected in series with rectifier bridge GR1) depends on the voltage applied, e.g. for 12 V the value of R7 is 330 Ω, for 20 V this value is 1500 Ω and for 48 V the value is 3900 Ω.
b. By interconnecting points 4 and 6. For this R7 should be removed and point d interconnected to c and e to f, so that rectifier bridge GR1 is connected to the internal +12 V.

When R1 is energised, +12 V is applied to the camera via the signalling line, so that the relevant lamps light up (see point 1 ). The +12 V is also applied to the base of TS3 so that TS3 becomes fully conductive and the "actual" lamps on the L.C.P. light up.
The lamp at the front of the module and, in the case of remote control, the lamp on the remote control panel then also light up.
The signalling voltage for "Call" is approx. 24 V and is available on connector 270 of the power supply unit. Via the "CALL" switch the 24 V is applied to the camera via the signalling line. This is also possible via the remote switches.
The signalling voltage is furthermore applied to TS2 via emitter-follower TS1 so that TS2 becomes fully conductive

and lamp "call" on the L. C. P. lights up.
In the case of remote control the lamp on the remote control panel also lights up.

## VIEWFINDER - CABLE COMPENSATION

### CIRCUIT DESCRIPTION

The unit corrects deviations of the video-signal for the viewfinder, caused by the use of a 600 or 1000 m camera cable. Felten and Guillaume, type 736. The video-signal is corrected Felten and Guillaume, type 736. The video-signal is corrected by the filters in the emitter circuit of TS1. In position 0-300 m there is no correction because this is already effected in the MON X module. Inverter stage TS2 drives output amplifier TS3-4. This amplifier supplies the signal to two outputs. H- and S-pulses are generated in the pulse-module in the C. C. U. Via the camera cable, the pulses are applied to the two identical amplifiers TS5-6 and TS7-8. The output of the H-pulse amplifier is connected to the scan failure and test generator board and the blanking and parabola generator; the output of the S-pulse amplifier is connected to the viewfinder.

VIEWFINDER

CIRCUIT DESCRIPTION

1. Video section, p. c. board U2

The video signal is applied to contrast control R4 via the connection plug. The video circuit is terminated with R3//R4 = 75 Ω. TS201-202 is an amplifier; C205 serves for adjusting the frequency response.
Via emitter follower TS203 the signal is applied to clamping circuit TS204-205. TS204 is conductive when the signal is negative during the clamping interval, TS205 when it is positive. After emitter follower TS206 output stage TS207 has been included. The collector impedance is formed by R214//R215 in series with correction coil L202; and L203 in series with GR204 and TS208.
In the normal condition diodes GR201, 202, 203, 204 and TS208 are conductive; L202 is then parallel-connected to L203.
Coil L203 serves for peaking. TS208 is conductive when R218 is earthed via the peaking switch. When the switch is open, TS208 is cut off and L202 is no longer connected in parallel with L203. The self-inductance of the collector circuit of TS207 increases so that high-frequency video components are boosted.
Diode GR204 is connected in series with TS208. When this transistor would be cut off the collector-emitter capacitance of TS208 would form a series tuned circuit with L203.
With GR204 the collector-emitter capacitance is connected in series with the diode capacitance so that the overall capacitance is reduced. The resonant frequency of the series tuned circuit then falls outside the desired frequency band.
For high frequencies voltage Vcb of TS208 might exceed the max. permissible value on account of oscillations due to L203. This is also prevented by GR204 being cut off. If L202 were connected direct to the supply circuit, there would be no voltage across GR204 + TS208 so that TS208 could not be bottomed. However, the reverse voltage of diodes GR201-202-203 is present across TS208 + GR204 so that TS208 can become conductive.
Diodes GR205-206 serve for white clipping. The clipping level has been adjusted to approx. 7.5 V with SP201-202.
Voltage surges on the collector of TS207 on account of flash-over in the picture tube are avoided with spark traps VL2 and VL3, connected to the cathode and Wehnelt cylinder of the picture tube.

Time base

To TS209 on p. c. board U2 either the sync signal or the VBS signal is applied. Selection is effected by resoldering a wire (d-f or d-g).
TS209 clips the signal; TS210 is only conductive during the peaks of the sync signal.
From the collector of TS210 the signal is applied to the vertical and horizontal time bases. The sync. signal is differentiated by C213-R226 and integrated by R227-C214 so that the pulses on the collector of TS211 are delayed.
Via inverter stage TS212 the pulses control clamping circuit TS204-205. The sync. signal is integrated by R234-C217. On the collector of TS213 only the vert. sync pulse is present which via C219 synchronises multivibrator TS214-215. R238 is the vert. sync control. Via GR208-209 and R245, capacitor C223 is rapidly charged to a positive value; R245 limits the charging current. During the forward scan TS214 is cut off. GR208-209 are then also cut off, because C223 is positive. C223 discharges via R246-244-243. The discharge depends on R244, which is the picture height control. R247-C224-R248 provide linearity correction.
The sawtooth voltage is amplified by TS216. The sawtooth voltage on the emitter results in a sawtooth current into C222. Across C222d parabolic voltage arises which is adjustable with R249 (vertical linearity). Via emitter follower TS217 output transistor TS218 is controlled. T2 is a choke which is coupled to the deflection coil via C230.
From the deflection coil the deflection current flows to R260 and thus drives TS216 (current feedback). R263 has been selected so that the voltage on the emitter of TS218 is 1.7 V. As a result the setting of TS218 becomes independent of tolerances. This ensures proper temperature stability of the output transistor.
Via the H.T. plug the sync signal reaches phase discriminator GR401-402 on p. c. board U4. To the junction of GR401-402 a sawtooth voltage of line frequency is applied. The flyback pulse from the output stage drives TS406. During the pulse TS406 is conductive and charges capacitor C409 via R415. When TS406 is cut off, capacitor C409 discharges via R414.
The control voltage from the phase discriminator controls multivibrator TS404-405 via TS402-403. Filter C404-R407 is a jitter filter. The frequency of the multivibrator is adjusted with R502 (p. c. board U5) which via GR402-401 also determines the control voltage.
Via driver stage TS306 the multivibrator controls horizontal output stage TS301 and H.T. generator TS302-303-304-305. One side of the deflection coil is connected to booster diode GR302, the other side to the linearity control (point c).
The flyback time is determined by C305 and C306.
GR301 is a rectifier which is conductive during the forward scan. On C304 a direct voltage arises, which is added to the supply voltage. This is necessary because the output stage requires a supply voltage which is some volts higher than the +17 V.
With R301 the effect of the rectifier circuit and as a result the horizontal amplitude is adjusted.

3. High tension

The high tension is generated in a separate generator. Transistor TS302 is an output transistor, GR303 is a booster diode. Via TS303 transformer T2 is connected to the supply voltage. TS303 is controlled by rectifier TS304 and TS305. The flyback pulse is rectified by GR304; the resulting direct voltage controls TS305. When the load increases, the pulse voltage decreases.
The base of TS305 becomes less positive and TS305-304-303 become more conductive and supply more current to the transformer so that the pulse voltage increases again.
The value of the high tension is adjusted with R308.
The current from the h.t. coil flows through R318. With R318 the effect of the current on the h.t. can be adjusted, i.e. the internal resistance.
The pulse from the h.t. winding is rectified in unit U4.
The voltage on C602 is used for the focusing potentiometer. Via GR602 and 603 the voltage is transferred from C602 to C603. The pulse voltage rectified by GR603 is added to this voltage, so that a voltage of approx. 15 kV is obtained.
The pulse on the collector of TS302 is rectified by GR307. The rectified voltage is applied to the focusing potentiometer and also serves as signalling voltage for the scan protection circuit.
With GR306 and GR305 a pulse derived from C307-C308 is rectified. The pulse amplitude therefore depends on the horizontal deflection current. With GR306 the peak of the pulse is clamped at the level of the voltage on C319. After this, the pulse is rectified with GR305. The rectified voltage controls the scan protection circuit.

4. Flyback suppression and scan protection circuit

Flyback suppression for the picture tube is obtained by mixing pulses obtained from the vertical and horizontal output stages on the collector of TS108 (p.c. board U1).
The vertical pulse is applied via C113.
The width of the vertical pulse on the collector of TS108 is determined by the value of C114. The horizontal pulses are applied via C111-R126. From C112 the peaks of the pulses are clamped at the level of the voltage on brightness control R1 with the aid of GR108. Via R125 the pulses and the brightness control voltage are applied to the Wehnelt cylinder of the picture tube.
The deflection failure protection is only operative for the horizontal deflection. This is necessary because the high tension is not derived from the horizontal output stage. Horizontal deflection failure would cause a vertical line on the picture tube. The vertical deflection is relatively slow with respect to the horizontal deflection. As a result a vertical line will burn in much sooner than a horizontal line.
To the emitter of TS107 a voltage of -68 V is applied, to the base a voltage of -72 V; TS107 is cut off and the anode of GR108 then has the same voltage as the brightness control.
When the horizontal deflection fails, no pulse voltage is applied to the base of TS107 via GR306-305. On account of the reverse voltage of GR306-305 the base of TS107 will nevertheless become positive with respect to the emitter. This is sufficient to drive TS107 into saturation. The voltage on the collector now becomes approx. -66 V and via GR109 this voltage reaches the anode of GR108 and cuts off the picture tube. GR109 prevents that, when TS107 is cut off, the negative parts of the flyback suppression pulses exceed the max. permissible voltage between the collector and base of TS107.

5. Supply section

The supply section consists of two parts: a 17 V supply and a 47 V supply.
The 17 V circuit is supplied by rectifier GR104-107.
TS1 is the series regulator. To reduce the dissipation in transistor TS1, part of the current for the supply is applied via R111-R112. TS1 is driven via differential amplifier TS105-106 and emitter follower TS104. SP105-106 supply the reference voltage. The supply voltage for TS106 is stabilised by means of SP101-102. The 17 V supply serves as a reference for TS102 in the 47 V supply section.
GR102 limits the $V_{be}$ of TS102. This transistor drives series regulator TS101.

## ZOOM INDICATOR UNIT

### CIRCUIT DESCRIPTION

The zoom indicator unit supplies an adjustable stabilised voltage to a reference potentiometer which is coupled to the zoom section of the lens. The voltage supplied by this potentiometer is applied to a meter.
The other side of the meter is connected to a fixed voltage.
In position "small angle" the meter deflection is adjusted to max. focal distance of the lens by means of R4. In position "wide angle" R6 is adjusted to minimum focal distance.
The indicator mounted underneath the viewfinder is connected between points 10 and 9. Between points 4 and 9 a second meter may be connected.
Points 4-9 are connected to points E and F of the signalling socket at the rear of the CCU.

## FILTER REVOLVER

### CIRCUIT DESCRIPTION

With the filter revolver the colour filters or grey filters or a combination of these are inserted between the lens and the prism. In this way the colour temperature of the illumination can to some extent be adapted to the illumination to which the camera is adjusted.
The grey filters are used when the aperture of the lens is minimal and the illumination level is too high (outside recording), to filter light strongly without affecting the colour temperature. The grey filter may also be used to change over from a small aperture e. g. F/16 to a larger aperture e. g. F/4.
The depth of focus then changes considerably which may be desired to achieve certain effects.
The filter discs are driven by a separate motor; the grey filter disc by M1, the colour filter disc by M2. Switching on and off of the motors is effected via relays controlled by transistors. The control signal for the transistors is obtained from two bridge circuits.
The bridge circuits consists of 4 resistors with a switch. The switches on the left of the diagram are located in the control rack (CCU), the switches on the right of the diagram are coupled to the drive motors.
The circuit diagram represents the situation with the switches set to position -6 V. Between the bottom and top of GR1 there will be a voltage difference, TS1 and TS2 are cut off and relay RE1 is not energised.
When the switch on the CCU is set to position -3 V, the diode bridge is no longer balanced and therefore supplies an output voltage. TS1 and TS2 become conductive and energised RE1. The motor is switched on and the switch coupled to this motor is also driven. When the switch is at -3 V, the motor is no longer energised. At this point the motor is mechanically stopped. Because the motor is only switched on and off and the polarity is not reversed, it will always have the same rotating direction.
Filters R9-C5 and R10-C6 suppress sparks at the relay contacts.

## ELECTRONICS UNIT

### CIRCUIT DESCRIPTION

In the block diagram the modules are indicated by means of a heavy dash-dotted line.
When one module contains 2 or more p.c. boards, these are indicated by means of a rectangle (continuous line) drawn within the dash-dotted lines.
The electronics unit accommodates the following circuits:

I. Video circuits in which the camera signals are processed. After this the signals are applied to the output as R-G-B signals, to the black-and-white monitor as mixed or non-mixed R-G-B signal, to an oscilloscope unit as a NAM signal and, if applicable, to an encoder as R-G-B signals.
II. A pulse unit which generates the required pulses. This unit also provides a test signal for adjusting the VIDEO OUT modules.
III. The vertical scanning circuits with the master controls for horizontal and vertical amplitude and linearity.
IV. Focus and beam-correction circuits.
V. Intercom and signalling.
VI. Remote control switch.
VII. Encoder and colour bar generator.

a. VIDEO IN module

The camera signals are applied to the VIDEO IN module.
The module has the following functions:

1. Cable length correction, to compensate for the attenuation in the camera cable.
   Adjustable to 0-25-50-100-150-200-250-300-600 and 1000 m. The incoming signals are available on the test sockets at the front for the purpose of checking. Furthermore, two control voltages can be selected by means of the cable length switch; one voltage for the timing circuit in the PULSE module (output, point 2) and one for cable compensation of the viewfinder signal in the MON X module (output, point 20).
2. Gain control in three steps, viz. -6 dB, 0 dB and +6 dB; 0 dB is normal operation.
3. Pulse compensation
   By means of this the influence of interference pulses in the camera signal on the black level is eliminated. These interference pulses occur during the camera blanking, as a result of cross-talk between the horizontal deflection coils and the plumbicon target.
4. Bridging
   With the relays the three colour channels are interconnected, so that they receive identical signals. During bridging, the circuits for automatic black level are made inoperative. Should this facility not be included, the colour channels would not be identical after the briding circuit, because the circuits for automatic black level control are adjusted individually.
   During bridging, the colour picture will contain a registration error, because the green plumbicon picture has been shifted with respect to the red and blue pictures due to the contour extractor.
5. The green channel includes green tilt correction. This correction serves for compensation of the effect of the oblique faces in the prism (correction by changing the gain in the rhythm of a sawtooth of vertical frequency).
6. Individual gain control. Each channel includes an individual amplitude control. The control range is from -2.5 dB to +3.5 dB (individual painting).
7. Automatic black level. This is to compensate for changes in black level due to stray light on the lens.
8. Line tilt correction. By means of this the tilt of line frequency in the signal is compensated for.
9. White clipper. This circuit clips off signals which lie 20 % or more above white level.

Per channel the VIDEO IN module supplies 2 output signals. One signal is applied to the MATRIX module, the other signal to the connection panel at the rear of the CCU. On this panel, the signals are indicated by R3, G3, B3. The output level is 0.7 V into 75 ohms.

b. CONTOUR EXTRACTOR module

This module receives the green signal via a switch at the input of the matrix module. In the CONTOUR EXTRACTOR module a 25 MHz carrier wave is modulated with the green signal amplitude. The signal passes through a 64 $\mu$sec delay line (63.5 $\mu$secs. for 525 lines) and is then amplified.
From the amplifier the signal is fed to a second delay line and amplifier. Each amplifier is followed by a detector.
The output signals have a delay of one line (1$\tau$ ) respectively two lines (2$\tau$ ) lines with respect to the input signal (0 ).
The signals are applied to the CONTOUR PROCESSOR module.

c. CONTOUR PROCESSOR module

In the CONTOUR PROCESSOR module the vertical contour signal is derived from the non-delayed and delayed signals. Moreover, the horizontal contour signal is derived from the 1 $\tau$ signal.
The contour signals are mixed and pass through a gate circuit which limits the small contour amplitudes (noise suppression). The contour signal and the 1 $\tau$ signal are fed to the MATRIX module.

d. MATRIX module

The red, green and blue output signals from the VIDEO IN module are applied to the matrix module.
By means of the switch after the green input, the signal is fed either direct to the matrix circuit (contour by-passed) or via the contour extractor (contour operate). Via the test sockets at the input, the output signals of the VIDEO IN

module can be checked, as well as the 1 output signal from the CONTOUR PROCESSOR. Via phase inverter stages positive and negative R, G and B signals are fed to the matrix. The matrix provides correction for the prism and for the negative components of the spectral curves. The matrix is accommodated on a plug-in p.c. board, so that different matrix coefficients can be applied. The output signals then reach the output amplifiers via switches MATRIX on-off and TEST.

Switch MATRIX on-off serves to facilitate registration of the camera.

For example, an appreciable amount of green picture information is introduced into the blue channel via the matrix, so that the blue picture is not pure. In position MATRIX off, the positive signals from the phase inverters are fed direct to the output amplifier. In the output amplifiers the contour signal is added to the video signals. Via the TEST SWITCH either the video signals or a test signal can be applied to the output amplifiers.

This test signal is obtained from the pulse module.

The output signals from the MATRIX module are fed to the VIDEO OUT modules, one for each of the colour signals.

e. VIDEO OUT module

The VIDEO OUT module has the following functions:

1. Aperture correction
2. Blanking mixer with white clipper and black level control
3. Gamma correction
4. Gamma selector for $\gamma = 1$ (linear), $\gamma = 0.6$-1 or $\gamma = 0.35$-0.6
5. Output amplifier for the gamma-corrected signal and one for the linear signal.

The module has three test sockets, one for the input signal, one for the signal just before the blanking mixer and one for the gamma-corrected output signal.

The gamma-corrected output signals are distributed as follows:

- two signals to the connection panel at the rear of the CCU, indicated by R1, G1 or B1
- one signal to the encoder
- one signal to the MON X module
- one signal to the MON W module.

The linear output signal is fed to the connection panel and is indicated by R2, G2 or B2.

f. MON-X module

The MON-X module includes a mixing circuit via which the R-G-B-Ext signals (either mixed or non-mixed) are fed to the black-white monitor and view finder. The module accommodates two p.c. boards. To one p.c. board the R-G-B-Ext 2 signals are applied. With the aid of a matrix a Y-signal is derived from the R, G and B signals.

By means of an inverter circuit a -G signal is derived from the G-signal.

The complete circuit consists of two channels, one for the black-and-white monitor and one for the viewfinder. With electronic switches the signals are mixed and applied to a second p.c. board via an amplifier stage. A sync. signal and the Ext 1 signal are also applied to this p.c. board. If required, the sync signal can be mixed with the monitor and viewfinder signals. The signals are then transferred to the output amplifier. With the aid of switches the signals can be disconnected and the Ext 1 signal can be applied to the monitor and/or viewfinder.

The output amplifier of the viewfinder includes a cable compensation circuit. This circuit provides a pre-emphasis for the viewfinder signal for cable lengths to 300 m. For lengths of 600 or 1000 m correction takes place in the camera head. The compensation circuit is controlled by the cable length switch on the VIDEO IN module. The module is fitted with test sockets for the outgoing monitor and viewfinder signals.

The monitor signal is fed to the connection panel where it is indicated by MON X.

g. MON W module

To the MON W module R-G-B signals from the VIDEO OUT modules are applied. From these signals a NAM (non-additive mixing) signal is derived which contains the instantaneously lowest and highest levels of the R-G-B signals. By means of a gate circuit the signals with the highest levels are added to the signals with the lowest levels. Via the output stage the resultant signal is then fed to output WFM-MIX on the connection panel.

h. PULSE module

The PULSE module accommodates a printed circuit board on which pulses are generated, a printed circuit board for generating a test signal and circuitry for shifting the H-pulse for the camera (timing).

To the pulse board S and B signals are applied. The S signal is clipped off and fed to a distribution amplifier.

From there the sync signal is transferred to the MON X module and to the two outputs S on the connection panel.

The S signal synchronises a horizontal generator which triggers the H-pulse generator. The H-pulse is fed to the timing circuit on the TEST AND DELAY UNIT and to the CONTOUR PROCESSOR.

From the H-pulse a clamping pulse is derived which is applied to the VIDEO OUT MODULES, the VIDEO IN MODULES and the MON X module via separate outputs.

By means of a gate circuit a V-pulse is derived from the S pulse. The B-signal is clipped and fed to the VIDEO OUT modules and the test generator. In the TEST AND DELAY unit the H-pulse controls a sawtooth generator which via a limiter circuit produces an H-pulse which is delayed with respect to the original H-pulse. The delay is determined by a control voltage from the cable length correction switch on the VIDEO MODULE, and a fine control on the front of the module.

The incoming and outgoing H-pulses are available on the test sockets for checking purposes.
The B-signal controls a sawtooth generator. The sawtooth voltage is limited in white so that a flat white level is obtained. For the outgoing test signal a choice can be made between the sawtooth signal and an external test signal. Both signals can be checked via a test socket.

j. INTERCOM module

The INTERCOM module comprises a printed circuit board for signalling purposes and an intercom p.c. board.
The call signals from the camera and control panel enter at point 14 of the signalling board. When a call signal is received from the control panel, the signal is applied both to the signalling board of the INTERCOM module and to the camera via 517 of the taper-pin block.
The call signal from the camera is applied via the same point.
The "on air" circuit can be connected between points 4 and 6 of the p.c. board. This can be effected by applying an external voltage to these points or by short-circuiting these points. In the latter case the switching voltage is obtained from the printed circuit board itself. Selection between one of these two methods is effected by resoldering some connections of the p.c. board. Switching can be effected both via plug SIGN and INTERCOM. Via plug SIGN the encoder phase (contacts C-D) can also be adjusted. Moreover, between contacts E and F a voltage is available which is obtained from the zoom indicator board in the camera head. To E and F a meter can be connected which indicates the focal distance of the lens.
The intercom board is available in three versions, viz. intercom A, intercom B, intercom C.
The intercom board serves for communication between camera, CCU and production room.
The description in this Service Manual is based on intercom C, which is included in the standard version of the camera chain.

k. SCANNING module

The SCANNING module contains a printed circuit board with the complete vertical time base circuitry and a printed circuit board with the horizontal shift circuitry. The master controls for horizontal and vertical amplitude and linearity are located on the module.
The vertical time base circuit consists of a sawtooth generator with three amplifiers. The generator is synchronised by a V-pulse. The individual controls for amplitude, linearity and shift are accommodated on the registration panel.
The vertical sawtooth voltage is also applied to a phase inverter stage. The positive and negative sawtooth signals from this stage are used for skew correction.

l. FOCUS AND ALIGNMENT module

This module incorporates the circuits for magnetic focusing and beam correction. For adjusting the beam correction a sweep generator has been included which supplies a signal of 5 Hz to 10 Hz or, when the generator is synchronised with a V-pulse, a 25 Hz signal.
The V-pulse is then derived from an output stage in the vertical time base circuit.

m. SPARE units

In position SPARE two single extension modules are fitted. This space can also be used for an automatic iris drive unit, e.g. for telecine.

n. REMOTE module

In the standard version the REMOTE module comprises one relay (connector 311).
This relay serves for changing over from local to remote operation (from a remote control unit). On request, it is also possible to include the relays of connectors 312 and 313. The module furthermore contains a meter with which the various supply voltages can be checked, as well as a printed circuit board with circuits for signalling a power supply or deflection failure.
The pilot lamps are located at the front of the module and on the control panel. Furthermore, an on-off switch for the camera chain has been provided. After switching-on, the chain is in position STAND BY. For OPERATION the switch on the control panel should be operated.

o. ENCODER AND COLOUR BAR modules

For these modules see the separate Service Notes in the file ACCESSORIES FOR STUDIO COLOUR CHAIN LDK 3.

p. Except for the modules already described, the electronics unit also contains a fan for cooling, a terminal block for applying the local mains voltage to the camera (utility outlet) and two sockets PROGRAMME SOUND for a direct sound connection via the camera cable to the camera head.
These sockets can be used for reporting or similar purposes.
The electronics unit is connected to the camera cable via a taper-pin block. In the camera head the camera cable is also connected to a taper-pin block.
The numbers on the taper-pin block in the electronics unit correspond to those in the camera head.
The connections for the local mains voltage (utility outlet) and the extra audio lines run directly via the camera cable.

VIDEO IN

CIRCUIT DESCRIPTION

The VIDEO IN module has the following functions:
a. compensation of losses caused by the camera cable
b. gain control
c. bridging
d. pulse compensation
e. green tilt compensation
f. painting
g. automatic black-level stabilisation
h. line tilt correction
i. white clipping

Note: The description applies to the blue channel.

Differential amplifier TS202-202 controls cable compensation circuit TS203-204. The compensation circuit has been proportioned for 3 steps, viz. 0-300 m, 600 m and 1000 m. At 0-300 m the emitter signal of TS203 is amplified by TS204 and added to the collector signal of TS203.
Thus the attenuation of the signal in the camera cable is compensated for. When the cable is longer, a stronger signal is applied to TS204, until the maximum value is attained at 300 m. The frequency response is corrected by means of C204 and a filter in the emitter circuit of TS204. For 600 m and 1000 m cables the compensation is adapted accordingly by connecting a different filter to the emitter of TS204.
The master gain is controlled in 3 steps (-6, 0, +6 dB) with TS205-206-207. For this, TS206 and 207 are bottomed or not. When the control voltage is 0 V, TS206 is cut off and TS207 is bottomed. R214 is then connected to earth and is connected in parallel with R212 for the signal. In the normal operating condition this is 0 dB. A control voltage of +12 V will bottom TS206, so that R213 is also connected in parallel with R212. This is in position -6 dB.
A control voltage of -12 V cuts off TS206 and TS207. In this case no resistors are connected in parallel with R212; this is the situation +6 dB.
After the gain control circuits, the three channels can be interconnected by means of the "bridging relays", so that from that point the 3 channels are controlled in a similar way. This facility can be used for equalising the gammas of the processing amplifiers (VIDEO OUT). However, this is an initial and not the definite gamma adjustment. The reason for this is that the gamma of the blue plumbicon is not the same as that of the red and green plumbicons. Final adjustment should therefore be effected with the aid of a test chart placed in front of the camera. Moreover, in cases of emergency the bridging facility can be used to set the camera to black and white, e.g. when a video amplifier in the section preceding the bridging circuitry should fail. Pulse compensation is effected with TS208 in the collector circuit of TS205. The collector impedance is dependent on the master gain.
The amplitude of the compensation pulse is then automatically adapted by means of the gain control. As a result, the ratio between the pulse and video signal remains constant.
Via TS209, emitter follower TS210 and TS201, the signal is fed to gain control circuit TS202. The left section of TS202 is a d.c. emitter follower, so that the emitter voltage of the right-hand section of TS202 will be stabilised. A variation of the base voltage by means of R212 will thus change the impedance of this transistor. R206 in combination with TS202 forms a variable voltage divider, so that the video signal on the base of TS203 is also influenced.
In a similar way the emitter voltage of TS202 can be varied by means of the individual gain controls on the registration panel. When these individual gain controls are in the zero position, the output voltage of the module can be equalised to the input voltage (0.7 V) with R212.
TS204 serves for automatic black level stabilisation. On printed circuit board U2 the signal which has passed TS211 is integrated by R228-C212. The direct voltage on C212 depends on the picture content. This voltage serves as supply voltage for TS210. TS210 is a switching transistor which is bottomed by clamping pulses. During the clamping pulses negative pulses will arise on the collector of TS210, whose amplitude is practically equal to that of the voltage across C212. Via TS205 the pulses (positive) are added to the signal during the flyback. This implies that the clamping level depends on these pulses. When the picture content increases, there will be more stray light on the lens, so that the "black" in the picture changes to dark grey. The pulses added to the signal by TS205 also become stronger. Because the peaks of these pulses are clamped further on, they will be kept at a constant level. As a result, the black level in the signal will be lowered, thus eliminating the effect of stray light.
This automatic black level control becomes inoperative when the "bridging" is switched on. This is necessary, because in the case of bridging a different black level is obtained since the three colour channels are directly interconnected. This would disturb the automatic black level control. The automatic black level control is disabled by removing the clamping pulses from the base of TS210. After emitter follower TS206 the signal is clamped by TS207. Due to transistor tolerances the coupling capacitor will be slightly charged either positvely or negatively, during one line period. This can be compensated for by applying a current of opposite polarity to the base circuit of TS208.
By means of R222 (line tilt) this current is adjusted so that the line tilt in the black level is exactly compensated for. Thus, a flat black level is obtained.
Via TS208 and TS211 the signal is fed to the output. The base voltage of TS211 is adjustable with R14 (white clipper). Signals which lie 20 % above white are clipped by TS211. The green channel includes green-tilt compensation for prism correction.

The angle of incidence of the light on the oblique sides of the prism is not the same for the top and bottom of the picture. Because the effect of the dichroid layers in the prism depends on the angle of incidence, there will be less light at the top of the picture than at the bottom of the picture on the green outlet of the prism.

In a black/white picture this results in a top edge which is light magenta and in a bottom edge which is somewhat green. Elimination is possible by increasing the green gain at the beginning of a field and by reducing it at the end of a field. This is a sawtooth shaped correction of vertical frequency. The gain variation is obtained with GR102...109, to the junctions of which sawtooth voltages of opposite phase are applied via TS110. The sawtooth voltage on the base of TS110 may be either positive or negative.

To TS13 on printed circuit board U2 clamping pulses are applied. With the potentiometers between collector and base pulses of variable amplitude and polarity are fed to the pulse compensation circuits on p.c. board U1. Via TS12 the clamping pulses are transferred to clamping transistors TS7, TS107 and TS207. Via a relay the pulses are then fed to TS10, TS110 and TS210.

When the bridging relays on p.c. board U1 are energised, the relay on U2 is also energised. Thus the "automatic black level control" is disabled during "bridging".

The variable resistor in series with R50 on U2 is in fact a series of resistors on the cable length correction switch which determine the value of a direct voltage. This direct voltage determines the pre-emphasis of the viewfinder signal in the MON-X module.

A similar circuit between R51 and R52 controls the phase (timing) of the H-pulse supplied to the camera head by the pulse module.

CONTOUR EXTRACTOR

CIRCUIT DESCRIPTION

The module accommodates two printed circuit boards with identical circuits. Printed circuit board U1 moreover contains a crystal oscillator. Crystal oscillator TS1 operates at a frequency of 25 MHz. With modulator TS2-TS5 the carrier wave is amplitude-modulated. The modulation depth is approx. 50 %; this is a compromise between deep modulation (signal-to-noise ratio) and linear modulation. TS2a-2b is a transistor pair in one casing, so that the best possible matched pair is obtained. The current of TS2b is determined by TS5. Via TS2a the carrier wave is applied to TS2b whose base is connected to earth. The collector signal of TS2b forms the carrier wave whose amplitude depends on the video signal applied to TS5. Thus the collector signal is amplitude-modulated. GR1 in the base circuit of TS5 serves for temperature stabilisation of transistor TS5. TS3 serves to remove the video components. This is because high-frequency video components are present across L3. The video components are applied both to the base and the emitter of TS3, so that they are no longer present at the collector of this transistor.

L3 forms a collector impedance across which no direct voltage is present. As a result, the control ranges of the transistors are considerably extended. R12 has been included for damping L3.

The value of R12 has been selected so that a signal voltage of 4 Vp-p is present at the input of the delay line. Via the double emitter-follower TS1-2, the signal is fed to the delay line. L2 of the double emitter-follower, in conjunction with the input capacitance of the delay line, forms a resonant circuit which is tuned to 25 MHz. In the delay line the signal obtains a delay of 64 $\mu$secs. The attenuation is approx. 60 dB. In HF amplifier U4 the signal is amplified to such a level that linear detection is possible. L1 in conjunction with the output capacitance of the delay line and the input capacitance of the TS1, forms a $\pi$ filter tuned to 25 MHz. Gain control R7 is adjusted for a video output signal of 0.4 Vp-p at a video input signal of 0.8 Vp-p. R7 moreover, serves to compensate for delay line tolerances. Filter L7 determines the bandwidth of the amplifier.

L6 is a filter with parallel and series resonance, so that a band-pass curve with a flat top is obtained.

L7 provides the d.c. path for GR2 and has a high impedance for the carrier wave. The output signal is detected by TS6. GR2 and R19 serve for temperature stabilisation of TS6 so that the signal is detected linearly. Filter C8-L4-C9 serves to suppress the 25 MHz signal.

L5...L9 provide an additional delay. R25 and R26 have been included for terminating the delay line.

By means of this additional delay, the delayed signal is brought in phase with the original signal. This is necessary in view of delay line tolerances.

The original signal obtains a slight additional delay in the processor module, where the contour signal is produced.

The eventual delay of the output signal of p.c. board U1 is adjusted by short-circuiting one or more of the units L5...L9.

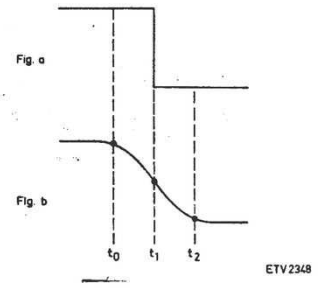
Printed circuit board U2 is identical to U1 except for the crystal oscillator. The input signal of U2 is the output signal of the HF amplifier on U1. This signal is amplified in TS1. The output signal of U2 has a delay of two line times with respect to the input signal of U1.

## CONTOUR PROCESSOR

### INTRODUCTION

This introduction explains how a contour signal is obtained. The principle described applies both to horizontal and vertical transients, as shown in Fig.a.

Due to different causes, amongst others lack of resolution of the plumbicon and the limited bandwidth of video amplifiers, the transient will be distorted. The trace then becomes as shown in Fig.b.




To derive a contour signal from this distorted transient, the amplitude of the transient at moment t1 is compared with the amplitudes at moments t0 and t2. In order to enable comparison at the same moment, the transient should be delayed twice, i.e. from t0 to t1 and from t1 to t2. These delays are equal, viz. twice 150 nsecs for horizontal transients and twice the line time for vertical transients.

The 150 nsec delay is called $\tau$ ', the delay of one line time is called $\tau$ .

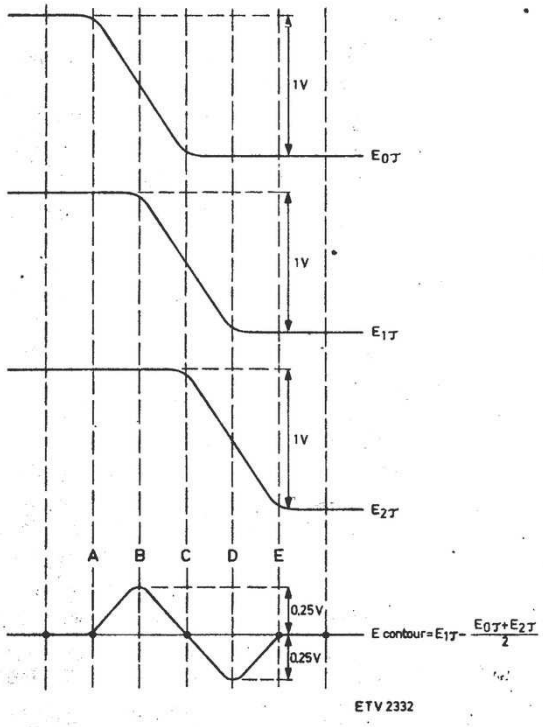



Fig.c shows the transient Eo$\tau$ and the delayed transients E1 $\tau$ and E2 $\tau$ below each other. (The following example only applies to the transients shown in figure c.)

Every horizontal unit of time is 1$\tau$ . The amplitude of each transient is 1 V. The formula for the contour signal E contour = $E1\tau - \frac{Eo\tau + E2\tau}{2}$ can now be applied to the three transients at the moments A...E.

A: Econtour = $1 - \frac{1+1}{2} = 0$ V

B: Econtour = $1 - \frac{0.5+1}{2} = 0.25$ V

C: Econtour = $0.5 - \frac{0+1}{2} = 0$ V

D: Econtour = $0 - \frac{0+0.5}{2} = -0.25$ V

E: Econtour = $0 - \frac{0+0}{2} = 0$ V

As appears from Fig.c, the contour signal is symmetrical with respect to transient E1$\tau$ which has been delayed once.

In Fig.d the E1$\tau$ and the contour signal have been added.

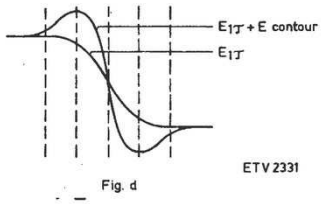



Fig. d

Note: It will be obvious that when the rise times and the amplitudes have different values than in the example, the contour signal will also have a different amplitude.

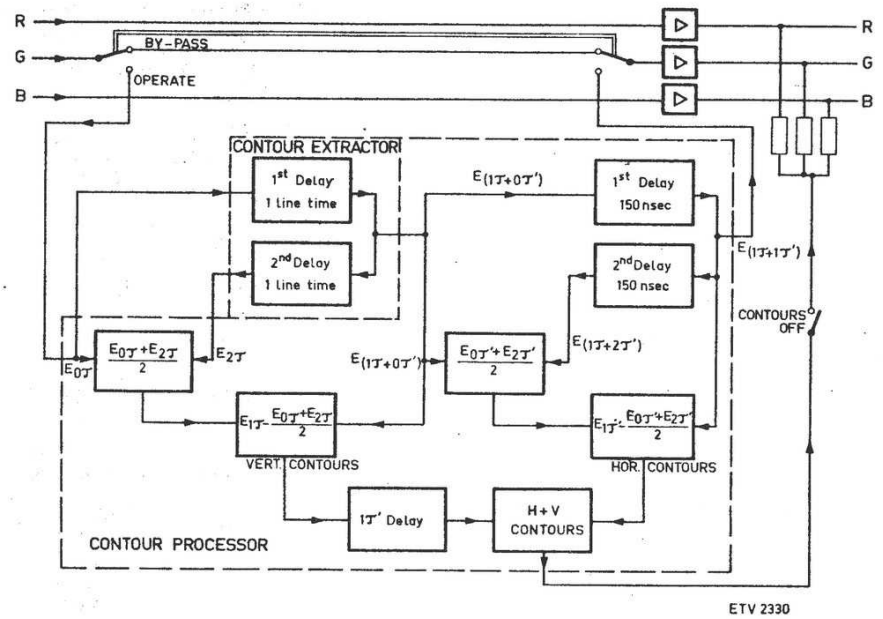
For colour cameras the "contours-from-green" principle is applied. The contour signal is derived from the green video signal because this represents 59 % of the luminance signal. Contour signals of the same amplitude are added to the red, green and blue colour signals, so that the total colour picture will have a sharp black-white contour. The advantage of this is that minor registration errors are thus eliminated.

Fig.e shows the block diagram of this system.

In the contour extractor the green Eo$\tau$ signal is twice delayed by one line time. The three signals E0$\tau$ , E1 $\tau$ and E2$\tau$ are fed to the contour processor, where the contour signal is formed in accordance with the formula. The E1$\tau$ signal is twice delayed by 150 nsecs, after which the horizontal contour signal is obtained in a similar way. The E1$\tau$ + E1$\tau$ ' signal is now applied to the green amplifier as video signal.

The vertical contour signal occurs at the same time as the E1 $\tau$ signal. The horizontal contour signal occurs at the same time as the E1$\tau$ + E1$\tau$ ' signal, which is fed to the green amplifier.

Before the vertical contour signal is mixed with the horizontal contour signal, the vertical contour signal should therefore be delayed additionally by 1$\tau$ '. The red and blue video signals should also be delayed by 1$\tau$ + 1$\tau$ ', but this is effected automatically during registration (horizontal and vertical shift).




During registration the contour signal is switched off because, as already stated, the contour signal eliminates minor registration errors.

The green video signal, however, is normally delayed by $1\tau + 1\tau'$.

The contour processor can also be made inoperative, so that the original green signal is then fed to the green amplifier.

When switching to "By-pass", the registration for the green signal should be re-adjusted with the green shift potentiometers.

## CIRCUIT DESCRIPTION

The input signal is fed to the DELAY module via GR9 and amplifier TS1-3 whose gain is adjustable. This input signal is the $0\tau$ signal. By varying the gain of TS1-3 the modulation depth of the carrier wave in the DELAY module is adjusted.

The $2\tau$ signal from the DELAY module is applied to point 18. R16 is adjusted so that $0\tau$ and $2\tau$ signals of the same amplitude are fed to TS4. L1-L8 delay the $0\tau$ signal to the same extent as the $2\tau$ signal is delayed by the DELAY module circuits. This delay is added to the delays of the two delay lines. Via TS18 the $1\tau$ signal is applied to TS5. Because TS4 is driven at the base and TS5 at its emitter, the signals $0\tau + 2\tau$ and $1\tau$ on the collectors of TS4-5 will be in phase opposition. Consequently, TS4 and 5 supply the signal $1\tau - \frac{0\tau + 2\tau}{2}$

R21 is adjusted so that when there is no contour, the difference signal is zero. Filter L9 delays the vertical contour signal. This delay is identical to that of the horizontal contour signal. This ensures that in the case of a square image the horizontal and vertical contours fit exactly together in the corners.

The horizontal contour signal is obtained in a similar way as the vertical contour signal. Filter L10-15 supplies the $1\tau'$ signal, filter L16-21 the $2\tau'$ signal. Across R83 the $0\tau'$ and $2\tau'$ signals are present.

Signal $\frac{1\tau' - 0\tau' + 2\tau'}{2}$ is present on common collector resistor R90 of TS21-22. R83 and R87 have the same function as R16 and R21 respectively. The horizontal and vertical contour signals are mixed in TS7 and TS8. R31 serves for adjusting the mixing ratio to 1:1. After amplification by TS9 the contour signal is applied to "small amplitude" circuit TS10-TS11. This is because the noise at the transitions between two points of slightly different brightness in the contour signal (i.e. low contour signal amplitude) is also amplified. TS10-11 form a class-B arrangement. R47 can be adjusted so that TS10 and TS11 are biased to the same extent but oppositely. In that case R48 = R49//R49. TS10 now only transfers the positive and TS11 only the negative signal amplitudes. When R47 is set to a lower value, the emitter of TS10 will become more positive and that of TS11 more negative. Both transistors now have a certain threshold so that weak contour signals cannot pass through.

With the aid of TS12 and TS13 a negative and a positive signal component are added. The contour signal reaches the output via TS14.

For the proper working of the above circuit the base voltages of TS10 and TS11 should have a fixed value. This is achieved by means of clamping transistor TS15 which receives an H-pulse Due to the clamping process a small "porch" will arise in the signal; this is eliminated by means of R42. The green signal applied to the video processing circuit is the $1\tau + 1\tau'$ signal ($1\tau$ both for horizontal and vertical delay). The signal is amplified by TS23-25. R95 is the gain control; this control is adjusted so that at 0.7 V signal on the processor input (test point M1) an 0.7 V signal is obtained on the output. Filter L22-23 delays the green signal to the same extent as the contour signal is delayed by TS7-8 and the subsequent circuitry. Delay filters L1-8, L10-15, L16-21 and L22-23 are terminated with 220 Ω at both ends.

## MATRIX MODULE

### CIRCUIT DESCRIPTION

The three input signals are applied to matrix U2 via a phase inverter. The potentiometers serve for making the input signals of the module equal to the output signals (0.7 V).
In the input of the green channel a switch has been included. Via this switch the green camera signal applied to point 7 is fed direct to the matrix (contour by-passed) or to the contour extractor (contour operate). From point 9 the signal is then fed to the extractor, the green output signal of the extractor being present on point 6.
Via points a, b, c, d, e and f positive and negative R, G and B signals are applied to the matrix unit. After matrixing the R-G-B signals are fed to the output amplifiers via points h, g and k.
For registration of the camera, the matrix should not be operative. The reason for this is that when the blue channel is adjusted with respect to the green channel, red picture information will be introduced in the green and blue channels via the matrix. Therefore, the matrix should be inoperative during registration. This is achieved by means of relays RE2, 4 and 6. By means of these relays the positive R, G and B signals can be fed direct to the output amplifiers via R7, R26 and R43.
The input impedance of the output amplifiers is low, so that the input currents of these amplifiers are determined by the matrix only. The output amplifiers have a very low d.c. output voltage, which is kept constant by a strong negative feedback via R14, R33 and R49.
When the matrix is switched on or off, this direct voltage will remain practically constant so that jittering is avoided.
Equality of the gain of the output amplifiers is ensured by precision resistors R11, R30 and R47 with which the gain is adjusted.
The contour signal is applied to the low-ohmic input of the output amplifiers via R10, R28 and R44. These contour signals have the same amplitude so that a luminance signal is obtained.
Via RE8 the contour signal can be disconnected. This is effected simultaneously with the matrix, and it is also necessary for registration. Possible registration errors are then not obscured by the contour signal.
The test signal is fed to the output amplifiers via relays RE1, RE3, RE5, RE7 and resistors R8, R27, R45.
The 0.7 Vp-p test signal is transferred to the VIDEO-OUT modules via the output amplifiers. The gain of the video output stages can be adjusted to 0.7 V on the oscilloscope unit with the aid of these test signals. This ensures that from the output of matrix unit U2 the three output amplifiers have unity gain.

This implies that the gain of the final amplifiers can only be equal when the amplitudes of the signals on the matrix outputs are the same.
Therefore, the matrix unit has been designed so that this is only the case when the amplitudes of the signals on the inputs are the same. When the test signal is switched off, the amplitudes of the input signals can be equalised with the potentiometers of the input amplifiers. When the input amplitudes deviate strongly with respect to each other, the contribution of e.g. red to green will not be correct, which is to be avoided.

## VIDEO OUT MODULE

### CIRCUIT DESCRIPTION

The video signal which only contains camera blanking, is applied to emitter follower TS1. In this transistor the signal is clamped, because the setting of the aperture corrector is level-dependent. In the aperture correction circuit the correction is adjustable with R11 and the level with R19. For aperture correction, switch SK1 should be in the position shown in the diagram. Delay line L1-C6-C7-C8 is terminated with R13-R14-R20, of which R14 is a select-on-test resistor.

In the other position of SK1 the correction circuit operates as a filter.

In this position the delay line is open-circuited at one end and then operates as an absorption filter (open /4 line). The signal from the collector of TS4 is now fed direct to the collector of TS5. Moreover, a positive direct voltage is fed to the base of TS5, so that diode GR1 is turned off, thus blocking the emitter signal of TS4.

Gain control is possible via TS6, e.g. by remote control. Under normal conditions point 1 is connected to -12 V via a resistor (8.2 kΩ - 1 %). This resistor is located in the remote module. During gain control, the amplitude potentiometer will change the direct voltage on the emitter of TS6 and thus the current through TS6 and TS7.

The base voltage of TS7 is constant, so that the impedance of TS7 will vary. TS7 forms part of the collector impedance of TS6, so that the gain will also vary. TS8 has been included for temperature stabilisation. R24 (preset gain) is adjusted so that the output amplitudes are equal for gamma = 0.35 and gamma = 1.

Due to the gain control circuit the d.c. level on the collector of TS7 will change and will be transferred as a variation. This variation is compensated for by TS9, which causes an equal but opposite d.c. variation on the collector of TS7. The signal is amplified in amplifier TS10, 11, 12. From the emitter of TS12 the signal is fed to TS17. With TS13 the signal is clamped.

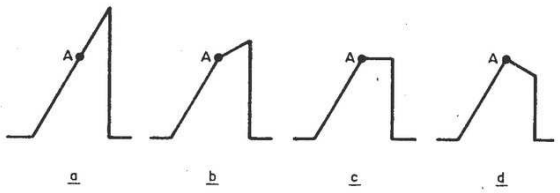
TS17 is the blanking mixer. The blanking signal is clipped and amplified by TS20. C29 and C27 correct the shape of the blanking pulse. GR11 has been included to ensure that the circuit of TS20 is only connected in parallel with TS17 during the blanking interval. On the collector of TS17 the video signal with blanking is present. By means of GR5-6 excessive blanking is removed; C32 prevents cross-talk of the signal via the diode capacitance when the diode is cut off.

The black level is adjusted by changing the clamping level of TS13. This is achieved with TS16 (master control), TS15 (individual control) and emitter follower TS14. By controlling the black level via transistors, interaction between master control and individual control is minimised.

The value of R50 in the emitter circuit of TS16 has been selected so that the black levels in the 3 colour channels change proportionally when operating the master black level control.

The circuit with TS17 also serves for white clipping. For this purpose the emitter signal of TS17 is fed to amplifier TS19 via emitter-follower TS18. To the base of TS19 a variable threshold is applied, so that TS19 only amplifies the "white" peaks of the signal, without affecting the phase.

The amplified white signal is fed back to the emitter circuit of TS17 via GR12. Thus the emitter signal is boosted during white while the base signal is kept constant. This results in a reduced white gain. By varying the gain of TS19 (with R64) the base and emitter signals of TS17 can be equalised during white. As a result the gain will be zero for white above the signal level selected with R66.




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"A" in the figures indicates the limiting level; in Fig.b the gain of TS19 is too low, in c the gain is correct and in d the gain is too high.

After the blanking mixer the signal is gamma-corrected with diodes GR7-8. These diodes are biased via R68. Emitter-follower TS21 serves to minimise the load for the gamma diodes. Via GR9-10, R76 and TS22 an uncorrected signal is fed to the gamma controls.

With R71 the gamma can be adjusted between 0.35 and 0.6; with R72 between 0.6 and 1. Via a switch and transistors TS25-28 the signal from R71, R72 or TS22 can be selected.

In position gamma = 0.35 point R84-85 is connected to earth. The base voltage of TS25 andTS26 is then practically zero. Via TS27 the emitter of TS25 becomes negative and TS25 is turned on so that the signal from R72 can reach the output amplifier via TS27. The emitter of TS26 is also negative, TS26 is cut off (PNP) and the signal from R72 is thus blocked. TS28 is cut off by the negative base voltage. In position gamma = 0.6 the base voltage of TS25 becomes strongly negative. TS25 is then cut off and TS26 is turned on so that the signal from R72 is fed to the output amplifier via TS27.

In position gamma = 1 the base of TS27 becomes positive so that TS27 is cut off and TS28 is turned on.

The linear signal from TS22 is then transferred to the output amplifier.

Potentiometer R90 in the output amplifier should be adjusted so that at equal signal amplitudes on the emitters of TS21 and TS22 the output signal can attain the required amplitude (range 0.5-0.8 V). TS30 serves for matching to the low input impedance of TS31. Amplifier TS31-33 is d.c. coupled. The value of R96 has been selected so that the direct voltage on the output is ≤ 0.1 V. Temperature stabilisation is achieved by negative feedback via R99-R101. Zener diode SP2 reduces the emitter d.c. voltage of TS32 without the disadvantages of a capacitor-decoupled resistor.

The linear signal from TS22 is applied to the output via TS23-24. R82 is adjusted in a similar way as R90.

MON X MODULE

CIRCUIT DESCRIPTION

Printed circuit board U1.
The base circuit of TS1 includes matrix R1, R2, R3 to which the R, G and B signals are applied. On the base of TS1 the Y-signal arises.
TS2 and 3 are switching transistors. Via R6 and R7 a positive voltage can be applied. When a positive voltage is applied TS2 and TS3 are cut off so that the signal is not transferred. When there is no voltage, both transistors are conductive and the signal is fed to output stage TS34-TS35 via R17-GR4. Circuits TS11-12 (red) TS16-17 (blue), TS29-30 (external) are identical to circuit TS2-3.
The G/-G signals are selected by TS21-26 and TS31-33. When resistors R74-R75 are connected to earth, transistors TS26 and TS25 are turned on. The collector voltage of TS25 then becomes approx. -12 V so that TS24 becomes more conductive. Because TS26 is conductive, a positive voltage is fed to R98-R99 so that TS32-TS33 are turned off. When the voltage on R74-75 is negative, TS25 and TS24 are cut off. R66-R67 are now voltageless and TS22 and TS23 are conductive. The green signal is subsequently fed to the output stage.
When the voltage on R74-75 is positive, TS25 will be conductive and TS26 will be cut off. TS22 and 23 are turned off and TS32 and 33 are turned on. Via inverter stage TS31 a negative green signal is applied to TS32. To obtain a black reference in the negative signal, a sync signal is added to the green signal via R102.
Similar switching circuits have been included for the viewfinder signal.
The output signals of p.c. board U1 are applied to p.c. board U2. Via R2 and R4 on this p.c. board a sync signal can be added to the VB signal.
Via a relay the monitor signal is fed to output amplifier TS2-4. The overall gain in the circuit between the input and the output of the module is approx. 0.9x. C4 serves for correction of the frequency response.
In the viewfinder channel the signal is pre-emphasised.
Via emitter follower TS6 the signal is transferred to the base of TS7. The signal also passes a voltage divider consisting of R26 and the dynamic resistance of GR2-5.
The dynamic resistance is controlled by TS12 and TS13 which receive a control voltage via TS14. This control voltage is derived from the cable correction switch in the VIDEO IN module. The amplitude of the signal on the base of TS7 will therefore depend on the position of the cable correction switch.
Via TS8 the signal is added to the collector signal of TS5. Thus the signal is additionally boosted in order to compensate for the attenuation of the low frequencies in the cable (compensation for a max. cable length of 300 m).

The frequency response of the camera cable is corrected with the filter network included in the emitter circuit of TS8. Via TS15 the viewfinder signal is fed to output amplifier TS9-11. With relays RE1 and RE2 an external signal (EXT 1) can be selected. In that case the output signals of p.c. board U1 are disconnected.

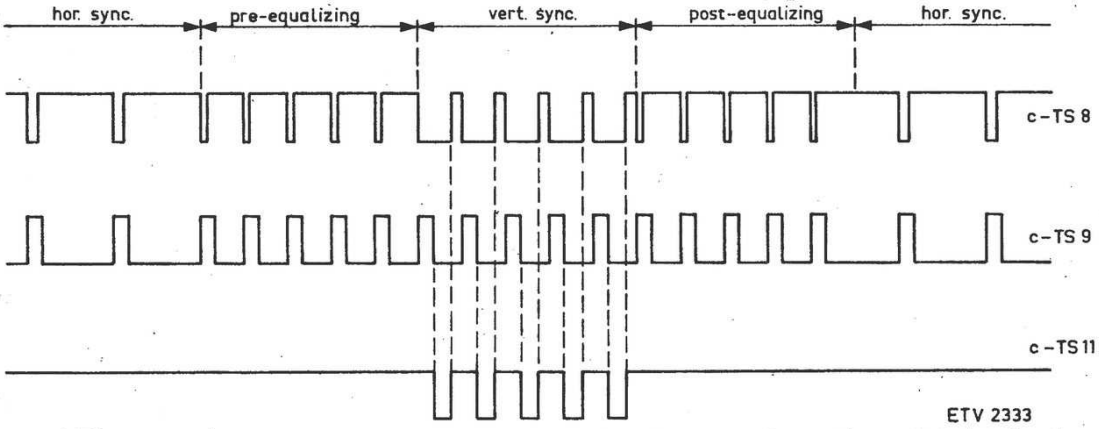
## PULSE MODULE

### CIRCUIT DESCRIPTION

Pulse section

The blanking signal is fed to emitter-follower TS24 which has a high input impedance due to the negative feedback provided by C27 and R70. TS25 operates as a limiter and clipper. GR8 is a d.c. restorer.

Via divider TS26-28 the blanking signals are applied to the output. The sync signal is processed in a similar way, but it is fed to 4 outputs. From the sync signal a V and H pulse is derived. The leading edge of the signal from TS8 triggers mono-stable multivibrator TS9-10. This multivibrator supplies a pulse of horizontal frequency with a duration of 7.5 μsecs.




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During the vertical interval the frequency is double the horizontal frequency.

On the emitter of TS11 this pulse is added to the sync signal. TS11 is an NPN transistor. The negative sync pulses will turn on TS11 and the positive multivibrator pulses will cut off TS11 (emitter drive). Only during the vertical interval (160 μsecs European standard, 190 μsecs American standard) both pulse signals will be negative, so that during this interval negative pulses are present on the collector of TS11. Only the first leading edge of these pulses will trigger mono-stable multivibrator TS12-13, which produces a V-pulse with a duration of approx. 200 μsecs. Via TS14 the V-pulse is transferred to the output.

The sync signal from TS8 also triggers mono-stable multivibrator TS15-16. This multivibrator supplies pulses of horizontal frequency with a pulse width of 40 μsecs. As a result, pulses with a PRF of half a line time (= equalising pulses, vertical pulses) can trigger TS15-16 only when they are shifted one line time with respect to the preceding trigger pulse. The pulses are supplied by TS15-16 and therefore all have a repetition time of 1 line.

The pulse from TS15-16 triggers TS17-18 which determines the duration of the H-pulse (approx. 4 μsecs). Via TS23 the H-pulse is transferred to the pulse delay circuit. With R30-C23 the H-pulse is delayed after which it is applied to the video amplifiers via TS20-22 as clamping pulse. The pulse delay circuit is shown in the left-hand part of the circuit diagram.

In this circuit the H-pulse is delayed in such a way that the delay in camera cable plus the H-pulse delay equals one line time. The H-pulse is inverted by TS7 and is then used for controlling a-periodic sawtooth generator TS9.

C16 is discharged to approx. -125 V by TS9, after which it is charged to +300 V via R35, R36 and TS8.

The sawtooth voltage on C5 will therefore have a steep edge $(\frac{dV}{dt})$ so that spurious signals contained in the sawtooth voltage (noise etc) have a negligible effect on the trigger moment of pulse shaper TS11-12. In the rest position TS11-12 is cut off. When the sawtooth voltage on C16 becomes higher than approx. -6 V, GR2 and TS11 become conductive.

The collector voltage of TS11 now decreases, so that TS12 is turned on. The emitter impedance of TS11 is then rapidly reduced so that the gain of TS11 increases.

This effect is cumulative. The result is that when the sawtooth voltage turns on GR1, the circuit with TS11-12 changes over abruptly. As a result a pulse arises on the collector of TS12. This pulse disappears when the sawtooth voltage on C16 decreases below the -6 V level, i.e. during the period that C16 is discharged by TS9.

It follows that the leading edge of the pulse on TS11 leads with respect to the H-pulse. When the voltage on the cathode of GR1 is changed, the position of the leading edge will also change. The cathode voltage of GR1 is adjustable with TS10.

The voltage on C18 will follow the emitter voltage of TS10 via zener diodes SV2, SV3; the cathode voltage of GR1 will follow the voltage on C18 via R41. The setting of TS10 is determined by the timing potentiometer at the front of the module (fine control) and a control voltage applied via point 22. This control voltage is obtained from the cable length correction circuit in the video input module.

The pulse from TS11 triggers mono-stable multivibrator TS13-14, so that an 8 μsec pulse is produced which is supplied to the camera via TS15.

Sawtooth generator

The blanking signal is used for controlling a-periodic sawtooth generator TS2-3. Thus the blanking is automatically introduced in the signal. By feeding back the sawtooth signal via C4 a good linearity is ensured. TS4 is cut off during part of the negative sawtooth signal; TS4 determines the duration of the black level of the sawtooth. With R14-C7 and the TEST switch, TS4 can be cut off completely by a negative voltage, so that the signal is blocked.

Amplifier TS4-5 is overdriven by the sawtooth signal, so that white limiting takes place. The level at which limiting takes place is determined by feedback resistor R17. The collector signal is fed to the output via the TEST amplitude control and emitter follower TS6. It is also possible to apply an external test signal to the output terminals via a selector switch. The sawtooth signal (INT) or the external test signal (EXT) are available on the test sockets at the front panel.

# INTERCOM

## CIRCUIT DESCRIPTION

By means of the intercom system communication is possible between camera, CCU and production room. The communication module in the CCU incorporates a "one-way" communication unit which prevents microphone signals from camera or CCU from reaching the production room headphone. The unit can be switched off at the local control panel, thus enabling normal communication.
Below the various intercom channels are discussed.

I. Camera-microphone to CCU telephone

On the camera heads two jacks are fitted, of which the telephone connections are in parallel (1 and 2). The microphone connections (3 and 4) are connected to the input of microphone amplifier unit U1.
When carbon microphones are used, a direct current from the microphone supply flows through the microphones via R1 and R2. When dynamic microphones are used, the supply voltage from the microphone power supply is used for supplying the amplifier incorporated in the microphone.
By short-circuiting T1 to SK1, the microphone signal is disconnected. The microphone signal is applied to transformer T2 via amplifier U1. Transformer T3 is connected to the secondary of T2. The secondary of T3 is connected to T1 in the CCU via the camera cable. The secondary of T1 is connected to volume control R2 via T2. R2 is connected to telephone amplifier TS5-6-7-8. The headphone is connected to output transformer T4.

II. CCU-microphone to camera-headphone

This audio channel is identical to the channel described above. The microphone is connected to points 3 and 4 of the sockets at the front of the module and is connected to microphone amplifier TS1-2-3-4 via transformer T3. Via T2, T1 and the camera cable the signal is fed to T3 in the camera. From the secondary winding of T3 the signal is applied to telephone amplifier U2 via T2 and volume control R1. Via T4 this signal is transferred to the telephone.

III. Camera-microphone to camera-headphone

As already stated in I, the camera microphone signal goes to T3 via microphone amplifier U1 and T2. Telephone amplifier T2 is connected to the centre tap of T2 via volume control R1. When the impedances between point 6 of T2 and earth and between point 12 and earth are the same, there is no signal on the centre tap (point 11); thus no signal is applied to the camera headphone. The impedances can be equalised with side tone control R6.

IV. CCU-microphone to CCU-headphone

This circuit is identical to that described in III, but is accommodated in the CCU module.

V. Production room to camera chain

Via the junction between T1 and T2 in the CCU the production room is connected to the intercom of the camera chain.
This connection is established via the "one-way communication unit".
In the drawn position of the relay contacts communication is possible only from the "production room microphone" to the "camera-chain headphone" due to the inclusion of isolating stage TS1. When relay RE1 is energised via switch SK14 on the L.C.P. the isolating stage is by-passed so that communication is possible in both directions.
At the front of the module in the CCU a pilot lamp is fitted, which is connected to the signalling system.
This "actual" lamp lights up when the camera chain is "on air".
The intercom board in the camera and the module in the CCU are provided with two power supply units each. One power supply serves for the amplifier and the other unit for supplying the microphones.

## SCANNING

### CIRCUIT DESCRIPTION

The V-pulse is amplified by TS1. By means of integrator R4-C2 a delay of approx. 150 μsecs is obtained. Via TS2 and the transformer, blocking oscillator TS3 is synchronised.
The oscillator frequency is mainly determined by R9-C4.
Diode GR1 prevents positive voltage surges across the transformer; this is in order to protect TS2. Across C6 a sawtooth voltage arises. The parabolic voltage across C5 is adjustable with R10 (master control for linearity). R16 is the master amplitude control.
TS6 is a phase splitter. The emitter signal is applied to three identical deflection amplifiers. Only the upper channel is described.
The collector signal of TS6 is integrated with R101-C101. The amplitude of the parabolic voltage across C101 is adjustable with the individual linearity control, which is connected in series with R101. Via amplifier TS101 the parabolic voltage is added to the sawtooth signal. The corrected signal is amplified by d.c. amplifier TS102...107, after which it is fed to the deflection coil. To minimise the effect of temperature variations, amplifier TS102...107 receives negative feed-back via R123.
The influence of the length of the camera cable is compensated for by strong current feedback via emitter resistance R109-R110. Parallel to R110 the individual amplitude control has been included. This potentiometer controls the degree of negative feedback and thus the gain.
To obtain an as high as possible direct voltage on the collector of TS107, TS106 has been connected in series with TS107.
The greater part of the collector direct current now flows via TS106 and not via R122. Filter R124-C109 serves for damping parasitic oscillations. The shifting current is supplied via a potentiometer which is connected to a negative and a positive voltage. Amplifier TS401-402 supplies the skew correction voltage required for the line output stages. The cursors of the skew correction potentiometers are connected to the cursors of the horizontal shift potentiometers via capacitors.

## FOCUS-ALIGNMENT MODULE

### CIRCUIT DESCRIPTION

The beam alignment coils are included in the collector circuit of two transistors in order to minimise changes in coil resistance (temperature). To compensate for the effect of temperature variations on the transistors, an NPN-PNP combination is used (e.g. TS7-8). When these two transistors have the same setting, the collector currents will eliminate each other. By controlling the setting of these transistors, the current required for beam alignment is obtained.

The focusing current is mainly supplied by TS16 and partially via R52. TS16 is driven by differential amplifier TS13-15. The base voltage of TS13 (which is additionally stabilised with ST1-5) is the reference voltage. The base current of TS15 is determined by the base voltage of TS14. Temperature variations are compensated for with feedback loop R47-48-49-45 and 44. Parasitic oscillations are suppressed with C11.

Modulation of the focusing current is possible with multivibrator TS17-18. The squarewave voltage on the collector of TS17 causes a squarewave current in the base of TS14 via high-ohmic resistor R56; thus the focusing current is modulated with a squarewave. The free-running frequency of the multivibrator is 5-10 Hz. However, the multivibrator can be triggered with a V-pulse via C10; the frequency then becomes 25 or 30 Hz (dependent on the vertical frequency), because both transistors are triggered by the sync pulse. The multivibrator is made inoperative by switching off the supply voltage. The synchronisation can be made inoperative by removing the interconnection in the line from C10.

## REMOTE MODULE

### CIRCUIT DESCRIPTION

The relay for changing over the operational functions are connected to connectors 311, 312 and 313.
The standard version comprises one relay which is connected to connector 311. In this case an interconnection board is connected to connector 312 and 313.
The relays are energised via a switch on the control panel. Energising is possible only when the remote control unit is connected.
The functions which can be controlled are divided as follows:

| connector 311 | connector 312 |
|---|---|
| iris control | stand-by/operate |
| individual video gain (painting) | contour on-off |
| master-black control | colour temperature switch |
| Ext 1 selector switch | individual black level |

Connector 313

- off
- colour bars
- master gain control
- grey filter
- colour filter
- gamma selector

The local mains voltage, the output voltages of the power supply modules and the 220 Va.c. for the camera head are applied to the fault indicator board.
Via an "AND" circuit with diodes GR1...GR9 oscillator circuit TS2-3 is controlled.
The input voltages, except for the mains voltage, are reduced to approx. +9.5 V and -10.5 V by means of voltage dividers and rectifiers. These voltages are applied to the diodes.
To the other sides of the diodes a positive +9.2 V voltage is applied via the base-emitter diode of TS1. This voltage is stabilised with SP2. When one of the voltages becomes too low, the base of TS1 will become more negative than the emitter via the relevant diode. TS1 is conductive and TS4 is turned on via GR10. The base current is applied to amplifier TS2-3. The amplifier now receives positive feedback via R27, so that TS2-3 starts oscillating.
In the collector of TS3 there will be an alternating current of very low frequency (between 2 and 10 Hz). The lamps connected to TS3 will consequently light up intermittently to indicate a defect in the supply circuit.
The oscillator frequency is determined by C5. By means of the meter at the front of the module it is possible to check which power supply section is defective.

For signalling a defect in the scanning circuits a similar method has been adopted.
Oscillator TS5-6 is controlled by TS7. A voltage from the protection circuit in the camera head is applied to GR13. When the deflection voltages are normal, a voltage of approx. -12.9 V is applied to point 6 so that TS7 is cut off. When the deflection voltages are too low, the voltage will drop to approx. 0 V. TS7 is then turned on and TS5-6 starts oscillating. The oscillator sends a current to the indicator lamps and to the STAND BY relay in the control unit.
The STAND-BY relay cuts out the 300 V to the camera head and closes the aperture. Thus the plumbicons are protected.
With switch "on-off" at the front of the module the chain is switched off or set to STAND BY. These switches have been provided to be independent of the control unit of the camera chain, which may be located at a distance of up to approx. 100 m from the CCU.

## POWER SUPPLY

### GENERAL DESCRIPTION

The supply unit comprises the following sub-units.

1. A.C. SUPPLY unit; this unit supplies the local mains voltage to the waveform monitor, picture monitor and the power modules. Furthermore, it supplies 24 Va.c., 24 Vd.c. and in conjunction with the AC-PS module, the 220 Va.c. for the camera.
2. Two modules, each comprising two isolated circuits for the stabilised 12-V output voltage.
3. One 125 V module.
4. One 300 V module.
5. One 16 V module which provides the supply voltage for the 12.9 V stabiliser in the camera.
6. One AC-PS module. This module measures and regulates the a.c. power supplied to the camera and also stabilises the supply voltage for the 16 V module.

The complete unit is cooled with cooling unit EL 8611/51.

### CIRCUIT DESCRIPTION

The local mains voltage is applied to the AC supply unit.
The unit consists of an isolating transformer and two relays.
One relay has been included in the switching-on and off circuit (points 8-10-11-12 of connector 53). This circuit also includes an interlock line (point 12, connector 53). This line is closed when the modules are fitted correctly in the power supply unit. When this is not the case, or when one of the modules has been removed from the unit, the interlock line is interrupted, so that the mains voltage cannot be switched on.
The second relay is operated by the first relay. This second relay switches on the mains voltage for the modules, the waveform monitor, the viewfinder and the a.c. power for the camera (210 V and 270 Va.c. to AC module).
The 24 Va.c. is used for supplying the intercom circuits; this voltage is also present when the power supply unit is switched off. The 220 Va.c. on points 5-7 of connector 53 serves for supplying cooling unit LDK 4976. Except for the supply of the waveform monitor and the viewfinder, the supply unit is connected to the equipment to be supplied via connector 70.
On the printed circuit board connected to a-b of connector 70 the mains voltage is rectified. The voltage on a-b is applied to a meter, so that it is possible to check the mains voltage.

## 2x2 V MODULE

### CIRCUIT DESCRIPTION

The primary winding of the mains transformer has been divided into two sections. These sections are connected in parallel for 110 V and 117 V and in series for 220 and 234 Va.c. Safety fuse VL1 and the thermal fuse on the transformer are shunted by a neon lamp. The lamp is fitted at the front and serves to indicate whether a fuse has blown.

The alternating voltage is full-wave rectified. The two stabilisers are identical, so that it suffices to describe only one of them.

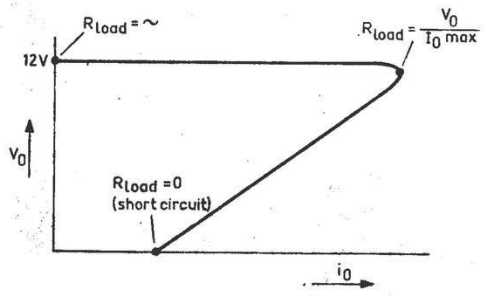
Series regulator TS6 is controlled by differential amplifier TS2-3-4-5 via TS1. This amplifier does not respond to the voltage between output terminals 8-6 but to that between terminals 7-5 (return line). These terminals are connected to the input of the apparatus supplied by the power supply module. Thus the voltage on the input of this apparatus is measured and kept constant. The loss in the connection cable from the module to the apparatus is thus also compensated for, because the current through the return line is very small. The differential amplifier is controlled as follows.

The measuring voltage on the return lines is applied to long-tailed pair TS2 and TS5. The setting of these transistors is such that TS2 is more conductive than TS5, whereas in the normal condition the base-emitter voltage of TS2 is practically equal to that of TS5. This setting is obtained by means of zener diode SP2 and precision resistors R4 and R6.

At an increasing load the output voltage will decrease. This variation is transferred to the base of TS5 and also to the emitter of TS2 via the emitter of TS5. Part of the voltage variation reaches the base of TS2. As a result TS5 and TS4 become less conductive and TS2 and TS3 become more conductive. Via TS1, TS6 receives a larger base current so that the increased load is compensated for.

The circuit has been proportioned so that when a certain load is exceeded both the output voltage and the output current decrease to such an extent that the dissipation cannot exceed the max. permissible value.

The current/voltage characteristic is as follows:




ETV 2350

The crossover point in the curve is obtained as follows. Above it is described how at an increasing load TS5 and TS4 become less conductive.

The emitter of TS2 has a low impedance because it is connected in parallel with the emitter impedance of TS5. When TS4 is cut off at a certain load, the emitter impedance of TS2 is no longer low. TS2 then receives a strong negative feedback via R10. The same applies to TS3, as TS4 is cut off. Due to this negative feedback the current control for TS1 and TS6 is also considerably reduced. By means of R9 it is possible to adjust the point at which TS4 is driven out of conduction; in other words R9 determines at which load the cross-over point is situated.

In this condition the collector current of TS3 is proportional to $V_{R8}$, which in turn is proportional to $V_{R7}$-$V_{R10}$-$V_{R4}$ and the output voltage. The current applied to TS6 is then a linear function of the output voltage. After passing the cross-over point the current voltage characteristic will therefore follow a resistance curve.

The cross-over point is gradual due to the curvature of the Vb and Vce characteristics of the transistors. When the output is short-circuited, TS3 should not be currentless as TS6 is then also cut off. Should this be the case, TS6 would remain cut off after removing this short-circuit because TS3 can only conduct when there is an output voltage. However, this output voltage can only be present when TS6 supplies an output current. Via R5 transistor TS3 still supplies some current when the output is short-circuited, so that this phenomenon can be avoided.

The value of the output voltage is determined with R15 which via TS5 and TS2, determines the setting of TS3.

R16 serves for temperature stabilisation of SP2.

Capacitor C4 provides negative feedback to the amplifier for high frequencies so that parasitic oscillations are suppressed.

## 125 V MODULE

### CIRCUIT DESCRIPTION

The primary winding of the mains transformer consists of two sections. These two sections are connected in parallel for 110 and 117 Va.c. and in series for 220 and 234 Va.c. The safety fuses are shunted by a neon lamp. VL2 is a thermal fuse which is fitted on the transformer. The lamps at the front serve to indicate whether a fuse has blown. The voltage from the secondary winding is full-wave rectified.

Via VL3 the voltage is applied to series regulators TS1 and TS2. The output voltage on C5 is stabilised by amplifier TS1-TS6. When the voltage on C5 increases, the base voltage and emitter voltage of TS6 will increase to the same extent. The base voltage of TS5 will slightly change due to voltage divider R14-16. The collector voltage of TS5 increases, and that of TS4 decreases. Via emitter followers TS1 and TS2, series regulators TS1 and TS2 become less conductive so that the voltage on C5 decreases.

When the output voltage is 125 V, the base voltage, and consequently the emitter voltage of TS5, can be determined exactly with precision resistors R14-R16. This means that the base voltage of TS6 has a fixed value which is determined by R21-R20, i.e. by the current through the zener diodes. To adjust for a nominal voltage of 125 V (with R22) the current through the zener diodes is, in fact, adjusted. The value of this current is determined by R14-R16. With R18 the temperature coefficient of the zener diodes is adjusted to practically zero. C6 provides a.c. feedback; thus parasitic oscillations are prevented.

Zener diodes SP1-3 limit the collector-emitter voltage of TS4.

## 300 V MODULE

### CIRCUIT DESCRIPTION

The primary winding of the mains transformer consists of two sections. These sections are connected in parallel for 110 and 117 Va.c. and in series for 220 and 234 Va.c. The safety fuses are shunted by a neon lamp. VL2 is a thermal fuse fitted on the transformer.

The lamps at the front of the unit have been provided to indicate whether a fuse is blown.

The voltage on the secondary winding is full-wave rectified. Via VL3 the voltage is applied to series regulators TS1 and TS2 which are mounted on a heat sink. The output voltage on C5 is stabilised with amplifier TS1-TS6. When the voltage on C5 increases, the base voltage and the emitter voltage of TS6 will increase by the same amount. The base voltage of TS5 will slightly change due to voltage divider R14-16. When the collector voltage of TS5 increases, that of TS4 will decrease. Via emitter followers TS1 and TS2 series regulators TS1, and TS2 then become less conductive, so that the voltage on C5 decreases.

When the output voltage is 300 V, the base voltage and consequently the emitter voltage of TS5 can be determined exactly with precision resistors R14-R16. Thus the base voltage of TS6 will have a fixed value which is determined by R21-R20, i.e. by the current through the zener diode.

To adjust for a nominal voltage of 300 V (with R22) the current through the zener diodes is, in fact, adjusted; the value of this current is determined by R14-R24-16-25. The temperature coefficient of the zener diodes is adjusted to practically zero with R18.

C6 provides a.c. feedback; this is in order to prevent parasitic oscillations. Zener diodes SP1-3 limit the collector-emitter voltage of TS4.

Series regulators TS1 and TS2 are shunted by zener diodes SP1 and SP2. When the output is short-circuited the diodes are turned on and limit the collector-emitter voltages of TS1 and TS2. Moreover, C3 and C4 discharge via R2 and the two zener diodes, so that fuse VL3 will blow. R2 serves to limit the short-circuiting current.

16 V MODULE

CIRCUIT DESCRIPTION

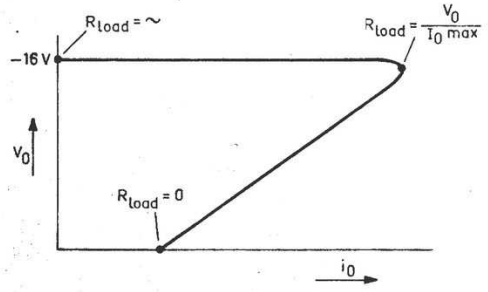
The primary of the mains transformer consists of two sections. These sections are connected in parallel for 110 and 117 Va.c. and in series for 220 and 234 Va.c. Fuse VL1 and the thermal fuse on the transformer are shunted by a neon lamp. The lamp at the front serves to indicate whether a fuse has blown. Series regulator TS7 is driven by differential amplifier TS2-3-4-5 via TS1 and TS6. This differential amplifier does not respond to the voltage between output terminal 4-5 but to that between terminals 6-3 (return). These terminals are connected to the input of the unit which is supplied by the power module. Thus the voltage on the input of this unit is measured and kept constant. The influence of the connection cable from the module to the unit is thus eliminated, because the current through the return line is only very small. The differential amplifier is controlled as follows:

The measuring voltage on the return lines is applied to long-tailed pair TS2-TS5. The setting is so that TS2 is more conductive than TS5, whereas in the normal condition the base-emitter voltage of TS2 is practically equal to that of TS5. This setting is achieved with zener diode SP2 and precision resistors R4 and R6.

At an increasing load the output voltage decreases.

The complete voltage variation is transferred to the base of TS5 and via the emitter of TS5 also to the emitter of TS2. Part of the voltage variation is present on the base of TS2. As a result TS6 and TS4 become less conductive and TS2 and TS3 become more conductive. Via TS1-TS6 the base current of transistor TS7 increases so that the increased load is compensated for.

The circuit has been designed so that when a certain load is exceeded, both the output voltage and the output current decrease in such a way that the dissipation cannot exceed the max. permissible value. This may be represented by the following curve:




ETV 2351

The cross-over point in the curve is obtained as follows:

As already stated, TS5 and TS4 become less conductive at an increasing load. The emitter impedance of amplifier TS2 is low because it is connected in parallel with that of TS5. When TS4 is cut off at a certain load, the emitter impedance of TS2 is no longer low. TS2 then receives strong negative feedback from R10.

The same applies to TS3 because TS4 is also cut off. Due to this negative feedback current control for TS1 and TS6 is considerably reduced. R9 determines the point at which TS4 is cut off; i.e. R9 determines at which load the cross-over point is situated.

In this condition the collector current of TS3 is proportional to $V_{R8}$, which in turn is proportional to $V_{R7} - VR_{10} - VR_4$ and the output voltage. The current applied to TS6 is then a linear function of the output voltage. After passing the cross-over point the current/voltage characteristic therefore follows a resistance line.

This cross-over point is gradual due to the curvature of the Vbe and Vce characteristics of the transistors.

When the output is short-circuited, TS3 should be conductive as TS7 is then also cut off. Should this be the case, TS7 would be cut off after removal of the short-circuit, because TS3 can only be conductive when there is an output voltage.

However, there can only be an output voltage when TS7 is conductive. Via R5 transistor TS3 still supplies some current when the output is short-circuited so that this phenomenon is avoided. The value of the output voltage is determined by R15 which via TS5 and TS2 determines the setting of TS3.

R16 serves for temperature stabilisation of SP2.

C4 provides negative feedback for the high frequencies so that parasitic oscillations are prevented.

P.S. - A.C. MODULE

CIRCUIT DESCRIPTION

The module contains a differential amplifier which makes the motor rotate clockwise or anti-clockwise. The motor drives a variable transformer T1 which is connected between the 270 V.a.c. and 210 Va.c. taps of the isolating transformer in the A.C. supply unit. The output voltage of the variable transformer can thus be changed between 210 and 270 Va.c. with respect to earth. The voltage across the variable transformer is applied to the camera and to transformer T2. This transformer supplies part of the alternating voltage fed to the rectifier which supplies the camera direct voltage. The differential amplifier is controlled by the alternating voltage which is returned via the camera head. Motor M1 is connected to 24 Va.c. via terminal 2. The 24 V circuit is connected to terminal 10 via bridge circuits GR1-4 and GR5-8.
The camera alternating voltage is rectified by GR10. The base voltage of TS6 is stabilised with SP1-2. The base voltage of TS5 is equalised to that of TS6 with R2 at the nominal alternating voltage between terminal 7 and 10. Terminals 12-13 are not short-circuited when the camera chain is switched on. TS5 and TS6 then have the same setting and TS3 and TS4 are cut off. TS1 and TS2 are now cut off and bridge circuits GR1-4 and GR5-8 are blocked. When the alternating voltage on input 1 increases, the base voltage of TS5 will become more positive. The collector voltage of TS5 decreases and the emitter voltage increases. As a result, the collector voltage of TS6 will increase. TS3 is turned on and TS4 remains cut off.
TS1 is driven into full conduction so that bridge GR1-4 constitutes a short-circuit. Motor M1 now operates variable transformer T1 so that the camera alternating voltage is reduced. When the alternating voltage in the camera head has reached the nominal value, the settings of TS5 and TS6 are the same again. TS1 is cut off and the motor is stopped. An opposite process takes place when the camera a.c. is too low.
When the mains voltage of the camera chain is too high, the voltage in the camera head can still be too high, even when the variable transformer has been turned down completely. In this case the variable transformer operates microswitch SK2. Motor M1 is then switched off, lamp LA1 HIGH lights up and thus indicates that the mains voltage is too high. When the mains voltage of the camera chain is too low, the variable transformer is set to the other final position. Motor M1 is now switched off by SK1 and LA2 (LOW) lights up thus indicating that the mains voltage is too low. When the camera chain is switched off, RE9 (in the AC supply) ensures that the variable transformer is turned down until SK3 opens. This is to prevent the camera a.c. from becoming too high when the camera chain is switched on at a high mains voltage.
This may also be the case when the length of the camera cable is reduced from 1000 to 50 m.
The working of this section is as follows:
SK3 is closed when the variable transformer is not in the lowest position.
When the chain is switched off, terminals 1-2 are open-circuited and motor M1 receives an alternating voltage via SK3. No alternating voltage is applied to the camera head when the camera chain is switched off. However, to ensure that the differential amplifier remains operative, terminals 12-13 are short-circuited with RE1 when the camera chain is switched off. The base of TS5 then receives a positive voltage via R4. TS6 is cut off (no base voltage) and the collector voltage of TS6 and the base voltage of TS3 are positive. Because TS5 is conductive the emitter voltage of TS3 will be less positive; TS3 and TS1 become conductive and motor M1 turns down the variable transformer. In the lowest position of the variable transformer SK3 is operated and the 24 Va.c. is disconnected. The position of SK3 is so that it opens just before the variable transformer reaches its final position and operates SK2.

A.C. UNIT

CIRCUIT DESCRIPTION

The mains voltage is applied to terminals 2 and 3 of terminal block 51. Transformer T1 serves as isolating transformer for the alternating voltage supplied to the camera head and the fan in the supply unit.
Rectifier GR1 supplies interlock relay RE2. The circuit for this relay is closed via the interlock connections of the various supply modules and the on/off switches on the rack or the remote control unit.
Contact 49-50 of RE1 is the hold contact for RE2.
RE2 energises RE1. RE1 switches the 220 V for the fan in the supply unit of the camera rack, the 210 V and 270 V to which the variable transformer of the camera a.c. stabiliser is connected, and the 24 Va.c. for this stabiliser and other circuitry.
Furthermore, the mains voltages for the waveform monitor and the B/W monitor are switched on. Contacts 13 and 14 of RE1 ensure that the variable transformer of the a.c. stabiliser is turned down when the rack is switched off. Thus it is prevented that the camera receives too high an alternating voltage e.g. when after switching off the rack, the length of the camera cable is reduced from 1000 to 50 m and the camera is subsequently switched on.

Switching on and off

The figure shows a detailed circuit diagram of the on-off circuitry.
On the left of connectors 53 part of the AC POWER SUPPLY unit is drawn.
On the right of connector 171 the switches and lamps of the local control panel (LCP) are shown. RE1 is the relay which switches the supply voltages for the modules, the waveform monitor, B/W monitor and cooling unit.
RE1 is energised by RE2; consequently, the chain is switched on or off via RE2.
The primary winding of the transformer is connected direct to the mains. As a result, the voltage from the 24 V rectifier is always available. To switch on the chain, RE2 should be connected to the + pole of the rectifier. This is effected as follows.
Point 12 of connector 53 is connected to the interlock line in the camera head, via the interconnections on the printed circuit boards of the power supply modules.
Via T of connector 172, the OFF switch, and J of connector 171 the connection runs to remote module 342. In position LOCAL of the remote switch points 3 and 4 of connector 314 are interconnected and via the OFF switch of the remote module the line runs to point 11 of connector 53.
This means that RE2 is connected to point 11 of connector 53 via the OFF switches of the local control panel and the remote module. By interconnecting points 10 and 11 of connector 53 relay RE3 is connected to the positive pole. This is effected with the STAND-BY switch on the local control panel or with the ON switch on the remote module.

From point 10 of connector 53 the connection runs to point T of connector 172 via the STAND-BY switch-OPERATION switch and the scan protection relay. Point T of connector 172 is connected to point 11 of connector 53.
With the STAND-BY switch points 10 and 11 of connector 53 are interconnected. RE2 energises RE1 and via a contact of RE1 points 10 and 11 of connector 53 remain short-circuited; the STAND-BY switch can now be released and opens again. The chain is now switched on. The STAND-BY switch also operates the stand-by relay on the local control panel. As a result of this, lamps OPERATION are turned off (moreover, the 300 V for the camera head and the hour counter are switched off, the iris is closed and lamps STAND-BY are switched on). Because the chain and consequently the deflection is then operative, the scan protection relay on the local control panel will be energised. However, the relevant contacts of the stand-by relay (when energised), will connect the stand-by relay to the OFF switch of the remote module via the OPERATION switch, and from there to the positive pole of the rectifier. Thus the relay will also remain energised when the stand-by switch and the scan protection relay are open. When switch OPERATION is pressed, the stand-by relay is de-energised. The camera head now receives the +300 V, the iris is open and the hour counter and the OPERATION lamps are switched on; the camera chain is now fully operative. The ON switch on the remote module has the same function as the stand-by relay; it short-circuits points 10 and 11 of connector 53. Switching off is effected with the OFF switch. This switch interrupts the connection between RE2 and point 11 of connector 53. In the case of a defect in the scanning circuits the relay contact of the scan protection relay closes. The stand-by relay is then energised again. When switch OPERATION is now pressed the stand-by relay will remain energised.