EC Mark III

Technical Manual

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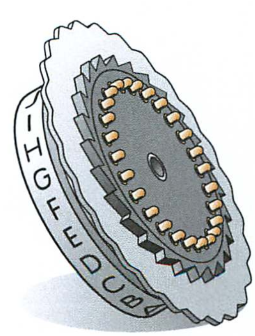
Project Easy Chair



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C O N T E N T S

1. INTRODUCTION

This manual is mainly intended for those who will, by the nature of their assignment, be required to give technical assistance to the man in the field and to take care of the maintenance and service to the equipment. It contains therefore a description of the system as a whole and of the operation of the various parts of the equipment. Circuit diagrams, component values, servicing instructions and voltage and current check points are included in order to assist maintenance and eventual repairs to be made.

1.1. General information about the equipment.

The system in actual operation occupies two areas, viz. the target area where the "passive element" is located, and the "base station" area where all other equipment of the system is installed and which is the controlling position for the entire system.
The base station consists of a transmitter, a receiver, a duplexer, an antenna and a power supply. Transmitter, receiver and duplexer are integrated into a single unit, referred to as the "transmitter cabinet" later on.
The power supply unit is intended for 50 - 60 cycles/second a.c. mains voltage operation.
The entire equipment is packed in two suitcases of the two-suiter-size. One suitcase contains the transmitter cabinet and part of the antenna. The other suitcase contains the power supply unit, the rest of the antenna and various items such as cables, headphones, passive elements, field strength monitor, spare fuses, etc.
The weight of each of these suitcases does not exceed 35 lbs., space being available for other items not necessarily related to the equipment.
Front-panel test possibilities have been included, which are necessary and sufficient for regular tuning-up purposes and for adjustment of the controls during actual operation. For maintenance and repair purposes other test and check possibilities are available inside the cabinet at various points of the circuit. The latter possibility should be used only when adequate measuring facilities are available. For these instances the description of each unit contains a section on "servicing" giving the necessary details on how to get access, how to check and what to keep in mind.

1.2. General operation of the system.

The system contains a transmitter at a nominal frequency of 378,5 Mc/s and a r.f. power output of between 0,4 and 40 W., adjustable with a front-panel control. This r.f. power goes through the transmitting arm of the duplexer to the

base station's directive antenna, which builds up a relatively strong r.f. field in the target area, where the passive element is located. This "P.E." contains a single dipole antenna feeding a crystal detector. The d.c. power thus derived is used to supply a transistorized modulator section. This modulator section is in fact an oscillator operating at about 100 kc/s (the "sub-carrier" frequency) and which is frequency-modulated by an amplified microphone voltage. The microphone itself picks up acoustic signals present in the target area.
This frequency-modulated subcarrier signal is fed back again to the crystal detector mentioned before and affects a subcarrier frequency impedance modulation thereof.
This impedance modulation causes a modulated reflection to originate from the P.E.-antenna. This reflected signal travels back to the base station directive antenna and is separated from the transmitting circuit by the duplexer. The receiver arm of the duplexer is connected to the receiver input.
From the transmitter master oscillator a signal is derived which acts as a r.f. carrier and which is fed into the receiver input circuit together with the duplexer output signal. The receiver r.f. part contains a r.f. amplifier and an amplitude-detector which can restore the original sub-carrier signal when phase relations between locally derived r.f. carrier signal and sideband-signal from the P.E. bear a correct phase relation, depending therefore on circumstances and relative distances between base station antenna and P.E. antenna. In order to do away with the unavoidable occurrence of nulls in the response, the principle of "automatic duplexing" has been incorporated, which is described in detail in a final research report on this subject. For the purpose of this manual it may suffice to mention that the use of two r.f. sections in the receiver is necessary, which both receive the r.f. carrier signal and the reflected signal, with the difference that one of the r.f. sections has a 90° r.f. phase shift included in the reflected signal path. Furthermore the resulting signals from the r.f. sections must be combined again with a mutual subcarrier frequency phase shift of 90° into one signal.
In this way a continuous received signal is obtained irrespective of distance etc.
The frequency-modulated subcarrier frequency signal is passed through a tuned circuit, through amplifying stages and through amplitude limiters to a frequency detector.
The output of this detector restores the original microphone voltage, which after audio amplification is applied to the headphone terminals. The annoyance caused by excessive noise in the headphones during the absence of a usable received signal can be diminished by a built-in squelch circuit.

2. CIRCUIT DESCRIPTION

2.1. Transmitter (Fig. 1)

Operation:

The transmitter contains a master oscillator (V_1 and V_2), a buffer amplifier (V3), a power amplifier (V4) and an output power control section (V5 and V6).
The master oscillator is of the balanced tuned-plate-tuned-cathode variety, the frequency of which is governed mainly by the tuned anode circuit, consisting of an electrical quarter-wave line L2.
The anodes of V1 and V2 are tapped down on this line for highest frequency stability. The operating frequency is adjusted at the laboratory with a pair of extension rods. These rods are secured, but readjustment is possible when necessary.
The cathode circuit L1 - C1 is fixed-tuned with lumped constants. A pick-up loop near L2 extracts about 100 milli-Watts of r.f. power to be used as a local oscillator signal for the receiver r.f. part.
The buffer-amplifier V3 derives its' r.f. drive from taps on the oscillator anode line L2. This tube operates under class-C conditions and obtains grid bias from the -20 Volts line, to which is added a bias developped during excitation by d.c. grid current flowing through grid resistors R3 and R4.
The anode circuit of V3 consists of an electrical half-wave line L3, loaded by the buffer tube output capacitance on one side and by an adjustable compression-type tuning condenser at the other side. H.T.-voltage is supplied at the r.f. voltage node points of L3 by a pair of r.f. chokes.
Driving power for the power amplifier V4 is obtained by inductive coupling between power amplifier grid inductance L4 and buffer anode inductance L3. The grid circuit is tuned to resonance by series trimmers C12 and C13.
The power amplifier operates under class-C conditions and derives its' bias from the -20 Volts line, to which is added a bias developped during excitation by d.c. grid current flowing through grid resistors R9, R10 and R8. For adjustment purposes this d.c. grid current can be checked on the "TEST 1" position of the front panel switch S5.
The power amplifier anode circuit L5 - C17 is similar to the buffer anode circuit. R.f. output power is extracted by coupling loop L6 and passed through a low-pass filter network C18 - L7 - C19 onto the duplexer. This low-pass filter serves to attenuate harmonics in the transmitter output.
A small capacitance C20 is used to develop some r.f. voltage on diode rectifier V5. The d.c. voltage developped by this diode is fed across resistors R14, R15, R17, R18 and shunt resistor R16 onto the "TEST 2" position of front panel switch S5 as a check on r.f. output during adjustment.

The d.c. voltage from this diode is also added to a negative voltage, adjustable between 0 and -20 Volts, from the front-panel control potentiometer R100 ("TRANSMITTER POWER"). The sum of these counteracting voltages is used as a grid bias for control tube V6.
Control tube V6 has its anode load R22 in common with the screen-grid circuits of r.f. tubes V3 and V4. This arrangement tends to stabilize the r.f. output power to a value determined by the setting of the "TRANSMITTER POWER" potentiometer and provides a smooth control curve over a wide range of powers. Moreover it improves independence from mains voltage and reduces hum and microphony.

2.2. R.f. receiver. (Fig. 2)

Operation:

The receiver r.f. part consists of two identical units, each containing a grounded grid r.f. amplifier V7 (resp. V8) and an anode detector V9 (resp. V10).
The signal received by the antenna passes via the duplexer onto the cathode circuit of V7 (resp. V8) through a matching network C28 - L8 (resp. C29 - L9).
A local oscillator signal, derived from the transmitter master oscillator is added to this input signal through resistor R23 (resp. R24).
Amplified signals are available at V7 (resp. V8) anode and passed on through tuning circuit C34 - L10 (resp. C35 - L11) to detector V9 (resp. V10) input.
This tuning circuit can be adjusted for maximum transfer by varying C34 (resp. C35).
The anode detector is self-biased with cathode resistor R27 (resp. R28). Condensers C36 and C38 (resp. C37 and C39) provide a low-impedance path for r.f. and subcarrier frequencies.
In V9 (resp. V10) anode circuit the incoming P.E. subcarrier frequency signal is recovered and fed to one of the corresponding inputs of the receiver i.f. amplifier.
The mean d.c. anode current of the anode detector V9 (resp. V10) can be checked on the front panel test meter M2 when the test meter switch S4 is set to the "TEST 3" or "TEST 4" position. In this way the amount of r.f. energy fed to the anode detector is indicated, as required amongst others when the interstage circuit C34 - L10 (resp. C35 - L11) is tuned.
For a local oscillator power of about 5 milliWatts applied to the r.f. receiver input terminal, the meter reading is on the average about 5 when the duplexer is correctly balanced.
In the absence of r.f. power the meter reading, showing the idling current of the auto-biased anode detector, is about 3.

2.3. I.f. and a.f. receiver (Fig. 3)

Operation:

This part of the receiver is fully transistorized and silicon transistors are used throughout for maximum thermal stability.
The two subcarrier frequency outputs of the dual r.f. receiver are fed to two corresponding i.f. inputs of the i.f. amplifier. Pre-amplifying stages V11 and V13 of the upper channel in the diagram are identical to stages V12 and V14 of the lower channel. They consist of an input transformer T2, resp.T3, matching the anode detector output impedance in the r.f. receiver to the relatively low input impedance of the grounded base amplifying stage V11, resp. V12. The output of this stage is directly coupled to transistor V13, resp. V14, acting as a phase splitter.
The output from collector and emitter of this phase splitter feeds a phase shifting circuit R45 and C59, resp. R46 and C60. These phase shifters are not alike for each channel, but provide a mutual phase difference of 90°. This arrangement is excellent with respect to constancy of amplitude and mutual phase difference over the required subcarrier frequency band of 50 to 150 kc/s.
The outputs from the phase shifters are combined into a single signal with resistors R47 and R48 and fed to the emitter-follower V15.
V15 drives amplifying stage V16 which contains an emitter resistance R52 providing negative feed-back, and which is selected to adjust the over-all sensitivity of the receiver to a pre-determined value.
The collèctor circuit of V16 contains the tuned circuit L14, C63 and a choice out of three additional tuning condensers C106, C107 and C108, selected by the panel control S6: "subcarrier tuning".
The three center frequencies chosen are respectively 67, 92 and 117 kc/s. The Q-factor of the tuned circuit has been chosen such that an amplitude decrease of 1,5 dB is found at the cross-over points, whilst the 3 dB bandwidth of each tuning curve is 40 kc/s.
The tuned circuit feeds into emitter-follower V17 which drives two amplitude-limiting circuits in cascade. These two circuits are identical and consist of a grounded-emitter amplifier V18, resp. V20, and an emitter-follower V19, resp. V21. Feedback across each circuit is possible via diodes D10 and D11, resp. D12 and D13. This feedback is amplitude-dependent and becomes effective when the output voltage of the amplifier exceeds the conducting threshold of the silicon diodes, i.e. for voltages having a peak-to-peak amplitude of about 0,9 Volts or higher.
This circuit arrangement operates quite effectively, and in order to increase the range of input signals for which

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symmetrical limiting is maintained, two circuits are cascaded.
The final limiting stage V22 is used to provide a high-level square-wave voltage for the cycle-counting type of f.m. detector D17 and D18.
Diodes D14, D15 and D16 are connected to successive stage outputs in order to have a subcarrier amplitude indication on the front-panel mounted meter M3. Using the outputs of three successive stages in this way increases the useful range of amplitude indication and causes the meter deflection to be logarithmic to some extent.
The f.m. detector restores the original audio signal, which is filtered by condenser C81 and inductance L18 before application to transistor V23. Voltage divider R79 and R80 deliver some extra d.c. base bias voltage for transistor V23, which for audio voltages acts as an emitter-follower, feeding the audio volume control R99 (See Fig. 8).
From the volume control two successive stages of audio amplification V25 and V26 and the audio output transformer T5 bring the audio signal up to the required audio level.
Negative feedback by an extra winding on the transformer T5 reduces the distortion and the output impedance of the output stage V26. The audio signal is brought to two headphone jacks in parallel, each intended for 600 Ohms loading.
The collector circuit of transistor V23 contains a tuned circuit T4 and C82 having a resonnant frequency of about 18,5 kc/s. When no subcarrier signal is present, the output of the f.m. detector consists of noise, containing a wide range of frequencies, i.a. also a 18,5 kc/s component.
This component excites the tuned circuit and thus develops a 18,5 kc/s voltage at T4 secundary, ample to drive the normally cut-off transistor V24 into conduction.
With V24 conductive the d.c. coupling between V24 collector circuit and V25 base circuit causes V25 to be non-conducting and therefore non-amplifying.
As soon as a subcarrier signal is applied which approaches the f.m. improvement threshold, the detector noise output decreases rapidly, thereby decreasing the 18,5 kc/s voltage developped across T4 secundary. V24 ceases to be conducting and V25 becomes conducting and therefore amplifying, in this way completing the audio path to the headphone output.
This squelch circuit can be put out of action by short-circuiting T4 secundary with front-panel switch S7: "Squelch-on-off" (See Fig. 8).

2.4. Duplexer. (Fig. 4)

The duplexer allows the use of a single antenna for simultaneous transmission and reception without excessive coupling between transmitter and receiver.
The main element of the duplexing circuit is a 10 dB directional coupler, schematically represented in the lower left hand part of Fig. 4.
This directional coupler is, by its very nature, able to separate signals going from transmitter to antenna from those coming back from the antenna, i.e. the received signals.
A sample of the transmitted power appears in the left hand arm of the lower coupler line and is dissipated there in resistors R101 - R106.
A sample of the received signal appears in the right hand arm of the lower coupler line and is fed to the receiver input. In fact the principle of automatic duplexing requires a dual channel receiver, having two inputs, to which the received signal must be fed with a mutual phase difference of 90° between them. This phase shift is provided for in the duplexer by the inclusion of a quarter wave extra length of line in the upper receiver channel. The input impedance of each input channel is 50 ohms, so that the two channels in parallel offer a 25 ohms load, which is matched to the 50 ohms directional coupler output by a quarter-wave section having a characteristic impedance of 35 ohms.
The signals reaching the receiver input will in general, besides the desired received signals, also contain an amount of transmitter power reflected from the antenna itself, due to a mismatch which is mainly governed by reflections from objects in the vicinity of the antenna.
In order to cancel these undesired reflections a matching circuit is included in the transmission line connection to the antenna. This matching device is represented in the upper left hand part of Fig. 4 and can be controlled from the front panel by two knobs designated as M1 and M2.
With these knobs controllable amounts of reactance can be shunted across the line at spatially separated points.
An eventual slightly incorrect termination of the directional coupler arm containing the resistors R101 - R106 will also result in an amount of transmitter power being reflected there and travelling to the receiver input through the lower duplexer line. Provided this mismatch is not too serious, it can also be cancelled by adjustment of the matching knobs in the transmission line to the antenna.
In order to facilitate the adjustment of the matching controls, a direct meter reading is provided, indicating the amount of mismatch in the antenna transmission line.

For this purpose a second directional coupler has been added, having a coupling ratio of 30 dB, and illustrated in the right hand upper part of Fig. 4.
This directional coupler has on one output side a terminating resistor R107 which has a pre-set matching circuit L19, L20, C110, C111 and C112. This termination dissipates the sample of transmitted signal. The sample of locally reflected signal appearing at the other duplexer output side is fed to silicon crystal detector D19 via a matching circuit L21, C113, C114 and C115. The r ectified signal is fed onto front-panel meter M2 when the front panel switch S4 is in the "MISMATCH"position. The meter circuit is protected against excessive current by silicon diode D20. This circuit allows the adjustment of the front-panel matching controls for a low meter reading and thereby a low value of reflection from the antenna.
The entire duplexer r.f. circuit is made of strip-line, built into two layers as indicated on the circuit diagram.
The r.f. connections from the duplexer to the remainder of the equipment are made by strip-line-to-coaxial transitions in the duplexer assembly and coaxial 50 ohms cables outside the duplexer. The length of some of these cables is critical, viz. the length of the cables running to the receiver inputs. One requirement is the preservation of a mutual quarter-wave difference in path length from antenna to the two receiver input connections.
Another requirement is that the total electrical length of transmission line and cable from one receiver input connection to the other, via the duplexer, should be a whole number of wavelengths, otherwise the local oscillator voltage impressed on both receiver inputs cannot exactly be in phase. Furthermore these two cables may not be exchanged, otherwise their relative phase would not be in accordance with the 90° phase difference introduced in the i.f. amplifier amongst the two channels before addition to a single signal.
The correct length and way of connection is given in Fig. 8: "Internal wiring transmitter cabinet".

2.5. Antenna.

The antenna, when built up to maximum size, consists of an array of 4 Yagi's in broadsize configuration, The array is mounted on a center support with swivel head onto a base plate, and can be aimed in all directions, irrespective of the polarization used. The gain of this array over an isotropic dipole is about 19 dB. The dimensions are about 1 x 1 x 1 meters.
All Yagi elements as well as the T-supports are matched to 50 ohms.
In cases where operating space is limited the array can be used in a reduced form, thereby sacrificing about 2dB in gain. The array then consists of two Yagi's in broadside whilst the correct match to 50 ohms is preserved.

A further reduction in size is possible by using only one Yagi antenna. The match is preserved again, but about 5 dB in gain is sacrificed as compared with the full-sized array. The reduced arrays still have all aiming facilities and can be built up from the antenna components packaged in the suitcase containing the transmitter cabinet.
Only when the full-sized antenna is required, antenna components from the other suitcase will have to be added.

2.6. Passive element.

It is envisaged that the equipment will be operated with a choice out of two types of P.E.'s, viz. the fully passive type and the battery-aided type. In this connection a description will be given of both types. Due to the fact that these units are embedded in and protected by epoxy-resin and therefore are generally not accessible, hardly any service or maintenance work is to be expected, so that only a very brief description of each for the sake of understanding the general operation can be considered adequate. A more extensive treatment of these items can be found in the research reports ad hoc.
Both types use a single dipole antenna ~~of some form~~ and a silicon crystal detector in conjunction with the transistorized subcarrier and audio frequency circuit part.
The type of antenna used depends on circumstances and requirements for installation.
One type consists of a symmetrical wire dipole and detector unit, to be used with a separate subcarrier- and audio-frequency part. Another type combines these two units into one integrated model which uses metal tubing for the dipole elements of such an inner diameter that all the circuitry is mounted inside one of the dipole halves. These types might be referred to as center-fed and end-fed types respectively.
The microphones to be used may be the miniaturized Shure MC30 or the higher-fidelity type B microphone, also depending on circumstances in each installation.

2.6.1. Operation of the fully-passive P.E. (Fig. 5)

Transistors V29 and V30 are connected together as an oscillator of the multivibrator variety, the load and coupling impedance of output transistor V30 being the internal impedance of the crystal detector at the d.c. terminals.
The frequency of oscillation is governed by a number of factors such as transistor parameters, the time constants of RC coupling means, the crystal impedance and to the largest extent by inductance L24.
Optimum values are determined during production at the laboratory.
A more or less rectangular waveform with a nominal subcarrier frequency of 100 kc/s is generated across the d.c. terminals

of the crystal detector, thus affecting the desired impedance modulation of the crystal detector.
Some of the factors governing the frequency of the oscillator are the output impedance offered by transistor V28 and the base voltage of transistor V29. Both of these values can be modulated simultaneously by application of an audio voltage to the base circuit of transistor V28. This audio voltage is the microphone voltage after amplification by transistor V27. In this way a subcarrier frequency modulation is obtained by the acoustical signals reaching the microphone.

2.6.2. Operation of the battery-aided P.E. (Fig. 6)

Transistor V31 and transformer T6 are the main elements of the 100 kc/s subcarrier frequency oscillator circuit.
The circuit is of the blocking-oscillator variety, the frequency being governed mainly by the transformer inductance and the amplitude of the switching current flowing through transistor V31. The average current flowing through transistor V31 passes through transistor V32, which acts as a variable emitter resistance for transistor V31. Any variation of this resistance will cause a corresponding frequency variation of the oscillator V31.
Frequency modulation of the subcarrier frequency, as required, is thus obtained by applying the microphone voltage to the control electrode of V32, being the base. For increased microphone sensitivity this microphone voltage is amplified by transistor V34 before application to V32 base.
The base current of oscillator V31 flows through T6 secundary and on to V33 base. V33 is thus switched from an isolating into a conducting state by a frequency-modulated nominal 100 kc/s frequency.
Resistor R113 governs V31 bias and V33 drive.
The collector circuit of V33 contains an auto-transformer T7 for providing an optimum match to the load, consisting of the r.f. modulating crystal and the associated biasing network R115 - C128.
Resistor R114 reduces ringing in the output transformer.
Condenser C124 is shunted across the battery terminals in order to preserve a low-impedance a.c. path under all circumstances.
Transistors V34 and V32 are connected as emitter resistances for transistors V33 and V31 respectively. The voltage drop across transistors V34 and V32 is about 25% of the battery voltage and is their d.c. supply voltage at the same time.
Condensers C127 and C125 take care of the necessary a.c. separation for audio and/or subcarrier frequencies between transistors V34 - V33 and V32 - V31.
This d.c. configuration has been adopted in order to economize on battery drain.

2.7. Power supply. (Fig. 7)

Operation:

Transformer T1 has a primary divided into 3 sections.
One section (10 Volts) is permanently series-connected in the mains circuit, whilst the two remaining sections (0 - 95 - 105 - 115 Volts) are either connected in parallel or in series by switch S1 and added to the first section.
This gives nominal mains voltage possibilities of either 105 - 115 - 125 Volts or 200 - 220 - 240 Volts respectively, from which deviations of + or -6% are of no consequence.
The smaller voltage steps are selected by switch S2 which chooses a tap on the 0 - 95 - 105 - 115 Volt sections.
In addition S2 has an open-circuit-position which serves as an "OFF"-position for the mains circuit.
Switch S1 is provided with a press-button lock which reduces the danger of an accidental switching action.
A correct mains voltage setting is indicated by meter M1 on the front-panel, which will then read somewhere in the green area. Meter M1 has an expanded scale and the green area covers mains voltage deviations of -6% to +6% with respect to the nominal value. Larger deviations from the nominal value will deflect the meter into a red area. The rectifier circuit for meter M1 contains a regular silicon diode D2 and a series-connected Zener-diode D1. The fixed voltage drop of about 6,5 Volts across the Zener diode is responsible for the suppressed-zero expanded scale characteristic of meter M1.
The mains circuit is protected against excessive current by fuses F1 and F2.
Application of mains voltage to the equipment is only possible when the power unit and the transmitter-receiver cabinet are interconnected, in which case an electrical interlock completes the power unit mains circuit (pins 1 and 9 of the multi-way plug).
A neon pilot lamp N1 is connected across one of the 105 Volts taps on the transformer T1.

The secundary of T1 has a 6,3 Volts section for heater supply of transmitter and receiver and a 400 Volts center-tapped high voltage section.
The latter feeds a bridge rectifier D3, D4, D5, D6 via a tumbler type "H.T."-switch S3 and fuses F3 and F4. "H.T."indication is provided for by neon pilot lamp N2.
The positive 400 Volts line from the rectifier is filtered by choke L12 and electrolytic condensers C48, C49, C50 and C51.
A positive voltage of 200 Volts is taken from T1 secundary center-tap and filtered by choke L13 and electrolytic condensers C49 and C51.
The negative output connection of the rectifier is returned to ground via Zener diodes D7, D8 and D9. The voltage drop

across these diodes is virtually current-independent and amounts to about 6,7 Volts per unit. This voltage drop is used to provide voltages of -6,7 Volts and -20 Volts. Resistor R34 is used to equalize and reduce the power dissipated by D7, D8 and D9.

3. SERVICING

All voltages mentioned are measured with a 20.000 ohms/Volt multi-range meter.

3.1 Transmitter.

Servicing:

The perforated top cover of the transmitter can be taken off after removing 4 machine screws, located above the r.f. tube brackets. This will detune the tuned circuits, but after readjustment normal operation can be resumed. Transmitter radiation will be worse in this case. The horizontally mounted buffer and poweramplifier tubes can be removed by first loosening the screws fixing the tuned circuits to the anode-pins. After that the wing nut under the tuned circuit condensor is loosened a few turns and the complete tuning circuit is withdrawn. The tube can be exchanged now and the reverse procedure is followed. The screws fixing the anode pins and the tuned circuit should be fastened quite firmly without applying too much stress to the anode pins however. Always aim to have the tube brackets perpendicular to the transmitter chassis.
Acces to the oscillator compartment under the transmitter chassis can be gained by first removing the cabinet left-hand side panel and then the covering lid of the screening box. Whenever necessary the master oscillator frequency can be readjusted by taking the extension rods of the line circuit between a pair of pliers and at the same time melting the drop of solder fixing them with a soldering iron. A slightly rotating movement of the pliers will be helpful.
The low-pass filter, the power control circuit wiring and the voltage distributing circuits are mounted under the transmitter chassis. Acces to them is in almost all cases sufficient when only the rear cover of the cabinet is removed. Under circumstances it might be necessary to remove the transmitter chassis as a whole by loosening 5 sheet metal screws on the chassis under the perforated cover.
When testing and aligning the transmitter it is advisable to load the r.f. output properly, either by a high power resistive load or by an antenna. In both cases the duplexer matching controls on the front panel should be set for a low meter reading on the "MISMATCH" test position.

EXITER

~~Transmitter~~ voltages and currents

	minimum output power	maximum output power
H.T. input voltage	450 V	395 V
Oscillator anode voltage (junction R2 - C3)	240 V	210 V
V3 grid current	0,7 mA	0,35 mA
V3 screen grid voltage (junction R5 - C7)	40 ~~35~~ V	140 ~~125~~ V
V4 grid current	0,3 mA	5,5 mA
V4 screen grid voltage (junction R12 - C14)	70 ~~65~~ V	265 ~~230~~ V
Power control voltage (junction R15 - R16)	0 V	-21 V
R.f. output power at antenna plug	1.5 < 0,4 W	50 > 30 W
V3 anode current (through R6)	17 ~~15~~ mA	45 ~~40~~ mA
V4 anode current (through R13)	25 ~~20~~ mA	210 ~~190~~ mA

3.2. R.f. receiver.

Servicing:

Access to the tubes, the r.f. input circuit, the subcarrier frequency output circuit and part of the voltage supply wiring can be gained by removing the bottom lids of the r.f. units. This can be done best with the aid of a slender or pointed tool, such as a small screwdriver or a scratch awl, working up the lid successively from a few corners.
The r.f. amplifier tube is of the light-house type, the grid-disc of which is threaded. A special tool is supplied to screw this tube in position or to unscrew same. Always handle this tube very carefully and avoid any unnecessary stress on the metal-to-glass seals.
When putting in the tube, it will be helpful to apply some heat-resistant grease to the thread. Heater connections for this tube are soldered directly to pins nr. 2 and 7 of the base.
Access to the interstage circuits can be gained by the removal of the top lids of the r.f. units. To do this it will be necessary first to remove 4 flat-headed screws from the front-panel after which the r.f. assembly as a whole can be hinged backward and downward. The connecting cables and wires are long enough to do this without unsoldering. The unit is thus left fully operative.
The ceramic tubular trimmer condenser, used for interstage tuning (C34 resp. C35) is of a mechanically delicate construction and should be handled accordingly.
When for any reason it would be necessary to take off the coaxial cables, be sure to put them in again in the correct way as shown on the drawing Fig. 8: "Internal wiring transmitter cabinet".

R.f. receiver voltages

H.t. voltage	170 V	to	195 V
	(dependent on transmitter power)		
Cathode voltage V7, V8	2,7 V	to	3,1 V
Cathode voltage V9, V10	12 V	to	> 100 V
Anode current V7, V8	18 mA	to	20,5 mA
Anode current V9, V10	1,2 mA	to	>10 mA

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3.3. I.f. and a.f. receiver.

Servicing:

The i.f. and a.f. receiver is housed in a screening box inside the main cabinet. The cover of this screening box can be pulled off. The unit is assembled in a flat plane for maximum accessibility.
The voltages at various test points as given in the table provide a check on the correct operation of each successive stage. These voltages represent an average for the first production series of equipment, but minor discrepancies may be expected due to transistor and component tolerances.
When going over the component list, it will be noticed that a small number of components is indicated as a range of values, rather than a single value. In these instances the numerical value of the component has been selected individually in order to cope with component and (in most cases) transistor tolerances. D.c. working conditions as given in the list of voltages at test points should be restored if any change of transistors or resistors would make this necessary.
Overall gain can be normalized with resistor R52. The gain should be such that the subcarrier amplitude test meter reading is between 1 and 2 on the scale for internal noise only, whilst the f.m. improvement threshold is reached for a meter reading of between 3 and 3,5. This threshold signal is indicated by a sharp drop in the noise output in the headphones when the subcarrier signal from a P.E. or another signal source is increased slightly. When the squelch circuit is operative this threshold is indicated by the activation of the audio circuit.
The indication of the subcarrier amplitude meter on noise alone should not vary appreciably when the "subcarrier tuning" switch S6 is used.
Whenever doubt arises as to the correct operation of the subcarrier tuning circuit, a check on this can be made as follows:
A signal source, adjustable over the frequency band of 50 to 150 kc/s and having a suitable output attenuator, is connected to the i.f. input terminals. This connection should be made via a condenser of about 0,01 mF and a resistor of about 22.000 ohms connected between the signal source and each of the 2 input terminals, separately or both at the same time.
An oscilloscope is connected to V17 emitter for observation of the subcarrier waveform and amplitude. Disconnections on any other part of the circuit are not necessary, unless the connecting wires to the measuring gear have an appreciable length.
The input signal is adjusted to such a value that the signal on the oscilloscope is well above the noise level, whilst

waveform distortion is not apparent. The 3 successive tuning positions of the "subcarrier tuning" control should now give -1,5 dB response relative to the maximum value for frequencies of 55 and 80 kc/s, 80 and 105 kc/s and 105 and 130 kc/s respectively.
The correct operation of the limiter stages can be checked by observing the waveforms on V22 collector and V21 and V19 emitter for a progressively increasing value of subcarrier input. These waveforms should retain their 50 - 50 symmetry quite well over a wide range of input voltages. If not, check d.c. voltages and/or test the diodes D10, D11, D12 and D13.

<u>I.f. and a.f. receiver voltages and currents</u>

Supply voltage	-6,7 V at 55 mA
V11 and V12 base	-2,0 V
V11 and V12 collector	-2,7 V
V11 and V12 emitter	-1,5 V
V13 and V14 collector	-4,5 V
V13 and V14 emitter	-2,0 V
V15 base	-4,2 V
V15 emitter	-3,7 V
V16 base	-1,8 V
V16 emitter	-1,2 V
V16 collector	-5,0 V
V17 emitter	-4,4 V
V18 base	-1,6 V
V18 emitter	-1,1 V
V18 collector	-3,2 V
V19 emitter	-2,5 V
V20 base	-1,6 V
V20 emitter	-1,1 V
V20 collector	-3,2 V
V21 emitter	-2,5 V
V22 base	-0,5 V
V22 collector	-3,0 V
R79 and R80 junction	-1,1 V
V23 emitter	-1,4 V
R85 and R86 junction	-0,23 V
V25 emitter	-1,6 V
V24 collector	-3,4 V
V25 base	-2,2 V
V25 collector	-2,7 V
V26 base	-0,6 V

3.4. Duplexer.

Servicing:

In general it is advisable to return the duplexer to the laboratory when it fails to meet the required performance. In the laboratory a number of points has been adjusted accurately, both mechanically and electrically. A full description of this procedure however would fall outside the scope of this manual.
When eventually taking out the duplexer for shipment, leave all coaxial cables fixed at the duplexer side and loosen them from the other end. Unscrew the antenna receptacle ring from the cabinet without removing the cable from the receptacle itself.
The duplexer as a whole is fixed to the front panel with 3 machine screws on the front panel side.
One failure which can be cured in the field however is an eventual deterioration of the crystal detector D19 providing the mismatch indication. Deterioration of the crystal will show up in insensitivity of indication of the exact matching point of the duplexer. This crystal can be reached from the bottom side with a pair of long-nosed pliers after the removal of the rear cover of the transmitter cabinet.
The duplexer contains two pre-set adjustments to be found in a recess just beside the crystal detector D19 and to be reached from the bottom. With these screws the correct zero mismatch indication on the front-panel meter can be adjusted.
The procedure for this adjustment is as follows:
The coaxial cable supplying l.o. power from the transmitter master oscillator to the r.f. receiver is loosened at the receiver end, thereby assuring that the receiver is fed only with r.f. energy originating in the duplexer. The antenna terminals are preferably loaded with a resistive power load, or otherwise with an antenna in a relatively free position and pointing away from the equipment. A medium amount of transmitter power is then fed into the load or the antenna.
The test meter switch is set to the "TEST 3" or "TEST 4" position, thereby measuring the anode current of the anode detectors of the r.f. receiver. Adjusting the matching controls on the front panel for minimum meter reading, at the same time adjusts the duplexer for minimum reflected transmitter power. When the optimum position is reached, the test meter switch is set to "MISMATCH", after which the test meter should read a value close to zero. When this is not the case, the reading can be brought to zero with adjustment of the pre-set adjustment screws mentioned before. These screws have been locked with a drop of coil cement, and should be relocked again after the adjustment. To finish, reconnect the l.o. power coaxial cable to the r.f. receiver.

3.5. Antenna.

Servicing:

It is recommended that in case of mechanical failure or electrical misbehaviour the antenna shall be returned to the laboratory for servicing. A mutual comparison between the elements of the suspected antenna and/or another antenna of unsuspected performance might help to locate the defective element, and thereby reduce the bulk of the shipment.
For this purpose the transmitter and the field strength monitor may be used advantageously, thereby also keeping an eye on the balancing controls of the duplexer, which might show a severe mismatch of one of the elements tested, thereby indicating a fault. It should be remembered however that in these instances a fairly unobstructed location of the element under test is necessary.

3.6. P.E.

These units are supplied in a form which renders them virtually inaccessible for repair in case a defect might occur. The servicing section of this manual therefore is restricted mainly to a test which will enable the user to check the operation of the individual units with an eye on rejecting those which might have become defective.
Another item to be treated in this section is the correct P.E.-antenna adjustment under conditions, where a specific surrounding plays its' part.
Test bench set-ups able to supply a host of figures and facts about each of the elements of the P.E. tend to be rather elaborated. They are described in detail in the research reports ad hoc, but are considered to be outside the scope and intention of this manual. A more practical way is a comparative test of a number of P.E.'s under simulated actual conditions. This may give a fair judgement of the P.E. as a whole.
To this end a suitable area and positions must be found. It is recommended to choose a path relatively clear of obstacles and preferably perpendicular to intervening walls or ceilings. This will be helpful in setting up a r.f. field at the P.E. site having a low level of reflected and scattered waves, thus providing a more homogenious r.f. field strength distribution at the P.E. position and making its actual position less critical. This can be checked by using the field-strength monitor supplied with the equipment and observing the standing-wave pattern at the P.E. location.
The distance chosen and the amount of attenuation on the path should be well within the range of the equipment and should on the other hand not be so small that minimum power at the base station still brings in the P.E. signal very strongly.

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In many cases it will be helpful to reduce the base station antenna size to the minimum.
The procedure to be followed is like this:
The base station equipment is adjusted for normal operation, duplexer matching checked, and the left-hand meter switch is switched as required between the "subcarrier amplitude" position and the "TEST 2" position. In the latter case the transmitter power is indicated.
Be sure that only one P.E. at a time is in the target area and place the different P.E.'s consecutively at exactly the same location. Eventually unused P.E.'s should be wrapped in metal foil for sure non-operation and/or for protection.
With a P.E. to be checked in position the transmitter power is adjusted to a point where the subcarrier signal is reducing most of the noise, viz. the point where the squelch circuit becomes operative. The reading of the meter in "TEST 2" position is noted. Now the transmitter power is increased until another, higher reading on the subcarrier amplitude meter is reached, e.g. 5,0 or 6,0. The meter reading in the "TEST 2" position is noted again.
In each case the "subcarrier" tuning must be in the optimum position. Listening via headphones at the base station equipment to some source of acoustical signal at the P.E. site, e.g. constant talking of a person or a broadcast receiver will give a judgement of the acoustical sensitivity and quality of the P.E. under test.
It will be clear that the P.E. requiring the smallest value of transmitter power for a given subcarrier amplitude is the most sensitive one with respect to r.f. excitation, and thus superior in view of attainable range.
This series of tests can be repeated for a number of P.E.'s and a comparison of figures will show which one is insensitive with respect to r.f. excitation, which one is inferior as an acoustical device, which one is greatly off correct subcarrier frequency, etc.
Most differences in r.f.sensitivity can be traced down to an inferior silicon crystal detector in the P.E. or an incorrect antenna length. The test method described will help to locate and solve the trouble.
When acoustical inefficiency is apparent, first try another microphone.
Low r.f. and acoustical sensitivity with a battery-aided P.E. might indicate a run-down battery. Better check batteries before the test begins.
If possible, actual installations should be checked also in this way, in particular when the material surrounding the P.E. is suspected to influence the antenna tuning. Otherwise a simulated surrounding should be used to find the optimum antenna length. In these cases the length of the dipole elements should be changed carefully, e.g. by differences of 1 cm at a time.

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An additional check on the battery-aided model is the following. The battery drain at 1,5 V battery voltage is about 170 micro-amps, decreasing to 80 micro-amps for a battery voltage of 1,0 V. It should be realised that if the crystal is defective or down the above mentioned current values may be quite different.

3.7. Power supply.

Servicing:

Fuses F1, F2, F3 and F4 and neon pilot lamps N1 and N2 can be exchanged from the outside of the unit by unscrewing their black bakelite caps.
F1, F2 and N1 are located at the left-hand side of the front-panel, F3, F4 and N2 at the right-hand side.
Access to the interior can be gained by removing 4 sheet-metal-screws, 2 from the bottom and 2 from the top side of the perforated cover, which after that slides off.
Further access can be gained by removing 3 sheet-metal-screws on the front panel for each rectifier unit, which then can be moved aside.
When dismantled like this, the unit is still fully operative, but self-protection will call for the utmost care in handling.
A special warning is valid for the cans of the electrolytic condensers, which are isolated from the chassis and which may have a potential of about 200 Volts with respect to the chassis.
A peculiarity in connection with fuses F3 and F4 should be mentioned here. When fuse F4 is defective, no 200 Volts will be supplied to the receiver, but the 400 Volts circuit is still operative for the transmitter. When on the other hand fuse F3 is blown, both the 200 Volts and the 400 Volts supplies are present as long as the total current drawn by transmitter and receiver is not too high. Due to the half-wave rectification in that instance, increased hum and decreased efficiency may occur. The use of maximum power from the transmitter will cause the fuse F4 to blow also.
Whenever the indication of the front-panel meter, showing the mains voltage, might become incorrect, this could be cured by shunting either resistor R29 or resistor R30 with another resistor to be determined experimentally. The meter should be in the middle of the green area when an a.c. voltage with a value as indicated by the switches on the front-panel is applied. Comparison with a high-grade a.c. voltmeter is recommended.

Power supply voltages and currents

Mains voltage nom. 220 V 50 c/s

Heater voltage, pins 6-7-8 to 14-15-16:

H.t. off	6,75	V
H.t. on, min.power	6,7	V
H.t. on, max.power	6,6	V

Transformer h.t. secondary:

H.t. off	412	V	c.t.
H.t. on, min.power	400	V	c.t.
H.t. on, max.power	385	V	c.t.

Plug pin no. 13	21	V	min.power		21	V	max.power	
Plug pin no. 5	6,7	V	"	"	6,7	V	"	"
Plug pin no. 3	195	V	"	"	170	V	"	"
Junction C48-C49-L13	215	V	"	"	190	V	"	"
Plug pin no. 11	450	V	"	"	390	V	"	"
Junction C48-L12	460	V	"	"	410	V	"	"

D.c. resistance transformer primary 115 V 5,2 ohms and 6,0 ohms

D.c. resistance transformer primary 10 V 0,4 ohms

D.c. resistance transformer secondary 400 V c.t. 47 ohms

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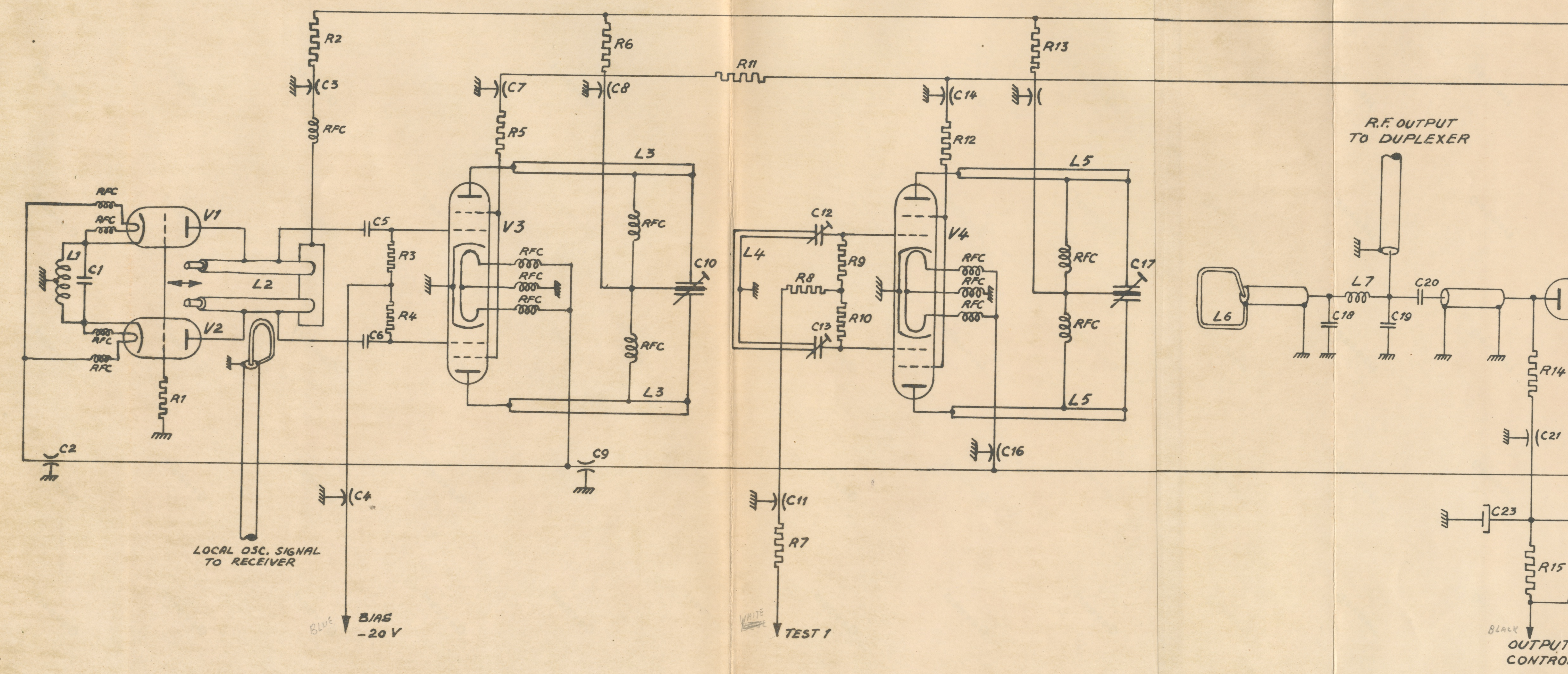
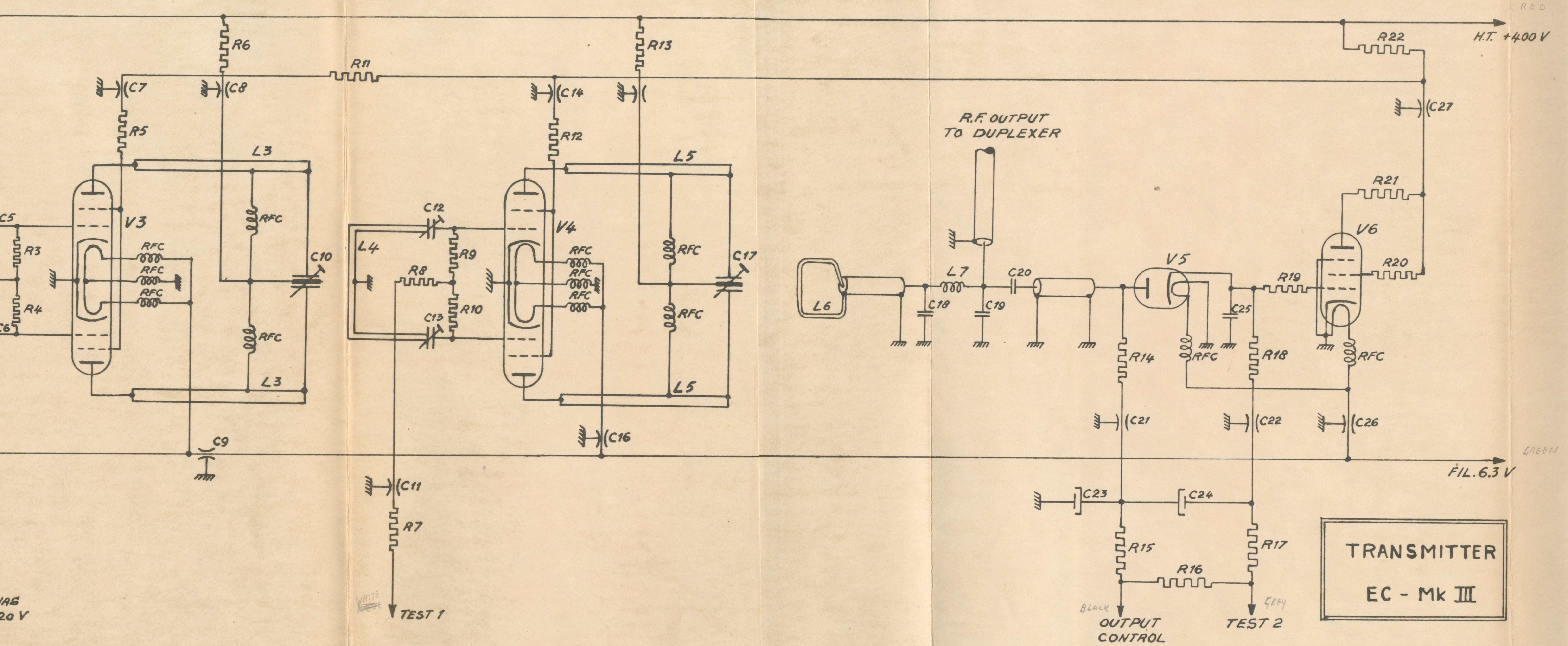
3.8. Wiring and cables.

A wiring diagram of the transmitter cabinet is given in Fig. 8. This diagram is more or less in the form of a map, showing the rear view of the cabinet with the rear cover taken off.
Units and components can be located by this drawing, as well as the correct connection and length of the coaxial cables between duplexer and receiver, which is critical.
If the necessity arises to exchange one of the panel controls or meters of the transmitter cabinet, it will generally be necessary to move the i.f. and a.f. receiver unit somewhat. In this case 5 screws, located inside the i.f. and a.f. receiver box, used to fix it to the 5 metal pillars on the front panel, are removed, and some connections are unsoldered as necessary. Care should be taken not to deform the r.f. chokes too much.
The tranamitter cabinet and the power supply unit are interconnected by a multicore cable, fixed to the power supply unit at one end, and having a plug for connection to the transmitter cabinet at the other end. Also fixed to the power supply unit is the mains cord at one end. This arrangement speeds up the setting-up procedure, saves space and decreases the chances of contact failure in plugs.
Transmitter cabinet and antenna are interconnected by a 50 ohms coaxial cable, about 7 feet in length. For minimum losses a relatively large diameter of cable has been chosen. With a small reduction in range but with an increase in operating facility, this cable may be replaced by a smaller-diameter one of the same characteristic impedance.



R2
R6
R11
R13
C3
C7
C8
C14
RFC
R5
R12
R.F. OUTPUT
TO DUPLEXER
L3
L5
RFC
V1
C5
V3
C12
V4
L1
C1
R3
C10
L4
R9
C17
L2
R8
L7
C20
V2
R4
C6
C13
R10
L6
C18
C19
R1
R14
C2
C9
C16
C21
C4
C11
C23
LOCAL OSC. SIGNAL
TO RECEIVER
R7
R15
BLUE
BIAS
-20 V
WHITE
TEST 1
BLACK
OUTPUT
CONTRO



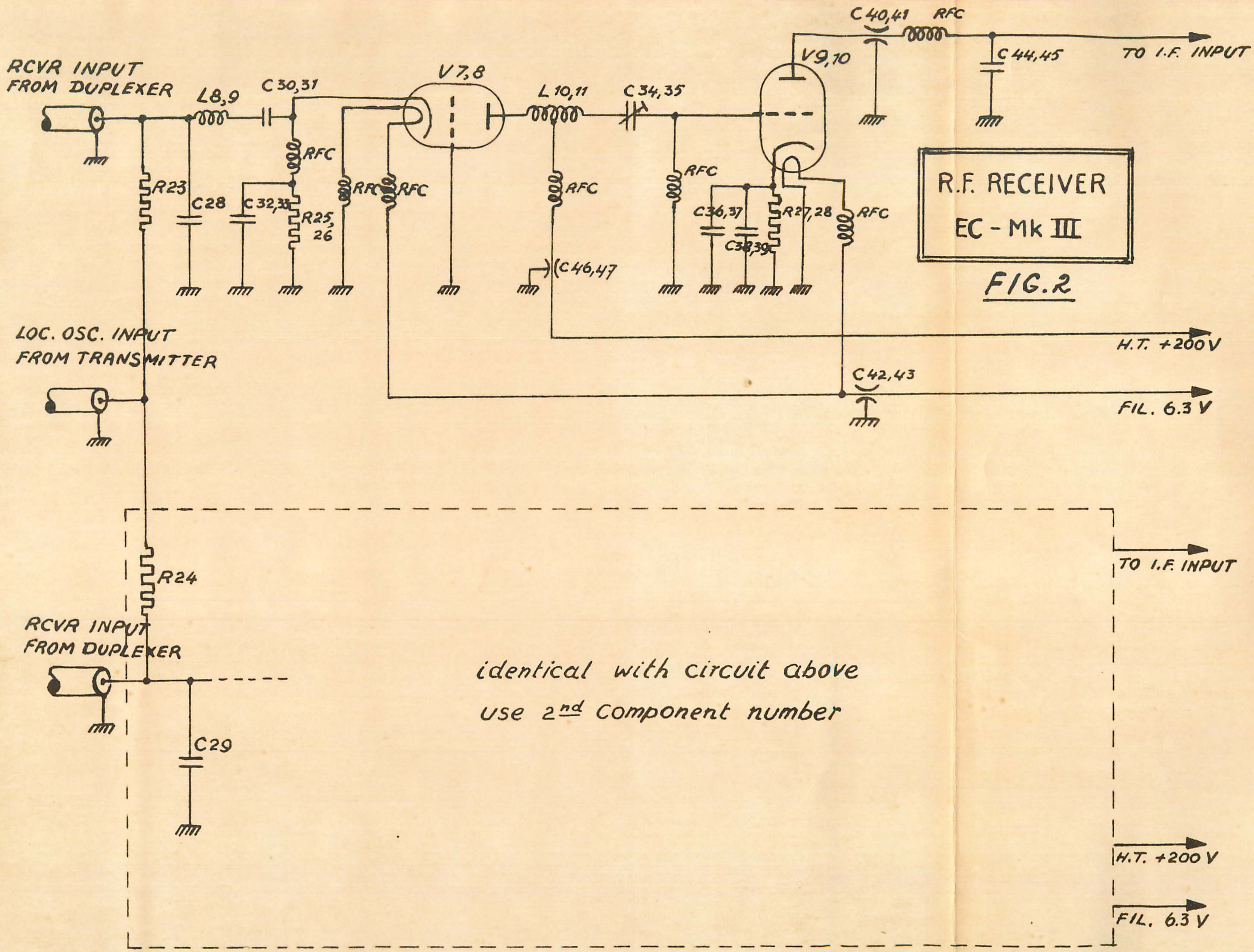
TRANSMITTER

EC - Mk III

FIG.1

COMPONENTS LIST FOR FIG. 1

V1, V2	EC81				Philips
V3	QQE03/20				"
V4	QQE06/40				"
V5	5726				"
V6	E180F				"
R1	6.800 ohms	$\frac{1}{4}$ W	10%		Vitrohm
R2	4.700 ohms	6 W	5%	wire-wound	Painton
R3, R4	18.000 ohms	$\frac{1}{4}$ W	10%		Vitrohm
R5	1.500 ohms	1 W	10%		Erie
R6	130 ohms	1 W	10%		"
R7	100 ohms	$\frac{1}{2}$ W	10%		"
R8	1.000 ohms	$\frac{1}{2}$ W	10%		Resista
R9, R10	10.000 ohms	1 W	10%		"
R11	47.000 ohms	1 W	10%		Erie
R12	820 ohms	1 W	10%		"
R13	12 ohms	1 W	10%		"
R14	2.200 ohms	$\frac{1}{2}$ W	10%		"
R15	1.200 ohms	$\frac{1}{2}$ W	10%		"
R16	180 ohms	$\frac{1}{2}$ W	10%		"
R17	1.800 ohms	$\frac{1}{2}$ W	10%		"
R18	18.000 ohms	1 W	10%		"
R19	330 ohms	$\frac{1}{2}$ W	10%		"
R20	100 ohms	$\frac{1}{2}$ W	10%		"
R21	33 ohms	$\frac{1}{2}$ W	10%		"
R22	15.000 ohms	6 W	5%	wire-wound	Painton
C1	1 pF	20%		ceramic	Stettner
C2, C3, C4, C7, C8, C9, C11, C14, C15, C16, C21, C22, C26, C27	560 pF	-20+50%		feed-through	Rosenthal
C5, C6	4.7 pF			ceramic	Philips
C10, C17	split-stator tuning capacitor, see text				
C12, C13	trimmer condenser 2 - 6 pF tubular ceramic				Philips
C18, C19	low pass filter capacitance, see text				
C20	1.25 - 2 pF individually selected				Stettner
C23	electrolytic condenser 25 mF 25 V				Philips
C24	electrolytic condenser 16 mF 12.5 V				"
L1	oscillator cathode tuning coil				
L2	oscillator anode tuning circuit				
L3	buffer anode tuning circuit				
L4	power amplifier gird tuning circuit				
L5	power amplifier anode tuning circuit				
L6	output coupling loop				
L7	low pass filter inductance				

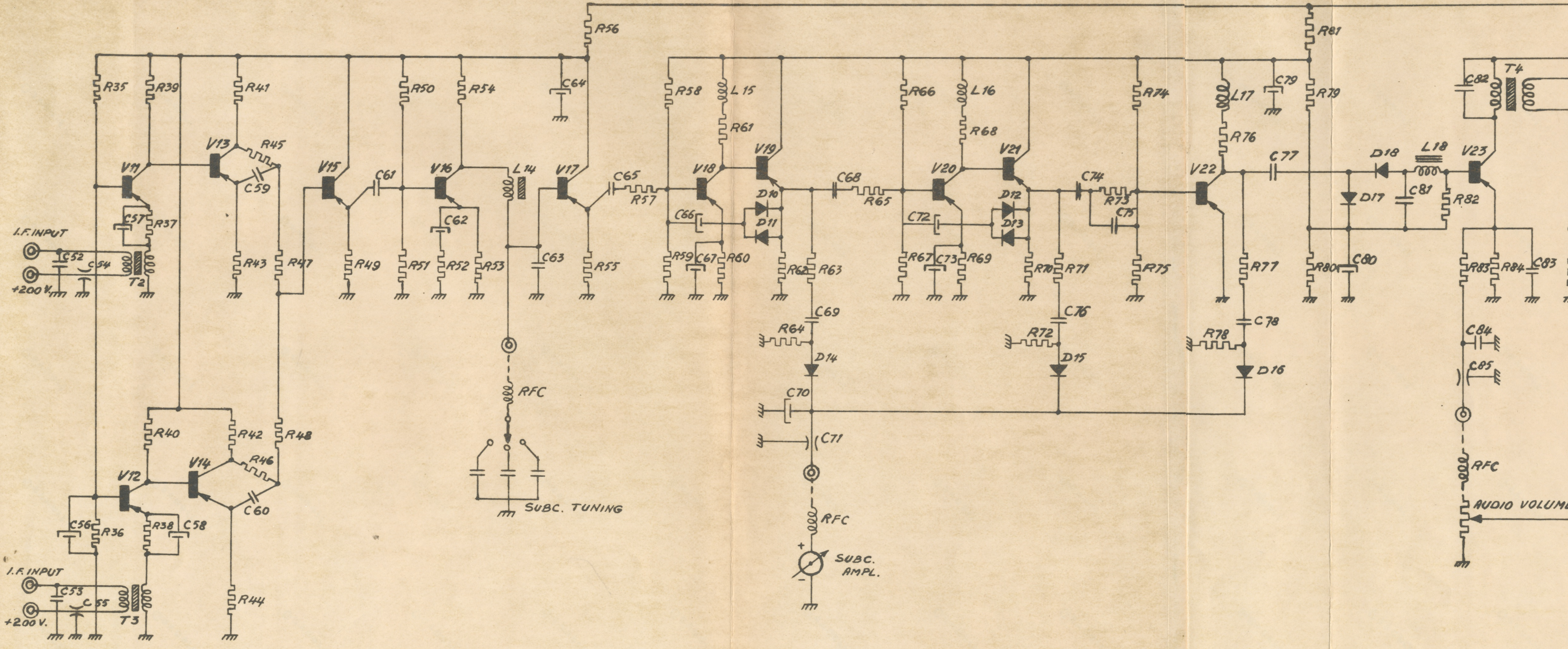


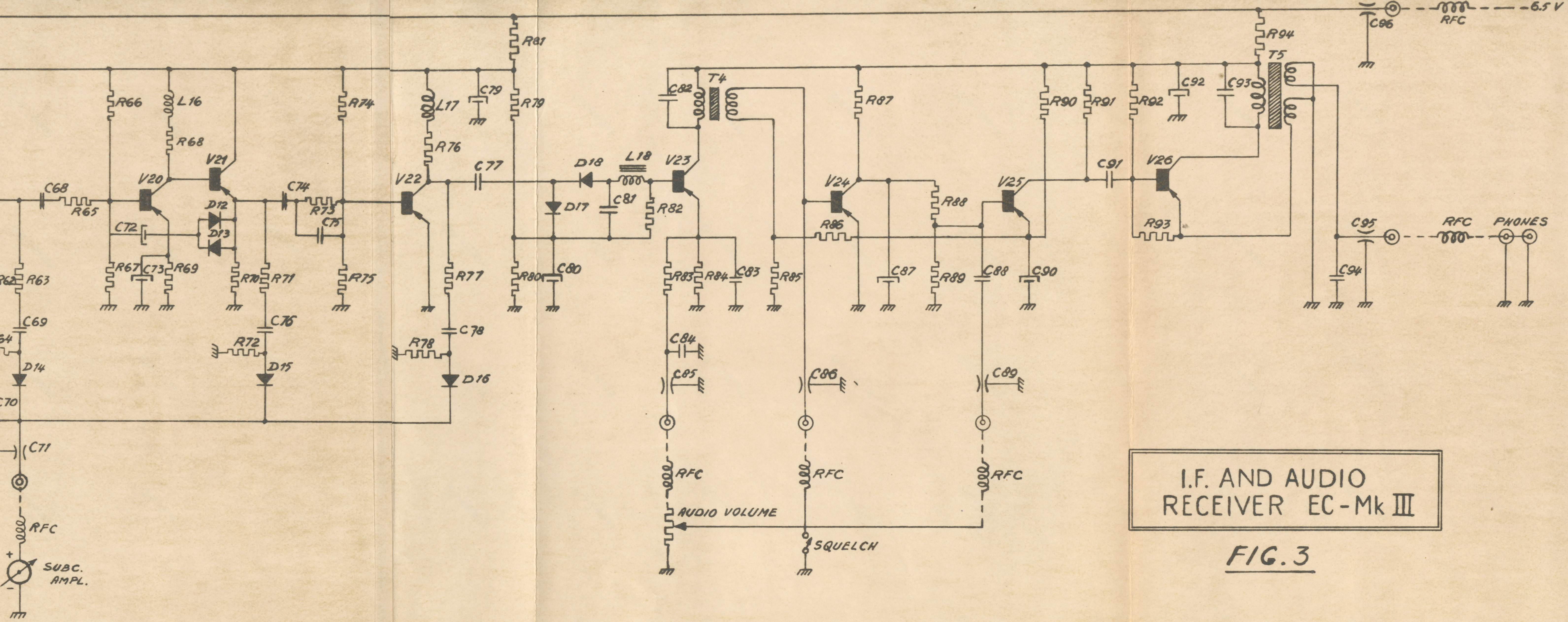
R.F. RECEIVER
EC - Mk III

FIG. 2

COMPONENTS LIST FOR FIG. 2

V7, V8	EC56 (lighthouse type)				Philips
V9, V10	EC81				"
R23, R24	180 ohms	¼ W	10%		C.G.E.
R25, R26	150 ohms	¼ W	10%		"
R27, R28	10.000 ohms	½ W	10%		Resista
C28, C29	4.7 pF	ceramic			Philips
C30, C31	2200 pF	ceramic			"
C32, C33	120 pF	ceramic			"
C34, C35	trimmer condenser 2 - 6 pF tubular ceramic				"
C36, C37	10.000 pF	125 V	20%	paper	WIMA
C38, C39	560 pF	ceramic			Philips
C40, C41	15 pF	ceramic feed-through			Stettner
C42, C43, C46, C47	560 pF	-20+50%	ceramic feed-through		Rosenthal
C44, C45	33 pF	ceramic			Philips
L8, L9	input tuning inductance				
L10, L11	interstage tuning inductance				


R56
R35
R39
R41
R50
R54
C64
R81
R79
C79
L17
R76
C82
T4
V13
R45
V11
C59
V15
C61
V16
L14
V17
C65
R57
R58
L15
R61
V18
V19
D10
D11
C66
C68
R65
R66
L16
R68
V20
V21
D12
D13
C72
C74
R73
C75
R74
V22
C77
D18
L18
V23
D17
C81
R82
C57
R37
I.F. INPUT
C52
C54
+200 V.
T2
R43
R47
R49
R51
C62
R52
R53
C63
R55
R59
C67
R60
R62
R63
R67
C73
R69
R70
R71
R75
R77
R80
C80
R83
R84
C83
C69
R64
D14
C76
R72
D15
C78
R78
D16
C84
C85
C70
C71
RFC
R40
R42
R48
V12
V14
R46
C60
C56
R36
R38
C58
SUBC. TUNING
RFC
SUBC. AMPL.
RFC
AUDIO VOLUM
I.F. INPUT
C53
C55
+200 V.
T3
R44



I.F. AND AUDIO
RECEIVER EC-Mk III

FIG. 3

COMPONENTS LIST FOR FIG. 3

R35	3300 ohms	10%	½ W carbon resistor	Rosenthal
R36	1500-1800 ohms		"	"
R37	1200 ohms		"	"
R38	1200 ohms		"	"
R39	2700 ohms		"	"
R40	2700 ohms		"	"
R41	390 ohms		"	"
R42	390 ohms		"	"
R43	390 ohms		"	"
R44	390 ohms		"	"
R45	1500 ohms		"	"
R46	560 ohms		"	"
R47	4700 ohms		"	"
R48	4700 ohms		"	"
R49	1800 ohms		"	"
R50	18000 ohms		"	"
R51	8200 ohms		"	"
R52	56 - 470 ohms		"	"
R53	560 ohms		"	"
R54	680 ohms		"	"
R55	3900 ohms		"	"
R56	15 ohms		"	"
R57	470 ohms		"	"
R58	18000 ohms		"	"
R59	8200 ohms		"	"
R60	560 ohms		"	"
R61	1500 ohms		"	"
R62	390 ohms		"	"
R63	1200 ohms		"	"
R64	3300 ohms		"	"
R65	390 ohms		"	"
R66	18000 ohms		"	"
R67	8200 ohms		"	"
R68	1500 ohms		"	"
R69	560 ohms		"	"
R70	390 ohms		"	"
R71	1500 ohms		"	"
R72	3300 ohms		"	"
R73	330 ohms		"	"
R74	approx. 6800 ohms		"	"
R75	680 ohms		"	"

COMPONENTS LIST FOR FIG. 3 (CONT.)

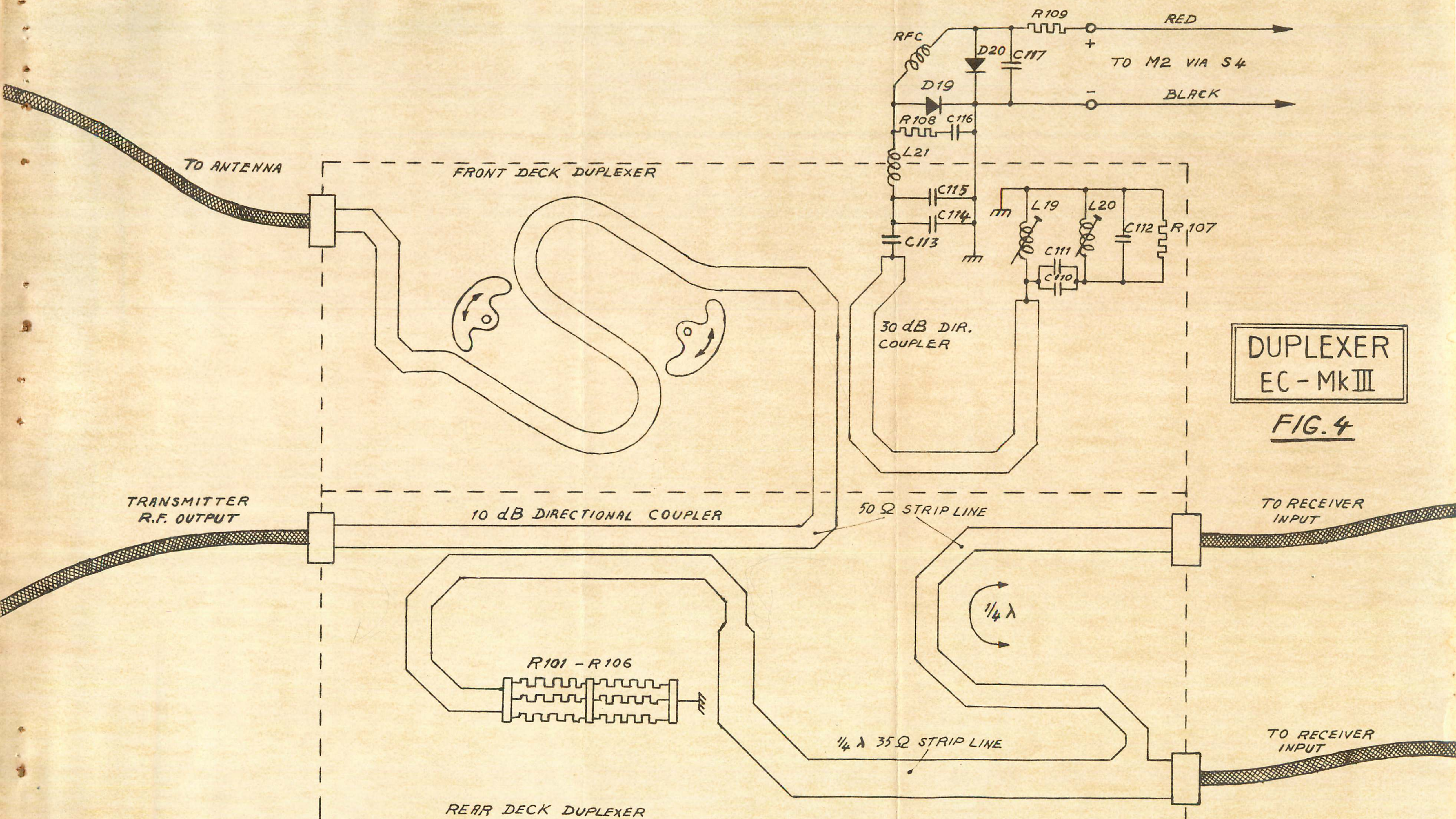
R76	2700 ohms	10%	½W carbon resistor	Rosenthal
R77	18000 ohms		"	"
R78	3300 ohms		"	"
R79	2700 ohms		"	"
R80	560 ohms		"	"
R81	15 ohms		"	"
R82	27000 ohms		"	"
R83	470 ohms		"	"
R84	6800 ohms		"	"
R85	68 ohms		"	"
R86	330 ohms		"	"
R87	39000 ohms		"	"
R88	10000 ohms		"	"
R89	47000 ohms		"	"
R90	1200 ohms		"	"
R91	3900 ohms		"	"
R92	39000-82000 ohms		"	"
R93	18000 ohms		"	"
R94	15 ohms		"	"
C52	100 pF		ceramic condenser	Philips
C53	100 pF		" "	"
C54	560 pF		feed-through condenser	Rosenthal
C55	560 pF		" "	"
C56	5 mF	12.5 V	electrolytic condenser	Philips
C57	5 mF	12.5 V	" "	"
C58	5 mF	12.5 V	" "	"
C59	2700- 4200 pF		mica-molded condenser	"
C60	820 - 1300 pF		" "	"
C61	0.01 mF		paper condenser	WIMA
C62	5 mF	12.5 V	electrolytic condenser	Philips
C63	56 pF		ceramic condenser	"
C64	50 mF	12.5 V	electrolytic condenser	"
C65	4700 pF		paper condenser	WIMA
C66	5 mF	12.5 V	electrolytic condenser	Philips
C67	5 mF	12.5 V	" "	"
C68	0.01 mF		paper condenser	WIMA
C69	0.01 mF		" "	"
C70	5 mF	12.5 V	electrolytic condenser	Philips
C71	560 pF		feed-through condenser	Rosenthal
C72	5 mF	12.5 V	electrolytic condenser	Philips
C73	5 mF	12.5 V	" "	"
C74	0.01 mF		paper condenser	WIMA
C75	0.01 mF		" "	"

COMPONENTS LIST FOR FIG. 3(CONT.)

C76	0.01 mF		paper condenser	WIMA
C77	120 pF		mica-molded condenser	Philips
C78	0.01 mF		paper condenser	WIMA
C79	50 mF	12.5 V	electrolytic condenser	Philips
C80	50 mF	"	" "	"
C81	620 pF		mica-molded condenser	"
C82	6800 pF		styroflex condenser	Leclanché
C83	0.05 mF		paper condenser	WIMA
C84	0.01 mF		" "	"
C85	560 pF		feed-through condenser	Rosenthal
C86	560 pF		" "	"
C87	8 mF	25 V	electrolytic condenser	Philips
C88	0.22 mF		paper condenser	WIMA
C89	560 pF		feed-through condenser	Rosenthal
C90	50 mF	12.5 V	electrolytic condenser	Philips
C91	0.1 mF		high-K ceramic condenser	L.C.C.
C92	50 mF	12.5 V	electrolytic condenser	Philips
C93	6800 pF		styroflex condenser	Leclanché
C94	0.05 mF		high-K ceramic condenser	L.C.C.
C95	560 pF		feed-through condenser	Rosenthal
C96	560 pF		" "	"
V11 - V26	OC460		silicon transistors	Intermetall
D10	S32		silicon junction diodes	"
D11	"		" " "	"
D12	"		" " "	"
D13	"		" " "	"
D14	OA81		germanium diodes	Philips
D15	"		" "	"
D16	"		" "	"
D17	"		" "	"
D18	"		" "	"
L14	3 mH inductance, 170 turns 0.3 mm enamelled copper wire, Ferroxcube core D 18/12, air gap 0.3 mm			Philips
L15	1.5 mH		inductance	
L16	1.5 mH		"	
L17	0.6 mH		"	
L18	1.5 H		inductance type S 192	Fortiphone
T2, T3	10:1		transformer, primary 200 turns 0.2 mm DSC, secondary 20 turns, 0.2 mm DSC, primary inductance approx. 50 mH, Ferrox cube core D 18/12, no air gap	Philips

COMPONENTS LIST FOR FIG. 3 (CONT.)

T4	1:1 transformer, primary 295 turns 0.2 mm enamelled copper wire, secondary 295 turns 0.09 mm enamelled copper wire, bifilar winding, primary inductance 10 mH, Ferroxcube core D 18/12, air gap 0.3 mm	Philips
T5	1 : 0.35 : 0.13 transformer, primary 1000 turns 0.1 mm enamelled copper wire, telephone output secondary 350 turns 0.16 mm enamelled copper wire, feedback tertiary 130 turns 0.10 mm enamelled copper wire, Ferroxcube core D 25/16, no air gap	"



DUPLEXER
EC - Mk III

FIG. 4

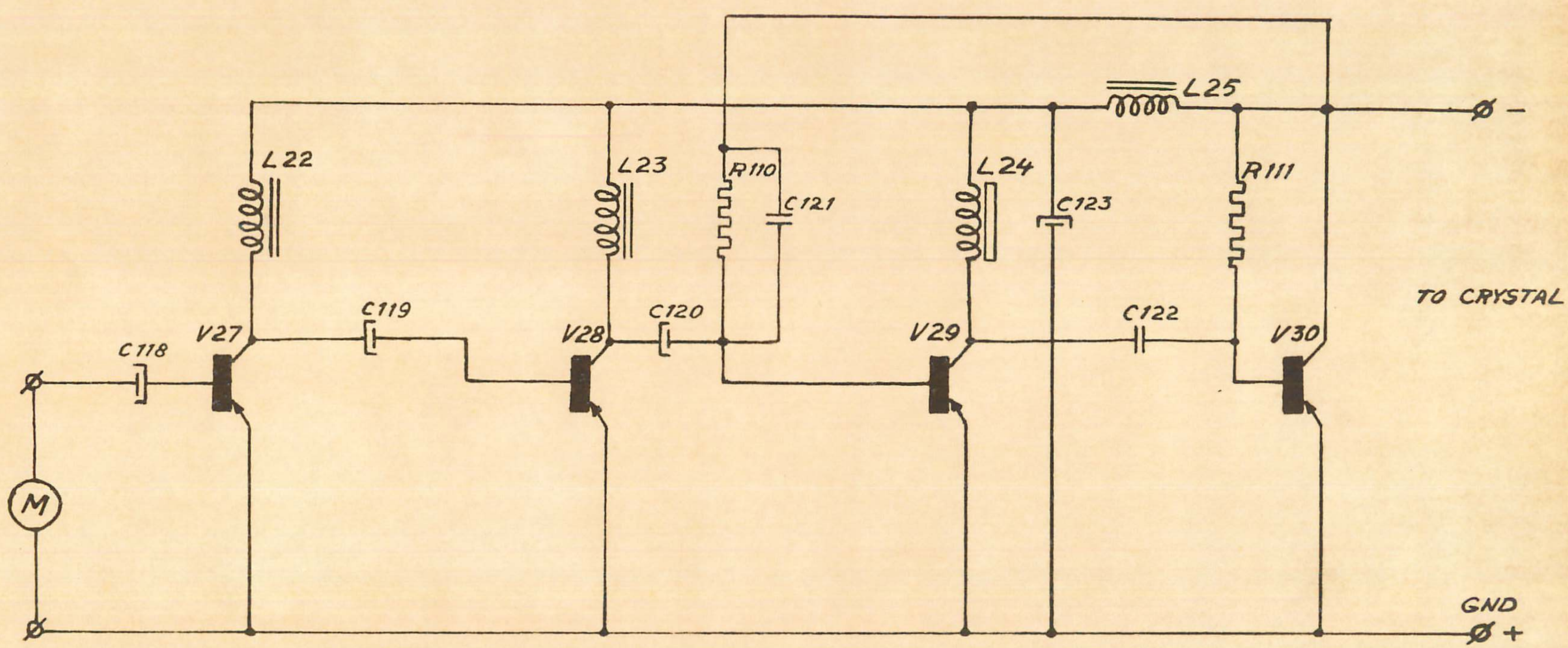
COMPONENTS LIST FOR FIG. 4

R101	68 ohms	10%	1 W	carbon	resistor	Erie
R102	68 ohms	"	" "	"	"	"
R103	68 ohms	"	" "	"	"	"
R104	68 ohms	"	" "	"	"	"
R105	68 ohms	"	" "	"	"	"
R106	68 ohms	"	" "	"	"	"
R107	47 ohms	"	$\frac{1}{2}$ W	"	"	"
R108	390 ohms	"	" "	"	"	Resista
R109	2700 ohms	"	" "	"	"	"

C110	4.7 pF	20%	ceramic	condenser	Philips
C111	3.3 pF or 4.7 pF	"	"	"	"
C112	3.3 pF or 4.7 pF	"	"	"	"
C113	1200 pF	"	"	"	"
C114	2.2 pF	"	"	"	"
C115	3.3 pF	"	"	"	"
C116	1200 pF	"	"	"	"
C117	1200 pF	"	"	"	"

L19	variable	inductance
L20	"	"
L21	inductance	

D19	CS2A	silicon r.f. detector	B.T.H.
D20	S32	silicon diode	Intermetall

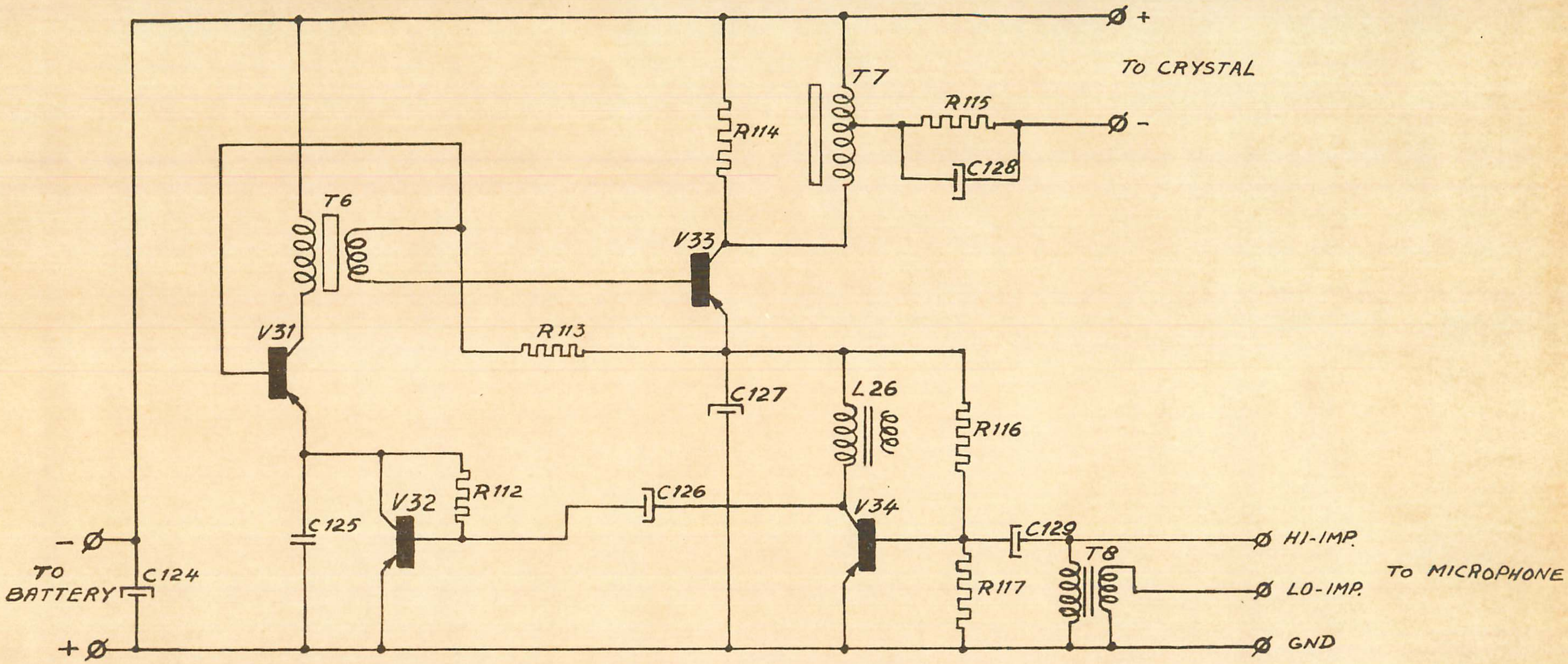


PE EC-Mk III

FIG.5

COMPONENTS LIST FOR FIG. 5

R110	15.000 to 33.000 ohms	10%	$\frac{1}{4}$W	carbon resistor	LCC
R111	33.000 ohms	"	"	" "	"
C118, C119, C120	2 mF	6 V		tantalum condenser	Philips
C121, C122	1000 pF			mica condenser	LCC
C123	10 mF	3 V		electrolytic condenser	Philips
V27	OC71	transistor			Philips
V28	OC71	"			"
V29	OC44	"			"
V30	OC44	"			"
L22	1.5 H	150 ohms		inductance	Fortiphone
L23	1.5 H	150 ohms		"	"
L24	6 mH			Ferroxcube-cored inductance	Philips
L25	1.5 H	150 ohms		inductance	Fortiphone



PE EC-Mk III
(BATTERY AIDED)

FIG. 6

COMPONENTS LIST FOR FIG. 6

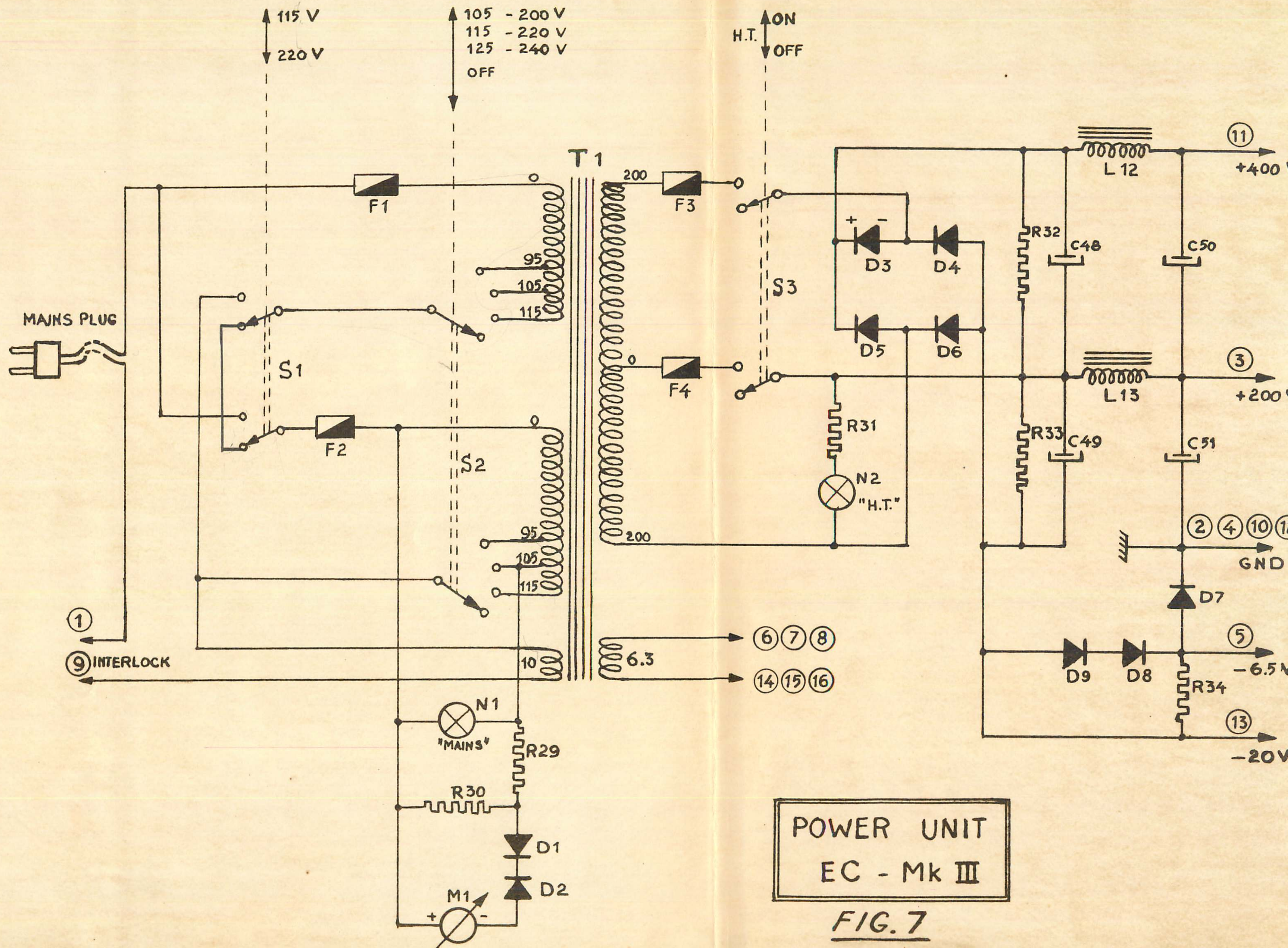
R112	220.000 - 330.000 ohms	10%	¼ W	carbon resistor	LCC
R113	22.000 - 33.000 ohms	"	" "	" "	"
R114	18.000 ohms	"	" "	" "	"
R115	390 ohms	"	" "	" "	"
R116	22.000 - 33.000 ohms	"	" "	" "	"
R117	15.000 ohms	"	" "	" "	"

C124	2 mF	6 V	tantalum condenser	Philips
C125	5000 pF		ceramic condenser	TCC
C126	2 mF	6 V	tantalum condenser	Philips
C127	4 mF	6 V	" "	"
C128	2 mF	6 V	" "	"
C129	0.25 mF	3 V	" "	"

V31	OC44	transistor	"
V32	"	"	"
V33	"	"	"
V34	"	"	"

L26 6 H - 900 ohms inductance (primary type S1 transformer) Fortiphone

T6	transformer,	primary 170 turns 0.11 mm enamelled copper wire secundary 85 turns 0.11 mm enamelled copper wire on Ferroxcube core D 14/8, no air gap	Philips
T7	transformer,	450 turns 0.09 mm enamelled copper wire tapped at 180 turns on Ferroxcube core D 14/8, air gap 0.04 mm	Philips
T8	transformer,	300 ohms to 6000 ohms impedance type S 1175	Fortiphone

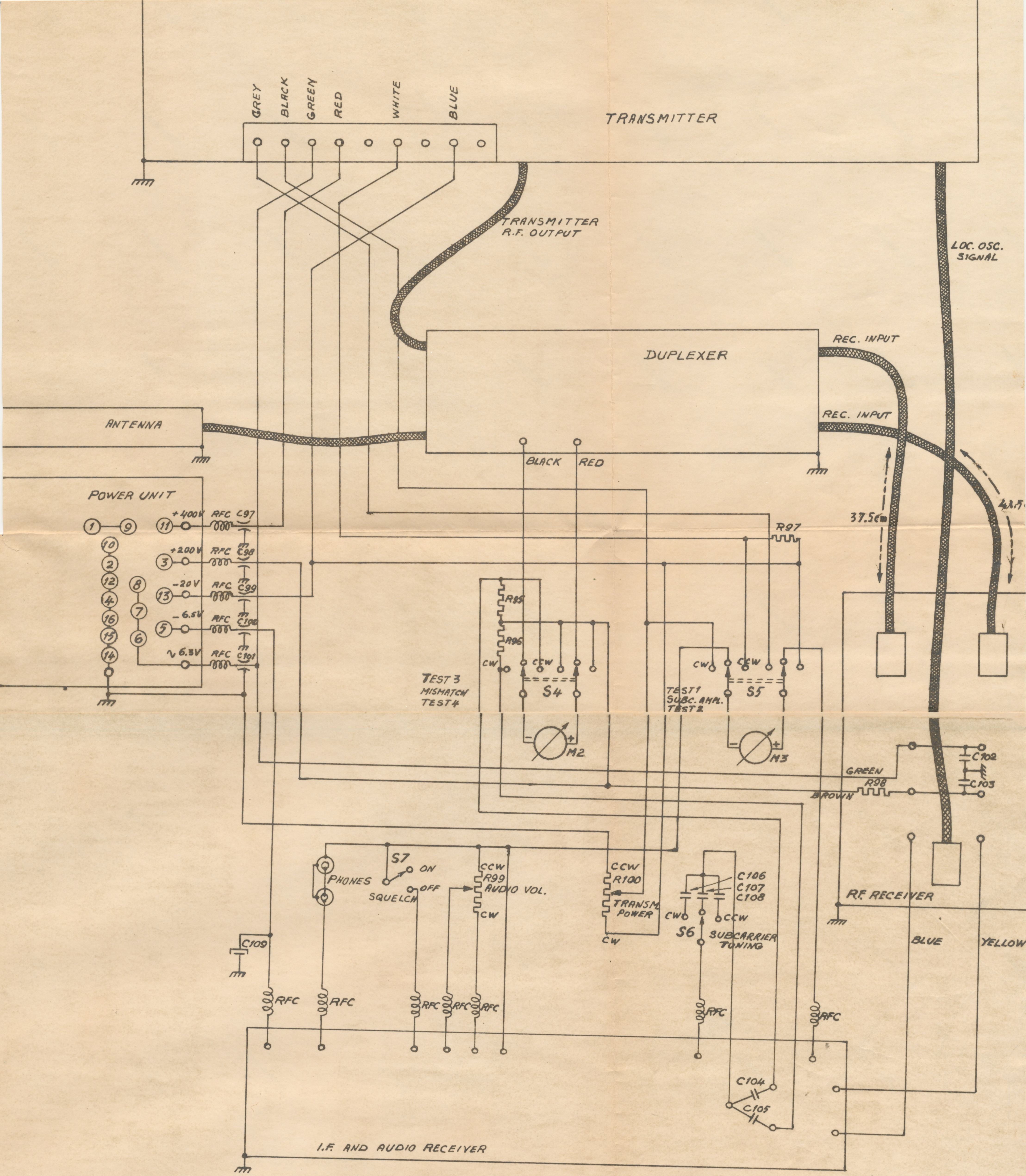


POWER UNIT
EC - Mk III

FIG. 7

COMPONENTS LIST FOR FIG. 7

R29	18.000 ohms	2 W	2%	high stability		Welwyn
R30	1200 ohms	6 W	5%	wire wound		Painton
R31	68.000 ohms	1 W	10%			Erie
R32, R33	120.000 ohms	1 W	10%			"
R34	330 ohms	1 W	10%			"
C48, C49, C50, C51	2 x 50 mF 400 V in parallel electrolytic condenser					Philips
L12	choke	3 H	300 mA	70 ohms		Weseman
L13	choke	5 H	65 mA	425 ohms		Philips
D1	Zener diode Z6 (6,5 V)					Intermetall
D2	Silicon diode S32					"
D3, D4, D5, D6	selenium rectifiers E250 C130, (250 V R.M.S. - 130 mA D.C.), 2 in parallel					Siemens
D7,D8,D9	Zener diode ZL6 (6.5 V)					Intermetall
F1, F2	Slow-blow fuse 2A					Schurter
F3, F4	" " " 0.5 A					"
N1, N2	Neon pilot lamps NE51					G.E.
S1	switch with lock d.p.d.t.					Bulgin
S2	Ceramic wafer switch 4 pos. 2 poles					Mayr
S3	tumbler switch d.p.s.t.					Bulgin
T1	transformer, input 2 x (95 + 10 + 10) V and 1 x 10 V output 2 x 200 V and 1 x 6.8 V					Weseman
M1	meter type 225 F.S.D. 500 μA					Ernest Turner



INTERNAL WIRING
TRANSMITTER CABINET
EC-Mk III (REAR VIEW)

FIG. 8

COMPONENTS LIST FOR FIG. 8

R95	27 ohms	½ W	selected	2%	Erie
R96	27 ohms	"	"	"	"
R97	15 ohms	"	"	"	"
R98	100 ohms	"	10%		"
R99	5000 ohms	potentiometer log.			Vitrohm
R100	10000 ohms	potentiometer wire-wound lin.			Colvern
C97, C98, C99, C100, C101	560 pF	-20 + 50%	500 V	feed-through ceramic	Rosenthal
C102	0.1 mF	-20 + 50%	35 V	ceramic	LCC
C103	0.02 mF	20%	500 V	paper	WIMA
C104, C105	0.15 mF	20%	500 V	paper	WIMA
C106	220-330 pF	molded silver- mica			Philips
C107	560-620 pF	" " "			"
C108	1100-1300 pF	" " "			"
C109	250 mF	12.5 V	electrolytic cond.		"
M2, M3	moving coil, model 225, f.s.d. 100 μA, 1200 ohms				Ernest Turner
S4	2 ctcts,	3 pos.,	wafer type		Mallory
S5	"	"	" "		"
S6	1 ctct.	3 pos.,	" "		"
S7	tumbler	s.p.s.t.			Bulgin