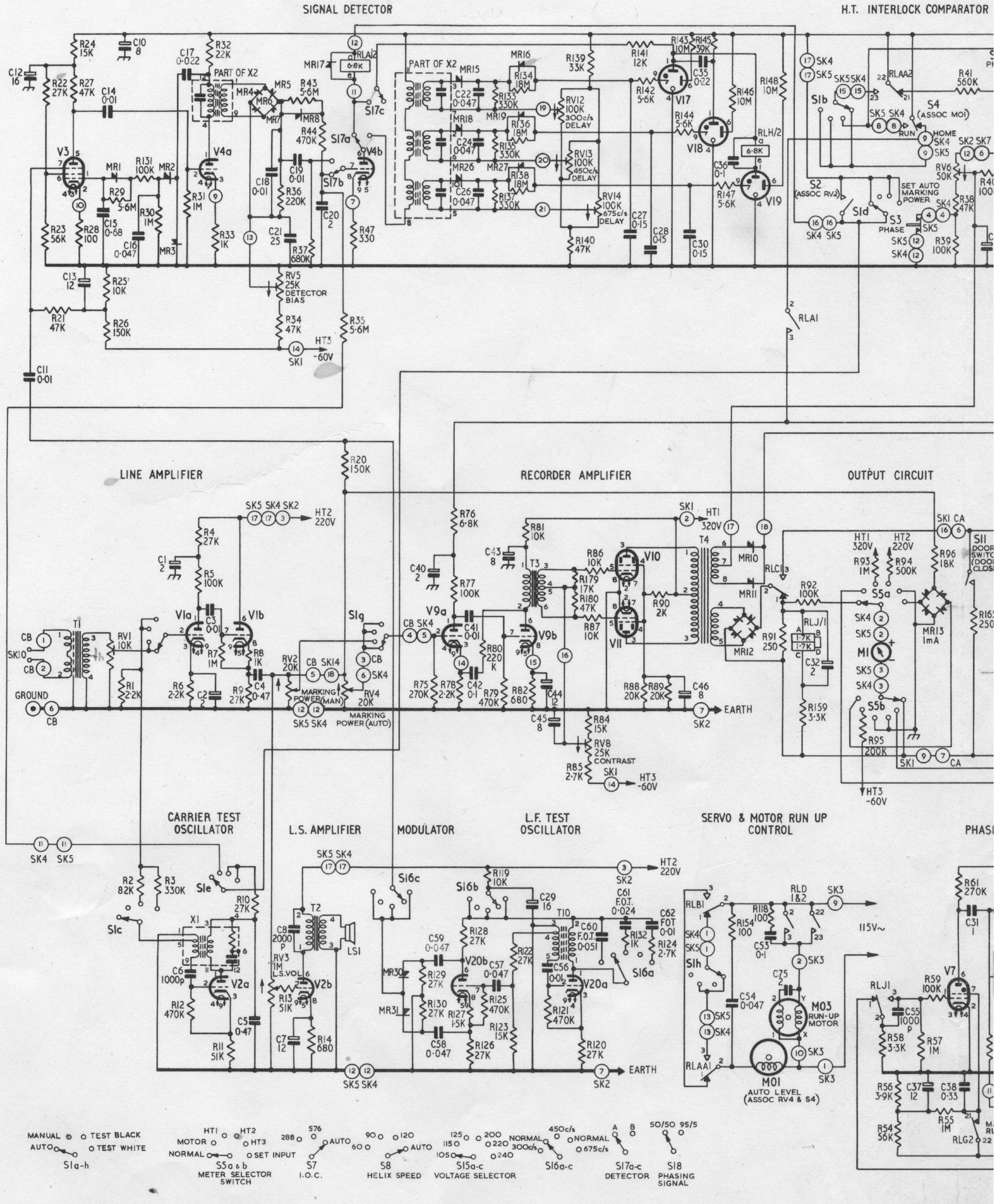
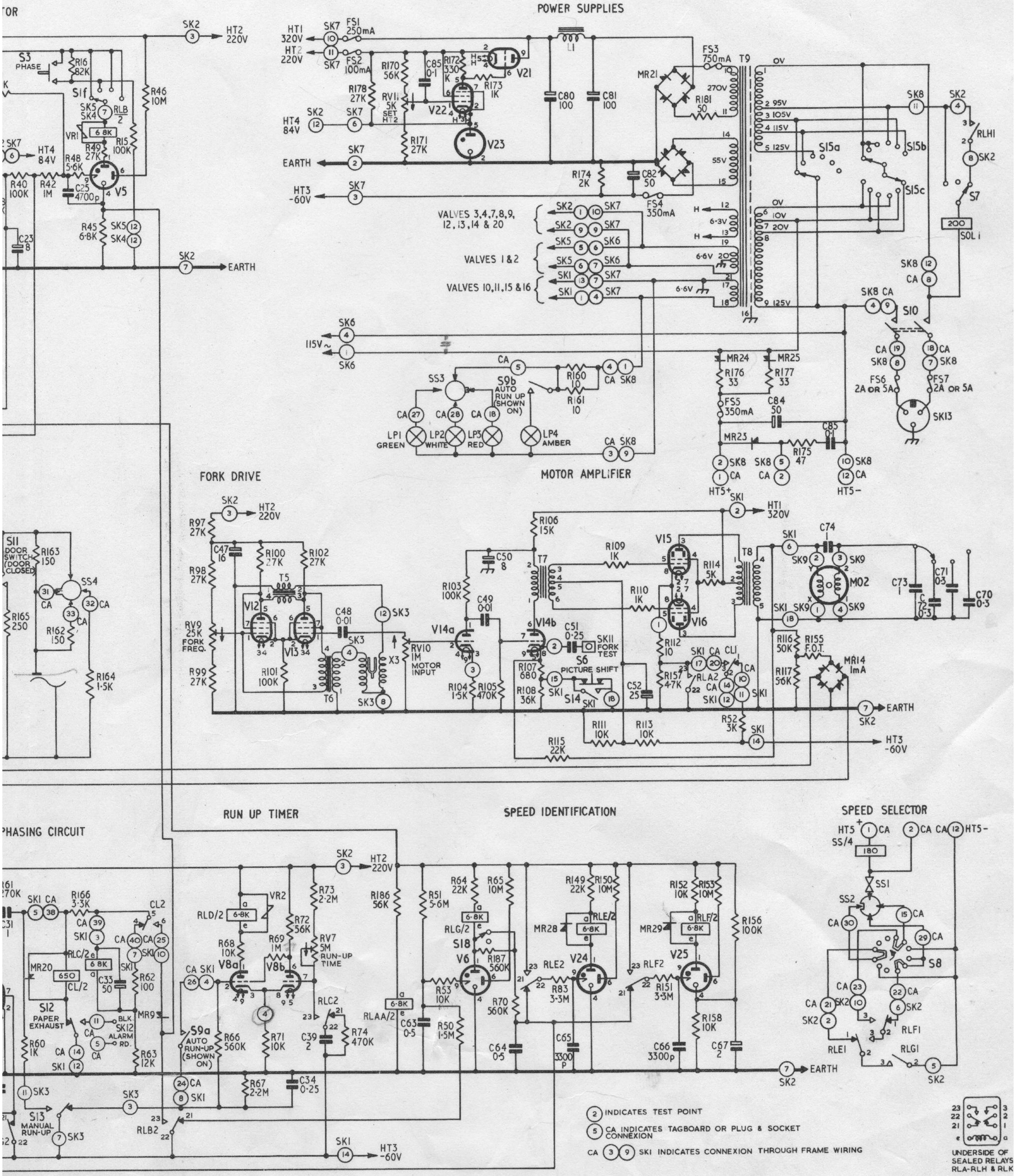
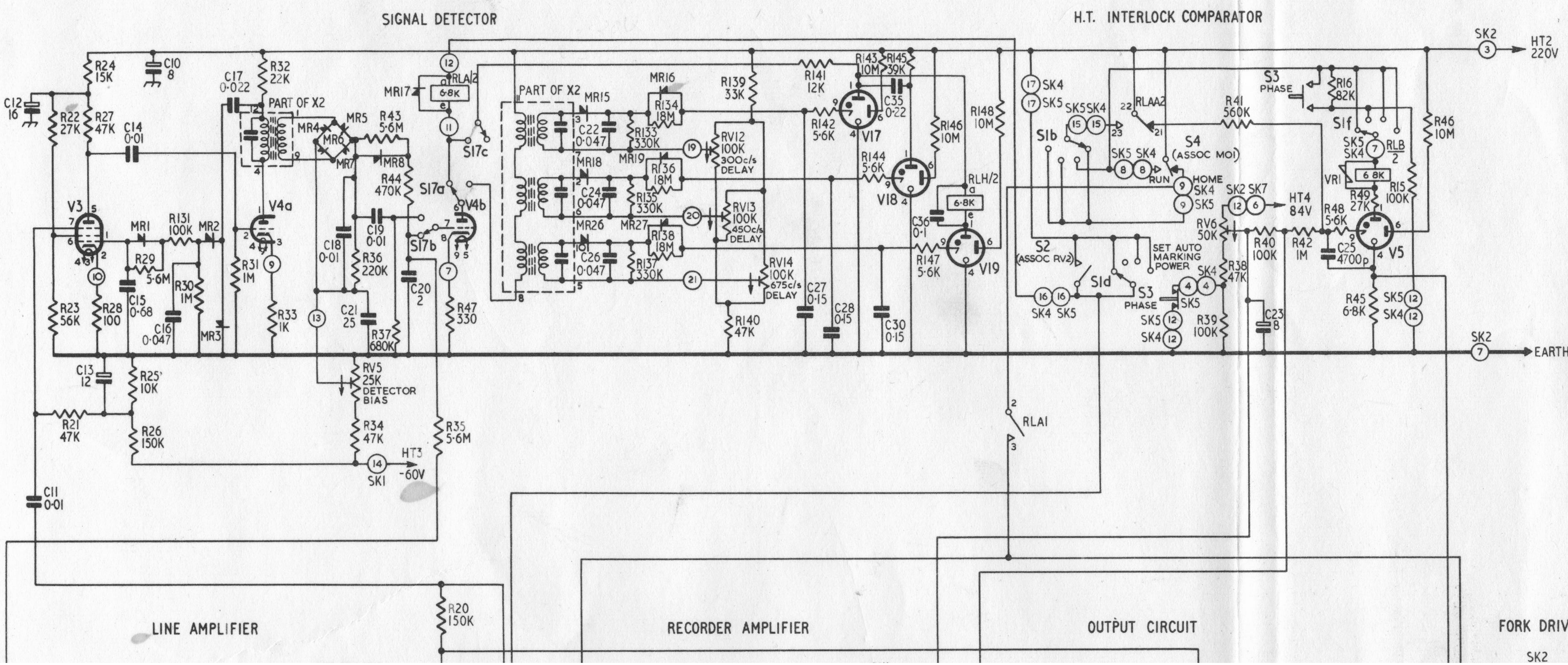


FIG. 5 OVERALL

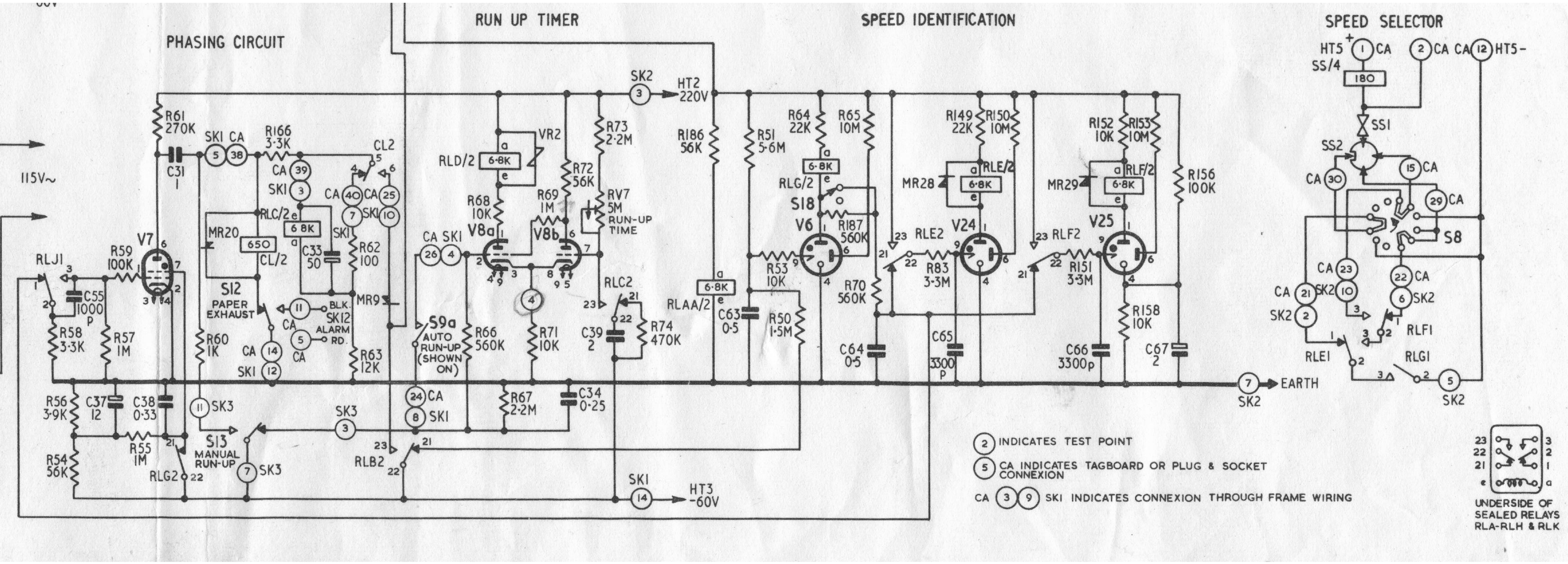


ALL CIRCUIT DIAGRAM

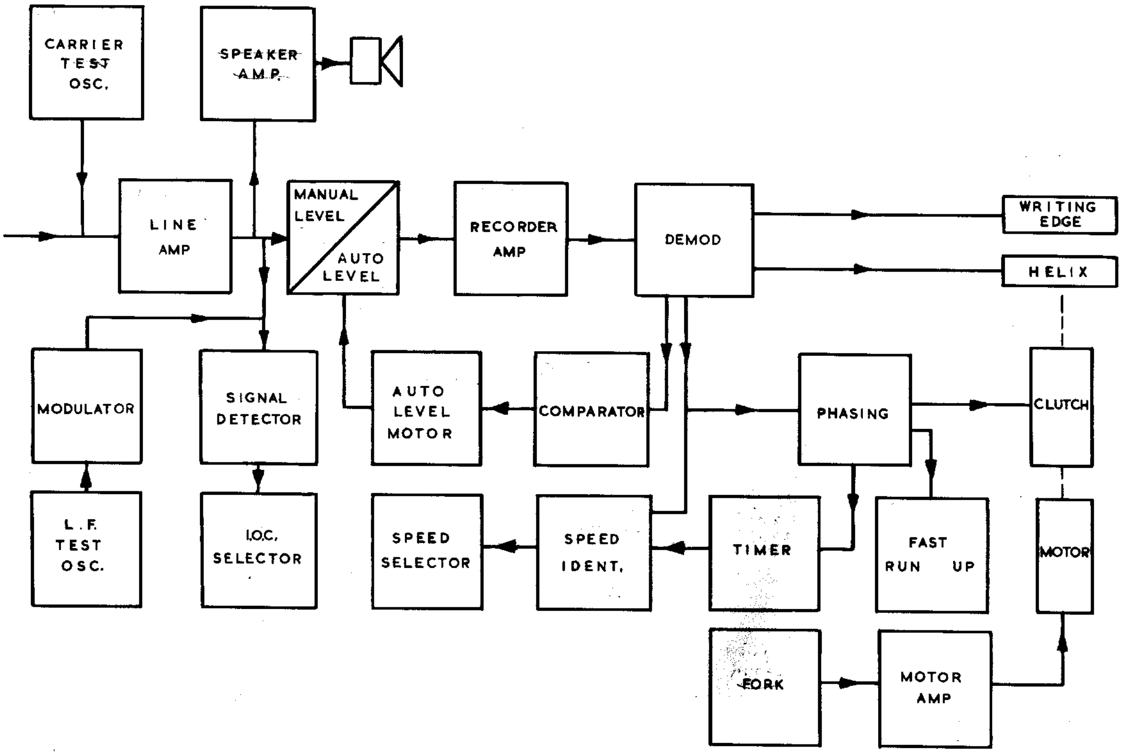
10.64
D-649-L/E1 3052 34 236E



SIGNAL DETECTOR
H.T. INTERLOCK COMPARATOR
LINE AMPLIFIER
RECORDER AMPLIFIER
OUTPUT CIRCUIT
FORK DRIV
HT2 220V
EARTH
HT3 -60V
HT4 84V
DETECTOR BIAS
PART OF X2
300c/s DELAY
450c/s DELAY
675c/s DELAY
SET AUTO MARKING POWER
PHASE
(ASSOC RV2)
(ASSOC MOI)
HOME
RUN



PHASING CIRCUIT
RUN UP TIMER
SPEED IDENTIFICATION
SPEED SELECTOR
115V~
HT2 220V
HT3 -60V
HT5 +
HT5-
EARTH
S12 PAPER EXHAUST
S13 MANUAL RUN-UP
S9a AUTO RUN-UP (SHOWN ON)
RV7 5M RUN-UP TIME
SK12 ALARM
BLK.
RD.
V7
V8a
V8b
V6
V24
V25
S18
S8
SS1
SS2
SS/4
2 INDICATES TEST POINT
5 CA INDICATES TAGBOARD OR PLUG & SOCKET CONNEXION
CA 3 9 SKI INDICATES CONNEXION THROUGH FRAME WIRING
UNDERSIDE OF SEALED RELAYS RLA-RLH & RLK



D-649-L/EB & L/EI BLOCK DIAGRAM

1.00 CIRCUIT DESCRIPTION

1.10 SIGNAL CHANNEL

Received line signals at SK10 are fed via the input transformer T1, the selector switch S1a (at AUTO or MANUAL) and the LINE LEVEL control RV1 to the line amplifier V1. This amplifier has two stages. The output of the second stage (a cathode follower) is fed to:-

Signal Detector Circuit - section 1.20.
Loudspeaker Amplifier Circuit - section 1.94.
Marking Power potentiometers - see below.

The output from one of the Marking Power potentiometers, either RV2 or RV4 (selected by S1g), is fed to the recorder amplifier V9, V10 and V11. The grid bias of the push-pull valves, V10 and V11, is preset by the CONTRAST control RV8 to provide a marking voltage ratio of 20:1 for a black: white signal level ratio of 12dB.

The secondary winding of the output transformer T4 feeds a full-wave rectifier MR12, the output of which- prior to speed selection and phasing - is absorbed by the dummy load R91 and RLJ/1.

When phasing occurs, RLC1 changes over and the output from MR12 is fed, unsmoothed, to the helix and writing-edge.

For a helix speed of 120rev/min, the marking power is directly connected to the writing-edge and helix. To cater for the lower power requirements at 90 and 60 rev/min, however, series and shunt resistors R162, R163 and R164 are switched into circuit by SS4 - one bank of the switch operated by the rotary solenoid SS/4 in the Speed Selector Circuit.

If the front cover of the recorder is opened, S11 connects the dummy load R165 across the recorder amplifier output to absorb the marking power.

1.20 SIGNAL DETECTOR CIRCUIT

1.21 Start/Stop Signal Operation and Index of Co-operation Selection (DETECTOR switch S17 at DET. 'B' and I.O.C. switch S7 at AUTO)

The Signal appearing at the output of the line amplifier V1 is fed to the suppressor grid of V3. The output of this valve is coupled to V4a, the anode load of which consists of the broadly tuned transformer in the detector unit X2, and the resistor R32.

The output from X2 is full-wave rectified by MR4, MR5, MR6 and MR7, smoothed by C18 and applied to the grid of V4b via C19.

The anode load of V4b consists of three tuned transformers, each transformer being tuned to one of the three control signal frequencies i.e. 300c/s, 450c/s and 675c/s.

Thus, on receipt of the 300c/s Start signal, the carrier signal is demodulated and, after some attenuation of the carrier frequency, the 300c/s modulation component is coupled to V4b. The output of the appropriate transformer in the anode load of V4b is rectified by MR15 and the resultant d.c. voltage is added to the reference voltage at the slider of RV12 (300c/s delay).

The voltage charges C27 via R134.

Provided that the duration of the 300c/s Start signal is sufficient and uninterrupted, the charge on C27 becomes large enough to fire the cold-cathode trigger tube V17, and relay RLA/2, in the anode circuit, operates.

If, however, the alternative 675c/s Start signal is received, the output of the appropriate transformer in the anode load of V4b is rectified by MR26 and added to the potential at the slider of RV14 (675c/s delay). The resultant voltage charges C30 via R138.

Provided that the duration of the 675c/s Start signal is sufficient and uninterrupted, the charge on C30 becomes large enough to fire the cold-cathode trigger tube V19, and operate relays RLA/2 and RLH/2, in the anode circuit of V19.

The paper feed rate, which is related to the Index of Co-operation, is selected by the solenoid SOL 1 on the operation or non-operation of relay RLH/2. For an I.O.C. of 576, RLH/2 does not operate, so that the solenoid SOL 1 remains unoperated. When, however, the I.O.C. is 288, RLH/2 operates, on receipt of 675c/s Start signal, energizing the solenoid and changing the paper feed rate accordingly.

At the end of the transmission, on receipt of the 450c/s Stop signal, the output from the appropriate transformer in X2 is rectified by MR18 and added to the potential at the slider of RV13 (450c/s delay). The resultant voltage charges C28 via R136.

Provided that the duration of the 450c/s Stop signal is sufficient, the charge on C28 becomes large enough to fire the cold-cathode trigger tube V18.

As explained above, during the transmission either V17 or V19 is conducting and, in conducting, the respective anode potential will fall to the required maintaining voltage.

When V18 conducts on receipt of the 450c/s Stop signal, the anode potential of V18 falls and this fall is connected via C35 to both V17 and V19. Consequently the anode potentials of V17 and V19 fall extinguishing whichever one is conducting at the time. Hence RLA/2 (and RLH/2 if operated) are released and the recorder reverts to standby ready for the next transmission.

To prevent false operation of the tuned detector circuits during a transmission, or on receipt of spurious signals, the rectifiers MR16, MR19 and MR27 provide short discharge times for C27, C28 and C30 respectively. Thus on receipt of such signals the capacitors charge slowly and then discharge rapidly, e.g. during the blanking pulse at the end of each scanning line.

To ensure that the input to the Signal Detector is fairly constant in level, despite variations in the level of the carrier signal, automatic gain control is employed. The output from V4a, across R32, is rectified by the voltage-doubler circuit C17, MR2, MR3 and C16 and appears as a negative d.c. voltage across C16. This voltage is connected to the control grid of V3 (via R131, R29 and MR1) and tends to reduce the gain of the circuit for large input signals. For signals of decreasing amplitude, the change of a.g.c. voltage at the grid of V3 is delayed, due to the time constant of C15, R29 and R131 - MR1 being biased in the reverse direction. For signals of increasing amplitude, however, the change of voltage at the grid of V3 is fast because MR1 is now biased in the forward direction and effectively short-circuits R29.

1.22 Carrier Signal Operation ~~D-649-L/E1~~ (DETECTOR switch S17 at DET 'A')
When operating to the carrier signal V3 and V4a function as described in section 1.21, but the circuit of V4b is modified by the DETECTOR switch S17.

The rectified output of MR4, MR5, MR6 and MR7 is added to the negative potential at the slider of RV5 (DETECTOR BIAS). This negative potential, which biases the grid of V4b to beyond cut-off, is thus overcome and V4b conducts operating RLA/2. R43 in the grid circuit of V4b provides a long discharge time for C20, while MR8 provides a short charge time. This circuit ensures that the recorder functions almost immediately on receipt of the carrier signal, and continues to function for a short time after the carrier signal's disappearance.

Although this circuit is designed primarily to accept carrier frequencies in the range 1800c/s to 2400c/s, it will operate quite satisfactorily to frequencies outside this range. However, for frequencies in the range 4000c/s to 5000c/s it may be necessary to readjust the DETECTOR BIAS control (RV5) see section 4.22.

1.30 AUTO LEVEL-SETTING CONTROL CIRCUIT
MO1 is a self-starting, synchronous uni-directional motor which drives the slider of the MARKING POWER (AUTO) potentiometer RV4. When the slider of the potentiometer is at the start of its track, a cam operates a microswitch S4 in the H.T. Interlock Circuit; this is known as the 'home' condition. At all other positions of the slider, the cam releases S4 - this is known as the 'run' condition.

In the normal standby condition, S4 is operated, i.e. it is in the 'home' condition; also relays RLAA/2 and RLB/2 are released and the motor MO1 is stationary.

At the beginning of a transmission, RLAA/2 is operated, via contact RLA1, and RLAA1 completes the circuit, via S1h, to MO1. MO1 drives the potentiometer and releases S4 so that it changes over to the 'run' condition. When the required output level is reached, RLB/2 in the comparator circuit operates, contact RLB1 changes over and the motor MO1 stops.

1.40 COMPARATOR CIRCUIT
For normal, automatic operation, the primary function of this circuit is to stop the auto level-setting motor MO1 (which drives RV4) when the output from the recorder amplifier has reached the correct level. It does this by operating RLB/2 which opens the motor circuit.

A tertiary winding on the recorder amplifier output transformer T4 produces - after rectification by MR10 and MR11 - a replica of the output marking voltage. This d.c. voltage, is applied across R40 and is added in series with the positive potential at the slider of RV6 (the MARKING POWER preset control). The sum voltage is applied to the trigger electrode of the cold-cathode tube V5 via the integrator circuit R42 and C25. The purpose of this integrator circuit is to present the trigger electrode of V5 with a voltage that is related not only to the peak amplitude of the recorder amplifier output voltage, but also to its power. Remembering that S1f is at AUTO, that RLAA/2 is operated and that S4 is at the 'run' position, relay RLB/2 is not operated until the recorder amplifier output voltage reaches the level required to make V5 conduct. When V5 conducts, relay RLB/2 operates and RLB1 stops the auto level-setting motor MO1.

The normally-open contact RLB2 closes and connects the cathode of V5 to the -60V supply; this ensures that negative trigger current does not flow. Also, the normally closed contact of RLB2 opens and permits the Speed Identification Circuit to function.

Thus, by adjusting RV6, the comparator circuit can be made to operate RLB/2 and stop the motor for any required marking voltage.

1.50 SPEED IDENTIFICATION CIRCUIT

Thus, by adjusting RV6, the comparator circuit can be made to operate RLB/2 and stop the motor for any required marking voltage.

1.50 SPEED IDENTIFICATION CIRCUIT

At the start of a transmission, the Speed Identification circuit is prevented from operating until the Signal Detector and Comparator circuits have set up.

The operation of RLA/2, in the Signal Detector circuit closes contact RLA1 which applies h.t. to V6, V24, V25 and associated components. This circuit, however, remains passive until RLB/2, in the anode circuit of V5, operates and until RLJ/1, in the Output Circuit, operates to the 'black' level output of the Recorder Amplifier.

After RLA/2 has operated and the input level set, RLB/2 and RLJ/1 begins to follow the phasing pulses-operating to 'black' level and releasing to the 'white' pulse.

Contact RLB2 removes the -60V bias from C63 which commences to charge towards H.T.2 potential.

When RLJ/1 operates, RLJ1 allows C64 to charge towards H.T.2 potential and, when RLJ/1 releases during the phasing pulse, C64 is discharged through R58. Therefore, the potential to which C64 rises will be proportional to the repetition frequency of the phasing pulses; i.e. the potential across C64 at 120 rev/min will be lower than the potential developed at 60 rev/min (see sketch).

The time constant for the charge of C64 is changed by S18 to allow for changes in black to white duration from 95/5 to 50/50 phasing pulses.

Within 2 seconds, speed identification has taken place and the potential across C63 rises to the striking voltage of V6. V6, therefore, strikes and RLG/2 operates energizing the Speed Selection circuit. In striking, V6 also prevents any further action of V24 and V25 owing to the reduction of its anode potential.

1.51 Operation at 120 rev/min

It is arranged that the potential reached by C64 at 120 rev/min is insufficient to fire either of the two trigger tubes V24 or V25 so that the remainder of the Speed Identification circuit remains passive.

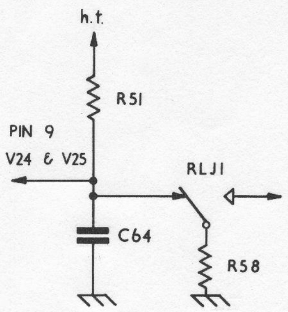
1.52 Operation at 90 rev/min

If the phasing signal is at 90 rev/min, the potential developed across C64 is sufficient to fire the trigger tube V24 and thus RLE/2 operates. The voltage across C64 is, however, insufficient to fire the trigger tube V25 because of the cathode bias due to R156 and R158.

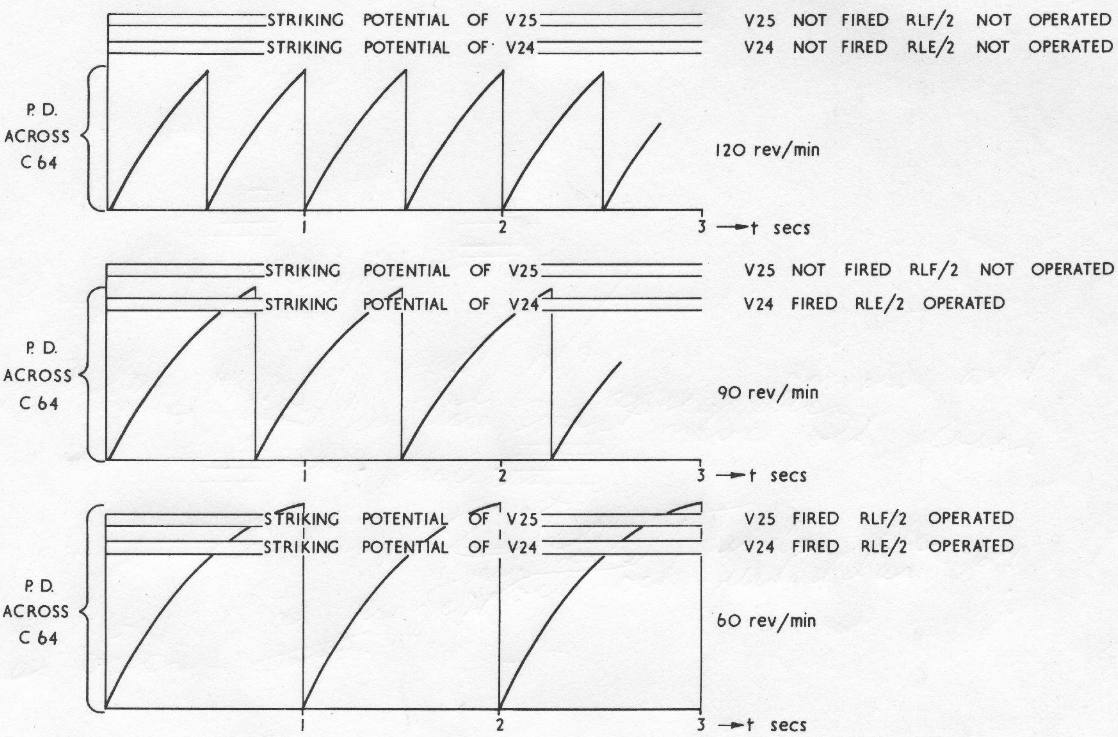
Contact RLE1 modifies the Speed Selector circuit and RLE/2 applies the h.t. potential to the trigger electrode of V24 via R83 to prevent the flow of negative trigger current.

1.53 Operation at 60 rev/min

If the phasing signal is at 60 rev/min, the potential developed across C64 is sufficient to fire both V24 and V25 and so operate relays RLE/2 and RLF/2 respectively. The contacts of RLE/2 function as described above and the contacts of RLF/2 function as follows: RLF1 applies a further modification to the Speed Selector circuit while RLF2 prevents the flow of negative trigger current through V25.



RELAY RLJ/1 FOLLOWS PHASING SIGNAL
THEREFORE C64 CHARGES TOWARDS THE h.t FOR THE DURATION OF THE 'BLACK' LEVEL AND DISCHARGES THROUGH R58 DURING THE 'WHITE' PULSE



SPEED IDENTIFICATION CIRCUIT

1.54 Speed Selection Circuit

This circuit consists essentially of SS/4 - a rotary solenoid - which sets the position of the speed change shaft in the gear-box to the required position. The solenoid is energized by the H.T.5 supply via SS1, SS2, S8, RLE1, RLF1 and RLG1.

As described in the preceding sections, either one or all of the relay contacts close and connect the H.T.5 potential to one or other of the contacts of SS2. Assuming that the cut out in the SS2 wiper is not already facing the contact to be selected, the circuit to SS/4 is made and the solenoid steps under the control of its commutating contact SS1, until it reaches the position where SS2 opens the circuit. This position is determined as follows.

60 rev/min	Contacts RLE1, RLF1 operated
90 rev/min	Contact RLE1, RLG1 operated
120 rev/min	Contact RLG1 operated

Manual speed selection is made by S8 being set to the required speed. In this case the relay contacts are ignored and direct connexion of H.T.5 is made to SS2 by S8, and the solenoid SS/4 steps as described above.

1.60 PHASING CIRCUIT

The purpose of this circuit is to operate the clutch relay CL/2 on receipt of a phasing pulse. When Speed Identification has taken place and relay RLG/2 has operated, contact RLG2 removes the -60V bias from C38 and the shield grid of the thyratron V7. As C38 discharges, the potential at the shield grid of V7 slowly rises and V7 is prepared for firing. When RLJ1 releases during the phasing pulse, the voltage across R58 (from C64) is applied via C55 to the grid of V7 causing V7 to fire. In firing, V7 discharges C31 through the clutch relay CL/2, which operates and releases the clutch, so that the drive from the motor MO2 to the helix is complete.

The clutch relay is held in by the -60V supply provided by the operation of contact CL2, and V7 is extinguished owing to the fall in its anode voltage. Contact CL2 connects the -60V supply via RLB2 to the relay RLC/2. RLC/2 is delayed approximately 1/4 second by the delay capacitor C33; this ensures that the helix is rotating before the operation of RLC/2 (contact RLC1) applies the marking power to the writing-edge. Contact RLC2 starts the Run-Up Timer Circuit.

If,during a recording, the Mufax paper runs out(or the front cover is opened) the paper exhaust switch SW12 changes over; this releases the clutch coil CL/2 which stops the helix. Contact CL2 is changing over releases relay RLC/2, contact RLC1 transfers the marking power from the writing-edge and helix to the dummy load R91.

The machine will operate an external alarm circuit if required. A 6·3 volt a.c. supply is connected to the red ALARM socket. When the Mufax paper has run out(or when the front cover is opened) SW12 connects an earth return path to the black ALARM socket, thus operating the external alarm system.

1.70 TEST CIRCUITS

1.71 Carrier Test Oscillator

With S1 at TEST BLACK, the signal input to the Line Amplifier is derived from the test oscillator V2 at a level similar to the nominal line input signal setting. Assuming that the DETECTOR Switch S17 is at DET 'A', this signal causes the Signal Detector Circuit to respond and the auto level-setting motor runs until RLB/2 operates. The helix will not start however, until phasing is simulated. This may be achieved either by switching S1 to TEST WHITE and back to TEST BLACK several times or by pressing the manual run-up button S13.

1.72 L.F. Test Oscillator and Modulator

The function of the L.F. Test Oscillator and Modulator is to provide amplitude-modulation of the carrier signal at the start and stop control signal frequencies, for the purpose of checking the operation of the Signal Detector.

The carrier signal is provided by setting S1 to TEST BLACK.
V20a is an anode tuned oscillator and the three frequencies 300c/s, 450c/s and 675c/s are selected by S16 and capacitors C60, C61 and C62 respectively. The output of the oscillator is connected to the phase splitter stage V20b, the two antiphase outputs of which are connected to the rectifiers MR23 and MR24. As a result, the impedance at the junction of the two rectifiers varies with the frequency of the oscillator. This forms a shunt modulator causing the amplitude of the carrier signal to vary at the L.F. Test Oscillator frequency.

1.80 H.T. INTERLOCK CIRCUIT

This part of the circuit is responsible for switching the H.T.2 supply to RLA/2 and V4b in the Signal Detector Circuit, V9a in the Recorder Amplifier and RLB/2 in the Comparator Circuit.

1.81 S1 at AUTO

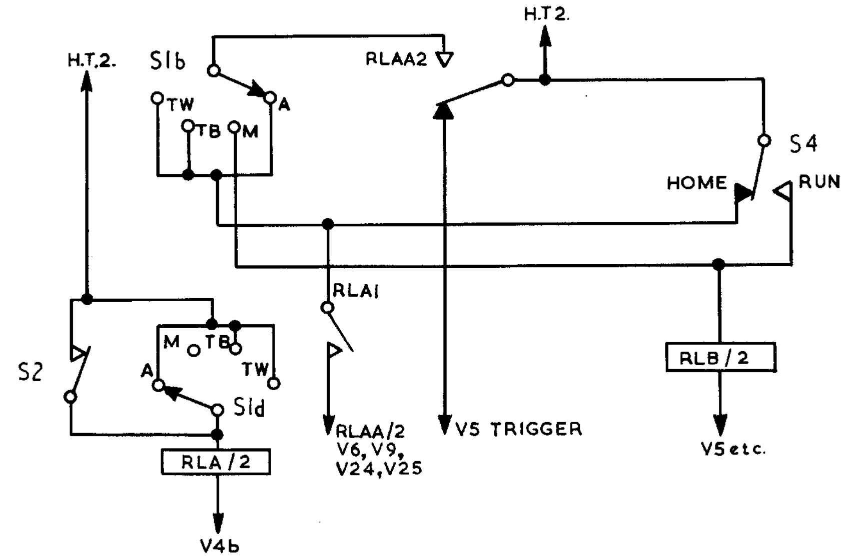
At AUTO, RLAA/2, the Speed Identification Circuit and V9a in the Recorder Amplifier Circuit have the H.T.2 connected thus:

(a) At standby the connexion is via the closed 'home' contact of S4 and RLA1 (open).

(b) When RLA/2 is operated, h.t. is applied to RLAA/2 and it operates. The connexions are now via contacts RLAA2, S1b and RLA/1. This connexion is not dependent on S4 which changes over to the 'run' position when the auto level-setting motor starts.

(c) When relay RLA/2 releases at the end of a transmission, the H.T.2 supply is disconnected from the the Speed Identifier and RLAA/2 which releases. Contact RLA/1 removes the h.t. from V9a and the Speed Identifier circuit. Thus the Recorder amplifier cannot be re-operated by the next transmission until the auto level-setting motor MO1, has driven the marking power control RV4 on to the 'home' position where S4 reconnects the H.T.2 supply as in (a) above.

V4b and RLA/2 are connected via S1d (or S2) to the 200V H.T. Thus RLA/2 can be operated while the auto level setting motor MO1, is driving the Marking Power potentiometer through the 'run' on to the 'home' position.



H.T. INTERLOCK CIRCUIT D-649-L/E1

The H.T.2 supply is also connected via R41 to the trigger electrode of V5 when RLAA/2 is released. This ensures the operation of RLB/2 in the event of the recorder power supply being switched on when S4 has previously been left in the 'run' condition. The operation of RLB/2 starts the auto-level setting motor which will run until RLB/2 releases; this occurs when S4 has been driven to the 'home' condition.

1.82 S1 at MANUAL
At MANUAL, S4 remains at the 'home' position. If however, the recorder power supply was switched off during a previous recording at AUTO and subsequently switched on again at MANUAL, S4 will be in the 'run' position and no recording can take place until S4 has operated. This is done by opening S2 (MARKING POWER control fully counter-clockwise) and pressing the PHASE button to operate RLB/2. The operated contact, RLB1 and the released contact RLAA1 complete the circuit to MO1, which drives until S4 is reset to the 'home' position, RLB/2 then releases and the motor stops.

The H.T.2 supply is connected to relay RLA/2 via S2 (which is closed when the manual MARKING POWER control is turned away from the fully counter-clockwise position). The detector circuit arrangements is such that at MANUAL, relay RLA/2 can always be switched off. S2 can also be switched on if S17 is in the DET. A position.

1.83 S1 at TEST BLACK or TEST WHITE
The H.T.2 connexions are exactly as for S1 at AUTO.

1.90 OTHER CIRCUITS

1.91 Run-Up Timer Circuit (AUTO)
The purpose of this circuit is to energize the paper run-up motor MO3 for a few seconds at the beginning of a transmission to remove dry paper from between the helix and writing-edge.

Normally, V8b is fully conducting and V8a cut-off. When RLC2 is operated, the discharged capacitor C39 is connected to the grid of V8b. This initially pulls the grid potential of V8b down to nearly -60V; V8b is thereby cut-off and its anode potential rises. V8a now conducts and RLD/2 operates. Contacts RLD1 and RLD2 complete the circuit to the run-up motor MO3.

Meanwhile, As C39 charges via R73 and RV7, the potential on the grid of V8b rises exponentially towards the H.T.2 potential. As V8b conducts again, its anode potential falls and V8a is cut-off. RLD/2 then releases and stops MO3. The time for which MO3 is switched on is determined principally by the time constant of C39, R73 and the variable resistance RV7, which provides a range of adjustment.

1.92 Fork Drive Circuit

This circuit provides an accurate 1000c/s signal voltage for the motor amplifier circuit. The use of a tuning fork and the design of the drive circuit, ensure a high degree of frequency stability.

The output from the fork 'grid coil' is transformer-coupled by T6 to the differential amplifier, the output of which is transformer-coupled by T5 to the fork 'anode coil'.

The fork frequency may be varied within small limits (40 parts in 10^6) by RV9, which controls the bias voltage of both valves; when the bias is reduced, the valves drive the fork harder and the frequency is reduced.

The fork frequency output is capacitance-coupled by C48 to the MOTOR INPUT preset potentiometer (RV10).

1.93 Motor Amplifier Circuit

The input, from the MOTOR INPUT preset control RV10, is passed through a conventional amplifier V14, V15 and V16 and transformer-coupled to the synchronous hysteresis motor MO2. Negative feedback is employed from the secondary of the output transformer to the cathode of V14b.

During standby conditions, when relays RLA/2 and CL/2 are unoperated, R157 in the cathode circuit of V15 and V16 produces a large negative self-bias which limits the amplifier output so that it cannot drive the motor. On receipt of a transmission however, the normally-open contact RLA2 closes and short-circuits R157. The amplifier then functions normally and the motor runs into synchronism.

One winding of the motor is parallel-tuned by C73. C72, C71 or C70 may also be connected in parallel to suit the 'RS' capacitance value (required for normal running) which is engraved on the motor body.

R108 in series with the cathode resistor of V14b is normally short-circuited by S6 the PICTURE SHIFT button. When the button is pressed, however, the short-circuit due to S6 is removed and R108 is alternately switched in and out of circuit by the commutator switch S14*.

During periods when S14 is open, V14b gain is reduced and practically no power reaches the motor, which falls out of synchronism and picks up again when S14 closes. Its average speed is therefore reduced and the chart is gradually displaced across the paper for as long as the PICTURE SHIFT button is pressed.

* The commutator is driven by the helix gear box and provides an open circuit for 3/4 of each commutator revolution.

1.94 Loudspeaker Amplifier

This is a conventional one-valve amplifier consisting of V2b and associated components. The volume control RV3 is operated by the knurled thumb control to the left of the paper ramp.

1.95 Power Supplies

Supply voltages taken from the power supply unit (bottom chassis) are as follows:-

H.T.1	320V d.c.
H.T.2	200V d.c. (stabilized)
H.T.3	-60V d.c.
H.T.4	84V d.c. (stabilized)
H.T.5	150V d.c. approximately
	115V a.c. for the auto level-setting and paper run-up motors.

The H.T.1 and H.T.2 supplies are derived from a 270V winding on the power supply transformer T9, via the full-wave bridge rectifier MR21 and the smoothing circuit L1, C80, C81 - the H.T.2 supply being stabilized by the conventional series regulator circuit V21, V22, V23. The voltage across the reference tube V23 also gives the H.T.4 supply. The negative H.T.3 supply is derived from a 55V winding on T9 via the full-wave rectifier MR22.

The H.T.5 supply is derived from the 115V tapping on the primary winding of the power supply transformer T9, via the half-wave rectifiers MR24 and MR25.

2.00 SEQUENCE OF AUTOMATIC OPERATION

This summary of the circuit's operation omits the functional details, which have been dealt with in the Circuit Description.

On receipt of the start signal,

(1) With S4 in the 'home' position the Signal Detector responds, operating RLA/2. Contact RLA1 starts the Speed Identification circuit and operates RLAA/2. Contact RLA2 starts the helix drive motor MO2. Contact RLAA1 starts the auto level-setting motor MO1. With S4 in the 'run' position RLA1 has an alternative h.t. circuit provided by RLAA2.

(2) The marking power (auto) control RV4 is driven by MO1 until the output from the Recorder Amplifier causes RLB/2 in the Comparator Circuit to operate. Contact RLB1 stops the auto level-setting motor MO1, and RLB2 removes the -60V bias from the timing network in the Speed Identification Circuit. RLB2 prepares the hold circuit for the clutch.

(3) After two phasing pulses, approximately, Speed Identification takes place, i.e. RLE/2 or RLF/2 are operated or left unoperated according to the pulse repetition rate. Contacts RLE1 and RLF1 set up the Speed Selector circuit.

(4) At the end of the timing period (approx. 2 seconds) RLG/2 operates. Contact RLG1 allows speed setting to occur and RLG2 removes the -60V bias from C38 and the shield grid of V7 in the phasing circuit, allowing C38 to discharge.

(5) After a short delay, while speed selection is taking place, the shield potential of V7 rises sufficiently so that the next phasing pulse causes V7 to conduct. The clutch relay CL/2 operates and the helix starts. Contact CL1 duplicates the function of contact RLA2 in the Motor Amplifier circuit, contact CL2 applies -60V to the relay RLC/2.

(6) After about 1/4 second RLC/2 operates. Contact RLC1 transfers the marking power to the helix and writing edge, and contact RLC2 initiates the paper run-up (if switched on).

Recording continues until the stop signal is received.

(7) On receipt of the stop signal RLA/2 and RLAA/2 release. Contact RLAA1 starts the auto-level setting motor MO1 which drives RV4 to the 'home' position. Contact RLA1 removes the h.t. from the first stage of the Recorder Amplifier and the Speed Identification circuit. (Alternatively, if operation is to the carrier signal, RLA/2 releases approximately 5 seconds after the disappearance of the carrier signal. After this the remainder of sub-section 7 supplies).

When RLA/2 releases, RLA1 removes the h.t. supply from the Speed Identification Circuit and RLG/2 releases. Contact RLG2 applies -60V to the shield grid of V7 disabling the Phasing Circuit.

When the auto-level setting motor MO1 has driven the switch S4 to the 'home' position, RLB/2 releases. Contact RLB2 releases the clutch relay CL/2 and RLC/2, stopping the helix and transferring the recorder amplifier output, if any, to the dummy load R91. Contact RLC2 short circuits C39 and restores the paper Run-Up circuit to 'stand by'.

3.00 TEST VOLTAGES

The following are typical test figures which may vary from machine to machine, or with a change of valves by ±10%.

When taking test figures, a 20 000 ohm/volt meter should be used and the meter range employed should be the highest consistent with good reading accuracy.

3.10 TEST POINTS

Arranged along the top edge of the electronic chassis (in its normal position) are test points numbered 1-18. Tests points 19, 20 and 21 are mounted on the small sub-chassis atop the electronic chassis. Most of these points give valve cathode voltages, and therefore provide a ready means of checking that these valves are operating.

The voltages should be checked under the following conditions (unless otherwise stated).

Voltage Selector (S15) at correct position for the power supply in use.
Supply switch (S10) at ON.
AUTO/MANUAL/TEST BLACK/TEST WHITE switch (S1) at MANUAL.
Manual MARKING POWER control turned away from the fully counter-clockwise position.
AUTO PAPER RUN-UP switch at ON.

SPECIFICATION

Index of Co-operation	288 or 576; Automatic or Manual Selection
Scanning Rate	48 or 96 lines/in. according to I. O. C.
Helix Speeds	60, 90 and 120 rev/min; Automatic or Manual Selection
Recording Medium	Mufax electrosensitive paper
Width of Record	18 in (45·7cm)
Speed of Reception	5/8in per min at 60 rev/min 15/16 in per min at 90 rev/min 1-1/4in per min at 120 rev/min } at 576 I. O. C.
	1-1/4in per min at 60 rev/min 1-7/8in per min at 90 rev/min 2-1/2in per min at 120 rev/min } at 288 I. O. C.
Input Impedance	600 ohms balanced; 2-wire
Input Level	+5dB to -40dB ref. 1mW into 600 ohms
Nature of Input Signal	Amplitude-modulated carrier, within the band 1800c/s to 2400c/s. Maximum carrier amplitude for a 'black' signal. Minimum Black/White ratio 12dB.
Control Signals (All control signals to be of five seconds duration)	300c/s for 576 I. O. C. 675c/s for 288 I. O C. } Start Signal 450c/s Stop Signal
Phasing Signals (Minimum duration of signal, 15 seconds for DET. 'B' operation, 20 seconds for DET. 'A', operation)	'Black' carrier signal level interrupted once per revolution of the drum by a white pulse. The transition from black to white must occur as the transmitter scanning enters 'dead' sector. (a) Black 95% of drum circumference, white pulse 5% of drum circumference or (b) Black 50% of drum circumference, white 50% of drum circumference
Fork Frequency	1000c/s (adjustable by 40 parts in 10^6)
Power Supply	105 - 125V, 200 - 240V; 50-60c/s
Power Consumption	150VA (90VA at standby)
Dimensions	28-1/2in wide x 22-3/4in high x 12-1/2in deep (72·5cm x 58 cm x 31·8cm)
Weight	150 lb (68kg) approx.

5.30 EQUIVALENT VALVES

If valves of the original type are not available, certain equivalent or near equivalent valves will suffice in most cases, as shown below.

Valve	Type	Equivalents
V1	12AT7	CV455, CV4024, ECC81, B309, M8162, 6060
V2	12AT7	As for V1
V3	6AS6	CV2522, CV4011, 5725, 6AS6W
V4	12AX7	CV492, CV4004, ECC83, M8137, 6057
V5	Z803U	6779
V6	Z803U	As for V5
V7	2D21	CV797, CV4018, EN91,5727, 2D21WA, M8204
V8	6060	As for V1
V9	12AT7	As for V1
V10	6L6GA	CV2796, 6L6, 6L6GB, 6L6WGB
V11	6L6GA	As for V10
V12*	QA2403	CV4014,* M8083 6064
V13*	QA2403	
V14	12AT7	As for V1
V15	6L6GA	As for V10
V16	6L6GA	
V17	Z803U	6779
V18	Z803U	6779
V19	Z803U	6779
V20	12AT7	As for V1
V21	A2293	11C1
V22	6AS6	As for V3
V23	85A2	CV449, CV4048, 5651, M8098
V24	Z803U	6779
V25	Z803U	6779

* As a temporary measure V12 and/or V13 can be replaced with 6F12, EF91, 6AM6, CV138, which have a slightly inferior long-term performance.