NATIONAL INSTITUTE OF OCEANOGRAPHY

WORMLEY, GODALMING, SURREY

Pop Up Bottom Seismic Recording System

by

J. J. LANGFORD and R. B. WHITMARSH

N.I.O. Internal Report No. A. 52

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Introduction

The Pop-Up Bottom Seismic Recording System comprises a Pop-Up Bottom Seismic Recorder (PUBS) and a shipborne Replay and Clock Unit. Fig. 3 is a block diagram of the complete system. The PUBS electronics comprises record and release electronics.

The record electronics converts seismic data into Frequency Modulation (FM) and Direct Recording (DR) forms which are then recorded with clock data on magnetic tape.

The release electronics controls the release of the PUBS equipment from the sea bed, enables shipborne equipment to track PUBS on the sea bed and in the water and aids location of the equipment at the surface.

The Replay Unit contains demodulating and processing electronics to reconstitute the data from tape. The unit also contains a clock section which is synchronised with the PUBS clock at the start of an experiment to enable correlation of ship and PUBS recorded data.

SECTION 1

GENERAL DESCRIPTION

MECHANICAL

1.1 PUBS Electronics (Fig. 1)

The PUBS electronics is contained in a spherical pressure vessel designed to withstand 9000 p.s.i. Fig. 1 is an illustration of the complete sphere with fittings.

The sphere comprises two hemispheres joined at the circumference by an equatorial ring and O ring seals. Electrical connections between the internal electronics and external fittings are made via Marsh Marine connectors at the equatorial ring.

To prepare PUBS for an experiment a careful pre-operational check is carried out to check the security of all fittings and correct functioning of the electronics. Details of pre-operational checks are given in Sections 3 and 4.

1.2 Replay Unit

The Replay Unit electronics contains the following units:-

(a) Two Rockland type 1020F filter units for signal processing.

(b) Demodulator electronics.

(c) Ship clock and control panel.

The Replay electronics is contained in a standard Vero cabinet. To remove any item first ensure that the mains supply is disconnected. Remove the rear panel and disconnect supply cable from terminal board. Individual demodulators are plug-in rack-mounted units and can be removed from the front of the unit.

ELECTRICAL

1.3 PUBS Electronics: Record (Fig. 4)

The output from a ceramic stack hydrophone is fed to a high input impedance amplifier. The amplifier has a bandwidth of approximately 2 Hz to 100 Hz and produces HI (high gain), LO (low gain) and DR (direct record) outputs with voltage gains of approximately 5000, 2000, and 50 respectively. The DR output is recorded directly on magnetic tape via the tape-recorder electronics.

HI and LO outputs are fed to frequency modulators which convert the HI and LO analog signals into frequency-modulated signals. The HI and LO frequency modulators have class B push pull output stages to facilitate recording onto magnetic tape.

The 15 MHz output from a Marconi type F3180-01 crystal oscillator is counted down by the frequency divider circuit to produce control signals which operate the tape recorder cycling contacts and clock timing signals.

The clock timing signals are amplified by the clock amplifier, and fed to the tape recorder.

Stabilised supplies to the 15 MHz oscillator, hydrophone amplifier, clock amplifier and HI, LO frequency modulators are provided by the +12V, +10V and +4V stabilised supplies.

At the start of an experiment, data is recorded on tape recorder 1. When all the tape in tape recorder 1 has been used, tape recorder 2 switches on and tape recorder 1 switches off, data is then recorded on tape recorder 2. Details of the tape recorder control circuits are shown in Fig. 4. Setting up instructions for the tape recorder control circuits are contained in paragraph 3.7.

1.4 <u>PUBS Electronics: Release</u> (Fig. 5)

During an experiment the PUBS is at the sea bed and the transponder and release receiver are operative. Both transponder and release receiver use the same scroll as a transducer.

The transponder emits a 10kHz acoustic pulse whenever it receives a 10kHz acoustic signal, this enables the PUBS range to be determined using the ship's echo-sounder. When the ship has reached minimum range from the PUBS, i.e., directly above the PUBS, a 10kHz frequency-modulated signal is transmitted from the ship.

When the release receiver has received this frequency-modulated signal for approximately 15 seconds it activates the release relays and the following actions result:-

a) A current is supplied to fire the explosive release, thus freeing the equipment from the sea bed.

b) The flashing light is activated.

c) The radio beacon is activated.

Should the release receiver fail to operate, a battery driven mechanical clock will activate the release relays at a pre-determined time. Should the explosive release fail to fire for any reason a corrodable link which has a life of several weeks will eventually free the equipment.

While PUBS is rising to the surface its range can still be obtained using the transponder and ship's echo-sounder. PUBS surfacing is indicated when the transponder trace abruptly ends, whereupon radio direction finding and visual search are started.

The flashing light is an electronic flash unit powered by a low voltage battery. The radio beacon outputs 1 watt at 4.157 MHz for 1 second every 20 seconds, but this ratio can be adjusted for identification purposes.

1.5 Replay Electronics (Fig. 6)

HI, LO and clock data from the tape recorder are fed via socket FP/SK1 to appropriate demodulators. The demodulated clock signal is fed via switch FP/SW1 to FP/SK2 for output to an ultra-violet recorder.

Outputs from the HI and LO frequency demodulators are fed to a patch panel. The patch panel enables the demodulated signals to be patched directly to the galvanometer output socket SK2 or via the signal processing filters F1 and F2.

The ship's clock output is fed to the galvanometer output socket SK2 via FP/SW1, the potentiometer FP/RV1 sets the amplitude of the ship's clock output. All demodulator outputs are low impedance balanced outputs and must not be earthed, otherwise the output transistors will be damaged.

DR signals from the tape recorder are fed via FP/SK3 to an internal monitor loudspeaker and via an attenuator to the galvanometer output socket FP/SK2.

The reset switch FP/PB1, resets the ship's clock and provides reset outputs at RS1 to RS4 which are required at the start of an experiment to synchronise PUBS and ship clocks.

SECTION 2

CIRCUIT DESCRIPTION

RECORD ELECTRONICS

2.1 Seismic Hydrophone

The seismic hydrophone consists of a stack of four PZT-4 piezoelectric ceramic discs (dimensions 2.125" dia., x 0.5" thick) separated by thin beryllium-copper sheets. The stack is sandwiched between two 0.25" thick aluminium discs. The elements of the stack are held together with Epikote/Epikure glue.

The four piezoelectric elements are electrically connected in parallel and the whole assembly is immersed in silicon oil in a polythene container. The hydrophone has a capacitance between 6000pf and 7500pf and a resistance of several megohms. The sensitivity of the hydrophone at STP is 15μV/μbar.

The piezoelectric material PZT-4 was chosen for the following reasons:-

(a) The material is insensitive to the short term pressure cycling which occurs when using the PUBS.

(b) Although the material is slightly sensitive to long term stress, it slowly recovers when the stress is removed.

2.2 Hydrophone Amplifier (Figs. 7; 8)

Input data from the hydrophone is fed to the gate of the field effect transistor VT1. Transistor VT1 has an input impedance of 10MΩ determined by R4 which is decoupled by C1. The output of VT1 is fed via the decoupling capacitor C2 to VT2 base. The output from transistor VT2 is fed via C4, R14 to VT3 base. C6 limits the bandwidth of the pre-amplifier to about 100Hz. Above 100Hz the response of the amplifiers falls at about 10db/decade.

Transistors VT3 and VT4 form an amplifier whose gain (of approximately 8) is determined by the ratio R17/R18. The DR output is taken from R17 and is approximately 50 times the input at VT1 gate.

The LO output from VT4 collector is fed out via C5 and also via C8 to VT5 base. VT5 and VT6 form another amplifier of gain 4 (determined by the ratio R21/R22). The HI signal is output from VT6 collector via C7.

The pre-amplifier limits with an input to VT1 in excess of 5mV. Maximum output on HI is approximately 10V peak to peak.

2.3 +12V Stabiliser (Figs. 8; 9)

The +12V stabiliser, which is contained on the same circuit board as the pre-amplifier, provides +12V stabilised supply from a 13.5V- 17.5V unstabilised battery supply. The circuit consists of a difference amplifier VT11, VT12 which compares the reference voltage from Zener diode D1 with the output voltage via R25, RV2, R26. If the output voltage at VT11 base rises above or falls below the voltage at VT12 base a difference is fed from VT11 collector to control the output transistors VT10, VT9. The output voltage is initially set by RV2.

2.4 HI and LO Frequency Modulators (Figs. 10; 11; 12)

HI or LO input is fed via the gain potentiometer RV1 and C1 to amplifier VT1. The gain of VT1 can be set to approximately 12 by connecting the link BC or to 1.1 with the link set to AC. C4 limits the bandwidth of amplifier VT1. The output from VT1 is fed via C12 to amplifier VT2 whose bandwidth is limited by C6. The output from VT2 is fed via C8 to VT3.

VT4, VT5 and VT3 form an astable multivibrator the frequency of which is determined by the voltage at VT3 base. The frequency is initially set using the potentiometer RV3 and subsequent a.c. signals from VT3 add or subtract to the d.c. voltage at VT3 base causing the frequency of the multivibrator to change. Fig. 12 shows the relationship between frequency and applied voltage for the multivibrator.

VT6 acts as a buffer stage between the multivibrator and amplifier VT7. The output from VT7 drives the push pull output amplifier VT8, VT9. The symmetry of the head current is set by RV3.

2.5 Clock Amplifier (Figs. 16; 17)

Clock input is amplified by the clock amplifier and fed to the tape recorder head. The amplifier is identical to the output stage of the HI, LO frequency modulators, details of which are given in paragraph 2.4.

2.6 +10V Stabiliser (Fig. 16; 17)

The +10V stabiliser is mounted on the same circuit board as the clock amplifier. A reference voltage is set at VT3 emitter by D1, D2. A portion of the output voltage is applied to VT3 base via potentiometer chain R5, RV1, R6. Thus the current through VT3 is determined by the base potential of VT3, i.e., output potential. The output from VT3 collector controls the current through VT1 and thus also the current output through the output transistor VT2.

2.7 +4V Stabiliser (Figs. 16; 17)

The +4V stabiliser is mounted on the same circuit board as the clock amplifier. A portion of the output voltage set by R11, RV2, R12 is applied to VT5 base. A current flows through VT5, depending upon the difference between VT5 base and the reference voltage set by D4 at VT5 emitter. R9 ensures that there is always a current flowing through D4 even if VT5 is cut off. R7 and VT4 form a very high a.c. load for amplifier VT5.

2.8 Clock (Figs. 13; 14; 15)

The fundamental clock frequency of 15 MHz is generated by the Marconi crystal oscillator, the output of which is amplified by VT1 and fed to the divide by five integrated circuit IC1. The crystal frequency is continually counted down to 1000 Hz at the output of IC5. IC6 produces one output of 100 Hz which is output to IC7 and one output of 500 Hz which is output to IC13.

The 100 Hz input to IC7 is further reduced by IC7, IC8 and IC9 to 0.1 Hz at the input to IC10. IC10 differentiates the 0.1 Hz square wave input from IC9 and the 20 Hz square wave input from IC7. The resultant outputs are fed to IC11 which is a dual bistable unit.

The bistable unit IC11 produces two outputs. One output consists of a 50 mS pulse every 10 seconds. The second output consists of a 20 mS pulse every 0.1 secs. These two outputs are added in the gate unit IC13. The result of this addition is inverted and not inverted in IC14, then returned to IC13. The not inverted signal is combined with a 500 Hz signal from IC6. The inverted signal is combined with 1000 Hz from IC5. The two resulting signals are added and then output from IC13 to IC14 where the signal is inverted and then output to the clock amplifier (see paragraph 2.5). This output waveform is shown in Fig.34. The 0.1 Hz output from IC9 is also counted down by IC15, IC16, IC17 to produce a 10 min. periodic output. This output switches the transistor VT1 on for 5 minutes and off for 5 minutes. When VT1 conducts the cycling relay switches on, it switches off when VT1 is cut off. The cycling contacts control the tape recorder duty cycle (see paragraph 1.3).

A reset input from the replay unit is provided to reset the logic at the start of an experiment.

2.9 Tape Recorders (Figs. 18; 19)

Two suitably modified UHER type 4000L tape recorders are used in each PUBS. The modifications are as follows:

(a) Power supply leads are brought out from the front panel of the recorder so that external supplies can be used.

(b) The original single track tape heads have been replaced by a 4-track combined record/replay head. Two types are used; they are the Mullard type ER7557 (no longer made) and the Marriott type FX44RP127. Signal leads to the head are brought out to a 5-pin DIN socket at the front panel (SK1 Fig.4) to enable connection to the PUBS electronics. The arrangement of the tracks on tape are as follows:

DR	top track
FMHI	
FMLO	
CLOCK	bottom track

(c) A microswitch fitted to the deck of the tape recorder senses the end of tape and disconnects the +6V supply from the tape recorder.

(d) The tape recorder loudspeaker has been removed.

Tape Head details:

Marriott Type FX44RP127

Typical inductance per track	= 30mH
Cross talk at 1 kHz	= -38db
Applied signal current	= 85μA
Applied bias at 50kHz	= 2mA
Output at 1 kHz	= 0.13mV
Output at 8Kc/s (ref.to 1kc/s)	= -16db

Mullard Type ER7557

Typical inductance per track	= 50mH
D.C. resistance	= 60 Ω
Output at 1kHz	= 0.45mV
Cross talk	= -38db

RELEASE ELECTRONICS

2.10 Acoustic Transponder (Figs. 26; 27)

Details of the acoustic transponder are contained in the N.I.O. Internal Report No. A.38.

2.11 Release Receiver (Figs. 24; 25)

Under development.

2.12 Radio Beacon (Figs. 20; 21; 22; 23)

There are two types of radio beacon in use at the moment, they are Type A and Type B both manufactured by U.M.E.L. Limited. Type B is identified by having an additional veroboard circuit attached to it.

(a) Type A (Figs. 20; 21)

Transistors VT9, VT10, VT11 and VT12 form an astable multivibrator stage whose output is fed to the series transistors VT7, VT6. These transistors connect the +18V supply to the carrier and modulation stages of the beacon.

Transistors VT5 and VT6 form another astable multivibrator stage which is normally disabled when used in PUBS. If required this stage switches the oscillator stage on and off and thus amplitude modulates the carrier at approximately 500 Hz via the series transistors VT4, VT3.

The carrier frequency is generated by the crystal oscillator XI, VT2 whenever the supply is on via VT7. The carrier output from VT2 is fed via the transformer L2 to the output transistor VT1. The transistor delivers 1 watt of r.f. power into a 50Ω load. The output impedance of the beacon, which is nominally 50Ω, can be adjusted by L1.

(b) Type B (Figs. 22; 23)

Transistors VT10 and VT11 form an astable multivibrator, which switches supply voltage to the beacon via transistors VT9, VT8 at the required duty cycle.

Transistors VT6, VT7 form a second astable multivibrator which connects supply voltage to the carrier oscillator via VT3, VT4 whenever supply has been connected via VT8, VT9. The output from the multivibrator controls the series transistors VT3, VT4 via buffer amplifier VT5. This multivibrator is normally by-passed when used in PUBS.

The carrier signal is generated by the crystal oscillator X1 VT2 and fed via L2 to the output transistor VT1. The output transistor delivers 1 watt of r.f. power into a 50Ω load. The output impedance which is nominally 50Ω, is set by L1, C2.

2.13 Back Up Clock

This is a mechanical device, designed around a Portescap Swiss clock movement type 131482 which is powered by a 1.5V battery giving an operational life of approximately 3 months. The output shaft of the movement is geared to give a 48 hour rotation. The output shaft is coupled via a slipping clutch to a cam which operates a microswitch. The output from the microswitch initiates PUBS release from the sea floor at the appropriate time.

2.14 Flashing Light (Fig. 30)

Under development.

2.15 Battery Supplies

Battery packs for the PUBS electronics are made up of individual mercury cells supplies by Mallory Limited. Details of these packs are given in the following table.

Battery Pack	Circuits Supplied	Initial Volts	Approximate Life (Hours)	Current Drain (mA)
13 x 1450R	Hydrophone pre-amplifier FM modulators crystal oscillator	17.55	22	) 60) 20-30
4 x 2550R	Clock	5.4	19	320
5 x 2550R	Tape Recorder	-6.75	19	310
5 x 135R 4/5 x 135R	Release Receiver " "	-33.75 -5.4	Several Months	
5 x 135R 4/5 x 135R	Acoustic Transponder " "	33.75 5.4	At least one experiment*	
3 x 135R	Radio Beacon	20.25	25 (at 10% duty cycle)	
4 x HP11	Flashing light	6		
3 x 135R	Explosive link	20.25	2 operations	

* See N.I.O. Internal Report A.38

REPLAY ELECTRONICS

2.16 HI/LO Frequency Demodulator (Fig. 28)

An FM signal from the tape recorder is fed via C2 to VT1. Transistors VT1, VT2 and VT3 form a very high gain amplifier which limits on any input from the tape recorder. The output from this amplifier stage is squared by the Schmitt trigger VT4, VT5. The output from the Schmitt trigger is fed to the monostable circuit formed by VT6, VT7. The monostable is fired by the negative edge of each pulse from the Schmitt trigger. The monostable period is set to 300 S by RV1. The output from the monostable is fed via a buffer stage VT8, VT9 to a low pass filter.

The low pass filter has a characteristic impedance of 1000 Ω and consists of a constant - K section and a shunt m-derived section. The filter has a bandwidth of 0.133Hz to 132Hz. Attenuation in the stop band is 60db between 500 Hz and 1400 Hz. A portion of the filter output is fed via RV2, C17 to the difference amplifier VT10, VT11. VT11 is referenced by a voltage derived from the resistor chain R45, RV3, R46. RV3 is used to balance the amplifier which has a gain of approximately 5. The difference outputs from VT10, VT11 are amplified by VT13, VT16 which each have a gain of 2, and fed to the second difference amplifier VT14, VT15. This stage provides the drive output to a galvanometer via the attenuator network R51, RV4, R52, R53.

2.17 Clock Demodulator (Fig. 27)

The first section of the Clock Demodulator is identical to the first section of the HI/LO Frequency Demodulator (see paragraph 2.16).

The output from the buffer amplifier VT8, VT9 is fed to transistor VT10. Transistors VT10 to VT13 form a filter unit, the frequency response characteristics of the filter

2.18 Ship's Clock

The ship clock circuit is identical to the clock used in PUBS (see paragraph 2.8) except for the following modifications:-

(a) 0.1Hz and 10Hz outputs are combined in an extra OR gate.

2.19 Power Supplies

Two power supplies are provided, one is a standard Coutant unit used to power the ship's clock, the other is shown in Fig. 33.

2.20 D.R. Attenuator (Fig. 31)

This unit contains a loudspeaker to monitor the DR signal from the tape recorder and a 10 x 3db step attenuator providing an output to the DR galvanometer.

2.21 Filter Units

Two Rockland Filter units are incorporated in the equipment. The following data is reproduced from the Rockland Type 1020F Filter Handbook.

a) Transfer Functions	:	Low Pass, High Pass
b) Response	:	4th order Butterworth or RC
c) Attenuation Slope	:	24db/Oct.
d) Cut off Frequency	:	0.01 Hz to 111.1KHz.
e) Amplifier Response	:	DC to 1 MHz (3db down)
f) Impedance	:	50 ohms
g) Max. Signal	:	20V p to p.
h) Drift	:	Better than 1mV/^{o}C.

SECTION 3

SETTING UP INSTRUCTIONS

3.1 Introduction

The following setting up instructions consist of two parts. The first part, which deals with individual circuits and elements, should enable each circuit or element to be checked independently. The second part is in the form oa a check list which is followed (usually just prior to launch of the PUBS) to check the overall operation of the PUBS.

PART 1

RECORD ELECTRONICS

3.2 Stabilised Supplies

+12V Stabiliser (Figs. 8; 9)

Connect +18V supply to the +12V stabiliser and a 100Ω load to the output. Connect a digital voltmeter to the +12V output of the stabiliser and adjust RV2 to give an output of +12V ± 0.1V. Vary the input voltage from +17.6V to +13.7V and check that the output voltage variations are within 12V± 0.2V.

+10V Stabiliser (Figs 16; 17)

Connect a +11.8V supply to the +10V stabiliser and 300 Ω load to the output. Connect a digital voltmeter to the +10V output of the stabiliser and adjust RV1 to give an output of +10V ± 0.1V. Vary the input voltage from +11V to +13V and check that the output voltage variations are within +10V ± 45mV.

+4V Stabiliser (Figs. 16; 17)

Connect a +11.8V supply to the +4V stabiliser and a 500 Ω load to the output. Connect a digital voltmeter to the +4V output of the stabiliser and adjust RV2 to give an output of +4V ± 0.01V. Vary the input voltage from +11V to +13V and check that the output voltage variations are within +4V ± 2mV.

3.3 Hydrophone Amplifier (Figs. 7; 8)

Connect a +12V stabilised supply to the Hydrophone Amplifier. Feed a 1mV, 70c/s signal via a 100:1 attenuator to the input of the amplifier at VT1 gate. Check that the DR output is an undistorted output of approximately 0.02V amplitude. Check that the LO output is an undistorted output of approximately 0.16V. Check that the HI output is an undistorted output of approximately 0.64V. Vary the frequency of the oscillator to ensure that the bandwidth of the amplifier is substantially flat between 1.5Hz and 100Hz.

3.4 Frequency Modulators (Figs. 10; 11; 12)

Connect +10V and +4V stabilised supplies to the modulator. Connect a frequency counter to TP2. Check that the output at TP2 is a square wave of approximately 3.8V peak to peak amplitude. Adjust RV2 so that the output at TP2 has a frequency of 834 Hz.

Use a double beam oscilloscope to display the current waveform through R35. Adjust RV3 so that the waveform display is symmetrical.

The Tape Recorder head current is set by selecting appropriate values of VT8 and VT9 emitter resistances. The value of the resistance for a given current is, $Re = \frac{2 \times 1.6}{I(head)}$

Set the link AB to the high gain position i.e., to position B. Set RV1 to maximum and inject a 70Hz, 100mV sine wave input from a suitable oscillator to the modulator input. Monitor the output at TP1 and ensure that the output is substantially distortion free with an amplitude of approximately 2.5V. Vary the frequency of the oscillator and check that the amplifier has a flat response between 1.5Hz and 400Hz. Fig. 12 is a plot of frequency output from modulator for d.c. input to VT3 base. If there are doubts about the linearity of the modulator, this can be checked by variation of RV2 to give the required d.c. voltage at VT3 base. This would of course require the carrier frequency to be reset to 834Hz at the completion of such a check.

The SET GAIN potentiometer RV1 is set up for a particular experiment, this information is given in Part 2.

3.5 Clock (Figs. 13; 14; 15)

Connect +12V and +5V supplies to the clock circuit. Connect an oscilloscope to the clock output and ensure that there is a square wave output switching between 500Hz and 1000Hz. Connect the reset input to earth and check that the clock output is inhibited. Connect a timing counter to the 100Hz output at pin 11 of IC6 and check that the period is 0.01 sec ± 1 part in 10^8. If the period is incorrect adjust the crystal oscillator by means of the variable capacitor at the side of the crystal case.

Connect a multimeter set to ohms, between the cycling outputs. Connect the reset line to earth and check that there is an open circuit condition (indicating the cycling relay is de-energised). Remove the earth from the reset line and check that after a period of exactly 5 minutes has elapsed a short circuit appears at the cycling contacts output (cycling relay energised).

3.6 Clock Amplifier (Figs. 16; 17)

The clock amplifier is identical to the output stages of the modulator circuit (see paragraph 3.4) and the setting up procedure for head current and output symmetry are also identical to that of the modulator.

3.7 Tape Recorder (Figs. 18; 19)

The following information is reprinted from the UHER technical information sheet supplied with each tape recorder.

Technical Specifications

All specifications are given on the basis of the pertaining DIN standards.

Tape Speeds	15/16 i.p.s. 1⅞ i.p.s. 3¾ i.p.s. 7½ i.p.s.
Reel Diameter	up to 5"
Playing time	6h. 24mins. (using 1800 ft. of triple play tape at 15/16 i.p.s.)
Wow and Flutter	± 0.2% at 7½ i.p.s.
Inputs	Microphone 0.1mV - 100mV into 40K
Outputs	2V/4 Ω 1V/15K Ω
Consumption	310mA when recording at 15/16 i.p.s.
Power Supplies	-6V

When a new tape recorder is acquired for use in PUBS, the existing tape head is replaced by a 4-track record-replay head. The original mounting plate must be modified to take the new head.

The leads to the new head are connected before the head is firmly clamped between a top plate and the mounting plate.

The machine is loaded with tape and the head is adjusted until the face of the head just touches the tape. The head is rotated until the head face is symmetrical with respect to the tape. The head is then locked firmly in place.

The head is now adjusted for height relative to the tape, to ensure that all 4 tracks on the head will record on tape. To ensure that the head is correctly aligned proceed as follows:-

(a) Load a tape onto the machine. This tape must have a standard signal recorded on the two outer tracks.

(b) Replay the tape and adjust the head height so that the signal strengths from the tracks are equal. N.B. The tape recorder electronics can be used to replay both tracks provided only one track is connected at a time.

(c) Monitor the output from one track and rock the head by means of the adjusting screw on the base plate to obtain maximum output. The head current for the DR channel will require adjustment when a new head is fitted. The setting up procedure is as follows:-

A prerequisite for any alignment is that the necessary measurements be made while the recorder is fed with an adjustable and constant supply voltage of 6 volts.

<u>R4, RF-Bias.</u> The RF-Bias influences the frequency response of the recorder. The voltage mentioned below is a mean value; the final adjustment should only be made after the frequency response has been checked. Connect an audio-frequency VTVM via a voltage divider to point A in accordance with Fig. Adjust for a VTVM reading of 250 millivolts by means of the variable resistor R4. If this value cannot be attained, first check the alignment of the RF block circuit. Set the recording level control at zero. Connect an audio-frequency VTVM across the contacts 3 and 2 of the "Accessories" socket and adjust for a minimum reading by sliding the ferrite core of the coil 561-23613.

<u>R11, Recording Level Indication.</u> Connect an audio oscillator across the contacts 1 and 2 of the "Radio/Phono" socket and feed a signal of 1,000 cps at approximately 10 millivolts. Connect an audio-frequency VTVM across the contacts 3 and 2 of the "Accessories" socket. Depress the recording key. Adjust, by means of the recording level control, a V.T.V.M. reading of 1.4 volts. Now adjust the recording level meter to read zero db, by means of the variable resistor R11.

<u>R19, Negative Feedback Of the First Stage of the Amplifier.</u> Readjustment will only be necessary after the sound head or the transistor has been replaced. An audio-frequency VTVM and an oscilloscope are connected in parallel across the contacts 3 and 2 of the "Accessories" socket. Connect an audio oscillator across the contacts 1 and 2 of the "Radio/Phone" socket and feed a signal of 1,000 cps at approximately 10 millivolts. Record the signal at 71/2 i.p.s. and at full recording level on UHER Test Tape. Simultaneously, the audio frequency VTVM must read 1.4 volts and the oscilloscope must show an undistorted sine-wave. Rewind the tape and play back the recorded signal. Adjust for a VTVM reading of 1.0V by means of the variable resistor R19. The oscilloscope must show an undistorted sine-wave (see Fig. 19).

R65, Initial Current and R64, Balancing of the Output Stage. Break the connection to contact A6 and interpose a milliammeter (range 15mA; internal resistance 19 ohms) and adjust an initial current of 5mA by means of the variable resistor R65. If an initial current of 5mA cannot be attained, provisionally adjust the variable resistor R64 accordingly.

Disconnect the loudspeaker and bridge the loudspeaker output with a 4-ohm resistor. Connect an oscilloscope across the loudspeaker output. Unsolder the connection to contact A5. Connect an audio oscillator across the contacts A5 and A2 (ground) and feed a signal of 1,000 cps. Vary the output voltage of the audio oscillator within the range of 200 to 350 millivolts until the oscilloscope shows a sine-wave similar to that shown in Fig.19. Adjust symmetry of the sine-wave by means of the variable resistor R64 (See Fig 19) Reduce the output voltage of the audio oscillator until the sine-wave has a shape similar to that shown in Fig. 19 Adjust the variable resistor R65 so that the lateral displacement between the two half-waves of the sine-wave becomes a maximum as shown in Fig.19. Then slowly turn back R65 until the lateral displacement has just disappeared and there is a smooth transition between the two half-waves as shown in Fig. 19.

Thereafter measure the initial current once again. It must fall into the range between 3 and 6mA. If the initial current does not fall into the range between 3 and 6mA, first adjust the variable resistor R65 and repeat the process described above.

R53, Speed Adjustment. The speed is adjusted by using an UHER Speed Test Tape at the speed of 71/2 i.p.s. Thread the tape and read the deviation. Adjust the deviation to ± zero % by means of the variable resistor R53 which is capable of counterbalancing deviations of up to approximately ± 8%.

R20, Adjustment of the Recording Level Meter for Battery Life Indication. Pull the knob of the recording level control and keep it in that position. Adjust the variable resistor R20 so that that the meter reads zero db at a supply voltage of 5.0 volts.

RELEASE ELECTRONICS

3.8 Acoustic Transponder (Fig. 26; 27)

Details of the setting up procedure for the acoustic transponder is given in the N.I.O. Internal Report No.A.38.

3.9 Release Receiver (Figs. 24; 25)

Under development.

3.10 Radio Beacon (Figs. 20; 21; 22; 23)

(a) Type A: Connect a 50 resistor to the output terminals of the radio beacon, then connect the beacon to a +18V supply. Connect an oscilloscope to the emitter of transistor VT7 and check that +18 volts appears at this point for approximately 1 second every 10 seconds. This mark space ratio can be adjusted by the variation of the values of C9, C10, R15 and R16 of the multivibrator circuit VT9, VT10, VT11 and VT12. Ensure that a shorting link is connected between emitter and collector of transistor VT4, this is to disable the modulation multivibrator formed by transistors VT5 and VT6.

Connect an indicator, i.e., oscilloscope or r.f. power meter, to the output of the radio beacon and adjust L1 and L2 for maximum output, which should be approximately 1 watt.

The carrier frequency of the radio beacon is usually checked using a frequency meter but it should be noted that the maximum continuous operating period of the output transistor is only about 3 to 4 seconds to exceed this period would destroy the transistor.

(b) Type B: The Type B radio beacon is set up using the same procedure used for Type A. It should be noted that in this case transistor VT3 collector and emitter are shorted together and that adjustment of the mark space ratio is affected by the variation of C13, C14, R19 and R20.

3.11 Flashing Light (Fig. 30)

Under development.

3.12 Back Up Clock

Connect a 1.5V supply to the clock mechanism. Start the movement by depressing the starter lever. Set both the lapsed time dials to some convenient setting e.g., 3 hours. Use a multimeter to check that both microswitches are 'off'. Check that when the set time interval has lapsed the microswitches are 'on'.

REPLAY ELECTRONICS

3.13 Ship's Clock (Figs. 13; 14; 15)

The procedure for checking the ship's clock is identical to that detailed in paragraph 3.5 with the following additional check; monitor the output of the NOR gate IC18 at pin 11 and ensure that the output waveform has an amplitude of approximately 3.8V.

3.14 Frequency Demodulators (Fig. 26)

Connect a stabilised +10V supply to the demodulator. Connect an oscillator to the input of the demodulator and feed in an 800 Hz sine wave at 0.5mV. Monitor the output at TP2 and check that an 800 Hz pulse waveform of approximately 10V amplitude is present. Adjust RV1 to give a pulse width of 300μs. Disconnect one end of R39 from the output of transistor VT9. Connect the oscilloscope to TP3 and use an oscillator feeding through R39 to check that the frequency response of the filter extends from 0.133Hz to 132Hz and that between 500Hz to 1400Hz the attenuation is better than 60db. Reconnect R39.

Connect an Avometer across the Galvanometer output and adjust RV3 to get a zero d.c. volt condition.

The potentiometer RV4 is in the form of a ten position 3db step attenuator and is used while using the demodulator to replay data from tape. The potentiometer RV2 selects the output level required to the galvanometer amplifiers and its setting is determined by the output level from the tape recorder.

3.15 Clock Demodulator (Fig. 29)

Connect a stabilised +10V supply to the demodulator. Connect an oscillator to the input of the demodulator and feed in a 500 Hz sine wave at 0.5mV. Monitor the output at TP2 and check that a 500Hz pulse waveform of approximately 10V amplitude is present. Connect the oscilloscope to the demodulator output and ensure that a 0V level is present. Quickly switch the oscillator frequency from 500Hz and then back to 500Hz, this should produce a pulse output. The leading edge of the pulse should coincide with switching from 500Hz to 1000Hz and the trailing edge should coincide with switching from 1000Hz to 500Hz. A ten position 3db step attenuator is used during replay operation to give suitable output drive to a galvanometer.

3.16 Rockland Filters

Setting up procedures for the Rockland Filters are given in the Rockland Filter type 1020F Handbook.

3.17 Control Unit (Fig. 6)

Connect 240V a.c. to the Replay Unit. Connect an oscilloscope via decoupling capacitors to pins A and B of socket FP/SK2. Switch FP/S_1 to SHIP'S CLOCK position and ensure that the correct FM clock output is present. Check that variation of SHIP'S CLOCK AMPLITUDE control FP/RV1 gives a variation of clock output between 0V and 3.8V. Connect an Avometer set to ohms across one of the RESET OUTPUT sockets FP/SK5 to 9 and ensure that an infinity reading exists. Press the RESET push button FP/PB1 and check that a zero indication is given on the Avometer. Check also that the CYCLING indicator FP/L1 is extinguished. Release the RESET push button check that the Avometer gives an infinite indication. Wait 5 minutes and check that the CYCLING lamp lights.

PART 2

PUBS CHECKING PROCEDURE

Part 2 contains a copy of a check list which is completed just prior to the launch of a PUBS and after its recovery. This check list is only completed when individual units are known to be satisfactory following the setting up procedure detailed in Part 1.

PUBS CHECKING PROCEDURE

DATE: STATION NO:

INTERNAL UNIT: SPHERE:

DEPTH:

TIME LAUNCHED:* TIME RECOVERED:

3.18 Pre-Launch Checks

No.	Check	Done	Comments or measurements
1	Make a note of release receiver frequencies before fitting internal unit into sphere.		
2	Switch on ship clock and acoustic transmitter.		
3	Use Avo to check operation of TR*micro-switches.		
4	Demagnetise magnetic tapes. Load tapes onto TR. Check that tape spools are properly locked in place.		
5	Reset TR counters. Connect mains power pack to TR 1 and using microphone annotate tape; mention a) Date b) Station No. c) Internal and external unit names d) Tape Recorder No. e) Tape Speed f) Type of tape used Note: Use 15/16 i.p.s. tape speed		
6	Load TR's into internal unit. Select and lock appropriate tape speed selection (the longest slot is for 15/16 i.p.s.). Set INPUT switch to MIKE (fully anti-clockwise). Pull out TONE switch.		*TR = Tape-recorder

7 STATION NO: SPHERE:

No.	Check	Done	Comments or measurements
7	Connect TR supply loads to TB.3+		
8	Ensure no pyrotechnic release device is fitted. Make all external connections from equatorial ring to internal unit.		
9	Check insulation and voltage of all battery packs. Load battery packs into internal unit. Connect batteries to appropriate TB. Check all batteries are in place. Fit lids over battery compartments. Expected Voltages TR -6.75V Clock +5.4V Hydrophone +17.55V Release Receiver -33.75V; -5.4V Acoustic Transponder +33.75V; +5.4V Radio Beacon +20.5V Flashing Light +6V Explosive Release +20.25V		
10	Connect PL 9 to equatorial ring. Set CONTACTS plug of internal unit to OUT position (this gives continuous tape recording).		
11	Press RESET PB. Check that TR 1 is on and TR 2 is off.		
12	Measure and note all supply voltages.		
13	Short TB2/B1 to TB2/C1, check that TR1 switches off and TR 2 switches on.		
14	Connect a loudspeaker to CLOCK TP. Ensure that clock output is working correctly. Ensure that 10 second marks are present on clock signal.		
15	Set CONTACTS plug to IN position (if necessar). Short RESET TP to EARTH TP. Check that clock stops and that TR 2 switches off. Remove ear h connection from RESET TP, check that after a delay of 5 mins. TR 2 switches on and after a further 5 mins. switches off again.		
16	Press TONE switch. Connect 5 pin signal plug to TR 1. Connect 5 pin signal cable between TR 1 and TR2.		
17	Connect dummy hydrophone box to HYDROPHONE socket and feed in 2 mV*RMS at 100 c/s from oscillator.		
18	Using an oscilloscope check that FM HI, FM LO, and CLOCK outputs at the appropriate TP's have correct appearance.		
19	Set oscillator output to 6* mV RMS. Set DR level meter on TR 2 0db using RECORD LEVEL switch.		
20	Press RESET PB. Repeat step 19 for TR 1.		
21	Disconnect dummy hydrophone and switch off oscillator. Check that resistance of hydrophone is infinite. Connect hydrophone to internal unit. Tap hydrophone to produce a deflection on the level meter of TR 1.		

+ TB = Tag board
* varies with conditions of experiment

STATION NO: SPHERE:

No.	Check	Done	Comments or measurements
22	Disconnect DIVIDE and RECORD supplies from TB 1 and TB 2. Do not disconnect RECORD supplies if clock is to be reset within $\frac{1}{2}$ hr.		
23	Plug in scroll, flashing light and aerial to equatorial ring. Check that transponder works, the flashing light, and radio beacon are off, and that there is no voltage at the EXP. REL contacts of TB 4.		
24	Using the acoustic transmitter, transmit at the higher release frequency, Check that a) 30V appears at the EXP. REL contacts of TB 4. b) the flashing light works. c) the radio beacon is working.		
25	Press RESET PB and repeat step 24 at the lower reed frequency.		
26	Check operation of back-up clock. Set clock to required release time. Do not switch on.		
27	Disconnect scroll, flashing light, and serial. Note: the equipment is now in a state of readiness which can be held for several hours if required. The following are completed just prior to locking top of sphere in position.		
28	Reconnect DIVIDER and RECORD supplies to TB 1 and TB2. Reset ship and internal unit clocks using push button on the ship clock and co-ax leads from the reset box. Check alignment of all clocks on UV recorder.		
29	Recheck all tape recorder switch positions (see step 6). Push START and RECORD switches on TR 1 and TR 2. Switch on back-up clock.		
30	Check that retaining brackets are secure. The sphere can now be closed.		
31	Disconnect acoustic transmitter from mains socket. Ensure that no voltage is present across ballast release socket. Attach pyrotechnic release device.		
32	When the equipment is on deck. Attach ballast weight and radio aerial. Check insulation of base of aerial, ensure bleed hole is unblocked.		
33	When the launch station is reached connect plug 9 (this action switches on TR 1).		
34	After launching the PUBS check with echo sounder that transponder is working. Stand by to transmit with acoustic transmitter if transponder is not working.		

STATION NO: SPHERE:

3.19 Post-Recovery Checks

No.	Check	Done	Comments or measurements
	After washing down and drying the equipment remove the radio aerial and transfer the sphere indoors.		
1	Note the state of the equipment on recovery, i.e., whether the acoustic transponder, light (if appropriate) and radio beacon were working.		
2	Disconnect the transponder, light and radio aerial and remove the top hemisphere. Reconnect the transponder, light and an aerial. Measure and record the following voltages at TB 1 to TB 5. 6V (TB 4) 18V (TB 1) 18V (TB 3) 5V (TB 2) 30V RELEASE (TB 5) 30V TRANSPONDER (TB 5) 5V RELEASE (TB 5) 5V TRANSPONDER (TB 5)		
3	Measure and record time offset of clock relative to ship clock (CLOCK-SHIPCLOCK) on UV record.		
4	Record counter readings on both tape recorders.		
5	Remove tape recorders and note state of tapes.		
6	Remove and dispose of all used batteries.		

SECTION 4

OPERATION OF THE EQUIPMENT AT SEA

4.1 Introduction

The preparation of the PUBS at sea requires a methodical and careful approach since there are certain types of mistake in the preparation which could lead to complete loss of equipment. It is strongly recommended therefore, on the basis of previous experience, that the preparation and check out should be carried out quietly without haste and without outside interruption.

4.2 Checking Procedure

The checking procedure which is listed in Section 3 covers the complete sequence of operations from starting with an unloaded instrument (no batteries, no tapes) upto laying the equipment over the side. The sequence of checks has been contrived so that combinations of normal instrument states and probably failure modes of different components of the PUBS system are checked. For this reason it is inadvisable to carry out the checks out of the prescribed sequence since one of the combinations might be omitted or be incompletely reproduced. If a fault is located in the instrument it may be advisable to repeat the previous checks after the fault has been rectified, particularly if an electrical component has been replaced or the wiring tampered with. Any unusual behavious of the instrument during the check out should be investigated or at least noted and described on the check list. Should there be any doubt about the reliable operation of any part of the scroll - release receiver - firing relay - Pyrorelease system, either replace the doubtful component or withdraw the instrument from the experiment.

4.3 Assembling the Hardware

4.3.1. Pre-cruise Assembly

Before each cruise all O rings seals, i.e., those of the hemispheres, blanking plugs, Marsh-Marine plugs and flashing light assembly, should be carefully inspected. Damaged or flattened O rings must be replaced. O ring grooves should be cleaned and the sealing faces rubbed hard with a tissue soaked in solvent. Vaseline should be applied lightly to the O rings, in preference to silicone grease.

Blanking plugs are done up hand tight with the special spade tool. The Marsh-Marine plugs are gently tightened with large pliers. Finally tighten and check all the sphere retaining bolts which anchor the sphere to the frame. Check that the correct bolts will pass through the eyes in the lifting brackets and through the holes for retaining the top frame (they may be blocked by paint). Similarly see that the top frame legs fit easily between the pairs of supporting brackets on the main frame. Check that the upper part of the counter weight slides snugly into the cylindrical guide hole in the base of the frame. This too can be blocked with paint.

It is also feasible to install the seismic hydrophones at this stage since they can be safely transported in their operational positions.

Equipment weights and the terminal ascent and descent velocities are as follows:

Equipment Weights

	PUBS ON DECK	PUBS IN THE SEA
2 hemispheres	296 lbs	
equatorial ring	59 lbs	-109 lbs
top frame	4½lbs	3 lbs
bottom frame	36½lbs	27 lbs
ballast (approx.)	100 lbs	80 lbs
stabilising fin and counter-weight	8 lbs	0 lbs
strayline float	30 lbs	-3 lbs
seismic hydrophone	4 lbs	2½lbs
internal unit without tape-recorders, batteries	14 lbs	14 lbs
2 tape-recorders	16 lbs	16 lbs
batteries (approx.)	8 lbs	8 lbs
	576 lbs	38½lbs

Net weight on descent	38.5 lbs
Terminal descent velocity	0.71m/sec; 43m/min
Net buoyancy on ascent	41.5 lbs.
Terminal ascent velocity	0.75m/sec; 45m/min

4.3.2. Pre-experiment assembly

When at sea the sole disassembly and assembly which should be required is that of removing the upper part of the frame and the upper hemisphere. Since at this stage all the external electrical cables will be installed, care is required not to let them drag on the floor or be trodden on when the upper frame is removed. The best means of securing these cables to the frame has been found to be with plastic strapping and not with sticky tape which removes paint when peeled off. From experience it is clear that the insulation of the red cable perishes much more slowly from contact with sea water than the same cable with a black insulation.

When removing or replacing the top hemisphere it is advisable to use the steel guides provided to protect the edges of the O ring face. This lifting operation is more easily done with the use of the Minihoist. When a top hemisphere has been lifted off it is essential to protect its O ring face, special care being taken if the ship is rolling or is likely to roll. When replacing a top hemisphere it is good practice to line up the marking letter on each hemisphere so that the same position is used for every experiment. The same procedure for cleaning the O ring sea as outlined above should be followed each time an equipment is assembled for a lowering.

When the top hemisphere has been bolted in place the PUBS will probably have to be hoisted into its trolley on deck since the height of most doorways does not allow the passage of the equipment with the top frame attached. Once the PUBS is on deck the top frame and stray line can be attached. The nuts securing the latter should be seized with split pins. The radio aerial can also be attached at this stage. The earth lead should be attached as near to the base of the aerial as possible and should also be several feet long to make good contact with the sea.

The system of attaching the Pyrorelease and ballast weight to the base of the PUBS is illustrated in Fig. 1. Before connecting the release cable to the Pyrorelease, plug in a loose plug to the cable and ensure that no current is flowing by means of an Avo set to its most sensitive scale, having depressed the reset button on the Avo beforehand. Beware of corroded plugs and sockets which can produce small currents in the presence of sea water. If no current flows connect the socket to the Pyrorelease plug with the lower flatter end of the device pointing away from you and from onlookers. Screw up the locking sleeve over the socket. Save for switching on the tape-recorder the PUBS is now ready for lowering.

4.4 Launching the PUBS

It has been found that a PUBS can be launched safely, even in rough seas, provided that the correct procedure is followed. Most captains require the ship to be hove to before the launch is begun. At this point the shorting plug which switches on the tape-recorder should be connected. Fig. 30 shows the sequence to be followed during the launch. It is important to fully extend the crane jib, before lifting the PUBS off the deck and lowering it to the sea, to prevent the equipment hitting the side of the ship. The stray line and float, which should previously have been laid outboard along the rail, are dropped last after the PUBS has been released from the quick release hook.

Immediately after a launch the operation of the acoustic transponder should be checked by monitoring the echo-sounder display. When this check is completed it is advisable to switch off the echo-sounder until the ship is beyond about five miles range from the PUBS to conserve the transponder batteries.

4.5 Seismic Shooting

During seismic shooting it is necessary to record the shot instant, shot weight and number, fuse length, time of flight (charge away to charge fired), depth under shot and time of each shot. The latter parameters are easily ascertained but the shot instant has to be measured by recording the signals from a hull-mounted geophone and the time-marks from the shipboard clock. This is normally done with a U.V. paper galvanometer recorder. The echo-sounder should be switched off for 3 minutes after each shot, when within 5 miles of the PUBS to prevent the transponder interfering with the seismic signals.

4.6 Relocation, Release and Recovery of PUBS

The rapidity with which acoustical contact can be re-established with a PUBS after conducting a seismic experiment depends on the accuracy of the ship's navigation, and to a lesser extent on any noise on the echo-sounder display due to rough weather and/or the ship's machinery. A variety of relocation procedures has been used in the past, when the PUBS contained a free-running pinger, but with the present acoustic transponder it is sufficient to make a number of passes over the anticipated PUBS position with the echo-sounder switched on. The transponder trace on the echo-sounder display will appear as a hyperbola at a later time than the bottom echoes. The crest of the hyperbola corresponds to the point of closest approach to the PUBS. By steering along perpendicular courses the true position of the PUBS can be quickly ascertained. When the ship is directly over the PUBS the transponder signal will coincide with the bottom echo.

At this point the acoustic command signal can be transmitted via the towed tadpole which is usually launched at the start of the relocation survey. These tadpoles are not suitable for towing above

6 knots. Between 1 and 3 minutes transmission is usually adequate to release the PUBS. When this happens the transponder signal will arrive at successively earlier times due to the Doppler effect of the ascending PUBS and so a break in the slope of the transponder trace will appear on the echo-sounder record. This break in slope is the sole indication that the ascent to the surface has begun. The ascent of the PUBS can be monitored by observing the transponder trace. However this trace can become discontinuous over certain depth ranges when the bottom reflected echo-sounder pulse can be the first pulse to arrive at, and therefore to trigger, the transponder after the transponder's 1.9 secs. dead period.

Because it is possible to position the ship directly over a PUBS using the transponder method it is therefore sensible to take the precaution of moving the ship off station by a cable or so before the PUBS breaks surface. When the PUBS breaks surface, or shortly beforehand, the transponder signals are lost. Radio signals, and light signals if it is dark, should be detected almost immediately.

The normal method of recovery is to bring the ship within grappling range of the PUBS and then to grapple the strayline. The crane jib should previously have been extended fully and swung outboard. The end of the stray line is hauled in and made fast to the ship's rail. A snap block fastened to the crane hook is then put on the line and the crane's cable used to pull the snap block up and away from the ship's rail. In this way the PUBS should be lifted clear of the water without it being possible to hit the ship's side. By elevating the crane jib the PUBS can now be brought inboard and lowered into its trolley.

4.7 Post-Experiment Checks

Before disassembly the PUBS should be thoroughly washed down with fresh water, including the hollow spaces in the tubular framework, to minimise corrosion. Any damage sustained while the PUBS was in the sea should be noted. The post-experiment checking procedure outlined in the check list (Section 3, Part 2) should be followed after the top hemisphere has been removed. Notes made at this time can be very useful for tracing faults if later an equipment malfunction is discovered.

APPENDIX

The following documents should accompany this report:

1. Instructions manual for Rockland HI/LO FILTER Model 1020F.
2. N.I.O. Internal Report No. A.38.
3. Mechanical drawings as follows:

    N.I.O. No. 4994

    N.I.O. No. 5037

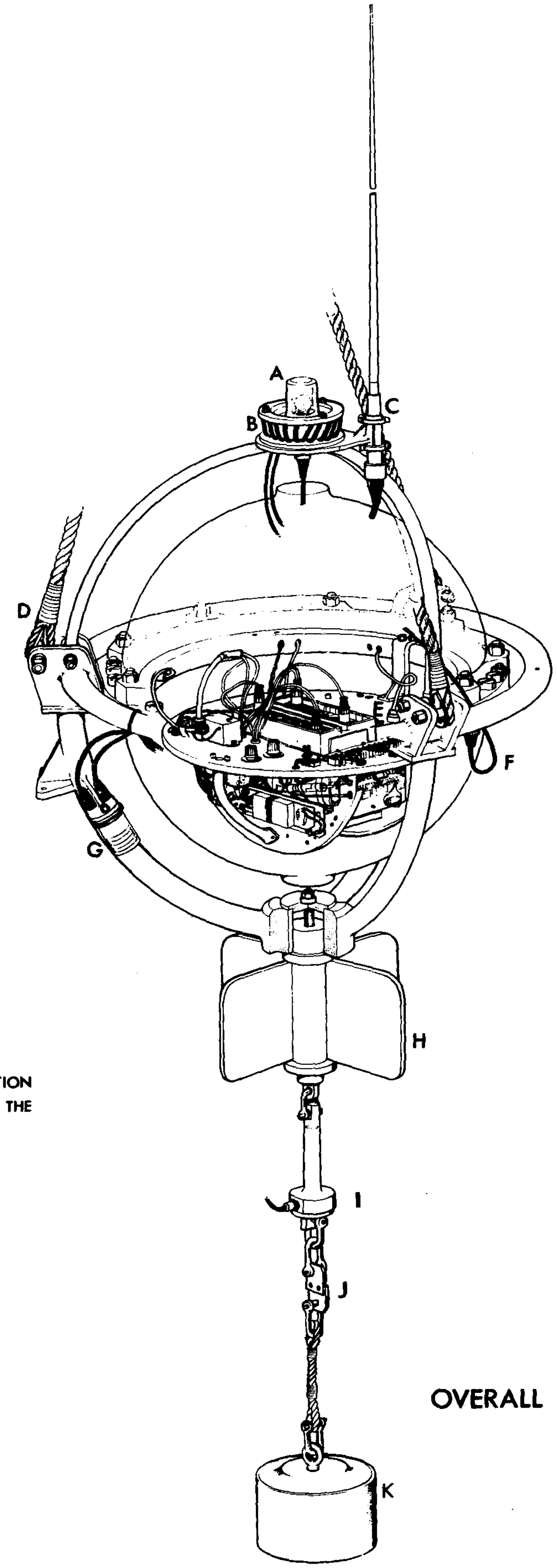
Release Receiver (sections 2.11 and 3.9)

FLASHING LIGHT (Sections 2.14 and 3.11)

A freely running blocking oscillator (VT1, T1, R1, R2, C1) whose output is rectified by D1 and smoothed by C2 produces a +450V d.c. supply for the flash tube ZFT4. Capacitor C3 charges up via R3 until the glow diode (D2) breakdown voltage is reached whereupon C3 discharges through the primary winding of the pulse transformer T2, via D2. The resulting output from T2 is a high voltage pulse which ignites the flash tube causing the +450V d.c. supply to discharge through the tube. This produces the required flash of light. The glow diode and flash tube extinguish and the cycle repeats.

The flash cycle is determined by a suitable choice of timing components R3 and C3.

<u>Flashing Light</u> (Sections 2.14 and 3.11)

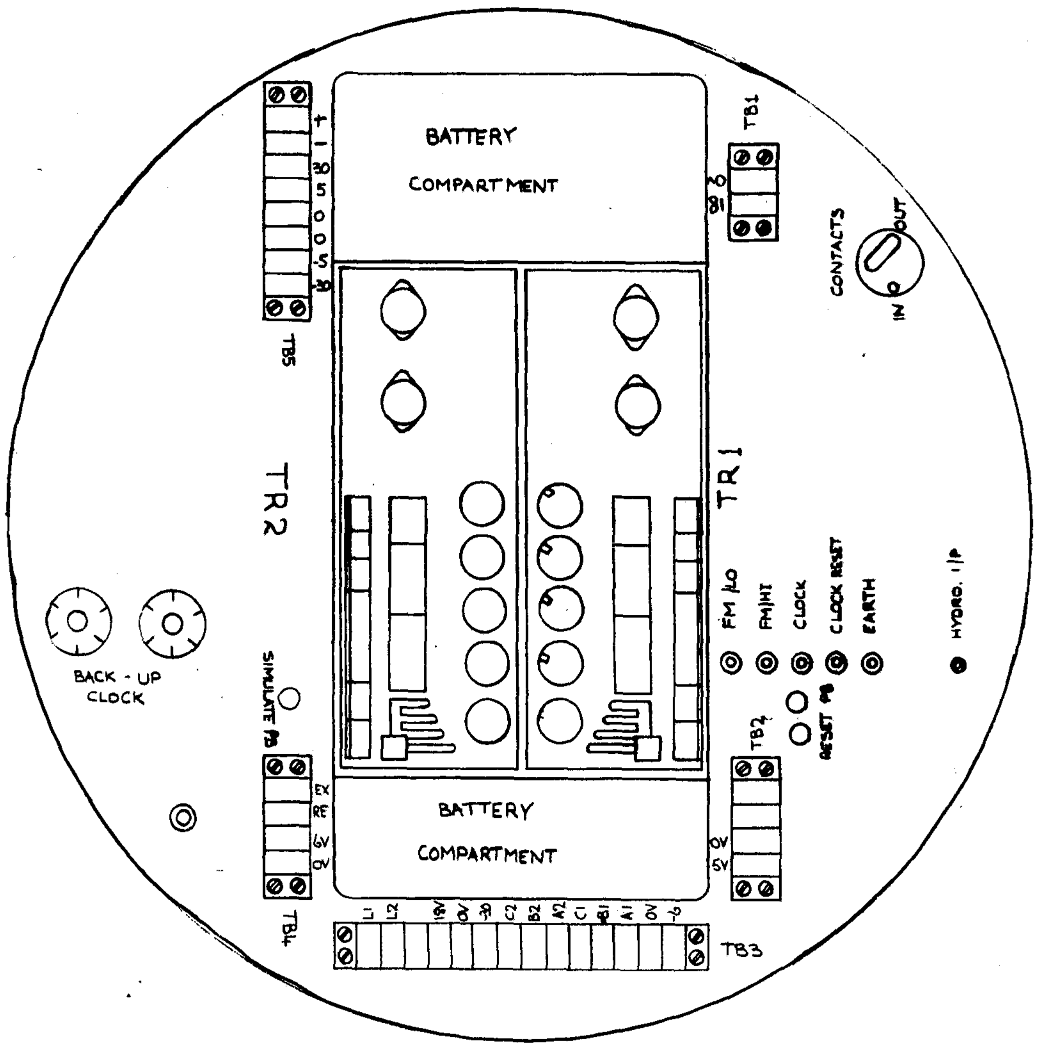


NOTE:

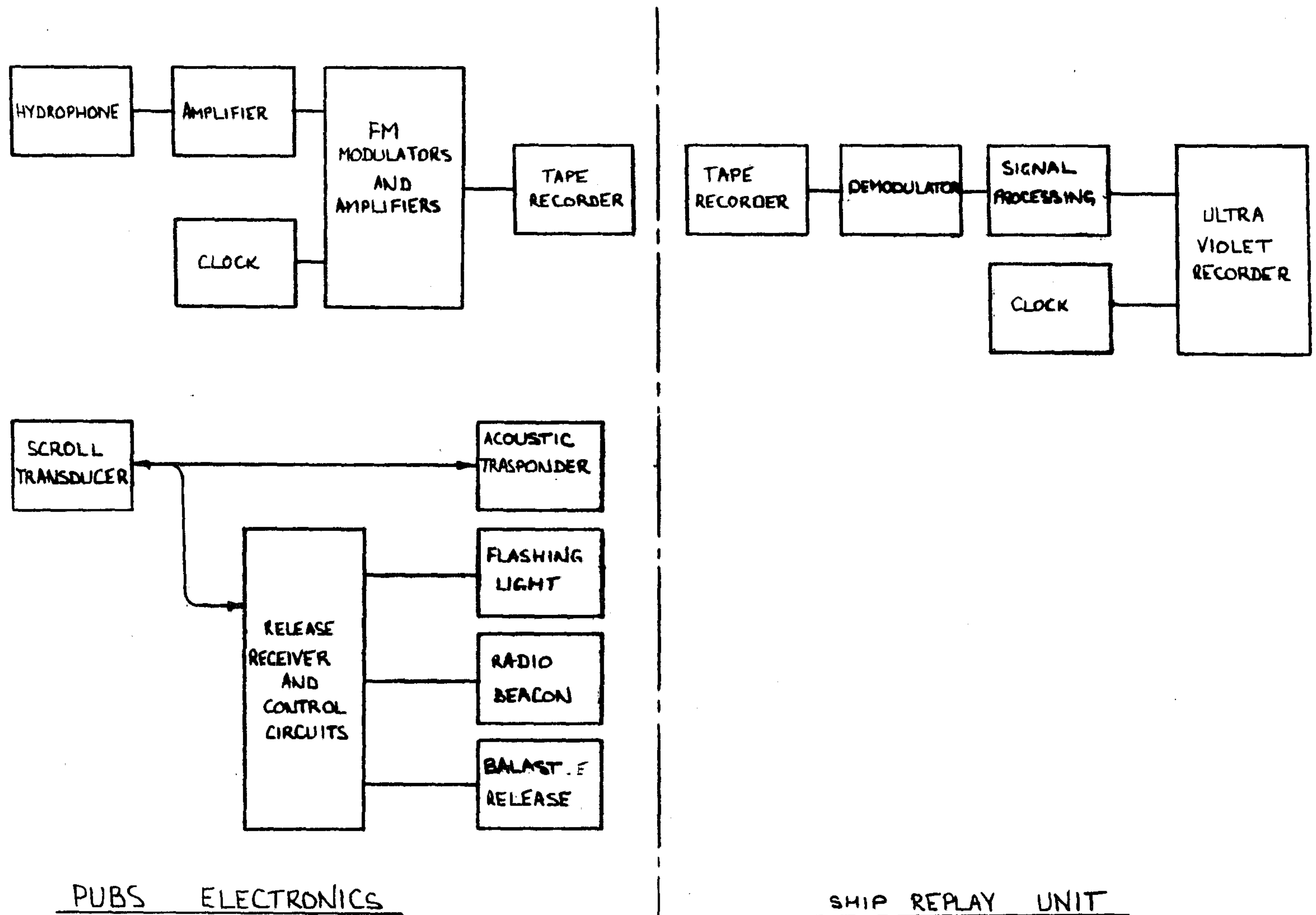
A = FLASHING LIGHT
B = TRANSPONDER AND RELEASE RECEIVER SCROLL
C = RADIO BEACON
D = STRAYLINE USED FOR LIFTING.
E = INTERNAL UNIT WITH ELECTRONICS.
F = ONE OF THE PLUGS USED TO MAKE CONNECTION WITH THE INTERIOR OF THE SPHERE THROUGH THE EQUATORIAL RING.
G = SEISMIC HYDROPHONE
H = STABILISING FIN
I = PYRORELEASE
J = SLOW ACTING CORRODABLE LINK
K = BALLAST WEIGHT

OVERALL VIEW: PUBS

FIG. 1



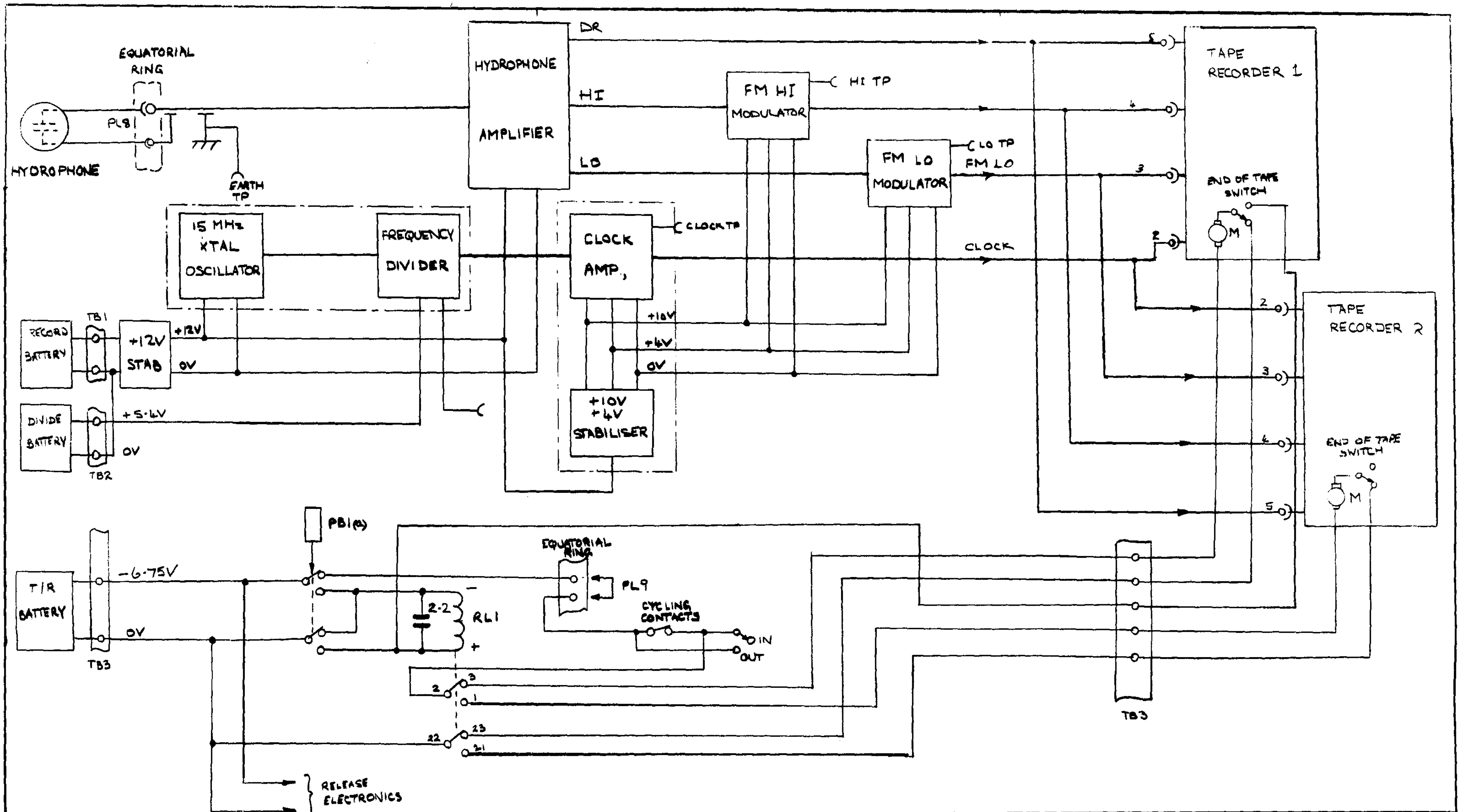
TOP VIEW : INTERNAL UNIT.
FIG 2



BLOCK DIAGRAM : PUBS RECORDING SYSTEM

FIG 3

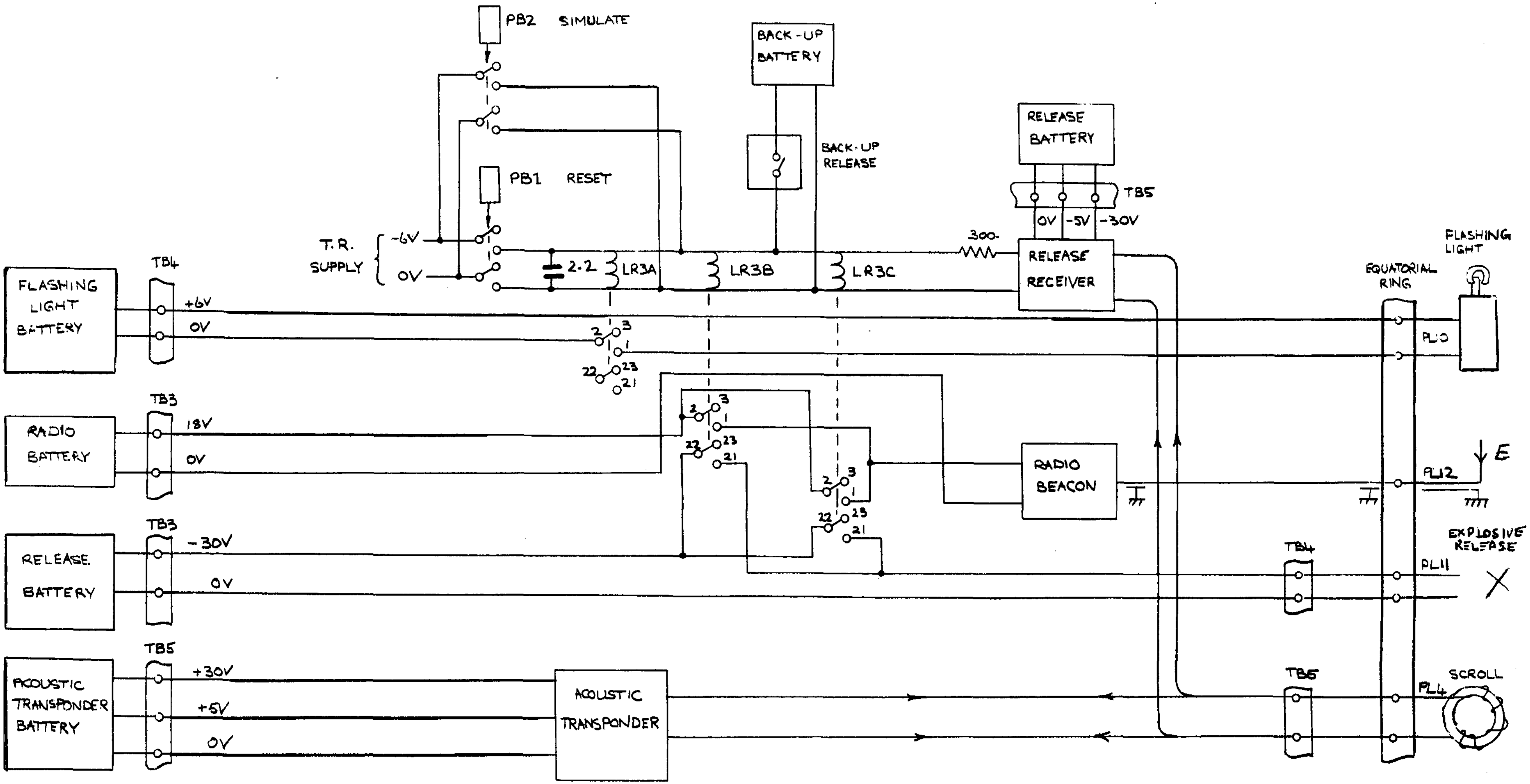
ISSUED TO	DRG. No. N10/	
	DRAWN BY DATE	SHEET No.
REVISED	ISSUED FOR ORDER No	FOR UNITS



BLOCK DIAGRAM - RECORD ELECTRONICS

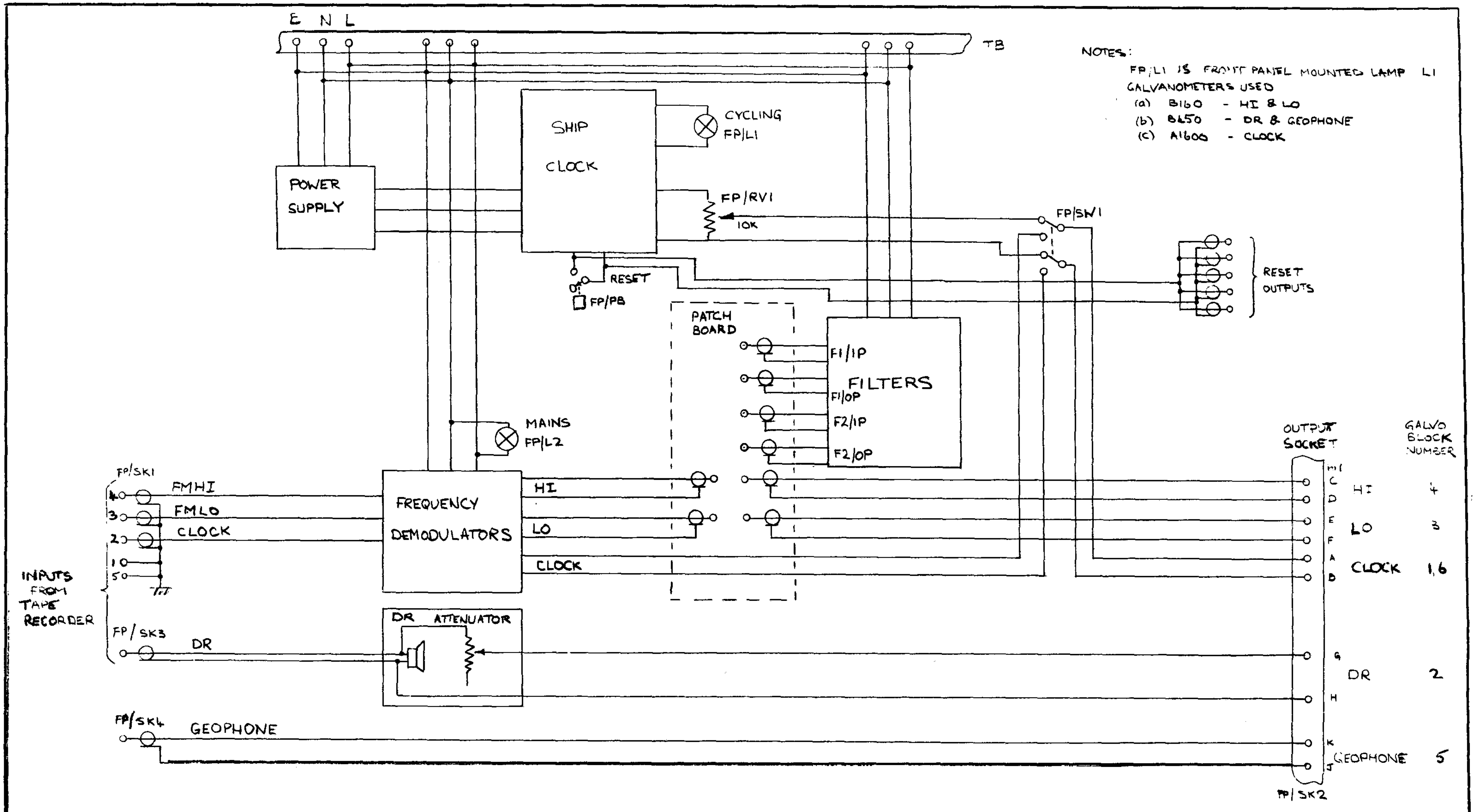
FIG. 4

CIRCUIT : -	
DRAWN BY : J. J. Langford	



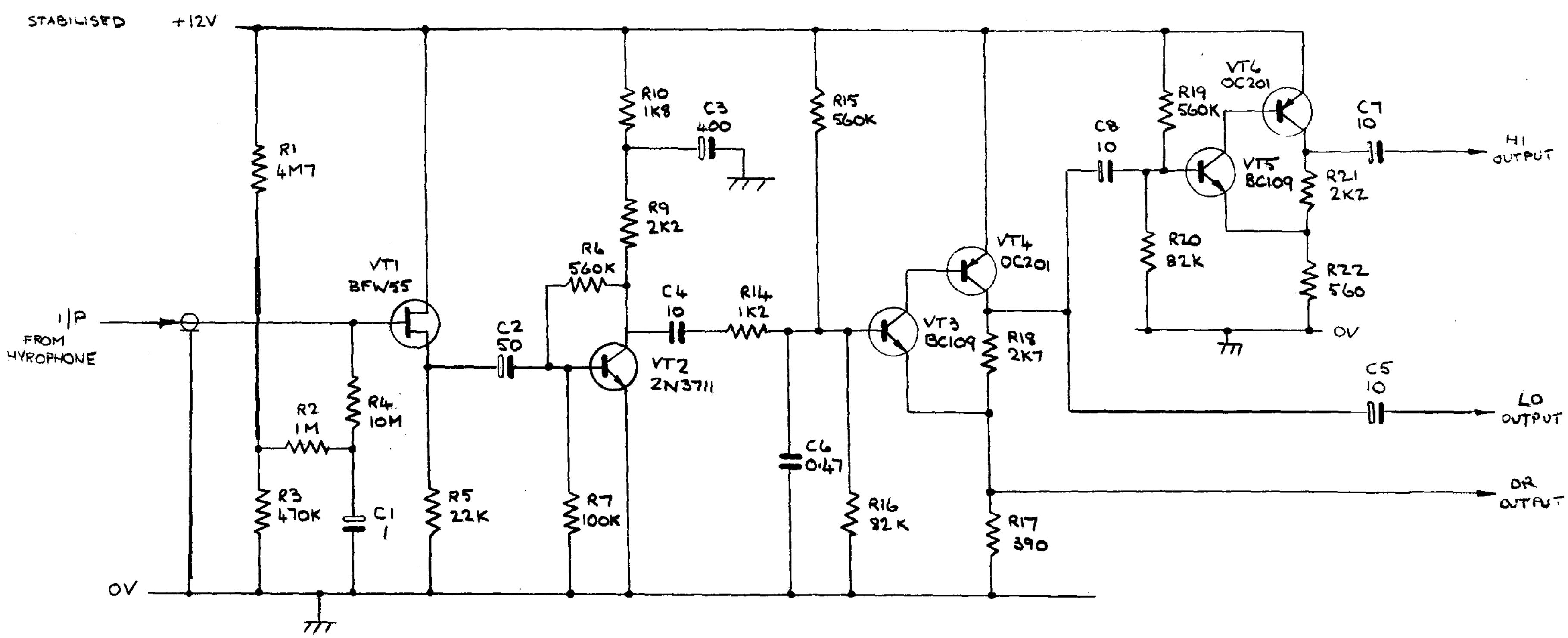
BLOCK DIAGRAM : RELEASE AND RELOCATION ELECTRONICS

FIG 5

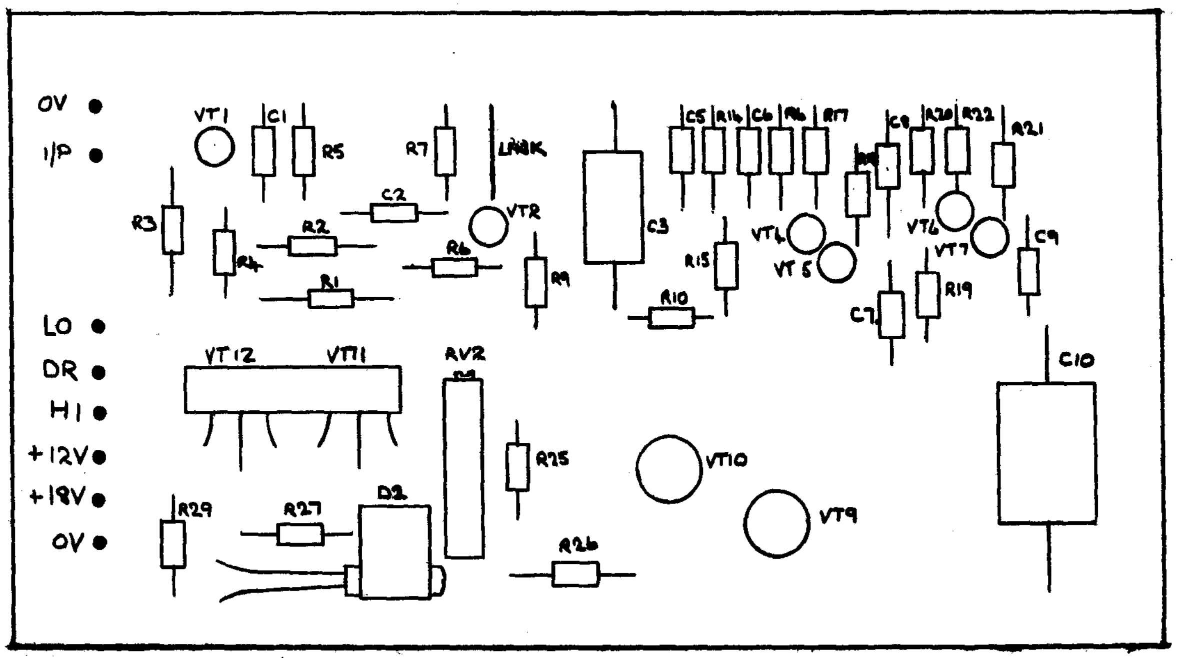


BLOCK DIAGRAM : REPLAY ELECTRONICS

FIG 6



CIRCUIT DIAGRAM : HYDROPHONE AMPLIFIER FIG. 7		CIRCUIT :- DRAWN BY : J J Langford



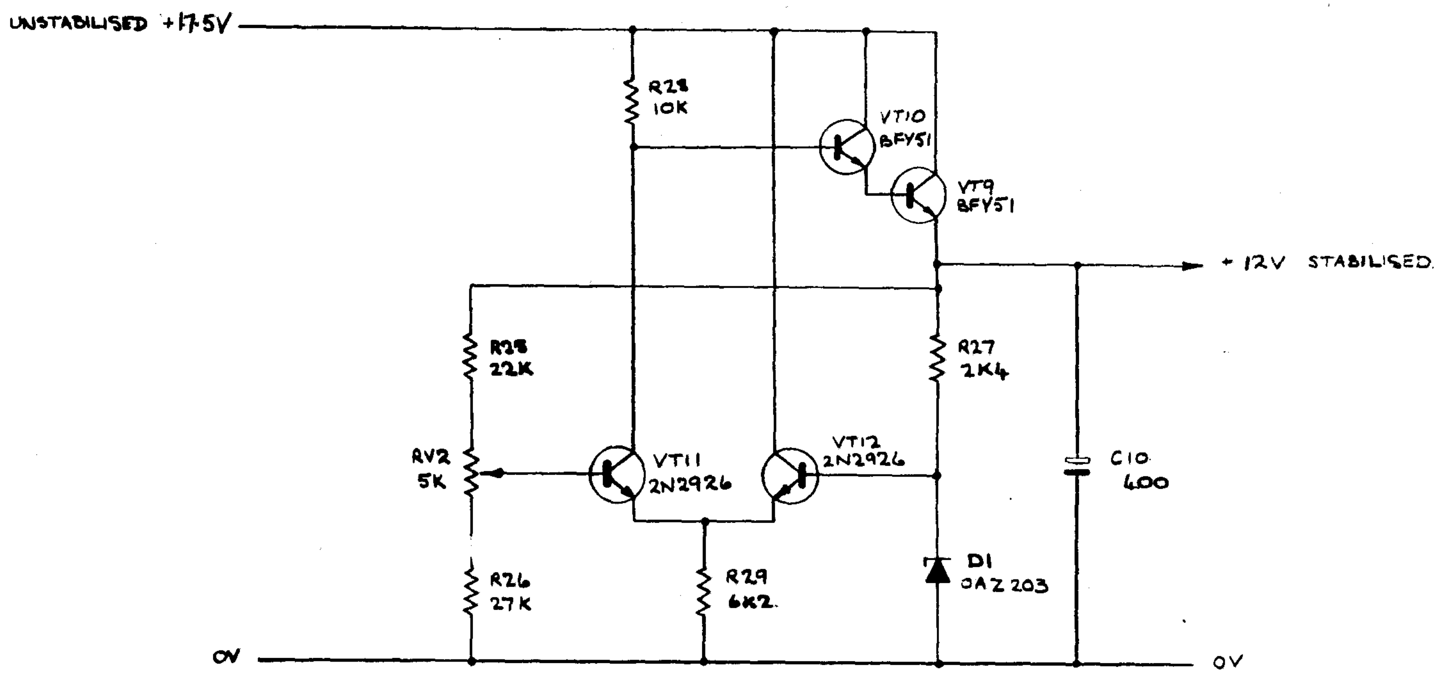
COMPONENT LAYOUT HYDROPHONE AMPLIFIER AND +12V STABILISER CIRCUIT BOARD

FIG 8

ISSUED TO	DRG. No. N10./	
REVISED	DRAWN BY [signature] DATE	SHEET No.
	ISSUED FOR ORDER No	FOR UNITS

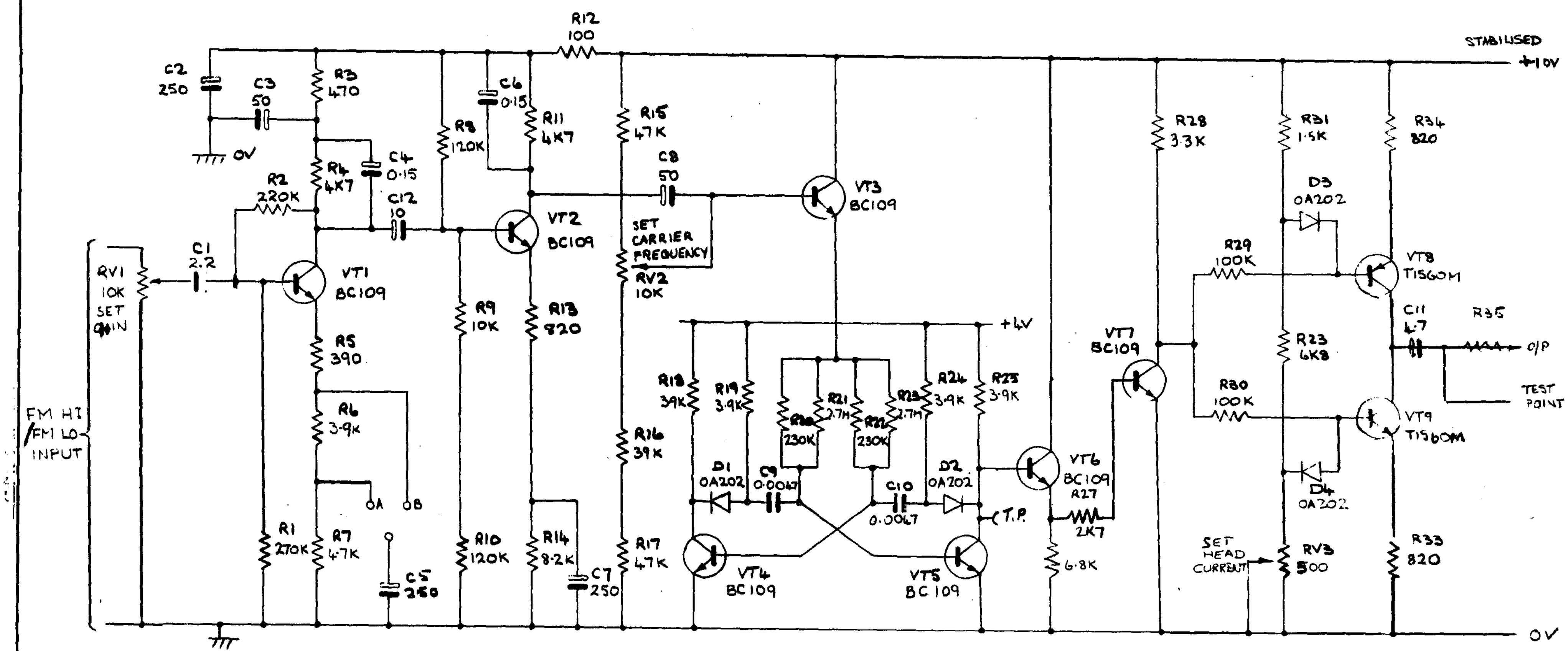
NATIONAL INSTITUTE OF OCEANOGRAPHY, WORMLEY, SURREY.

N I O FORM No. 29 (11/61)



CIRCUIT DIAGRAM : +12V STABILISER
FIG. 9

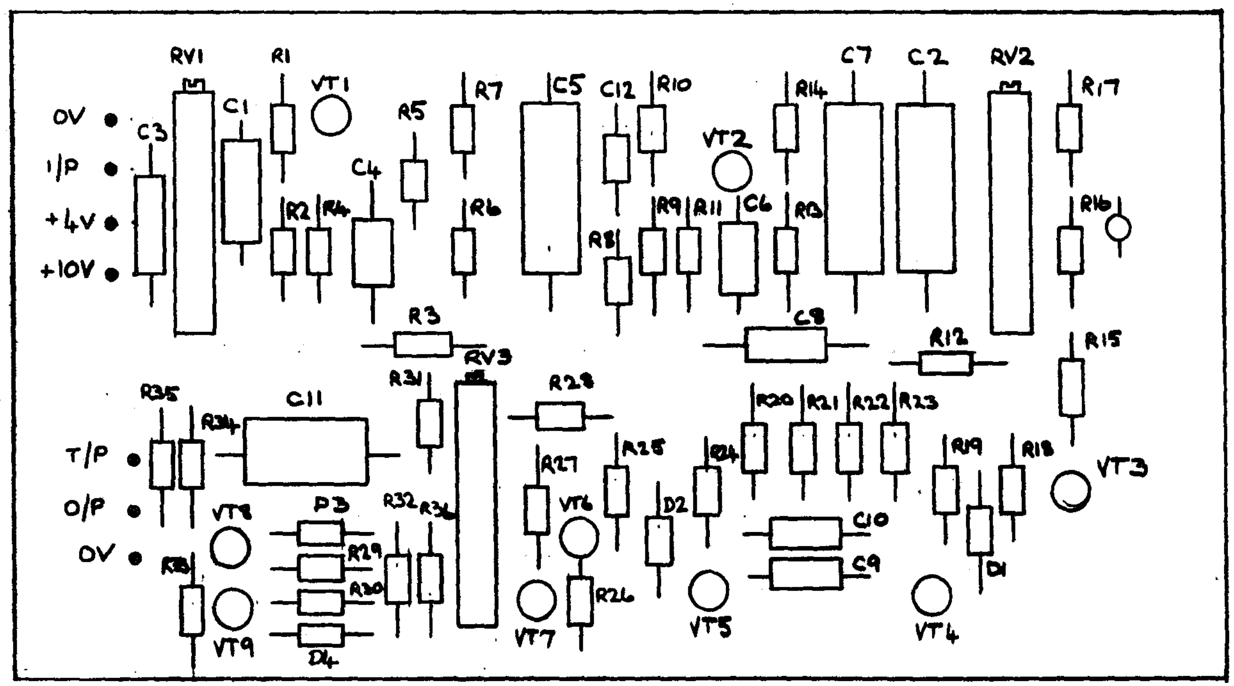
CIRCUIT :-
DRAWN BY :- J. J. Langford



NATIONAL INSTITUTE OF OCEANOGRAPHY. WORMLEY. SURREY.	CIRCUIT DIAGRAM : HI/LO FREQUENCY MODULATOR FIG 10	CIRCUIT DRAWN BY *[signature]*

PRINT TRIMMING LINE

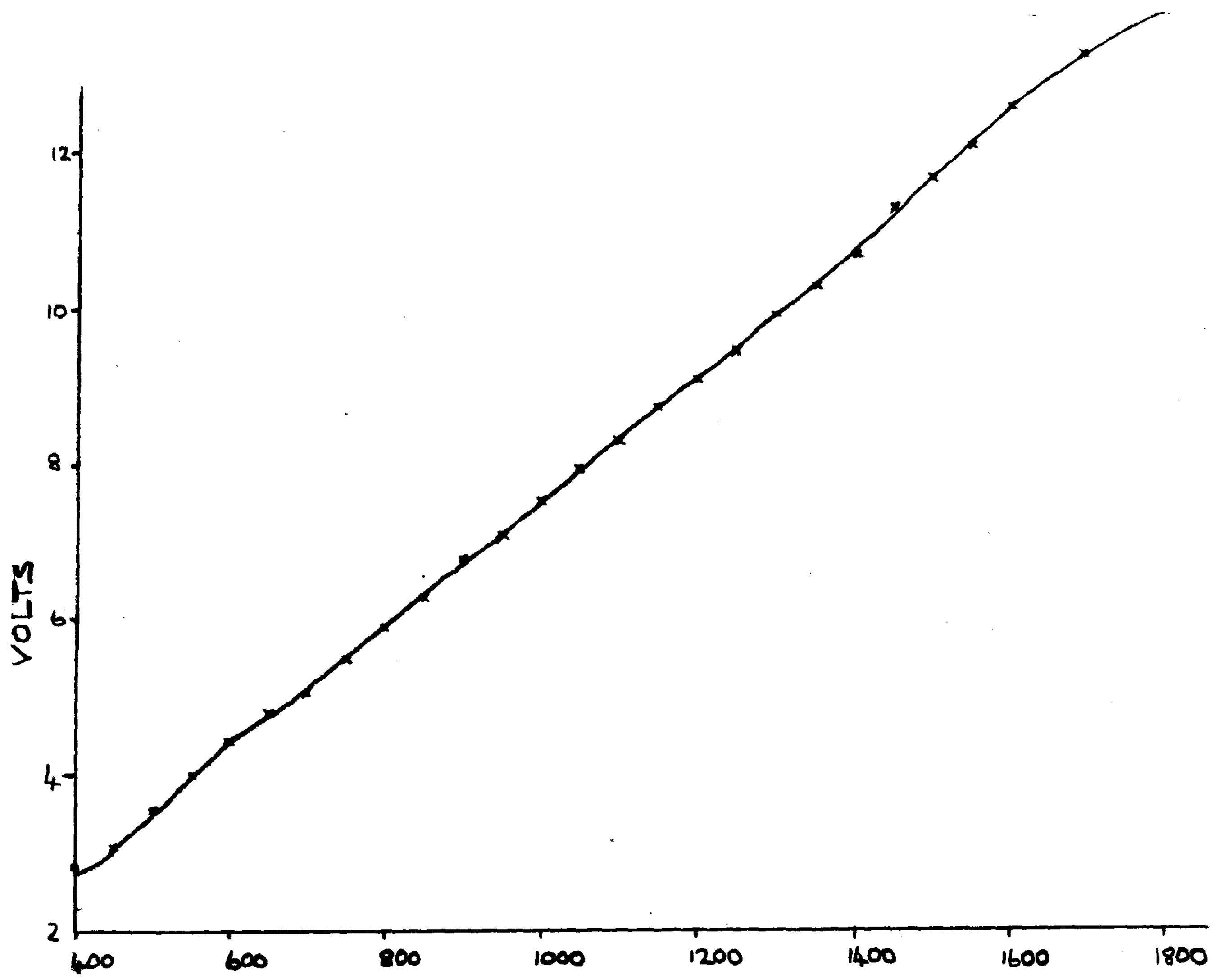
N.I.O. FORM No. 45 (1/66)



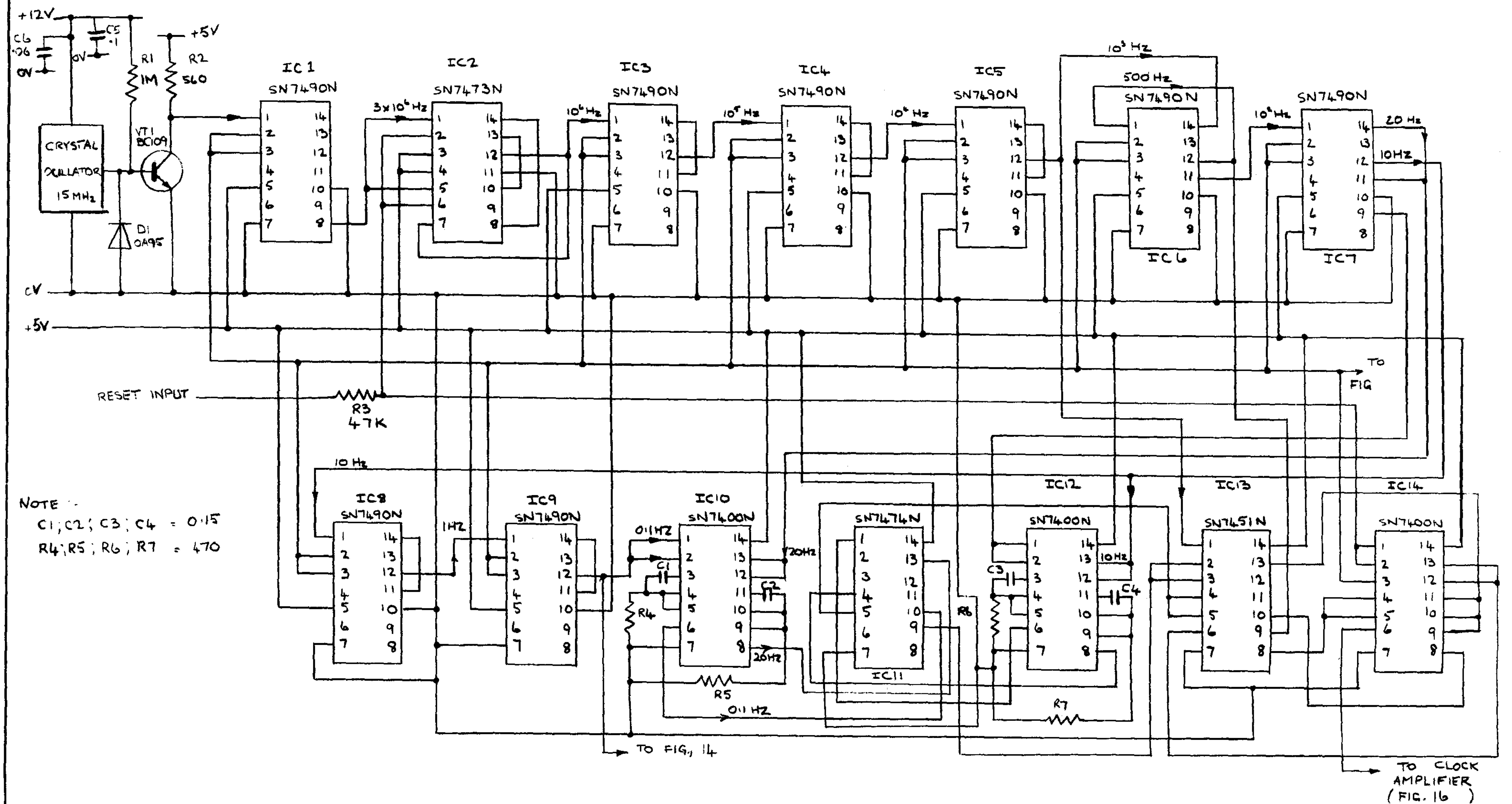
COMPONENT LAYOUT : FM HI Lo MODULATOR CIRCUIT BOARD

FIG 11

ISSUED TO	DRG. No N10./		
REVISED	DRAWN BY J.J. [signature] DATE		SHEET No.
	ISSUED	FOR ORDER No	FOR UNITS

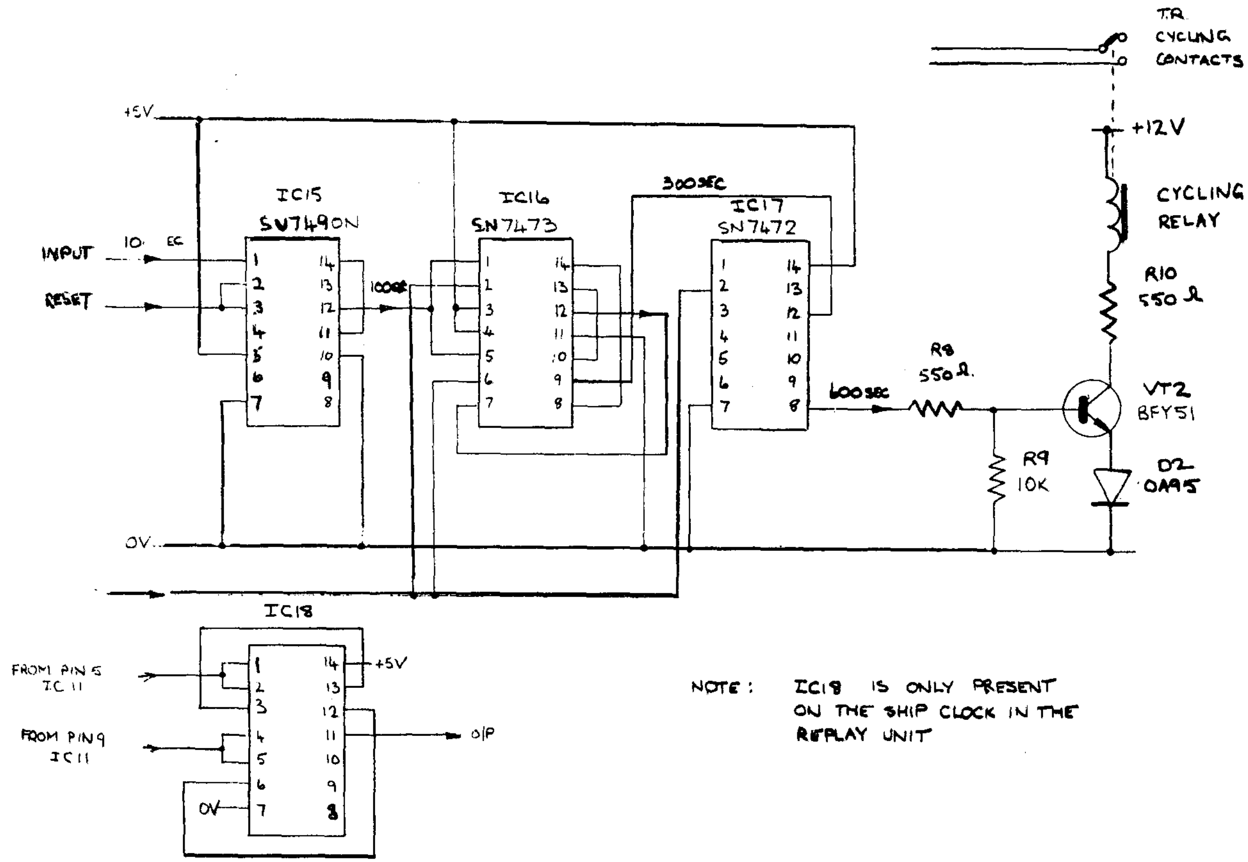


HI/LO FREQUENCY MODULATOR CHARACTERISTICS FIG 12



CIRCUIT DIAGRAM . CLOCK
FIG 13

CIRCUIT :
DRAWN BY : J J Langford

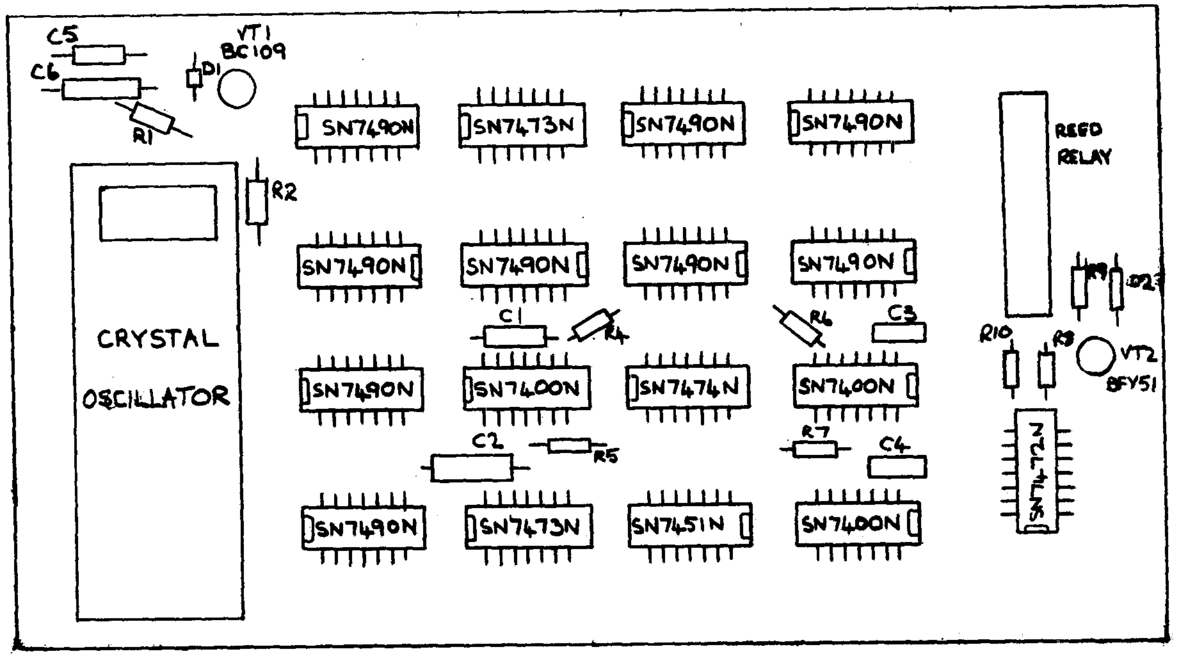


CIRCUIT DIAGRAM : CYCLING

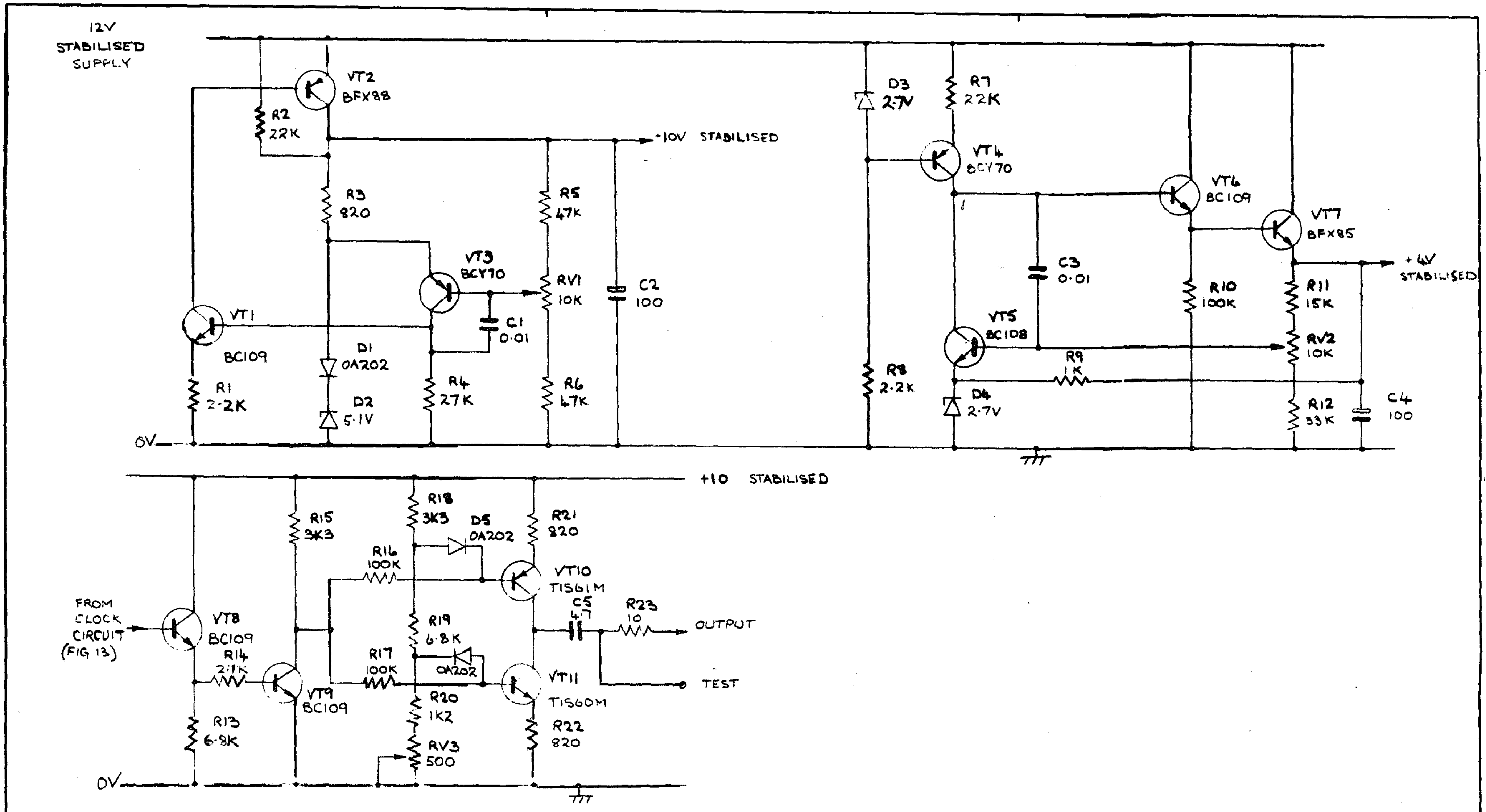
FIG : 14

CIRCUIT :

DRAWN BY : J J Rainford



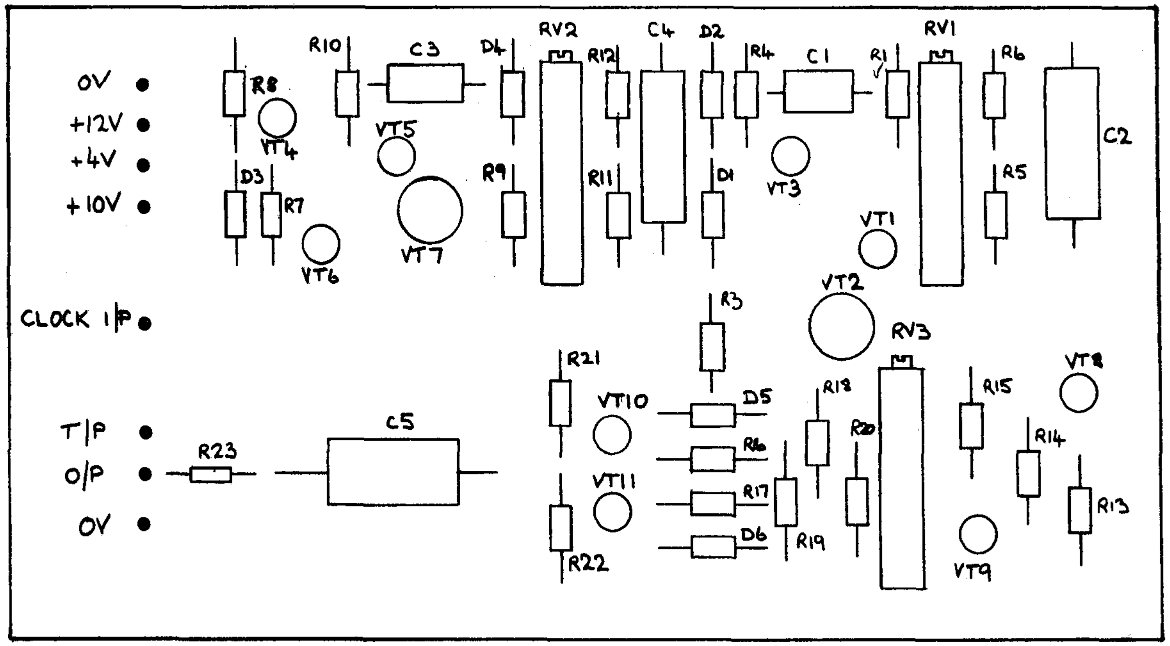
COMPONENT LAYOUT : CLOCK CIRCUIT BOARD FIG 15	ISSUED TO	DRG. No N10/	
	REVISED	DRAWN BY J. Langford DATE	SHEET No.
		ISSUED FOR ORDER No	FOR UNITS



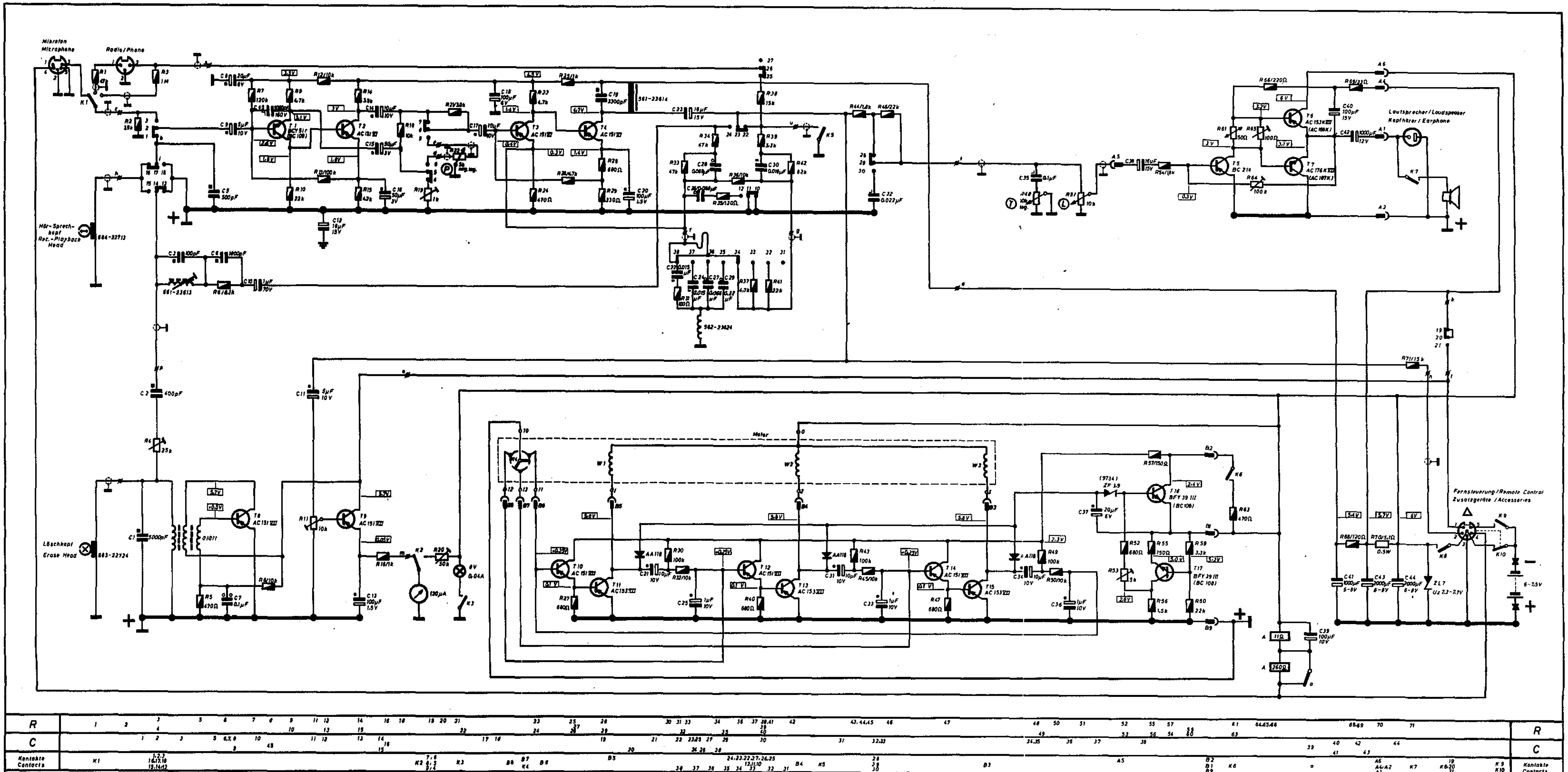
CIRCUIT DIAGRAM : CLOCK AMPLIFIER ; +4V, +10V STABILISERS

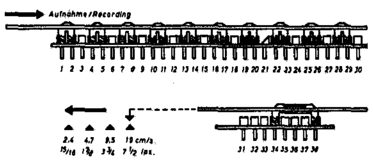
FIG. 16

CIRCUIT	
DRAWN BY	J J Langford



COMPONENT LAYOUT : CLOCK AMPLIFIER ; +4V ; +10V STABILISERS FIG 17	ISSUED TO	DRG No. N10./		
	REVISED	DRAWN BY J. J. Langford	DATE	SHEET No.
		ISSUED	FOR ORDER Nº	FOR UNITS

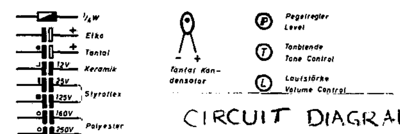




Lage der Kontakte		Position of the contacts
K1	Eingangswähler auf der Frontplatte	input selector, on the front panel
K2	am Pegelregler R22	at the level control R22
K3	an der Tonblende R48	at the tone control R48
K4	Anlaufverteiler im Motor	distributor inside the motor
K5	am Gestänge für Start	actuated by the start mechanism
K6	am Gestänge für Vor-Rücklauf	actuated by forward/rewind system
K7	am Lautstärkeregler R51	at the volume control R51
K8	am Geschwindigkeitsumschalter	actuated by the speed selector
K9	im Batteriekasten	inside the battery compartment
K10	an der Fernsteuerungsbuchse △	at the remote control socket △

Alle Spannungen in Stellung Aufnahme mit Röhrenvoltmeter (Ri ≥ 10 MΩ) gegen + Pol der Batterie gemessen. Das Gehäuse (⏚) ist vom + Pol der Batterie isoliert. Alle Schalter in Ruhestellung (bzw. Wiedergabe) gezeichnet.

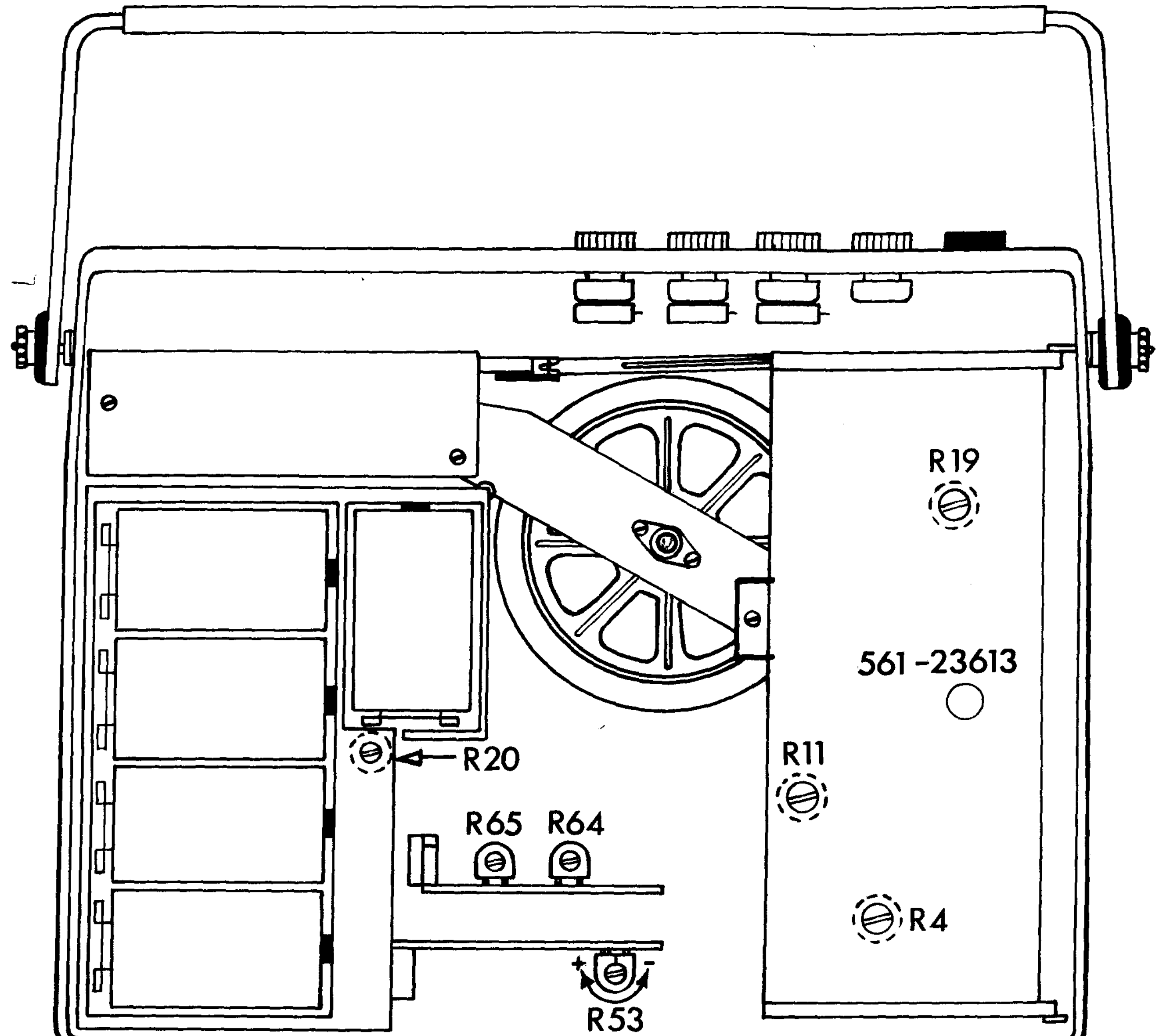
All voltages are measured in recording position with VTVM (impedance 10 megohms) to positive terminal of the battery. The chassis (⏚) is insulated from the positive battery terminal. All switches shown in rest position, or in playback position resp.

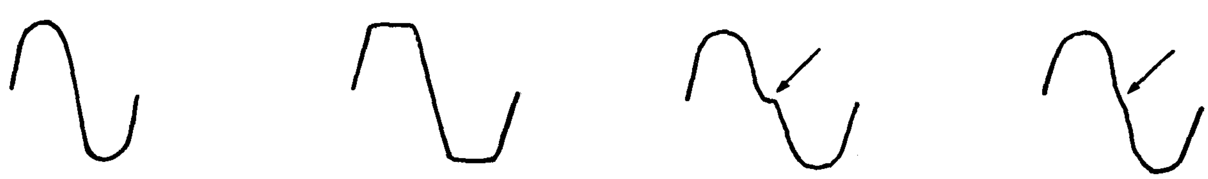


UHER **4000 REPORT-L**

Stromlaufplan — Circuit Diagram

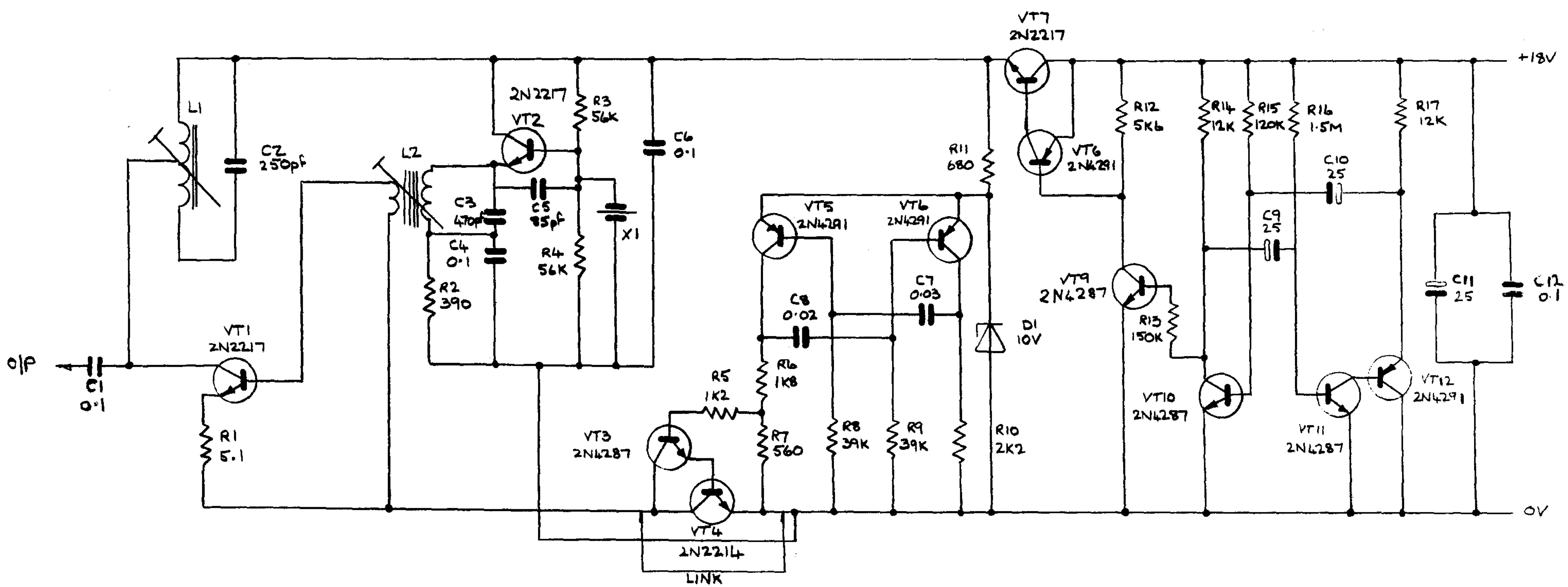
CIRCUIT DIAGRAM: TAPE RECORDER
FIG. 18





COMPONENT LAYOUT: TAPE RECORDER.

FIG.19

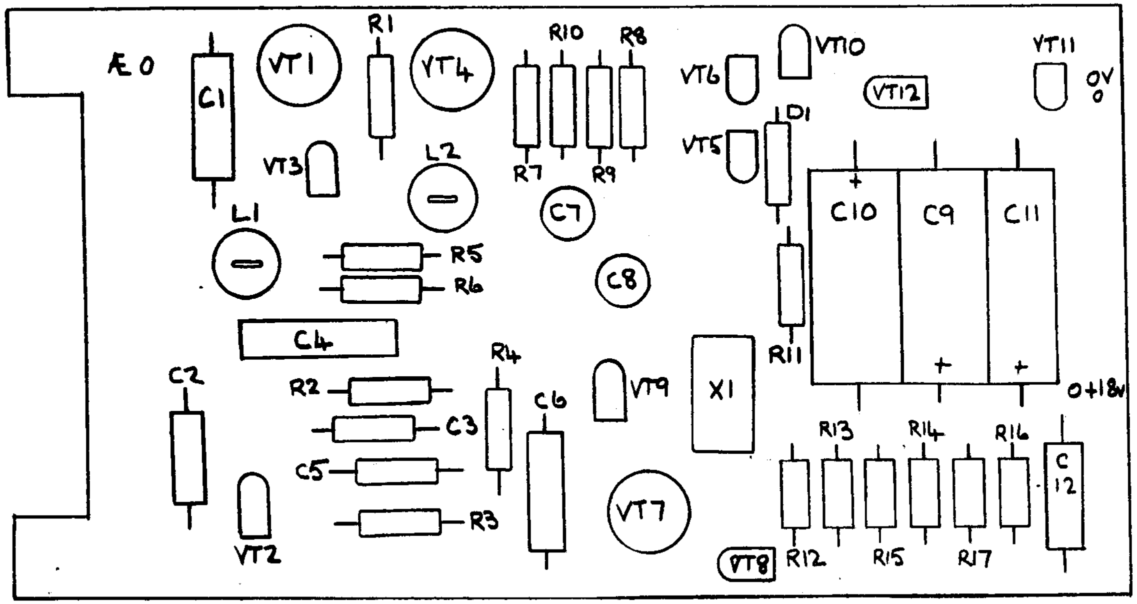


CIRCUIT DIAGRAM : RADIO BEACON TYPE A

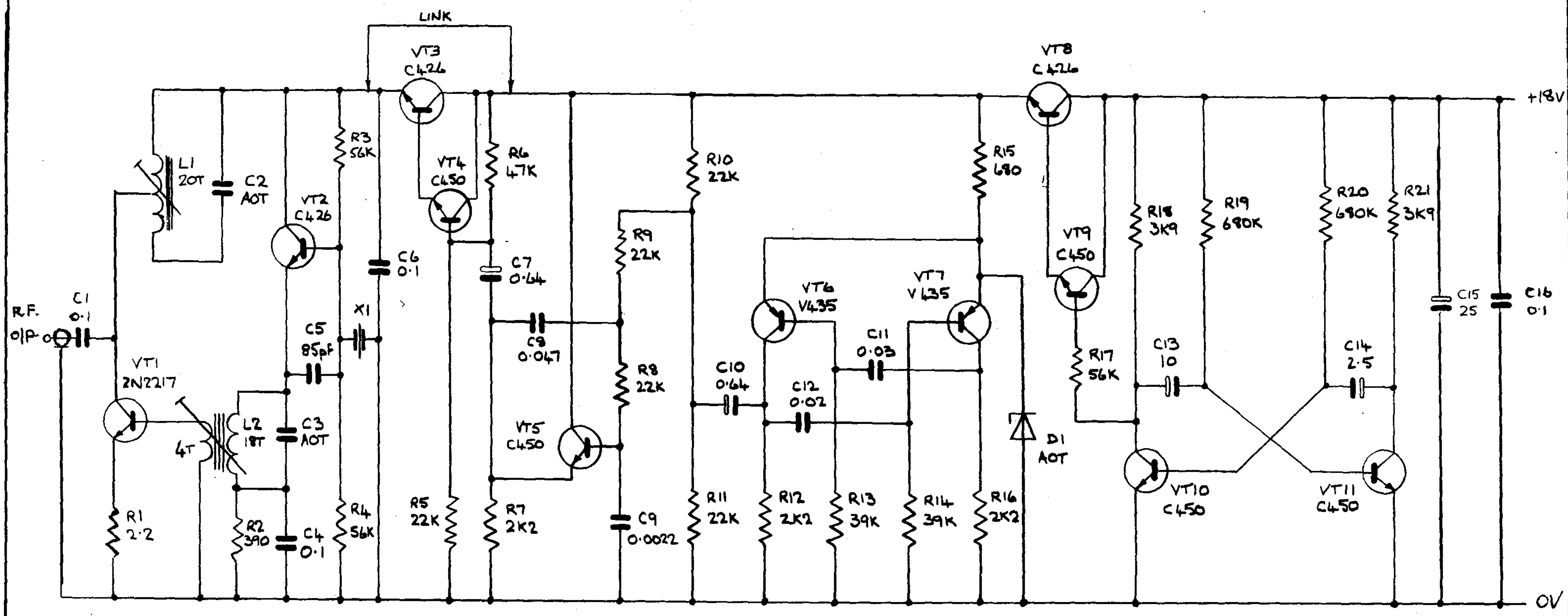
FIG 20 (UMEL LTD)

CIRCUIT

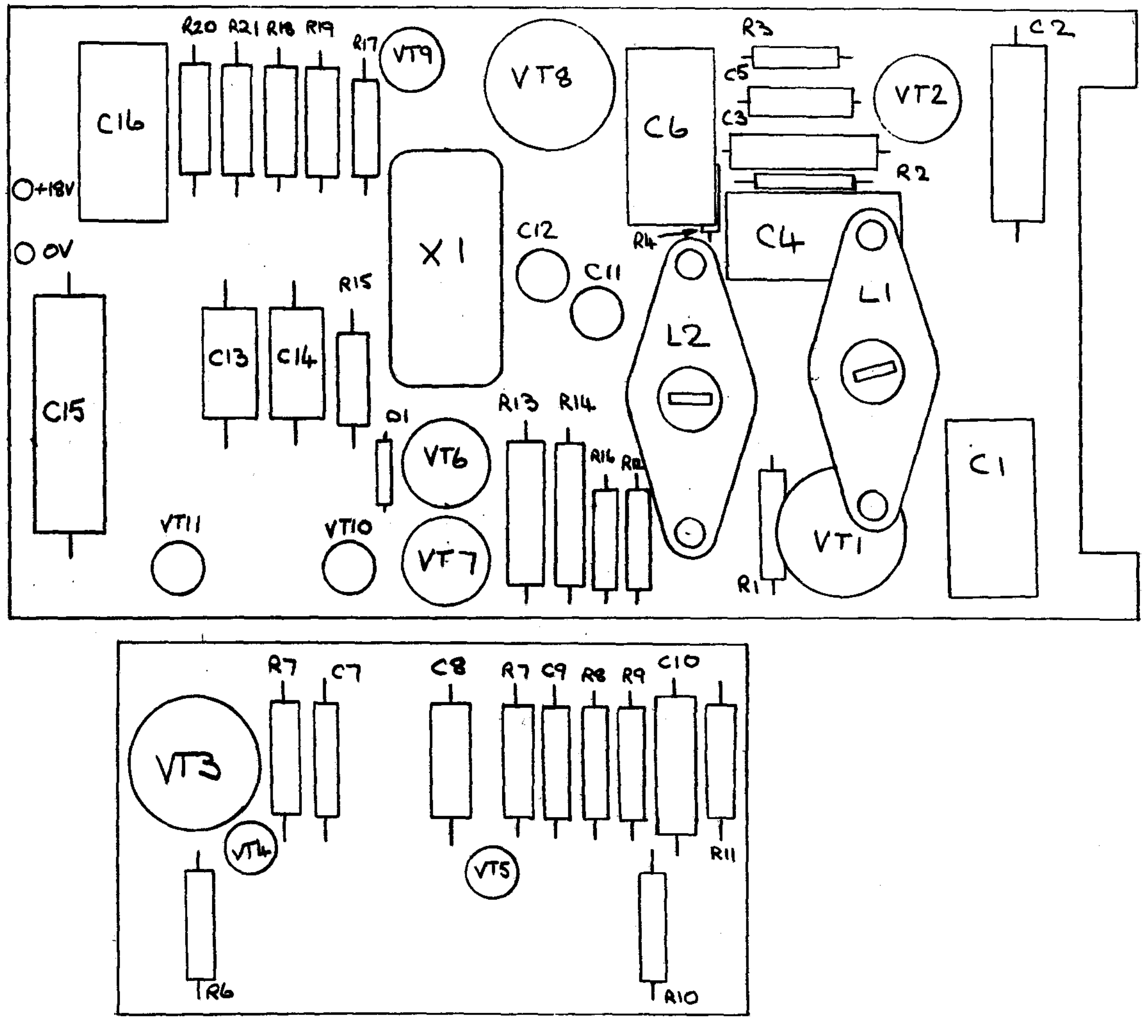
DRAWN BY



COMPONENT LAYOUT : RADIO BEACON TYPE A FIG 21 (UMEL LTD)	ISSUED TO REVISED	DRG. No. N10./ DRAWN BY J. J. Langford DATE — SHEET No. ISSUED — FOR ORDER No — FOR UNITS



CIRCUIT DIAGRAM : RADIO BEACON TYPE B FIG 22 (UMEL LTD)		CIRCUIT DRAWN BY



COMPONENT LAYOUT: RADIO BEACON TYPE B
FIG 23. (UMEL LTD)

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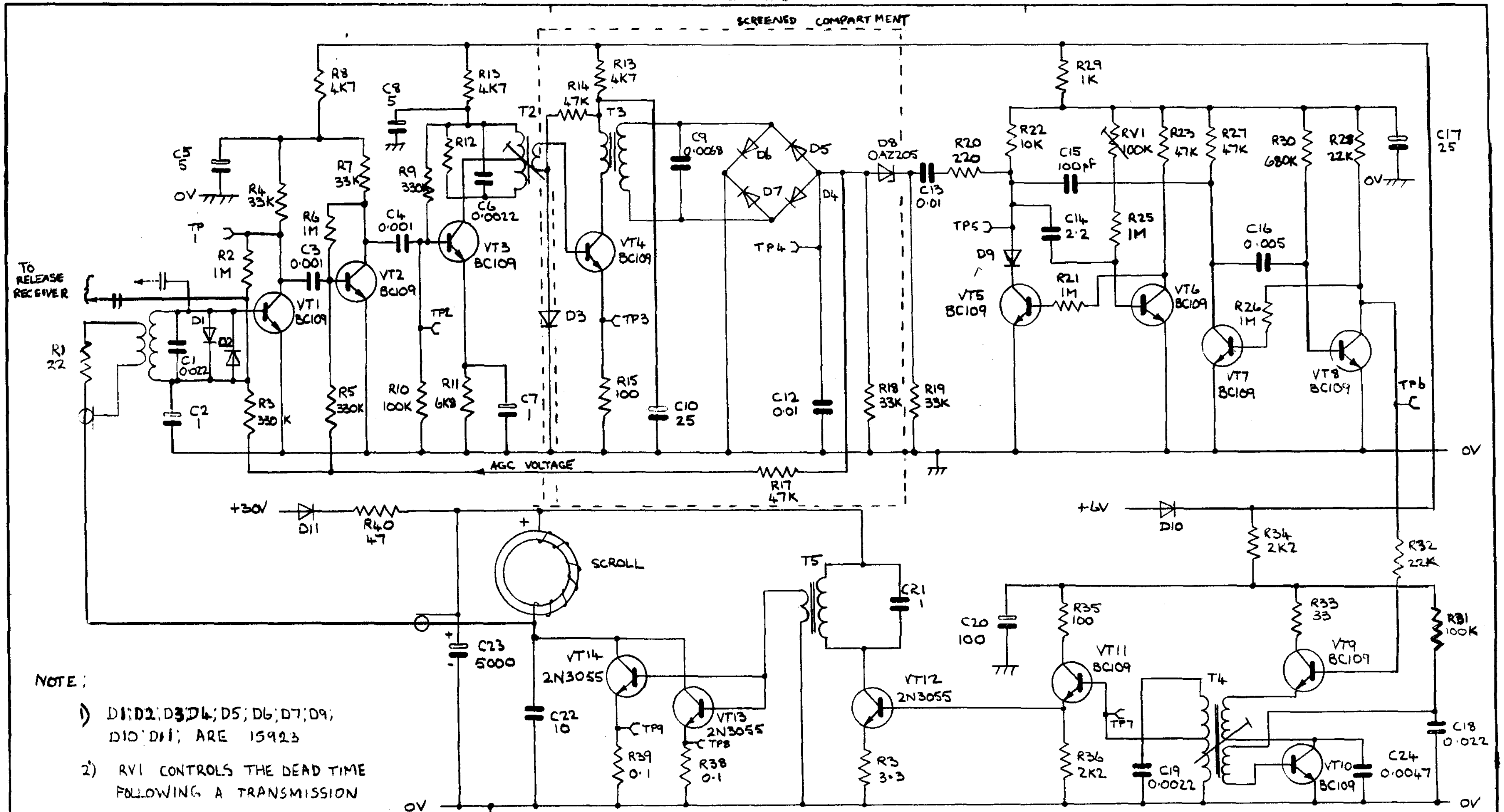
DRG. No. N10./

DRAWN BY DATE 5/7/71 SHEET No.

ISSUED / FOR ORDER No FOR UNITS



NOTE:

1) D1; D2; D3; D4; D5; D6; D7; D9; D10; D11; ARE 15923

2) RV1 CONTROLS THE DEAD TIME FOLLOWING A TRANSMISSION

3) FOR VALUE OF R12 SEE SETTING UP INSTRUCTIONS

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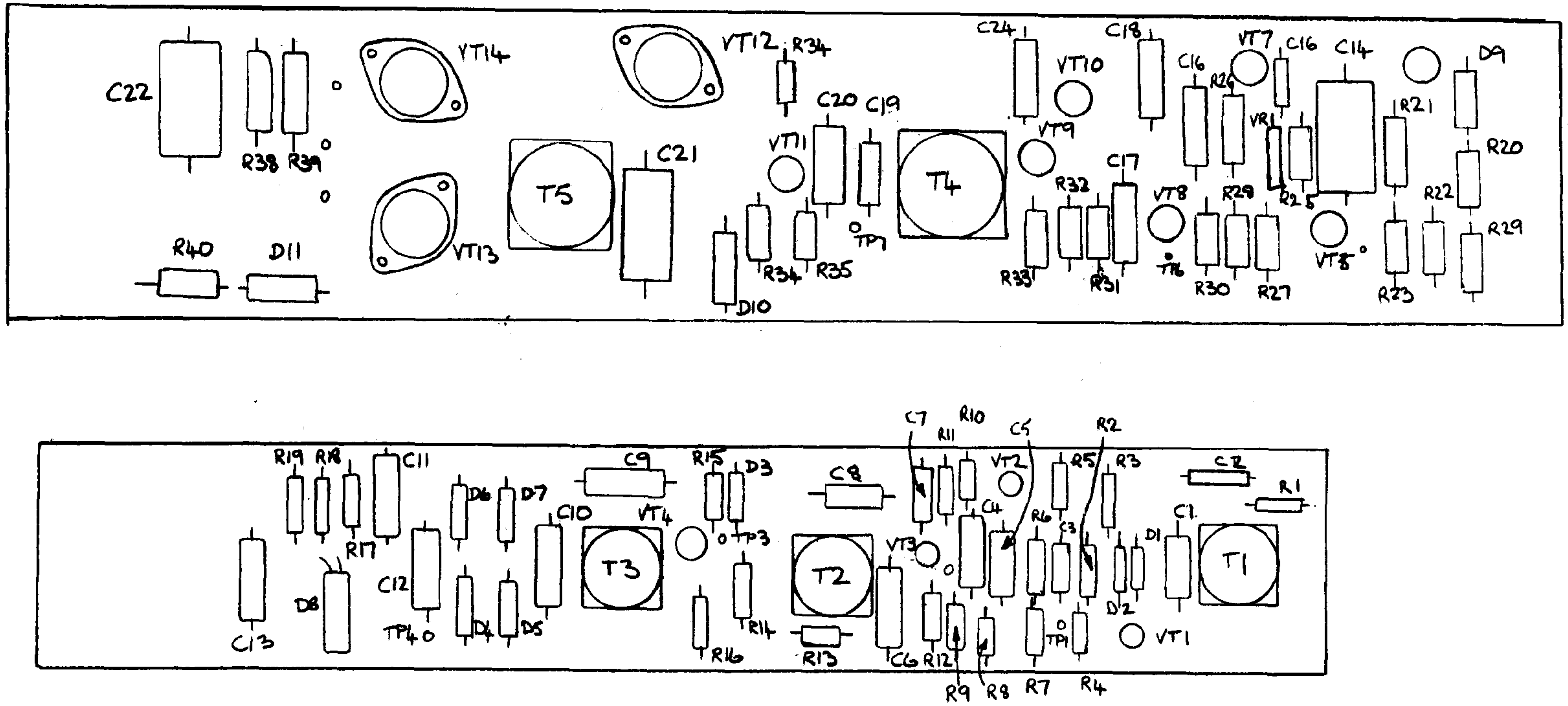
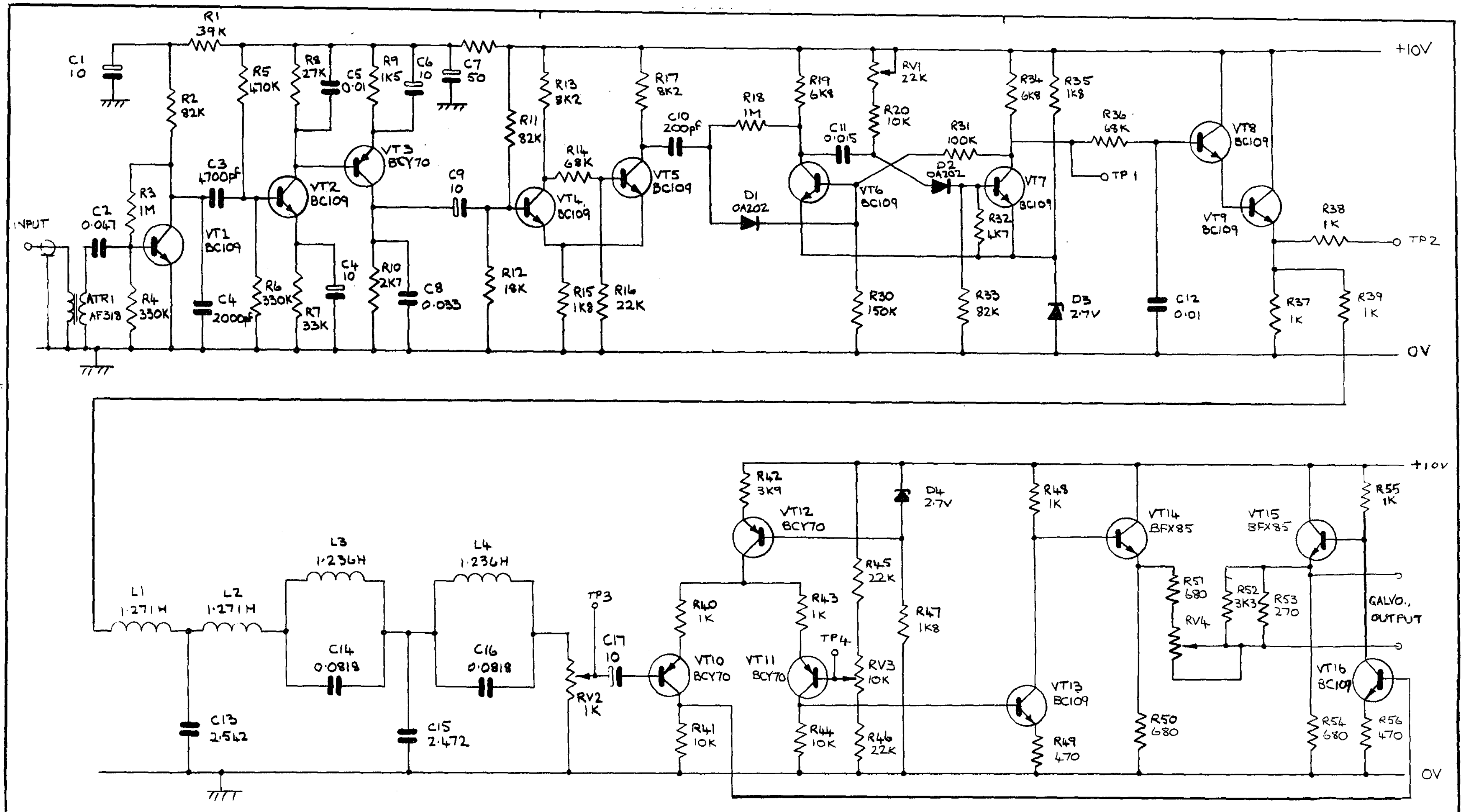
CIRCUIT DIAGRAM : 10KHZ ACOUSTIC TRANSPONDER FIG. 26		CIRCUIT DRAWN BY

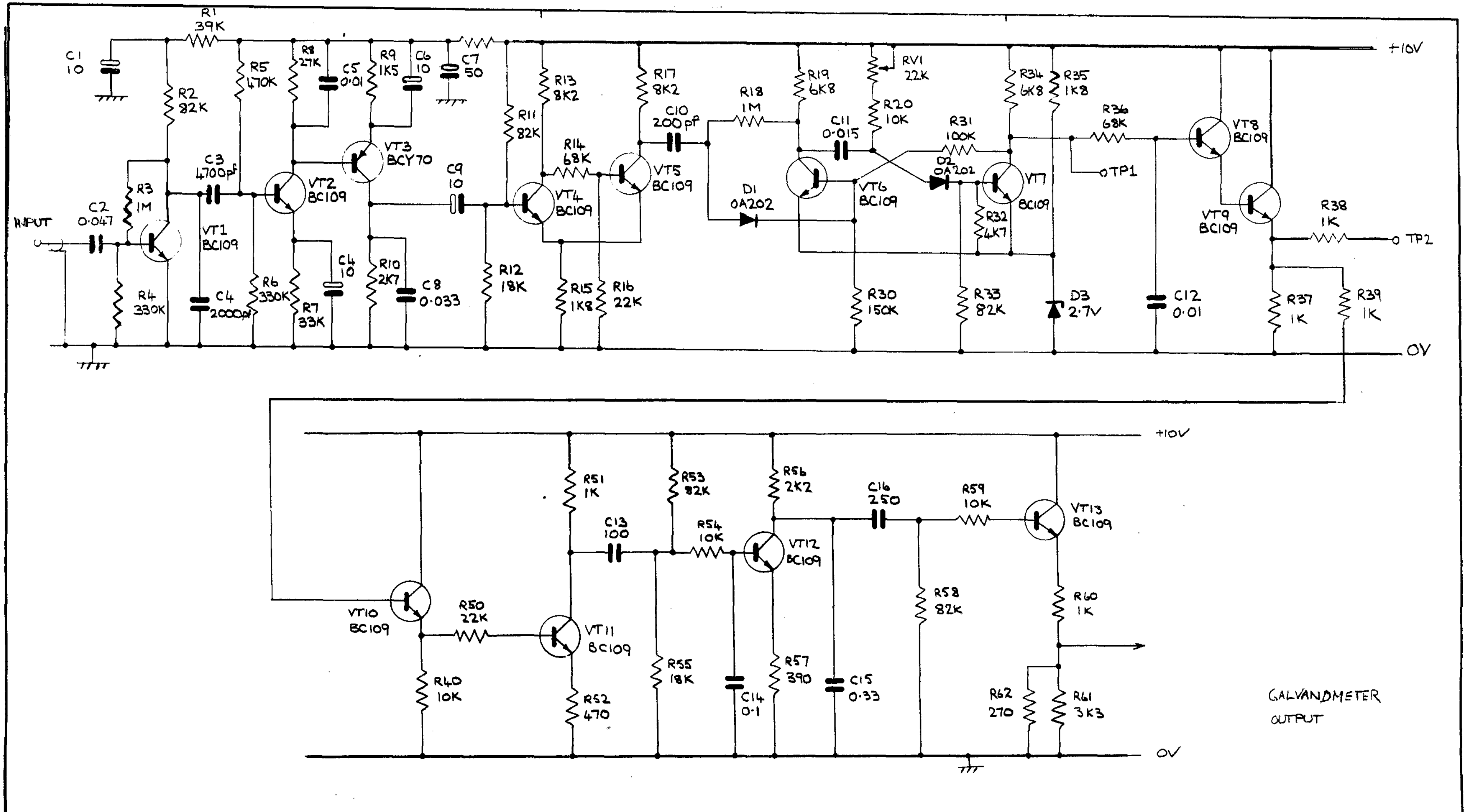


COMPONENT LAYOUT 10 KHz TRANSPONDER FIG 27	ISSUED TO	ORG. No. N10 /
	REVISED	DRAWN BY [signature] DATE Sept 70 | SHEET No.
		ISSUED FOR ORDER No FOR UNITS



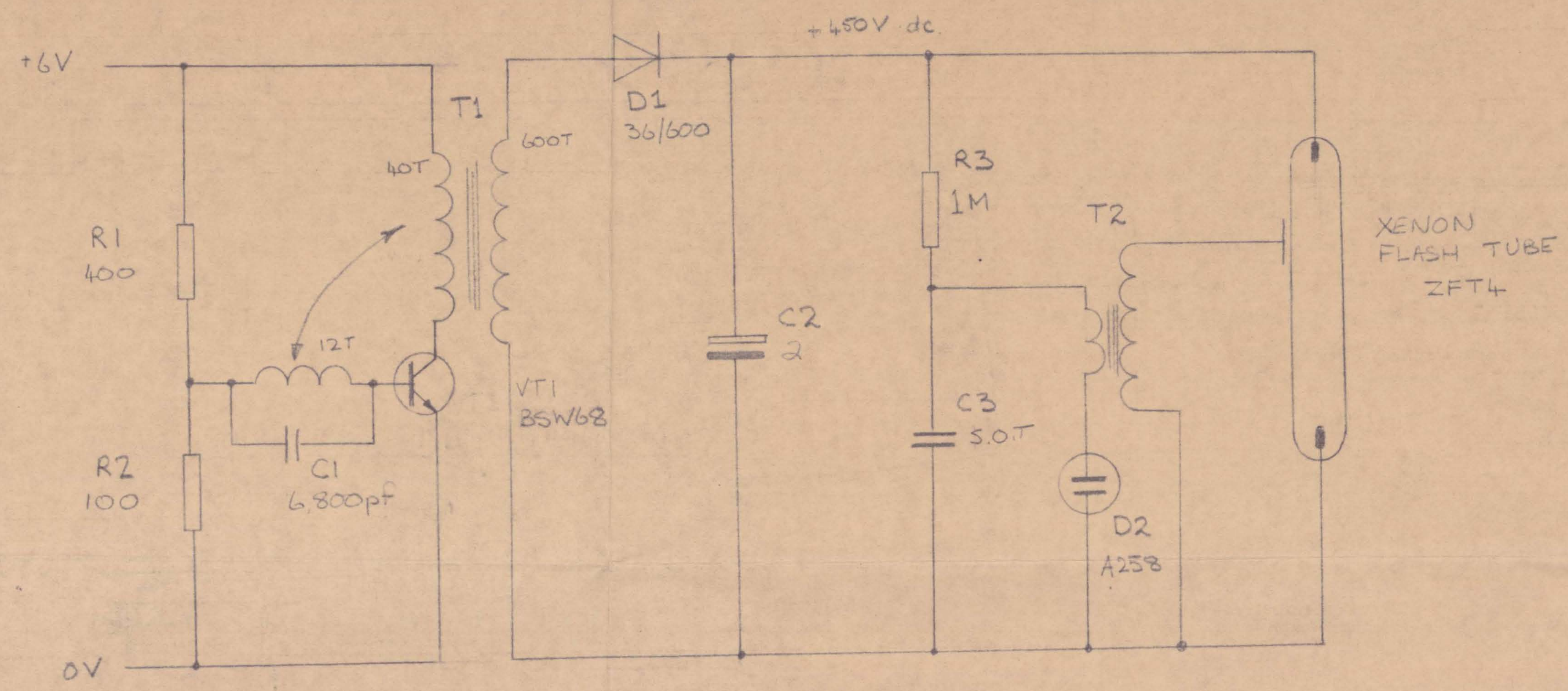
CIRCUIT DIAGRAM : HI/LO FREQUECY DEMODULATOR
FIG 28

CIRCUIT :
DRAWN BY :



CIRCUIT DIAGRAM : CLOCK DEMODULATOR
FIG : 29

DRAWN BY :



S.O.T : SELECTED ON TEST FOR FLASH RATE

THE FEEDBACK TRANSFORMER (12T) IS ADJUSTED SO THAT THE FREQUENCY OF OSCILLATION IS APPROX, 12KHz

CIRCUIT DIAGRAM: FLASHING LIGHT

FIG 30.

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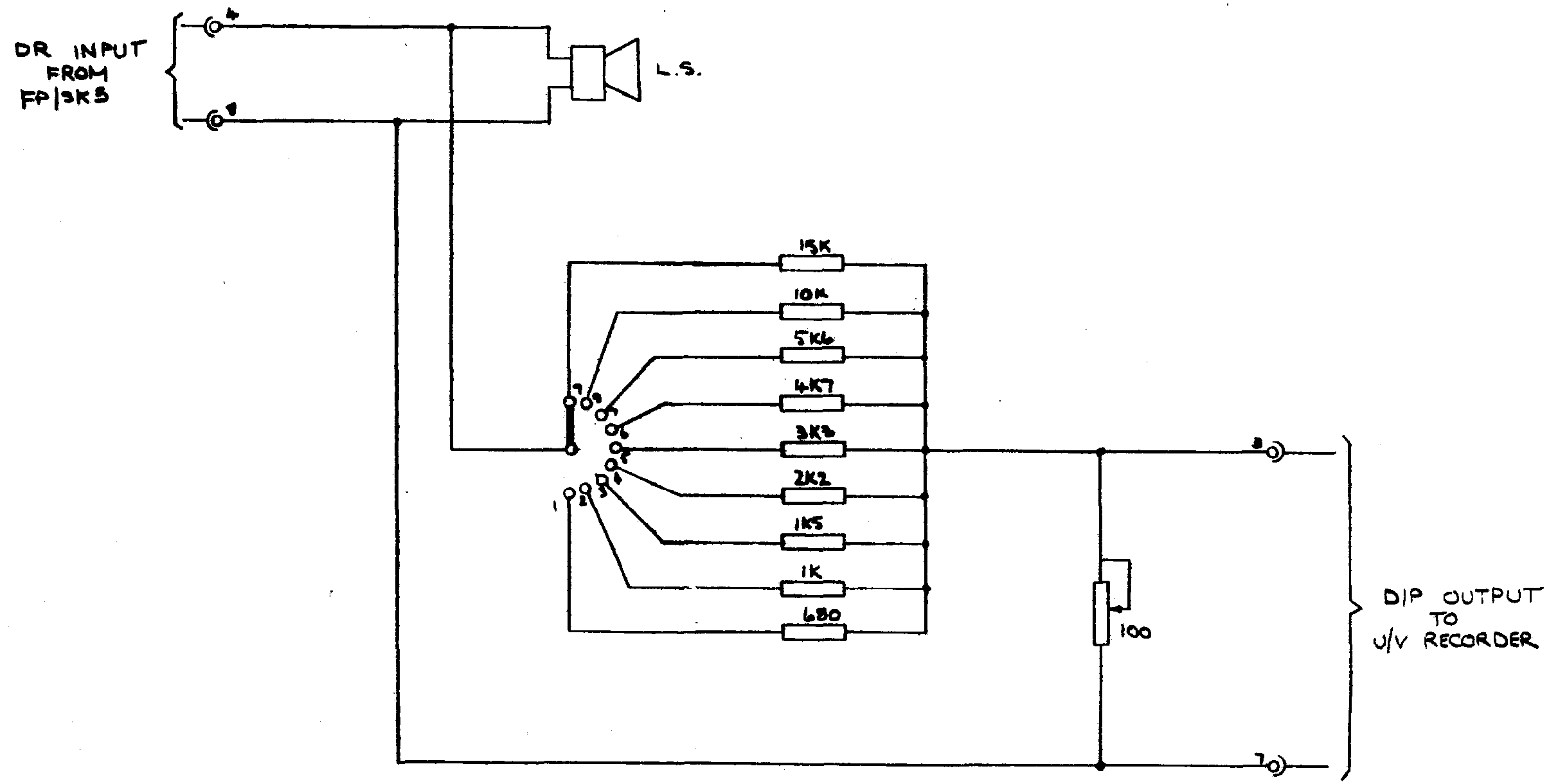
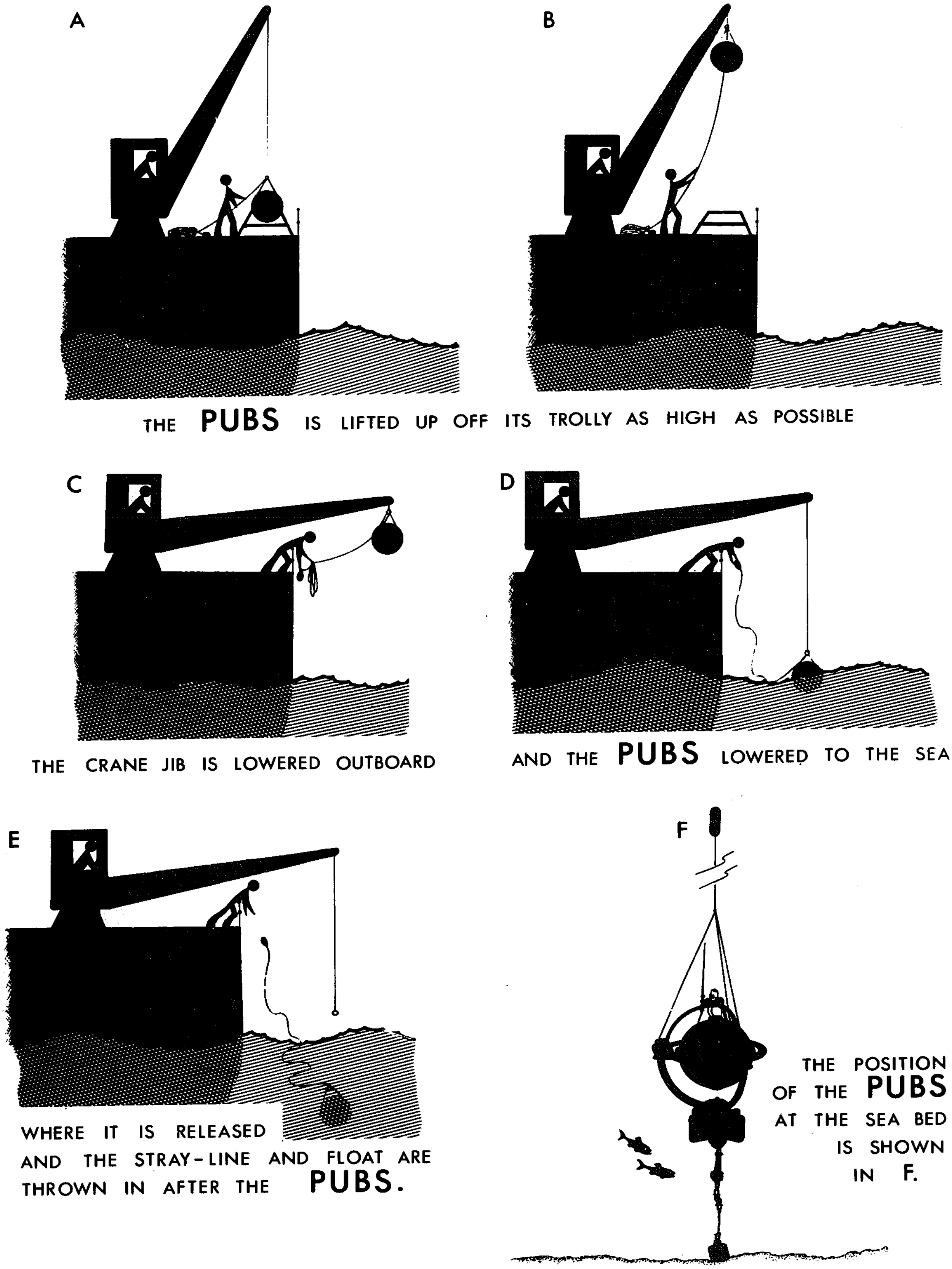
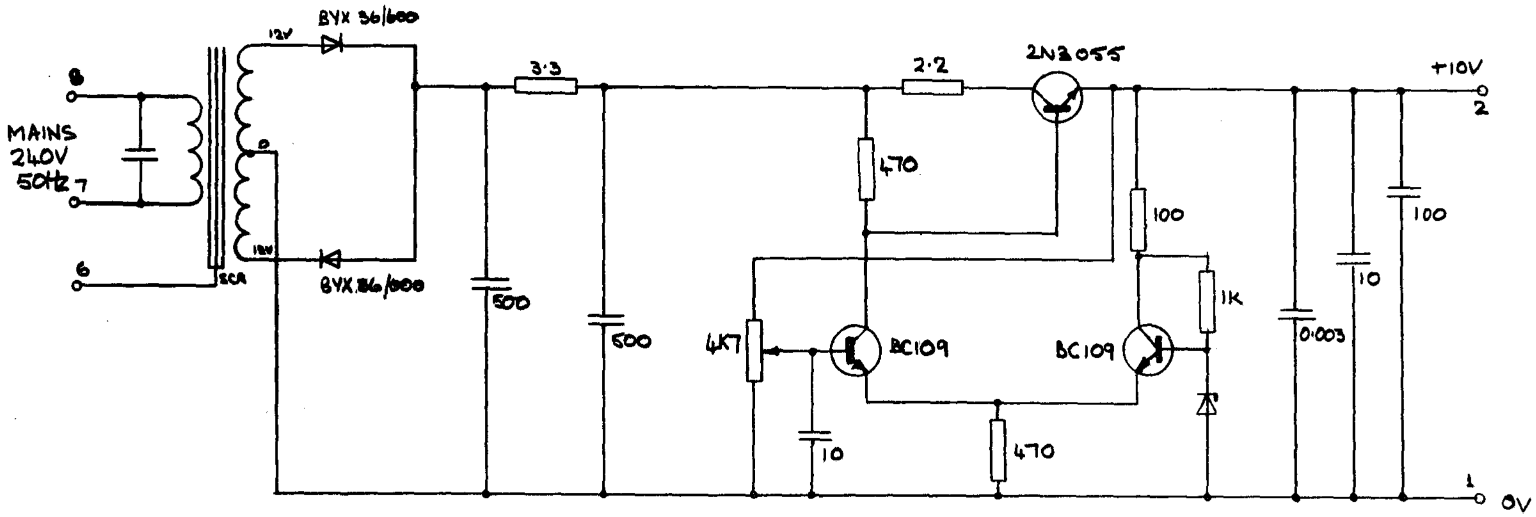
NIO. FORM No. 45 (1/66)



CIRCUIT DIAGRAM : DR ATTENUATOR FIG 31	ISSUED TO	DRG. No. N10./		
	REVISED	DRAWN BY	DATE	SHEET No
		ISSUED	FOR ORDER No	FOR UNITS



CARTOON: LAUNCHING SEQUENCE.
FIG. 32



CIRCUIT DIAGRAM : REPLAY UNIT POWER SUPPLY

FIG. 33

ISSUED TO

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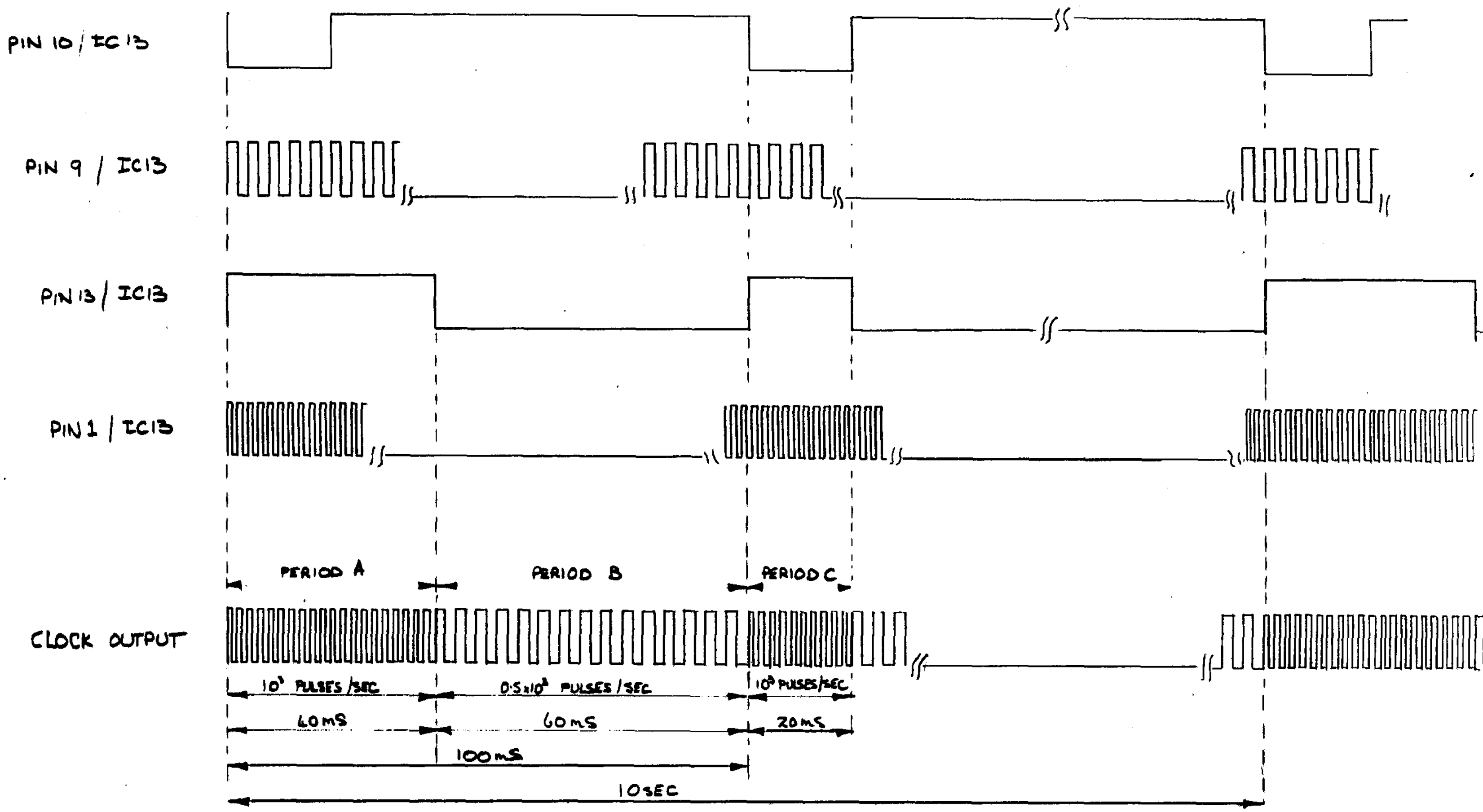
DRG. No. N10./

DRAWN BY DATE SHEET No.

ISSUED FOR ORDER No FOR UNITS



NOTE:

PERIOD A OCCURS ONCE EVERY 10SEC
" B " " " "
" C " " " 100mSEC

DIAGRAM: CLOCK OUTPUT WAVEFORM FIG 34	ISSUED TO	DRG.No. N10./		
	REVISED	DRAWN BY	DATE	SHEET No
		ISSUED	FOR ORDER No	FOR UNITS