IX. An 8-valve A.C./D.C. superheterodyne receiver with push-pull output stage

Introduction

This circuit was designed especially for high output power on 110 V mains, this being achieved by using two valves type UL 41 in push-pull, in conjunction with a voltage-doubling circuit in the power section. This arrangement enables the receiver to be operated on 110 V to 127 V A.C. mains, as well as 220 V A.C. or D.C. mains.
The following valves are used :

UCH 42, or UCH 41	— frequency changer,
UAF 42	— I.F. valve and A.G.C. diode,
UAF 42	— A.F. valve and detector diode,
2×UL 41	— output valves in push-pull,
2×UY 41	— rectifying valves,
UM 4	— tuning indicator.

Although the receiver is designed primarily for two wave-bands, it can naturally be modified to accommodate more.

DESCRIPTION OF THE CIRCUIT

The mixing stage

This part of the circuit is identical with that of the circuit VII. The use of the UCH 42 ensures greater sensitivity, as well as a better signal-to-noise ratio particularly in the short-wave range.
The respective values of the resistors R_1 and R_2 are 27 and 18 kΩ for use with the UCH 42, or 47 and 22 kΩ with the UCH 41.

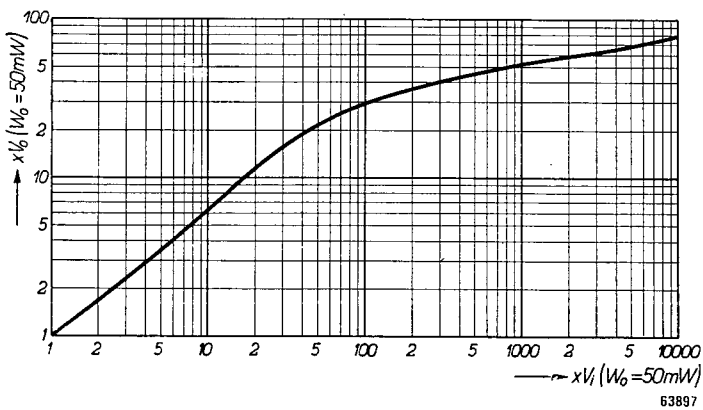

Fig. 2. The A.G.C. characteristic.

The I.F. stage

The first UAF 42 serves as I.F. amplifier, the diode functioning as rectifier for the A.G.C. voltage. An 18 ohm resistor in the negative line of the power section provides the delay voltage, as well as the grid bias for the frequency changer and the I.F. valve. Fig. 2 shows the A.G.C. characteristic of the receiver.

A.F. section

The second UAF 42 is the A.F. amplifier and phase inverter, with resistors of 0.1 MΩ and 0.12 MΩ in the anode and cathode circuits respectively ; the coupling resistance in the cathode circuit is slightly higher than that in the anode circuit in view of the fact that for A.F. currents the cathode resistoris connected in parallel with the screen grid resistor. The amplification of this stage is about 20. Parasitic capacitances with the diode circuit, which might be detrimental to the push-pull action at the higher frequencies, are compensated by a capacitor of 100 pF connected across the cathode resistor. A simple tone control is provided by connecting between the control grids of the output valves UL 41 a network comprising a capacitor of 2200 pF, a 27 kΩ resistor and a 0.5 MΩ potentiometer.
The feedback circuit is such that there is no reduction in gain when the volume control is set to maximum. Winding S_5S_5' of the output transformer provides a negative feedback voltage and winding S_6S_6' a positive feedback voltage, which just compensate each other at the maximum setting of the volume control. When the volume is reduced, for instance when the signal received is fairly strong, the feedback voltage from winding S_5S_5' predominates. Fig. 3 shows the response characteristics of the A.F. section when the volume control is:
a. at a setting corresponding to 1/10 of its total resistance,
b. at maximum setting.

The power section

The output of the receiver is also quite high on the lower mains voltages, this being ensured by using two rectifiers type UY 41 as voltage doublers on mains voltages of 110 to 127 V ; when operated on 220 V they are connected in parallel.

To ensure that the rectified direct current will not exceed the permissible maximum of 100 mA on mains voltages of 110 to 127 V, the screen grids of the output valves are operated at half the supply voltage. In Fig. 1 the switch connections for 110 V are indicated by means of full lines, and those for 220 V by dotted lines. The matching resistance between the anodes of the output valves is 8000 ohms at 110 V to 127 V, and 5000 ohms at 220 V; it is therefore necessary that the speaker transformer be provided with a tapping, which can be switched on changing over from low mains voltage to high, and vice-versa.

The output is about 4.4 W at 110 V, 6.3 W at 127 V and 7.3 W at 220 V, with 10% distortion.

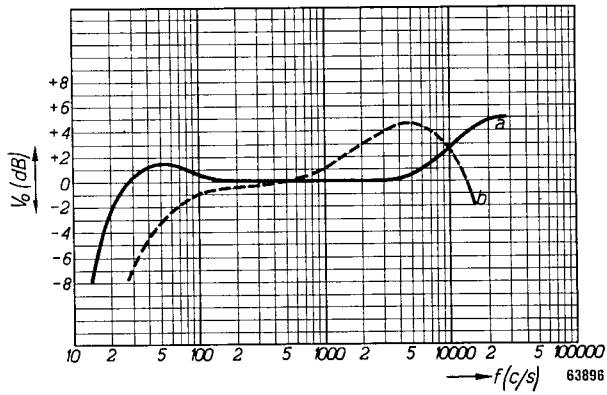

Fig. 3. Response characteristic of the A.F. section with the volume control at :
a. 1/10 of its total resistance,
b. maximum setting.

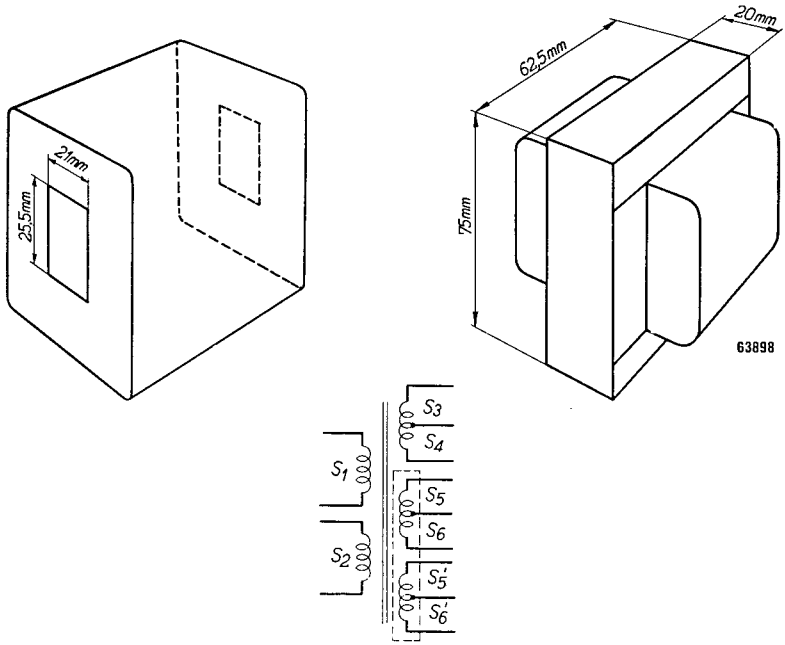

Fig. 4. Dimensions of the output transformer.

MEASURED VALUES

Voltages and currents of the output stage

Mains voltage	Modulation	Anode current mA	Screen grid current mA
110 V A.C.	No signal	36	4.6
	Full without A.G.C.	42	7.8
127 V A.C.	No signal	43	5.6
	Full without A.G.C.	55	11
220 V A.C.	No signal	75	15
	Full without A.G.C.	80	36

Mains voltage	Modulation	Voltage across				
		C_1	C_2	C_3	C_4	C_5
110 V A.C.	No signal	202 V	182 V	170 V	92 V	88 V
	Full without A.G.C.	190 V	173 V	163 V	86 V	81 V
127 V A.C.	No signal	235 V	210 V	197 V	110 V	107 V
	Full without A.G.C.	220 V	197 V	186 V	100 V	95 V
220 V A.C.	No signal	214 V	179 V	169 V	—	—
	Full without A.G.C.	203 V	152 V	142 V	—	—

Sensitivity, as measured at an output power of 50 mW, using a signal with 30% modulation at 400 c/s. :

At the control grids of the UL 41		2×400 mV_{RMS}
Between control grid and cathode of the A.F. valve UAF 42		20 mV_{RMS}
At the control grid of the I.F. valve UAF 42		0.87 mV_{RMS}
At the control grid of the UCH 42 (at 1 Mc/s)		10 μV_{RMS}
At the aerial (at 1 Mc/s)	approx.	3 μV_{RMS}

Winding data of the output transformer

Winding	Number of turns	Wire diameter
S_1	1650	0.16 mm
S_2	1650	0.16 mm
S_3 - S_4	21 + 83	0.8 mm
S_5 - S_6	21 + 83	0.1 mm
S_5' - S_6'	21 + 83	0.1 mm

The windings S_5 - S_6 and S_5' - S_6' are connected in parallel and are wound in such a way as to ensure the least possible leakage inductance with respect to S_1 and S_2.

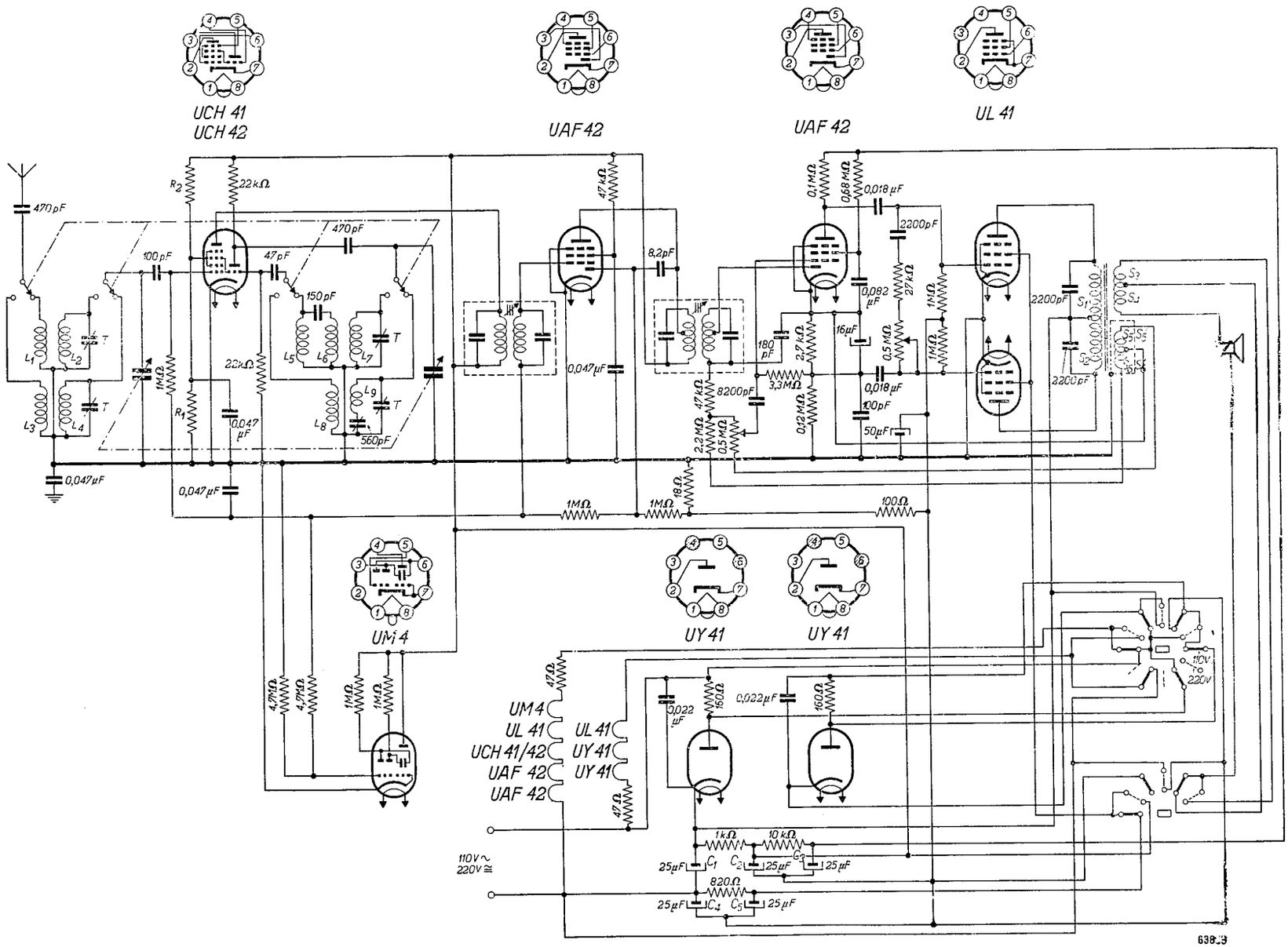

Fig. 1. An 8-valve superheterodyne A.C./D.C. receiver with voltage-doubling circuit on low mains voltages