# U.H.F. TRIODE EC 80 FOR GROUNDED-GRID CIRCUITS

The EC 80 is an indirectly heated triode designed for use at ultra high frequencies. As an amplifier the tube can be used up to 500 Mc/s. The amplification factor and the mutual conductance are high ($\mu = 80$ and $S = 12$ mA/V), while the noise of the tube is very small (noise figure about 8 dB at 300 Mc/s with a bandwidth of 4.5 Mc/s).

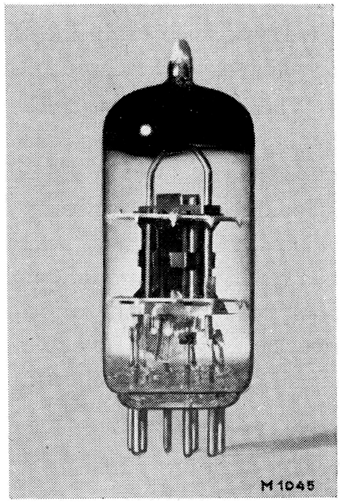


*Fig. 3. Photograph of the EC 80 (actual size).*

These properties make the EC 80 suitable for a number of applications on decimetric waves, for example in Citizens Radio and professional equipment, radio links, measuring equipment, etc. etc. Due to its high mutual conductance and low noise the EC 80 will also be of great use in a number of applications at lower frequencies. We mention, for instance, broad-band amplifiers, I.F. stages following a crystal mixing stage, etc. The EC 80 is specially intended for use as an amplifier and mixer in grounded-grid circuits. In these circuits the grid, instead of the cathode, is the common electrode of the input and output circuits. In fig. 4 the basic diagram of a grounded-grid amplifier is shown; in such a circuit an appropriately constructed grid will act as a screen between anode and cathode, making a separate screen grid superfluous. In spite of the ultra high frequencies, it will therefore be possible to use triodes instead of pentodes in these circuits with good results.

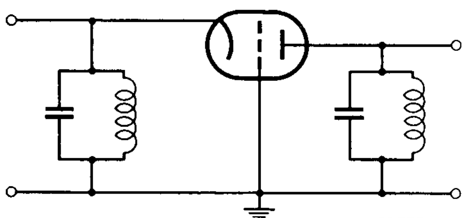


*Fig. 4. Triode in grounded-grid circuit. The d.c. sources have been omitted.*

Owing to the absence of the so-called partition noise inherent in a pentode, the total noise of a triode is much smaller than that of a pentode. This explains the favourable behaviour with respect to noise of the triode EC 80 in grounded-grid circuits.

In order to reduce the effects of troublesome capacitances, self-inductances and resistances, the measures described in the Introduction have been taken. In this connection special attention must be drawn to the self-inductance of the grid lead. This lead being common to both the input and the output circuits, self-inductance will tend to cause instability. In the case of the EC 80 this has been avoided by connecting the grid to four pins in parallel. If the corresponding socket contacts are connected to earth, the self-inductance of the grid lead and the tendency to instability will be reduced to a minimum.

Whereas the gain of a tube at lower frequencies is only slightly influenced by the input and output impedances of the tube, this is no longer the case on decimetric waves. Due to the influence of transit-time effects, resistance and self-inductance of the connecting leads, etc., these input and output impedances are reduced in such a way that their influence on the gain becomes very great, and as a result, the control of amplifying tubes will require power. Therefore, instead of speaking in terms of voltage amplification, as normally is done at lower frequencies, we will have to take into consideration the power gain. The definition of this quantity is as follows:

*The power gain of an amplifier is the optimum ratio between the output power and the power available at the input.*

As the power gain is dependent upon the width of the frequency band to be amplified, it is always necessary to mention the bandwidth of the amplifier. As a first approximation the product of power gain and bandwidth has a constant value, so that the gain at any bandwidth can be calculated if the gain at a certain bandwidth is known.

The noise of a receiver or an amplifier is defined by *the noise figure F, representing the available signal-to-noise power ratio at the input, divided by the signal-to-noise power ratio available at the output.* Here both the noise and the signal are expressed as power, taken over the bandwidth of the amplifier, whilst the noise properties of the input power source are expressed in terms of a resistor at room temperature.

As may be seen from the operating data of the EC 80 mentioned under Technical Data, the *power gain G* at a frequency of 300 Mc/s and a bandwidth of 4.5 Mc/s is about 15 dB and the *noise figure F* about 8 dB (see also fig. 8).

# TECHNICAL DATA

## HEATER DATA

Heating: indirect with a.c. or d.c.; parallel supply

| | | | |
|---|---|---|---|
| Heater voltage | $V_f$ | = | 6.3 V |
| Heater current | $V_f$ | = | 0.48 A |

## ELECTRODE ARRANGEMENT

To ensure stability of functioning in grounded-grid circuits, the four grid contacts must be connected to earth.

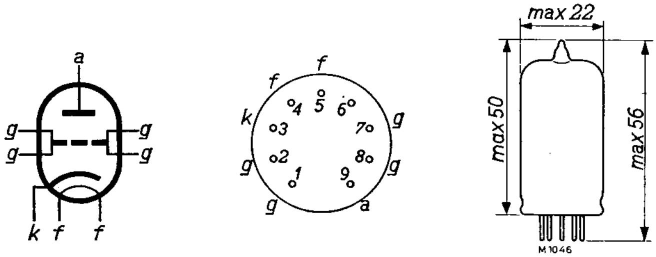


*Fig. 5. Electrode arrangement, electrode connections and maximum dimensions in mm (noval base).*

## CAPACITANCES (measured with the tube cold and with grounded grid)

| | | | |
|---|---|---|---|
| Input capacitance | $C_{(g+6)(k+f)}$ | = | 5.1 pF [1] |
| Input capacitance | $C_{(g+f+6)k}$ | = | 9.3 pF [1] |
| Capacitance between anode and cathode | $C_{ak}$ | < | 0.075 pF |
| Capacitance between anode and cathode plus heater | $C_{a(k+f)}$ | < | 0.08 pF |
| Output capacitance | $C_{a(g+6)}$ | = | 3.4 pF [1] |
| Output capacitance | $C_{a(g+f+6)}$ | = | 3.4 pF [1] |
| Capacitance between cathode and heater | $C_{kf}$ | < | 8 pF |

## TYPICAL CHARACTERISTICS

| | | | |
|---|---|---|---|
| Anode voltage | $V_a$ | = | 250 V |
| Cathode bias resistor | $R_k$ | = | 100 Ω |
| Anode current | $I_a$ | = | 15 mA |
| Mutual conductance | $S$ | = | 12 mA/V |
| Amplification factor | $\mu$ | = | 80 |

## OPERATING CHARACTERISTICS (grounded grid)

| | | | |
|---|---|---|---|
| Power gain at 300 Mc/s (bandwidth 4.5 Mc/s) | $G$ | = | appr. 15 dB |
| Noise figure at 300 Mc/s (bandwidth 4.5 Mc/s) | $F$ | = | appr. 8 dB |

## LIMITING VALUES

| | | | |
|---|---|---|---|
| Anode voltage in cold condition | $V_{ao}$ | = | max. 550 V |
| Anode voltage | $V_a$ | = | max. 300 V |
| Anode dissipation | $W_a$ | = | max. 4 W |
| Cathode current | $I_k$ | = | max. 15 mA |
| Grid current start ($I_g = +0.3\ \mu A$) | $V_g$ | = | max. —1.3 V |
| External resistance between heater and cathode | $R_{fk}$ | = | max. 20 kΩ |
| Voltage between heater and cathode | $V_{fk}$ | = | max. 100 V |

[1]) 6 denotes pin No. 6.

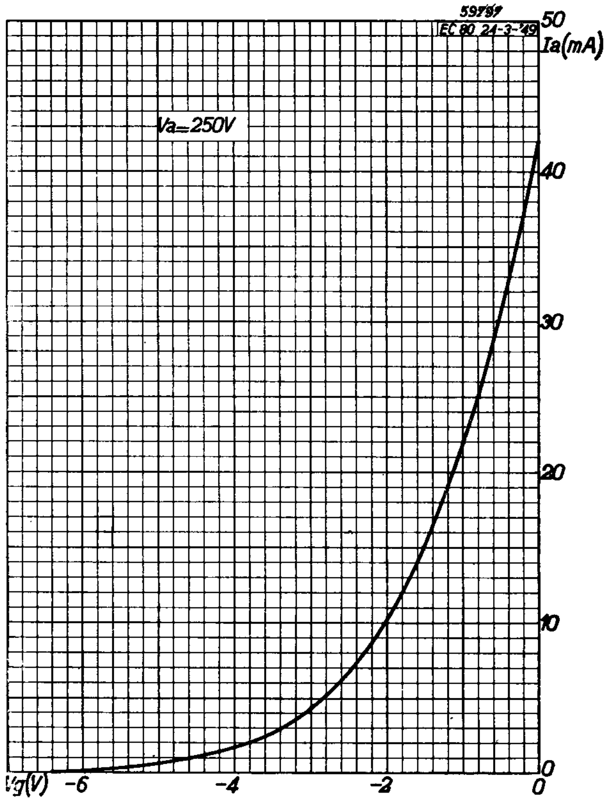


*Fig. 6. $I_a/V_g$ characteristic of the EC 80 at an anode voltage of 250 V*

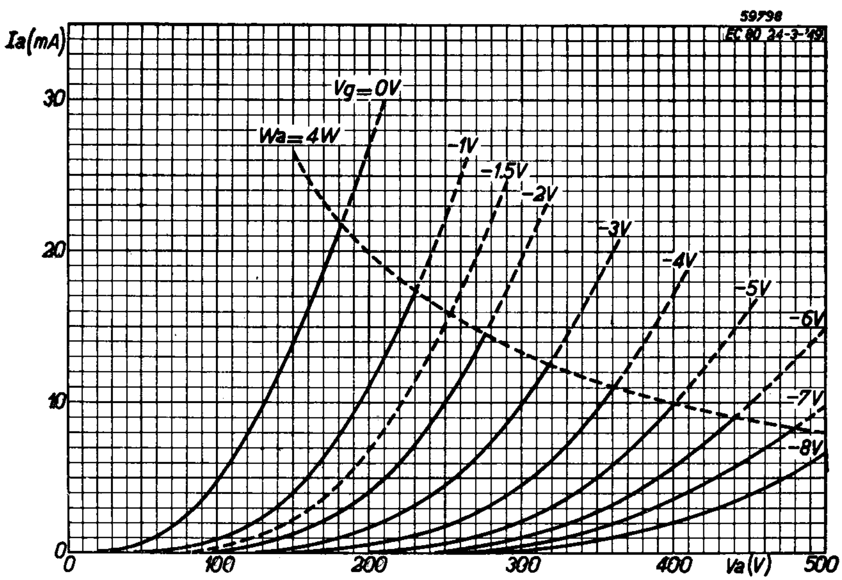


*Fig. 7. $I_a/V_a$ characteristic of the EC 80. The maximum admissible anode dissipation is indicated by the dashed line $W_a = 4\ W$.*

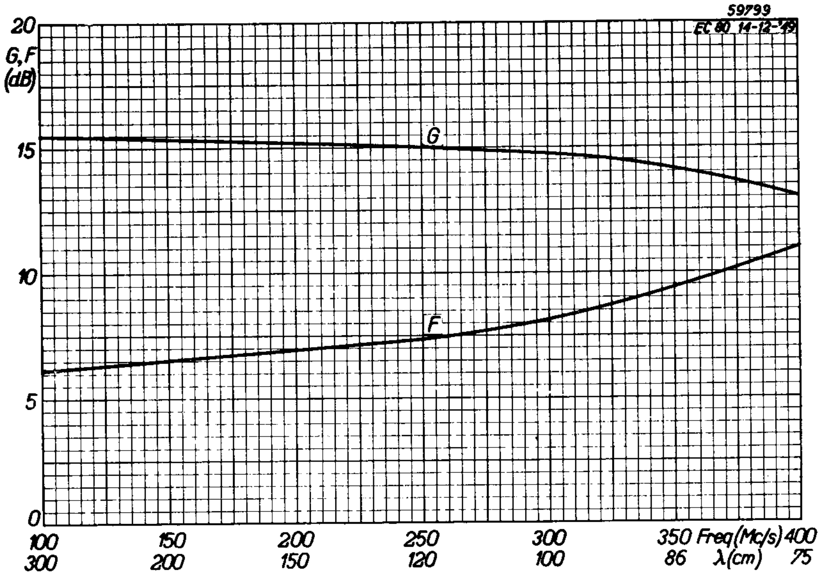


*Fig. 8. Power gain G and noise figure F of the EC 80 as a function of the frequency f and wavelength λ.*

## BASE AND SOCKET

The EC 80 is provided with the standard noval base, and can therefore be mounted in a socket of normal construction. However, at the very high frequencies at which the tube is used, the material of the socket must answer high requirements. The socket type 5908/46 is recommended.

Its small dimensions and normal operating voltage make the EC 80 specially suitable for use in fixed, as well as in mobile equipment. The tube can be mounted in all positions; if, however, shocks are to be expected, or if the tube is not mounted in an upright position, it is recommended that the tube be supported.

In order to ensure stable functioning of the EC 80, it is recommended to use a cathode resistor for obtaining the negative grid bias (see e.g. fig. 10*a* with resistors $R_2$ and $R_7$ of 100 $\Omega$).

# H.F. SECTION OF A RECEIVER FOR 300 to 400 Mc/s WITH THE TUBES EC 80, EC 80 and EC 81

Figs 9 and 10 show a photograph and the circuit diagram of the H.F. section of a receiver using two tubes type EC 80, as an amplifier and a mixer respectively, in a grounded-grid circuit, and an EC 81 as a local oscillator. The H.F. circuits are not normal L.C. circuits as shown in the simplified circuit diagram of fig. 10a, but coaxial line circuits (see figs 9 and 10*b*). These have a short-circuiting plunger which is adjustable for tuning purposes. The frequency range of the receiver runs from 300 to 400 Mc/s (100 to 75 cm), whilst the bandwidth is 5 Mc/s. The power gain of the H.F. stage is about 12 dB and the noise figure about 8 dB. The mixer is connected as a triode. It is, however, also possible to use it as a diode (grid connected to anode). In the circuit given, both the amplified aerial signal and the locally generated voltage are applied to the cathode.

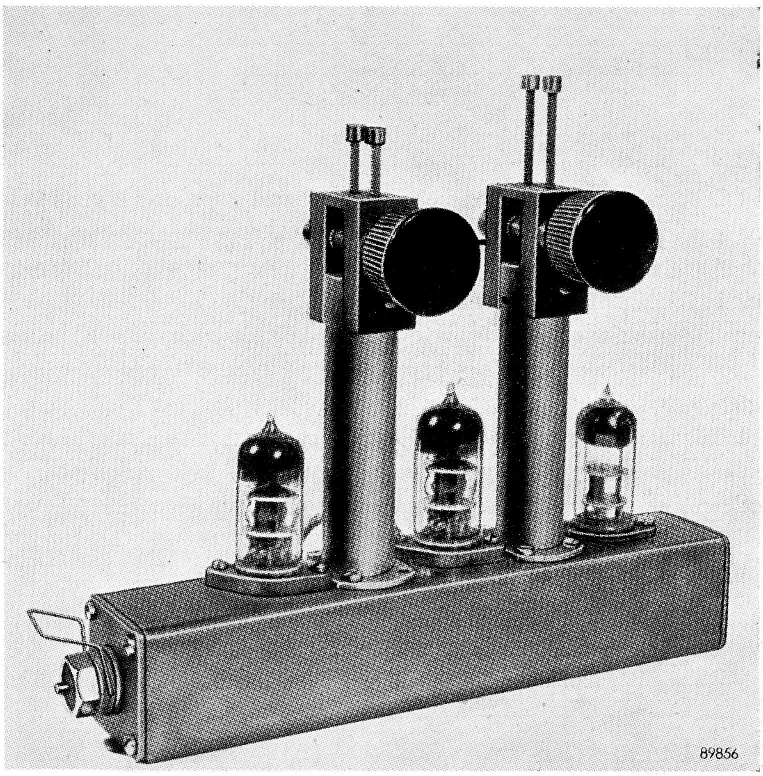


*Fig. 9. H.F. section of a receiver for 300 to 400 Mc/s ($\lambda$ = 100 to 75 cm). Mounted on the chassis are two tubes EC 80 (H.F. amplifier and mixer), one tube EC 81 (local oscillator) and two variable coaxial line circuits.*

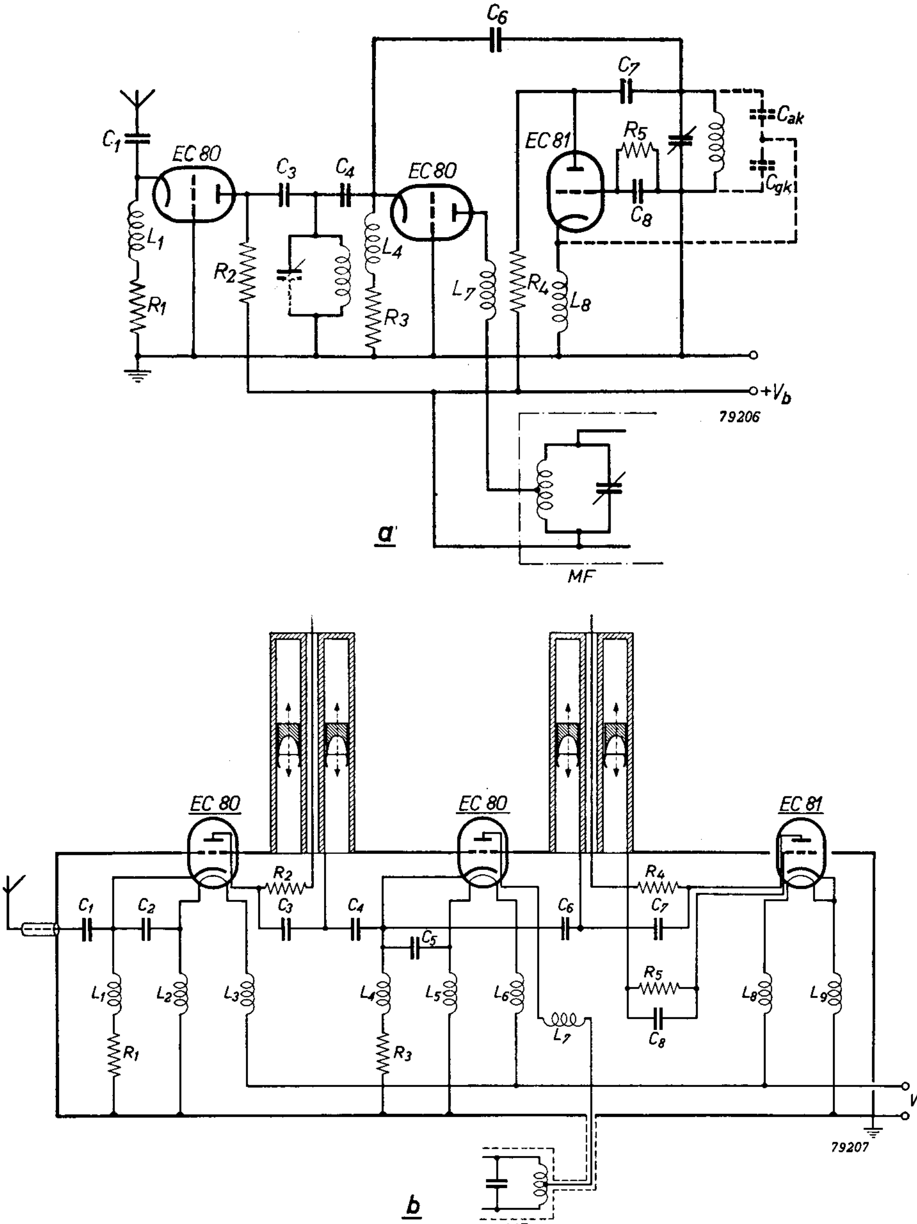


*Fig. 10. Circuit diagram of the H.F. section of the receiver of fig. 9; (a) in simplified form, (b) complete. The first EC 80 tube functions as a U.H.F. amplifier in grounded-grid circuit, the second one as a triode mixer in grounded-grid circuit. The EC 81 tube operates as an oscillator. $R_2$ and $R_7$ of 100 Ω each are resistors for automatic positive cathode voltage (with respect to the grid connected to earth). $R_5$ and $R_{11}$ are anode resistors of 1000 Ω each. $R_{12}$ is the oscillator grid leak of 10 000 Ω. $C_1$, $C_2$, $C_3$, $C_5$, $C_7$ = 100 pF. $C_4$ = 5.6 pF. $C_6$ = 2 pF. $C_8$ = 56 pF. The oscillator (EC 81) functions as a Colpitts oscillator by means of the interelectrode capacitances $C_{ak}$ and $C_{gk}$ (dotted in fig. 10a).*

The aerial can be matched to the input of the first EC 80 amplifying tube by properly selecting the length of the connecting lead. The self-inductance of this lead together with the input capacitance of the tube will then give the right transformer ratio for maximum input power.

The capacitor $C_4$ is not only a separating capacitor, but forms at the same time, with the input capacitance of the second EC 80 tube, a voltage divider, matching the low input resistance of the next stage to the higher output resistance of the preceding stage. The local oscillator of the receiver is equipped with the tube EC 81.

The oscillator circuit consists of the coaxial line circuit shown at the right, with a short-circuiting plunger, by means of which the frequency can be adjusted. The oscillator functions as a Colpitts oscillator with the aid of the interelectrode capacitances $C_{ak}$ and $C_{gk}$, as is indicated by the dotted capacitors in fig. 10a. The frequency range of the oscillator is about 300-400 Mc/s (100 to 75 cm). The frequency drift during the heating time of the tube is only 50 000 c/s. The oscillator voltage is applied to the cathode of the mixer tube EC 80 via the capacitor $C_6$, and is sufficiently high for obtaining optimum conversion gain. The heater and cathode leads of the tubes have been provided with H.F. chokes ($L_1$ to $L_9$). The wire length of these chokes is about 23 cm. The anode leads have been decoupled by feeding them through the inner conductor of the transmission lines.

The receiver can be tuned by means of two knobs. Each knob adjusts the plunger of a coaxial line circuit via a rack and pinion. The tuning frequency can be indicated by a pointer moving along a calibrated scale, thus facilitating the operation of the receiver.