TECHNICAL INFORMATION
COVERING
PACEMAKER TRANSISTOR BROADCAST RECEIVER

Manufactured by COLLIER & BEALE Ltd. WELLINGTON.

TYPE SET - Battery, Superhetrodyne, Portable Self Contained Ferrite Rod Antenna.

TRANSISTORS (Eight) - 2N247 RF. Amp., 2N247 Mixer, 2N219 Oscillator,
2N219 I.F. Amp., 0A85 Detector, OC71 1st A.F. Amplifier
OC71 Driver, 2-OC72 Output.

POWER SUPPLY - Self Contained 6 volt Lantern Battery ER509 or equivalent.

BATTERY DRAIN - Total Quiescent Battery Drain 9mA, at 65° F

TUNING RANGE - Broadcast 530-1600 Kc.

CAPACITORS

Ref. No.	Cap.		Volts
C1	0.1	μfd.	100
C2	0.1	"	"
C3	0.1	"	"
C4	0.1	"	"
C5	0.1	"	"
C6	0.1	"	"
C7	0.1	"	"
C8	0.005	"	Ceramic
C9	0.03	"	"
C10	600	μμf	Padder
C11	500	"	Sil.Mica
C12	500	"	"
C13	0.001	μfd	Ceramic
C14	0.03	"	150
C15	0.03	"	150
C16	8	"	25
C17	8	"	"
C18	32	"	3.5
C19	50	"	12.5
C20	0.1	"	100
C21	100	"	12.5
C22	100	"	"
C23	3-30	μμf	Trimmer
C24	3-30	"	"
C25	3-30	"	"
C26	3-30	"	"
C27	3-30	"	"

MISCELLANEOUS

COIL WINDING RESISTANCES

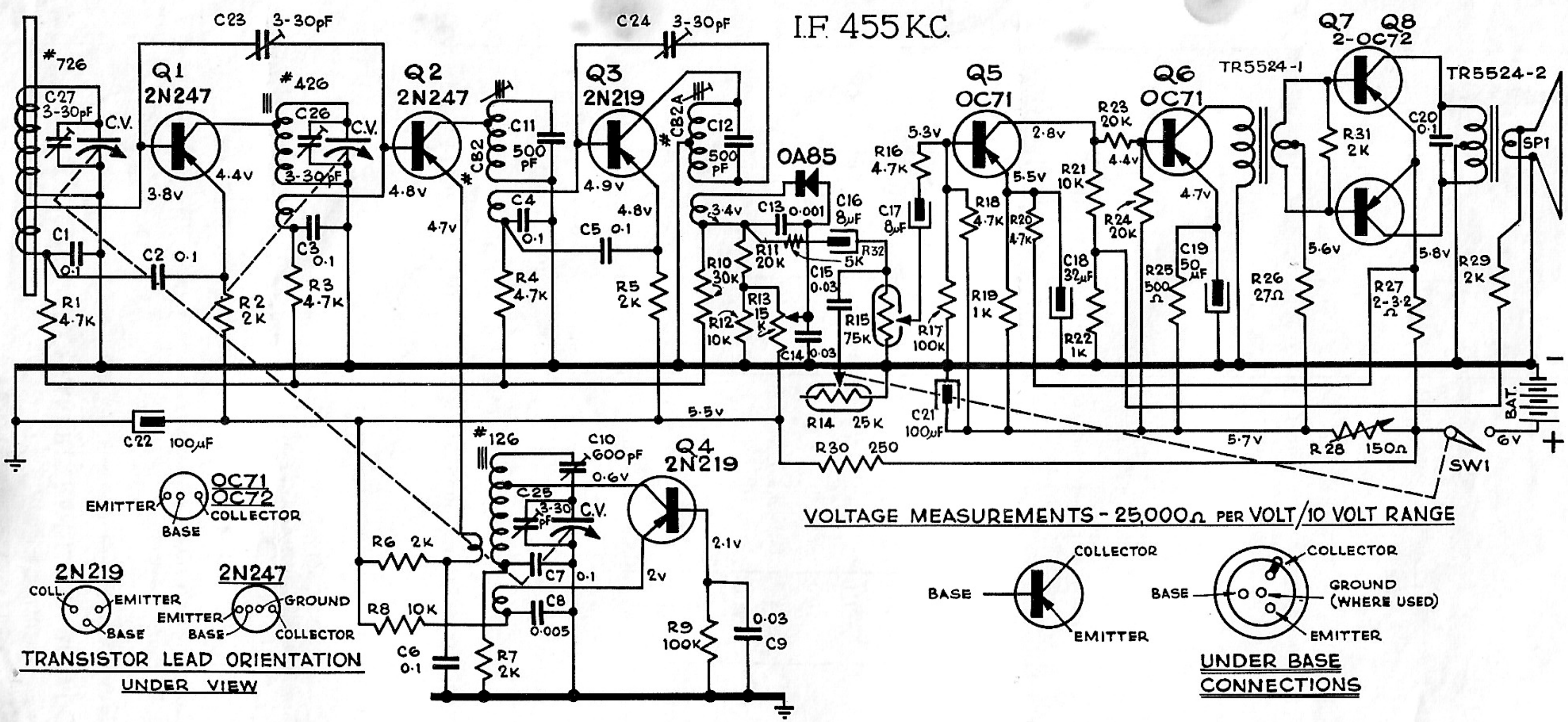
Ref.No.	Tuned	Base	Injection	
726	0.3 ohm	0.2 ohm		B.C.
426	1.4 "	0.25 "		"
126	0.75 "	0.3 "	0.1 ohm	"
CB2	1.35 "	0.25 "		I.F.
CB2A	1.3 "	1.1 "		I.F.
	Res.Pri.	Res.Sec.		
TR5524-1	290 ohm	56 ohm		
TR5524-2	14.5 "	0.35 "		

SP1	4x6 Rola Speaker
SW1	on/off Switch actuated by R14
CV	Polar Gang (351 uufd.swing)

Battery 6 volt LANTERN BATTERY ER 509 or EQUIVALENT

RESISTORS

Ref. No.	Res.		Watts
R1	4.7K	ohm	½
R2	2K	"	"
R3-4-32	4.7K	"	"
R5-7	2K	"	"
R8	10K	"	"
R9	100K	"	"
R10	30K	"	"
R11	20K	"	"
R12	10K	"	"
R13	15K	"	Pre-Set
R14	25K	"	Pot
R15	75K	"	½
R16	4.7K	"	"
R17	100K	"	"
R18	4.7K	"	"
R19	IK	"	"
R20	4.7K	"	"
R21	10K	"	"
R22	IK	"	"
R23-24	20K	"	"
R25	500K	"	"
R26	27	"	"
R27	2-3.2	"	"
R28	150	"	Pre-Set
R29	2K	"	½
R30	250	"	"
R31	2K	"	"



SCHEMATIC DIAGRAM MODEL TRANS-PORTABLE.

1. All voltage measurements shown are from points to chassis, with a battery terminal voltage of 6 volts.

2. All voltage checks should be made with a voltmeter of 10 V. full scale reading and having a total resistance of 250,000 ohm (25,000 ohm/V)

3. When making resistance checks, disconnect battery and observe the polarity of electrolytic condenser, where such appear.

4. Nominal tolerance on components makes possible a variation ± 10% in voltage and resistance readings.

5. Avoid operations on the receiver with battery connected. Always re-check total battery current before permanently re-connecting battery.

6. To remove transistors, disconnect battery and free projecting leads of transistor from socket

TRANSISTOR PORTABLE

DESCRIPTION OF CIRCUIT

The circuit, generally, comprises a superheterodyne with a tuned radio frequency stage, a crystal diode demodulator and a three stage A.F. amplifier with the final push pull stage operating class "B".

The separate sections of the receiver are fairly conventional and follow quite closely standard electron tube practice. Apart from the impedance transformations involved in the coupling units, particularly those of the R.F. and I.F. sections, to contend with operating conditions of transistors, there are other special features incorporated which contribute valuably to the outstanding performance of the receiver. These features, along with a stage by stage description are mentioned below.

It should be appreciated that transistors are current amplifiers and because of the low operating voltages, the currents concerned in both input and output circuits connected to them are relatively high. The impedances of the terminals of transistors in the common emitter connection as used in this receiver are similarly extremely low in comparison to pentode or tetrode valves and quite high ratios are required in coupling the tuned circuits efficiently and to ensure the requisite magnitudes of signal currents. Other than these special characteristics, the transistors as employed in the receiver have a functional application and behaviour similar to the triode valve.

The highly developed R.C.A. Drift transistors (2N247) used in the R.F. and mixer stages have an extremely low value of base/collector capacitance which makes neutralisation simple and non critical and furthermore, the value is much more of a constant factor than in conventional transistors with changes in base current to the point that full and completely stable A.V.C. control is possible.

The input circuit is comprised of a high 'Q' coil and ferrite rod. This is followed by a type 2N247 transistor in neutralised grounded emitter connection. Signal input to the base is via a tertiary winding closely coupled to the main winding. This circuit is tuned by a section of the variable condenser in the usual way.

Steady operating bias for the transistor is obtained in part from the emitter resistor and by an appropriate value of battery bias as determined by a potential divider comprising resistors R12 and R13. Some self bias results from the drop in base filter resistor (R1) and the diode load and filter resistors. The normal no signal emitter current of this stage is .4 - .45 m.a.

The output circuit comprises a high 'Q' dust cored coil with a 50% tap for the collector. This is the 1st I.F. stage transformer and is single tuned by a 500 pf condenser and the adjustable core. Base current for the I.F. stage transistor is fed from a close coupled tertiary winding of approximately 10% total turns. Steady operating bias is obtained in the same manner as for the R.F. and converter stages.

The three base feeds for the R.F. converter and I.F. stage transistors have a common supply from A.V.C. filter resistor R10, and the demodulator diode load comprising R11 and R12. A fair order of base current flows in this circuit at all times and under no signal conditions, it approximates 30 u.a. The total value of resistance in this common circuit is thus an important factor in establishing the correct value of operating base current.

The collector of the I.F. stage transistor (Q3) is series fed from one end of a centre tapped dust core coil of similar characteristics to the input transformer of the same stage. Neutralisation is effected by capacitive feed-back from the free end of the coil through adjustable trimmer C24.

The working gain of the I.F. stage is high and the intrinsic feed-back capacitance of the transistor requires to be accurately balanced out to avoid unwanted regeneration and excessive side-band cutting. The adjustments of both neutralising condensers are dealt with later in this bulletin.

The I.F. output from Q3 is taken via a close coupled tertiary winding in the I.F. coil and feeds a crystal diode rectifier. The A.F. component of the rectified I.F. carrier is passed on to the A.F. amplifier via the volume control (R15). The D.C. component as developed across diode load (R11) and voltage divider (R12) (R13) is fed to the bases of the R.F. converter and I.F. transistors opposing the steady negative bias, for full A.V.C. control.

It should be appreciated that the order of total base current flowing in the diode circuit would be such as to bias the crystal diode to a non conducting state, and thus signal rectification could not occur below an amplitude where the peak value of the I.F. carrier matched the opposing bias. The voltage divider (R12 (R13) provides the means of unifying the D.C. potentials at the diode terminals and thus its normal conducting condition. The voltage divider, also, largely establishes the normal working point of the R.F., converter and I.F. transistors as previously mentioned, with no signal collector currents of approximately 380 - 420 micro amps each. Under A.V.C. control the figure will reduce and in the case of strong local signals, may have a value of 30 - 50 u.a. each.

Separate oscillator injection is employed, both to realise the maximum conversion gain and to permit full A.V.C. control of the converter. An Autodyne or self oscillating converter would preclude the use of A.V.C. control because of the heavy reduction in transistor transconductance which would result under strong signals.

The local oscillator employing an R.C.A. 2N219 Transistor (Q4) is of quite conventional form using a common base circuit. The collector is series fed from a tap on the tuned winding. Emitter feed is via a close coupled tertiary to provide the feed back. Oscillation is vigorous and is well maintained over the operating frequency range with a battery supply down to 2-volts approximately. A separate injection winding feeds the emitter of the converter stage at a level ensuring optimum mixing and maximum conversion gain. The variable padding condenser (C10), is in the "hot" end of the circuit and any adjustment to this should be undertaken with a non-metallic screw sriver, to avoid unwanted added capacitance.

The A.F. amplifier receives its input from the crystal rectifier as previously described, via the volume control (R15), and a matching resistor of 4.7 K (R16). The 1st stage (Q5) is D.C. coupled to the following driver stage via the collector feed resistor (R21) and matching resistor (R23). Steady bias for the base of the 1st stage is via a divider across the battery supply comprising resistors (R17) and (R18). Steady bias for the 2nd stage is obtained from the collector feed and matching resistors and the base shunt resistor (R24).

There are two additional side circuits associated with the 1st stage amplifier. One of these is the common connection between the emitters of Q5 and the output stage (Q7) (Q8), via R20. This is a D.C. loop and provides for the temperature and voltage stabilisation of the output stage.

The second side circuit concerns the collector feed of Q5 and is for the purpose of introducing negative A.F. feed-back over the driver and output stages. The collector feed in this case is fed from a divider across the loudspeaker voice coil comprising resistors (R29) and (R22). The effective gain reduction of this feed-back is 7 db and is an important factor in the high standard of reproduction attained.

The A.F. output of driver stage (Q6) is transformer coupled to the output stage (Q7) and (Q8). This stage is biassed to to a low value of quiescent current and operates as a class "B" amplifier.

Operating base bias for the class "B" stage is obtained from the drop in common feed resistor to the A.F. amplifier stages (R28). The value of this resistance is adjustable and thus the normal working current of the stage and the total drain of the whole receiver, is substantially regulated by its setting. No adjustment of this resistor should normally be required. Replacement of transistors Q5 and Q6 or of resistors associated with these stages could result in some total current change, in which case the total battery current would indicate the possible need of readjustment to the nominal value of 9 m.a. with a battery terminal voltage of 6 volts.

Output of the power amplifier feeds the loudspeaker in the usual way and an U.P.O. of 300 milliwatts is available with a battery voltage of 6 volts. A feed from the voice coil is taken via R29 to the collector of Q5 to provide negative a.c. feed back as previously mentioned.

The temperature and voltage stabilisation already referred to operates by virtue of inverse D.C. feed-back. Any steady emitter current increase in the output stage, resulting in an increase in the normal quiescent current in the stage, increases the voltage drop in R27. The resulting negative going potential applied to the emitter of Q5, reduces the latter's trans-conductance and through the D.C. coupling that of Q6 also. This results in a reduced current through R28 with a close restoration of normal current condition in R27. Steady battery voltage variations result in a similar measure of control and thus the optimum working point of the class "B" stage is safely maintained under all conditions and over a wide range of battery voltages.

R.F. SECTION ALIGNMENT

The normal factory settings should hold good for an indefinite period. The routine of adjustments together with recommended test points is described below, assuming normal conditions in the A.F. amplifier.

Before checking alignment of the I.F. transformers, the setting of the diode biassing pre-set resistance (R13) should be checked. If random noise output is possible, the correct adjustment is that providing maximum noise output. Alternatively, a D.C. voltmeter of 1 - 3 volts full scale with an internal resistance of 10 - 20,000 ohm per volt, clipped across the diode, will show zero volts with the correct adjustment. This adjustment is not critical and once set will hold good for an indefinite period for a given set of transistors in the R.F. converter and I.F. stages.

The I.F. amplifier may be checked or aligned using an A.F. output meter in the usual way. Signal input should be fed to the base of the converter (Q2) via an isolating capacitor of .1 mfd. approximately. Unmesh the variable condenser, and with a signal of 455 Kc/s, adjust the I.F. coil cores as required.

The I.F. stage neutralising condenser is fairly critical and if widely out of adjustment, may exert some influence on the tuned circuits. Neutralisation is most easily effected by observing the character of random noise while adjusting the trimmer above and below the stable state. The setting which results in a smooth sharp hiss is the correct one. Alternatively, the S.G. may be rocked a few Kc/s and the side-band responses checked in the usual way for absence of regeneration.

Any material change in neutralising capacitance will necessitate some readjustment of the I.F. coil cores and the fixed frequency adjustment should be re-checked for a single peak output.

Adjustment of the signal circuits follows regular practice. Dial calibrations are established with the condenser fully meshed and with the cursor and dial diametral line in register. The dial disc is held friction tight to the condenser spindle and may be rotated or completely withdrawn as required.

H.F. trimming adjustments should be undertaken at approximately 1400 Kc/s and L.F. padding at 600 Kc/s. Signal input for aligning converter and oscillator circuits, is most easily achieved by clipping the generator directly to the aerial circuit section of the tuning gang. Thereafter, the aerial circuit is aligned using random noise as the signal source and evidence of peaking.

R.F. stage neutralising is non critical and the factory setting of the compression trimmer should hold good under all conditions and for an indefinite period.

A.F. SECTION ADJUSTMENTS

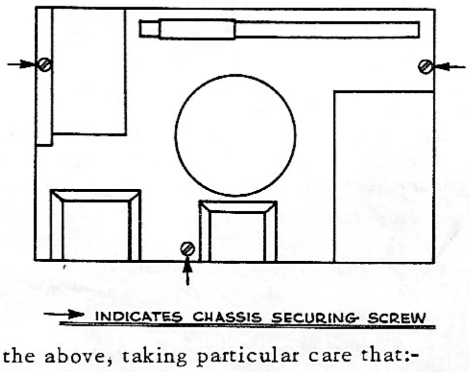
The audio frequency section has only one adjustment which could materially affect the performance of the receiver. This is the quiescent or no signal current setting of the output stage. The adjustment is made with R28 and the measurement is the total no-signal battery current of the whole receiver. For a battery terminal voltage to 6 volts and at an ambient temperature of 65° - 70° f, the normal total battery current should be 8.75 m.a. to 9.5 m.a. Under these conditions, the output stage should operate satisfactorily throughout the life of the battery and under normal variations in temperature.

A milliampmeter with a scale of not less than 100 m.a. should be used. Care should be exercised in resetting the resistor to avoid sustained excessive total battery currents.

TO REMOVE CHASSIS

To remove chassis from case, first draw off tone and volume knobs, unscrew dial knob screw and draw off knob. Draw off dial scale, fully mesh variable condenser.

Remove 3 chassis support screws and withdraw chassis by swinging outward on lower edge and slewing slightly to clear battery switch.



→ INDICATES CHASSIS SECURING SCREW

To refit chassis, reverse the sequence of the above, taking particular care that:-

(a) Variable condenser is fully meshed.
(b) Approximately 1/16" clearance exists between dial disc and fixed cursor.
(c) Tone knob is fitted with shaft turned fully clock-wise and with "off" knob adjacent to fixed "off" indicator.

WHOLLY DESIGNED IN NEW ZEALAND

Telegraphic Address
"GULTOUCH"

H.W.CLARKE (N.Z.) LTD.

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WELLINGTON,

26th November, 1957.

Dear Sir/s,

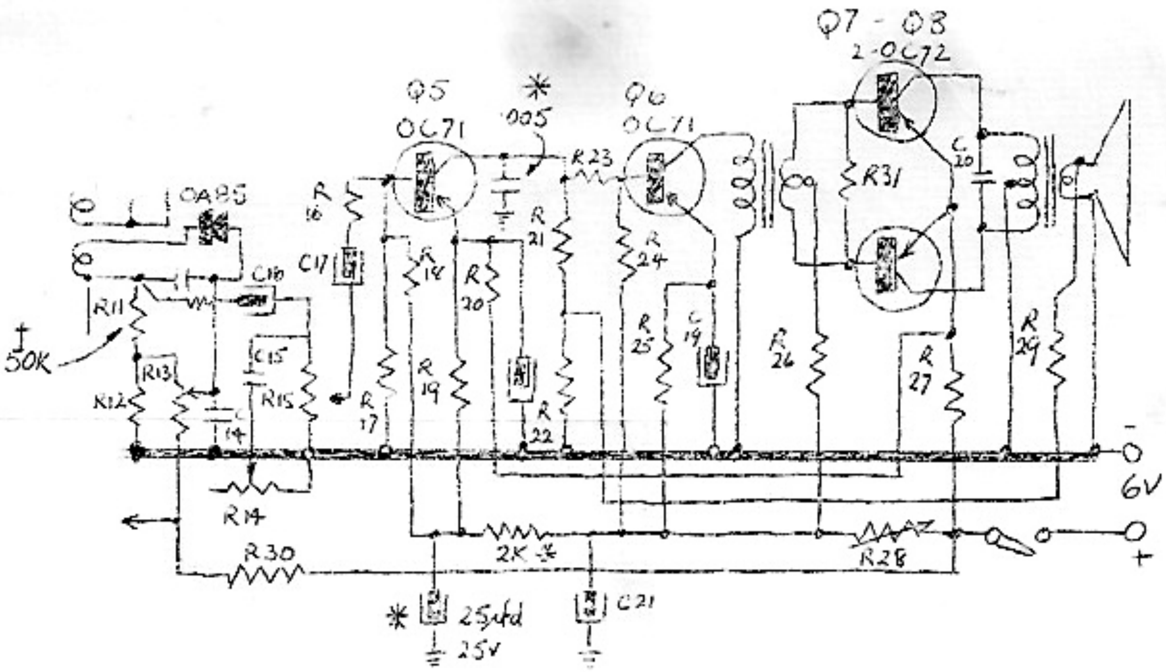
Enclosed herewith is a copy of the Pacemaker Circuit Modification. This will bring you up to date on certain design changes which were introduced in the Transistor Receiver after its production had commenced.

The diode load Resistor R11 was increased to 50,000 ohms in order to enable the Receiver to cope with strong signals with greater ease. Secondly, an audio decoupling network consisting of a 2,000 ohm Resistor and a 25 ufd electrolytic was added in order to keep the receiver stable when the battery was getting towards the end of its useful life. It was found previously that when batteries were becoming discharged, their internal resistance led to some low frequency oscillation which would have meant the earlier replacement of the battery than would otherwise be necessary.

The final alteration concerns the addition of a high frequency bypass capacitor of 0.005 ufd from the collector of the OC71 (Q5) to remove any residual traces of IF signal energy which may happen to enter the audio system. If this is allowed, a certain "shrieking" could be noticed on approaching the side bands of strong carriers.

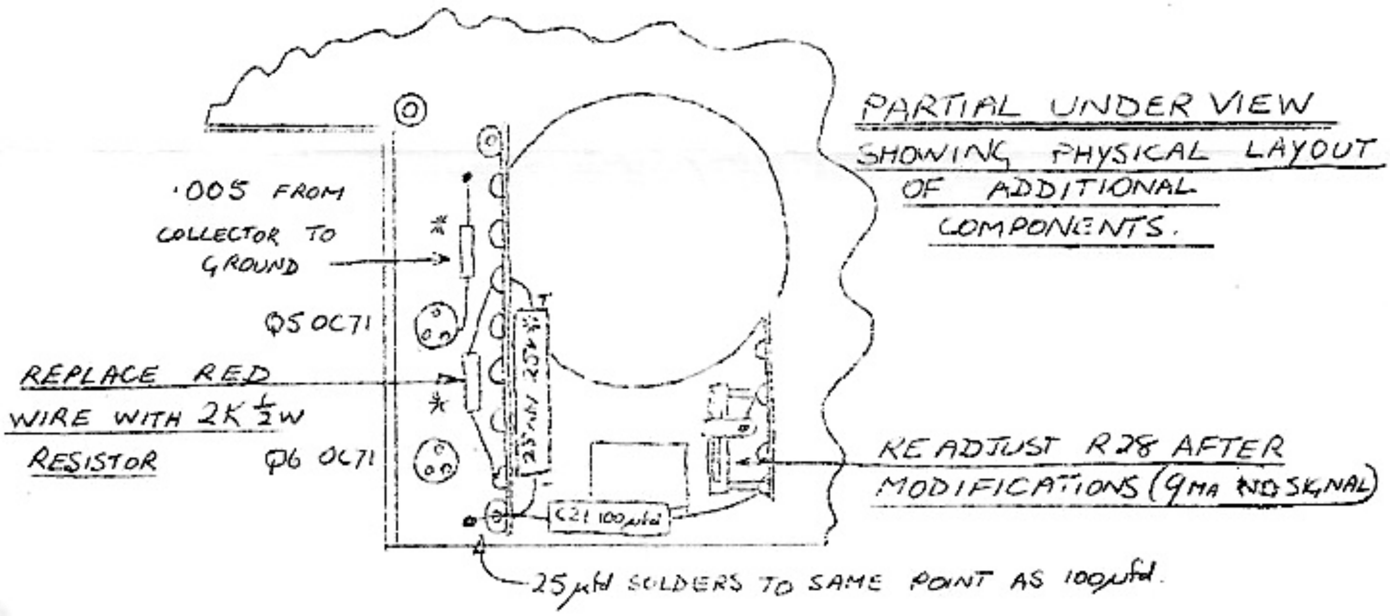
Yours faithfully,
H.W. CLARKE (N.Z.) LTD.

Encl:



* ADDED COMPONENTS

\+ VALUE CHANGE



THIS MODIFICATION APPLIES TO EARLY PRODUCTION SER Nos 68401 TO 68893 INCLUSIVE. RECEIVERS AFTER THIS SHOULD HAVE THESE MODIFICATIONS INCORPORATED

TRANSPORTABLE