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# SIGNAL GENERATOR CT406

**GENERAL AND TECHNICAL INFORMATION**

Ministry of Defence

FOR USE IN THE

ROYAL AIR FORCE

(Prepared by the Ministry of Technology)

# SIGNAL GENERATOR CT406

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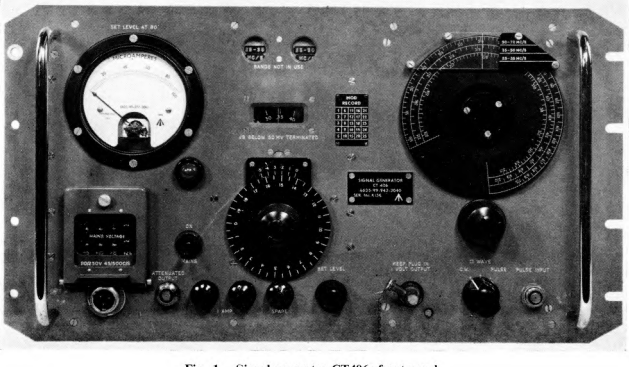


**Fig. 1. Signal generator CT406: front panel**

## GENERAL AND TECHNICAL DESCRIPTION

### Function

This instrument is an intermediate frequency c.w. signal generator for use in aligning and testing i.f. amplifiers. It has facilities for internal square-wave modulation and for external pulse gating of the output.

### Brief description (fig. 1)

**2.** The instrument is primarily intended for bench use and is contained in a standard case. It may, if required, be mounted in a standard 19 in. rack.

**3.** Two outputs are provided, 1 VOLT OUTPUT for unattenuated output into a 75-ohm termination, and ATTENUATED OUTPUT fed via a calibrated piston attenuator having a 75-ohm output impedance. The attenuated output level is indicated on two scales, one for coarse control and the other for fine control. The coarse scale, from 0–100dB in 5dB steps, appears in a window situated above the fine scale, which is calibrated in 0·5dB steps and covers the range 0–20dB. The fine scale can be read accurately to 0·1dB by means of a vernier scale.

**4.** Three coil sets are supplied, each set comprising an oscillator and an output coil assembly. The coil sets not in use are stowed in a compartment behind the front panel, with the oscillator coil frequencies shown through two windows in the panel. A microammeter is used in conjunction with a SET LEVEL control to adjust the generator output to the correct reference level relative to the calibrated scales.

**5.** The instrument incorporates a PULSE INPUT socket and a switch that allows the output to be pulsed from a negative external pulse or modulated by an internally generated square wave.

**6.** A power lead and coaxial output lead are provided.

### Specification

**7.** Frequency coverage

| | |
|---|---|
| Range 1 | 25–35MHz |
| Range 2 | 35–50MHz |
| Range 3 | 50–70MHz |
| Square wave modulation | 1kHz. |
| External pulsed input | 10V minimum negative, output pulse amplitude same as c.w. level. |
| High output | 1V into 75-ohm load. |
| Low output | 0–100dB down to 50 millivolts delivered into a 75-ohm load. |
| Power input | 110–125V or 185–250V, 50–500Hz single-phase. |
| Dimensions and weight | |
| Height | 12¼in. (31 cm.) |
| Length | 19¾in. (50 cm.) |
| Depth | 11¼in. (28·5 cm.) |
| Weight | 60lb. (27·3 kg.) |

### Installation

**8.** After unpacking, check the instrument for damage in transit and check the action of the controls. Check the meter for freedom of movement by means of the mechanical set-zero screw, then re-set to zero.

**9.** The unit is normally supplied in a case for bench use. However, if it is required to be rack-mounted, the case must be removed. This reveals the rack mounting holes and also releases a safety microswitch that disconnects the supply. If this mounting is adopted, provision must be made for closing this microswitch or shorting its terminals. Care must be taken to disconnect the supply if internal adjustments are to be made to the instrument.

**Note . . .**

*In the case of certain racks, insertion of the unit will automatically close the microswitch.*

*Power input adjustment*

**10.** Before connecting the power supply, ensure that the adjuster panel at the front of the instrument is correctly set to suit the local supply voltage.

*Coil changing*

**11.** To change the operating frequency band, proceed as follows :—

(1) Disconnect the power supply, then remove the case by releasing the two Dzus fasteners (turn 90° counter-clockwise) at the top.

(2) Spring open the large clips on the screening box and remove the lid.

(3) Select the oscillator coil covering the frequency range required. Unplug the oscillator coil in circuit and replace with the one selected. Stow the unused coil so that its frequency range shows through the front panel window.

(4) Remove the inner screening box lid, then unplug transformer in circuit and replace with the transformer covering the same frequency range as the oscillator coil. Stow the unused transformer in the space vacated by the transformer to be used.

(5) Replace the lid of the inner screening box. Replace the lid of the outer screening box and refit the case.

(6) Reconnect the power supply.

**Caution . . .**

*Handle the unprotected output coils with care, as displacement of the windings will result in loss of calibration.*

## Operation

*Controls* (fig. 1)

**12.** There are five operating controls on the front panel; their functions are as follows :—

| | |
|---|---|
| (1) Frequency | Calibrated rotary dial having three scales covering the frequency ranges. |
| (2) Output selector switch | Three-position rotary switch selecting:<br>C.W.<br>SQUARE WAVE C.W. modulated by a 1kHz square wave.<br>PULSE, external pulse gating. |
| (3) SET LEVEL | For setting the microammeter to the reference level, i.e. 80 microamps. |
| (4) Output attenuator | Rotary output control calibrated 0–100dB on two scales. |
| (5) Power switch | Toggle switch controlling the power input. |

In addition, three coaxial sockets are provided for 1 VOLT OUTPUT, ATTENUATED OUTPUT and PULSE INPUT.

*C.W. operation*

**13.** Ensure that the impedance presented at the signal generator output terminals is 75 ohms, as the output calibration is on this basis. The generator output impedance is nominally 75 ohms, which results in approximately 3dB increase in output when unterminated. The output calibration is correct when the SET LEVEL control is adjusted to maintain a meter indication of 80 microamps. The output voltage of the generator varies slightly with frequency so it is advisable to check this setting when making large changes of frequency.

**14.** With the SET LEVEL control set as above, an output of 0–100dB down at 50 millivolts can be obtained from the ATTENUATED OUTPUT socket when this is terminated by 75 ohms. In addition to this, a fixed output of 1 volt (nominal) into 75 ohms can be obtained from the 1 VOLT OUTPUT socket.

**Note . . .**

*When not in use, the* 1 VOLT OUTPUT *socket must be terminated by its load plug. This is essential both to prevent radiation and to maintain correct calibration of the attenuated output.*

*Square wave modulation*

**15.** With the selector switch set to C.W. adjust the SET LEVEL control as described in 'C.W. operation', then switch to SQUARE WAVE modulation. The output of the generator will then be square-wave modulated at approximately 1kHz and 1:1 mark-to-space ratio, the output amplitude during the mark period being identical with the normal C.W. output of the generator. As r.f. output is now present only for approximately half the time, the SET LEVEL meter will indicate approximately 40 microamps, slightly more or less if the mark/space ratio of the square wave generator is slightly greater or less than 1: 1. Whatever the meter now indicates, is the level that should be maintained over the whole tuning range, since the mark/space ratio remains constant.

*External pulse modulation*

**16.** For external pulse modulation, a pulse input of between 10V and 50V amplitude, negative-going, is required for satisfactory modulation. There is no p.r.f. limitation and pulse widths of up to 20 microseconds are acceptable. The gating system functions by causing the input pulse to control the bias gate to the output stage.

**17.** The level should be set by returning the selector switch to C.W.

## Circuit description (fig. 6)

*Power supply*

**18.** 440–0–440V a.c. from the power transformer T7 is applied to a full-wave thermionic rectifier V6 and the d.c. output is smoothed by the choke input filter L9, C33. A negative line is also obtained from the same source via the metal rectifiers MR3, MR4, connected across the supply, in reverse polarity to V6. This supply is smoothed by the choke input filter L8, C32 and the voltage is stabilized against large changes in load current (due to the operation of V1), by the neon stabilizers V7, V8 and resistor R26.

**19.** Stabilization of the positive line is provided by the triode-connected series valve V9 functioning as a variable impedance in the supply line, with the impedance controlled by the shunt valve V10. Changes in the positive line voltages are detected by V10 control grid, which is connected across the positive and negative lines via the potentiometer R29, R30, R31. The voltage changes appear amplified at V10 anode, which is directly coupled to the grid of the series valve V9, and thus regulate the impedance of this valve.

**20.** The capacitor C34 ensures that rapid fluctuations of the h.t. line potential are passed directly to V10 grid, instead of through the integrating network formed by R29, R30 and the stray capacities at V10 grid.

**21.** Three l.t. windings on T7 supply the valve heaters. One winding supplies the heaters of the h.t. thermionic rectifier and series valve V9, the cathodes of which are at h.t. potential. A separate winding supplies V1, which operates at negative h.t. The third winding supplies the remainder of the valve heaters and the 'power on' pilot lamp.

*Push-pull oscillator*

**22.** The r.f. oscillator comprises the double-triode V3, with associated components. The grids of V3A, V3B are connected to opposite ends of the tuned circuit T1, C19, C20, C21, C22 and function as a Colpitts oscillator in push-pull.

**23.** The tuned circuit feeds the grids with voltages in anti-phase which, after amplification, are fed back via the capacitors C16, C18 to the tuned circuit to augment the oscillations occurring there. This action is cumulative, and the positive half-cycles drive V3A and V3B alternately into grid current. C16, C18 charge negatively and increase the bias on the grids of V3 until the amplitude of oscillation stabilizes.

**24.** The amplitude of oscillation is governed by the h.t. voltage at V3 anodes, variable by RV2 – the SET LEVEL control. The action of RV2 is modified by an internal control RV1, ganged with the tuning capacitor.

*Gating stage*

**25.** The oscillator output is fed via T1 to the push-pull amplifier V4, V5. The potential at the centre tap of T1 secondary, and therefore the grid bias of the amplifier, is set by the gating stage V2. This ensures that the bias point and the output of the amplifier are the same for either c.w. or pulse operation. The operation of the gating circuit depends upon the setting of the three-position selector switch SA.

**26.** When SA is in the CW position, V1 is cut off since the grid is returned via SA1 to the negative line. V2B is also inoperative. The two halves of the double triode V3 function as a push-pull Colpitts oscillator, C16 and C18 providing regenerative feed back. During positive half cycles the two halves are driven alternately into drawing grid current. The amplitude of oscillation is determined by the anode voltage as set by the action of RV1 which is ganged to the tuning control to maintain linearity of the level limiting frequency characteristic of the oscillator. V2A functions as a diode clamp, limiting the junction of L7, R3 to a maximum of 1·5V positive. If the centre tap of the oscillator transformer secondary tries to go more positive than this, V2A conducts harder and so limits the voltage. A silicon diode MR5 is connected between V2A grid and earth to compensate for variations in different valve characteristics.

**27.** With SA in the SQUARE WAVE position, V1 cathode is switched to the tapped inductance T8 in the grid circuit and the circuit functions as an electro-coupled Hartley oscillator, at a frequency of 1kHz. The sinusoidal waveform appearing at the anode is clipped to a square wave by V2, and this grid modulates the push-pull amplifier via T1 secondary.

**28.** In the PULSE position, SA2 connects V1 cathode to the negative line and SA1 connects the grid to R2. The combination of R1 and the silicon diode MR1 produces on V1 grid a voltage, positive with respect to the negative line, of 0·5V. The operating point of V1 is the difference between this voltage and the cathode bias.

**29.** In the absence of a pulse input V1 conducts, the junction of R3, L7 goes 25V negative and cuts off the amplifier V4, V5. V2B cathode is connected to the junction of R3, L7 and the fall in potential at this point takes the cathode voltage nearer the grid potential and the valve then commences to conduct. Any further drop in V2B cathode voltage produces a rapid increase in current through the valve and prevents V1 anode voltage from falling. The circuit remains in this state, with V1 and V2B conducting and V2A inoperative, until a negative gating pulse is applied.

**30.** With the arrival of a pulse V1 is cut off, causing the anode voltage to rise and cut off V2B also. The anode voltage continues to rise towards positive h.t. until V2A starts to conduct. The condition is then the same as in c.w. operation, with the amplifier biased to the c.w. operating point, and the generator therefore produces a signal for the duration of the input pulse.

**31.** At the end of the input pulse, V1 again conducts, the amplifier is cut off and the generator output is suppressed until the next pulse occurs.

*Output stage*

**32.** Two r.f. pentodes in push-pull, V4, V5 form the output stage, working under class A conditions. With S1 switched to C.W., the junction of R3, L7 applies a 1·5V positive bias to V4, V5 via T1 secondary, while the cathode bias resistors R14, R16 develop 2·5V providing an operating bias of approximately 1V.

**33.** The primary of the output transformer T4 is damped by R18 to maintain a substantially flat frequency response. Further damping is provided by R21 in series with R25 across the secondary. R25 is the high level output load (chained to the output socket) and must always be connected except when the high-level output is in use. The capacitor in series with the output secondary is to tune out the leakage inductance of the winding.

**34.** A portion of the output is rectified by the germanium diode MR2 and applied to the meter via a decoupling filter R22, R23, C28, C29, C31. With the output secondary terminated by its impedance R25, the meter indication is approximately proportional to the field strength at the mouth of the piston attenuator bore. The voltage across the meter will therefore be a function of the output secondary loading, and the meter will give the correct reading only with the load plug connected.

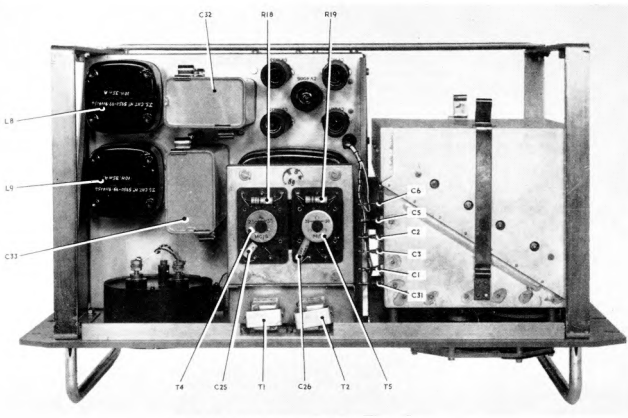


Fig. 2. Signal generator CT406: top view

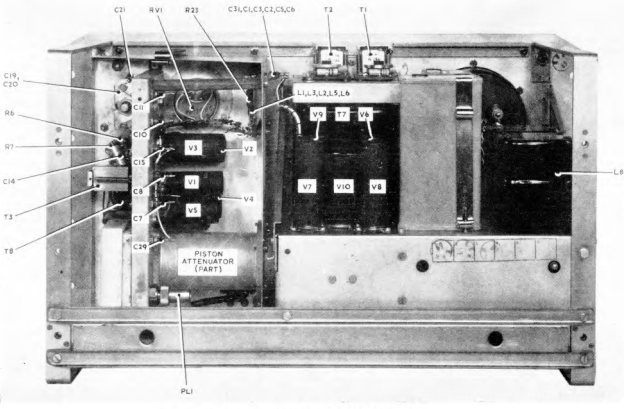


Fig. 3. Signal generator CT406: back view

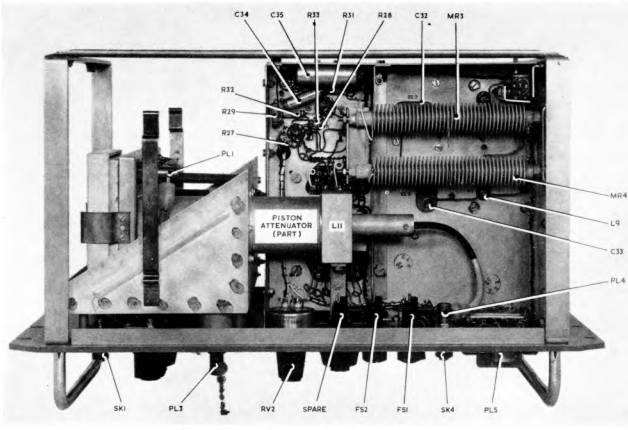


Fig. 4. Signal generator CT406: underside view

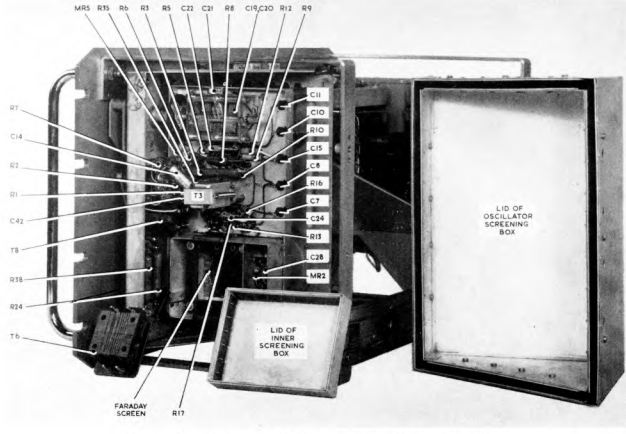


Fig. 5. Signal generator CT406: end view showing screening boxes

**35.** The attenuated output is derived from the pick-up loop of the piston attenuator, L11, and fed out to the ATTENUATED OUTPUT socket SK4. The source impedance of this loop is 75 ohms, set by R20. C27 is to tune out the pick-up loop inductance. A Faraday screen at the open end of the attenuator bore removes the unwanted components of the wave entering the bore. The dimensions of the bore are chosen to give an attenuation of 20dB per inch.

## SERVICING INFORMATION

### General

**36.** Servicing must be restricted, at second or third line, to replacement of valves and of passive components other than those associated with frequency or output level calibration. See fig. 2, 3, 4, and 5 for locations.

**37.** Correct designations of all spare parts are given in Electronic Equipment and Spares Schedule No. EESS/25002.

**38.** Valve pin connections and electrode voltages are given in Tables 1 and 2.

### Preset control, RV1

**39.** The internal preset control RV1 is coupled to the calibrated frequency dial and, if replaced, should be set to give equal resistance values at each end of the frequency dial.

### Function tests

**40.** All tests are to be carried out at the nominal input voltage with the power input taps set accordingly.

*Test equipment required*

**41.** (1) Variable power supply with monitor voltmeter.

(2) Universal testmeter, 20,000 ohms/volt.

(3) Wavemeter to cover 24MHz to 70MHz with crystal check, if close calibration is required.

(4) Pulse generator to provide a prepulse and 1 microsecond pulses at about 2kHz p.r.f., source impedance 500 ohms.

(5) Double-beam oscilloscope, bandwidth 5MHz.

(6) Beat frequency oscillator, to cover 1kHz.

(7) I.f. amplifier or suitable frequency, including a demodulator.

*Supply regulation*

**42.** The negative line is held at 216V nominally, but may vary by $\pm$11V, depending upon the stabilizing neon characteristics. The positive line is stabilized at 240V when the negative line is 216V, but may vary with the negative line potential provided that the ratio 240/216V is maintained. The fixed potentiometer comprising R29, R30, R31 controls the voltage at which the positive line is stabilized.

**43.** Connect the CT406 to the variable power supply and adjust the input to nominal. Connect the 20,000 ohms/volt testmeter between the positive line and chassis, vary the power input plus and minus 10% and check that the positive line voltage does not change by more than 2V.

*Calibration check*

**44.** This should be carried out using the wavemeter in 41(3) above loosely coupled to the generator 1 VOLT OUTPUT socket.

**Note . . .**

*If any loss of calibration is found in frequency or output level, it is recommended that the instrument be returned for fourth line re-calibration. Under no circumstances should the trimmer C22 or the iron dust core of T1 be disturbed.*

*Modulator frequency check*

**45.** Connect the beat-frequency oscillators, set to 1kHz, to the double-beam oscilloscope. Connect the generator output, set to the nominal frequency of the i.f. amplifier, to the oscilloscope second input.

**46.** Switch the generator modulation switch to the SQUARE WAVE position and check that the oscillator frequency is approximately 1kHz. The frequency may be adjusted if required by re-selecting the capacitor C37.

### Lubrication and cleaning

**47.** The selector switch SA may be cleaned as necessary using an approved switch cleaner, and the spindle lubricated sparingly with a thin oil. The attenuator rack and slow motion drive gears should be lubricated as required with a light grease.

**48.** When replacing the internal screening cans, ensure that the contacting surfaces are clean and firmly seated, since intermittent contact at these points may result in r.f. radiation.

**Caution . . .**

*Do not attempt to take the attenuator gearing out of mesh.*

## TABLE 1

### Valve base connections

| Valve | Type | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Base |
|---|---|---|---|---|---|---|---|---|---|---|---|
| V1,4,5 | CV4014 | G1 | K | H | H | A | G3 | G2 | | | B7G |
| V2 | CV4024 | A/2 | G1/2 | K/2 | H | H | A/1 | G1/1 | K/1 | HCT | B9A |
| V3 | CV858 | A/2 | A/1 | H | H | G1/1 | G1/2 | K(Common) | | | B7G |
| V6 | CV4005 | A/1 | | H | H | | A/2 | K(Common) | | | B7G |
| V7,8 | CV1833 | K | A | | A | K | | A | | | B7G |
| V9 | CV2179 | G1 | K,G3 | H | H | A | | G2 | | | B7G |
| V10 | CV4006 | | G1 | K | H | H | | A | G2 | G3 | B9A |

## TABLE 2

### Valve electrode voltages

All voltages are measured with respect to chassis, using a 20,000 ohms/volt meter, with the generator set to C.W. output and tuned to 45MHz. The readings of V3 A/1 and A/2 were taken at both extremes of RV2.

| Valve | A/1 | A/2 | K/1 | K/2 | G1/1 | G1/2 | G2 |
|---|---|---|---|---|---|---|---|
| V1 | +1·5 | — | −205 | — | −214 | — | 0 |
| V2 | +1·5 | +245 | 0 | +1·5 | +1·5 | −25 | — |
| V3 | +35 to +65 | +35 to +65 | 0 | 0 | — | — | — |
| V4 | +235 | — | +3·5 | — | +1·5 | — | +245 |
| V5 | +235 | — | +3·5 | — | +1·5 | — | +245 |
| V6 | 440 a.c. | 440 a.c. | +375 | — | — | — | — |
| V7 | 0 | — | −107 | — | — | — | — |
| V8 | −107 | — | −214 | — | — | — | — |
| V9 | +260 | — | +245 | — | +240 | — | +355 |
| V10 | +240 | — | 0 | — | −1·5 | — | +24 |



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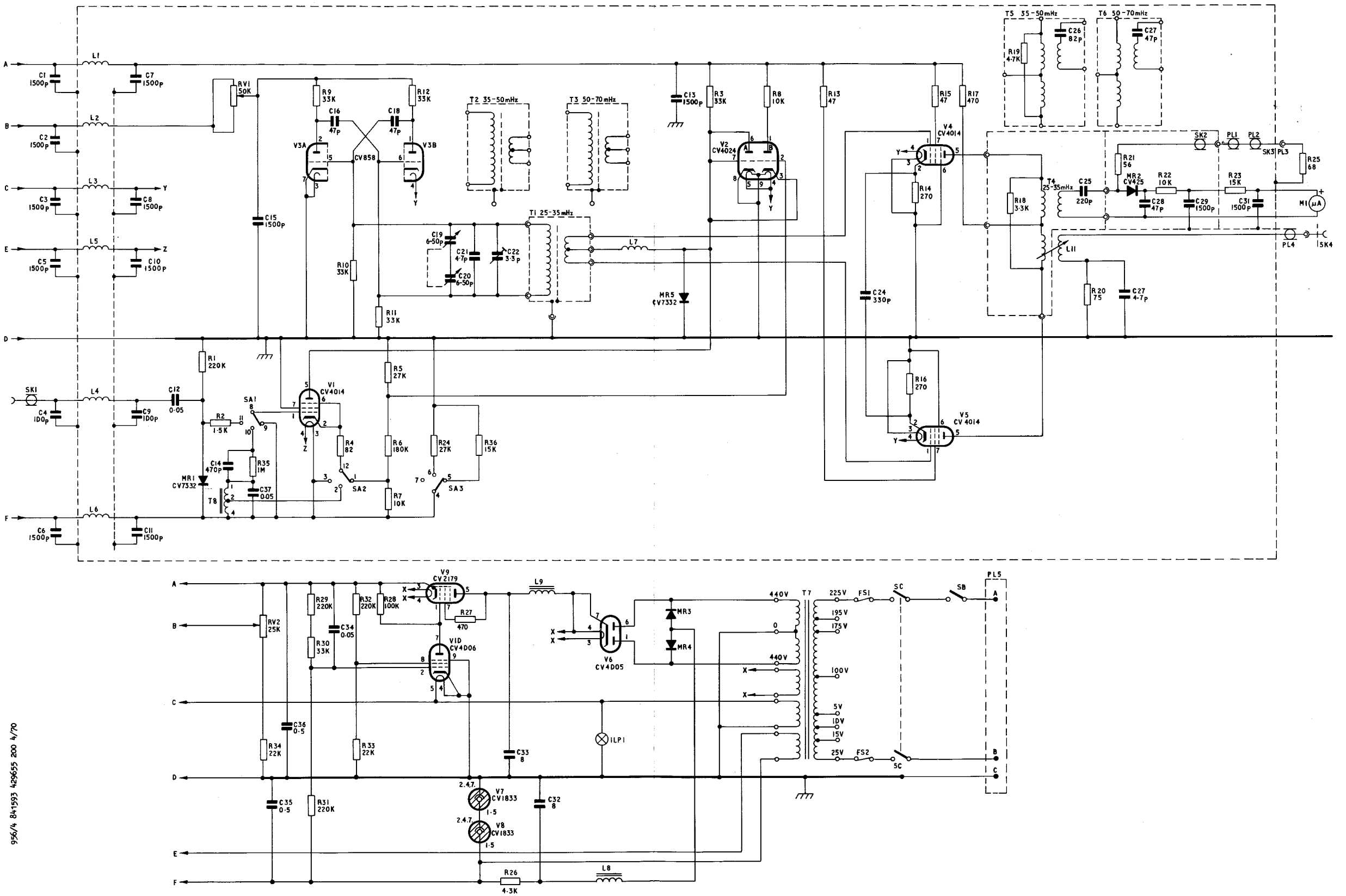


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Fig.6. Signal Generator CT406: Circuit.

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