

Unequal biasing of the valves in push-pull would cause the distortion to increase considerably. The biasing is kept equal by negative direct-voltage feedback.

The total gain of the three stages is about 12 000. The loop gain is smaller by a factor of 6 to 4 (the potentiometer ratio) i.e. about 2000 to 3000. This is sufficient for reducing the internal resistance of the output stage to the required low value.

Measurements were also carried out under non-linear loading. For this purpose the circuit of fig. 7a was used, with different values of  $R$ . Current passes through the diode in the branch parallel with  $R$  only during that part of the period in which the instantaneous value of the alternating voltage is higher than the voltage across the capacitor in this branch. The diode current is consequently more or less pulse-shaped (fig. 7b) and the total

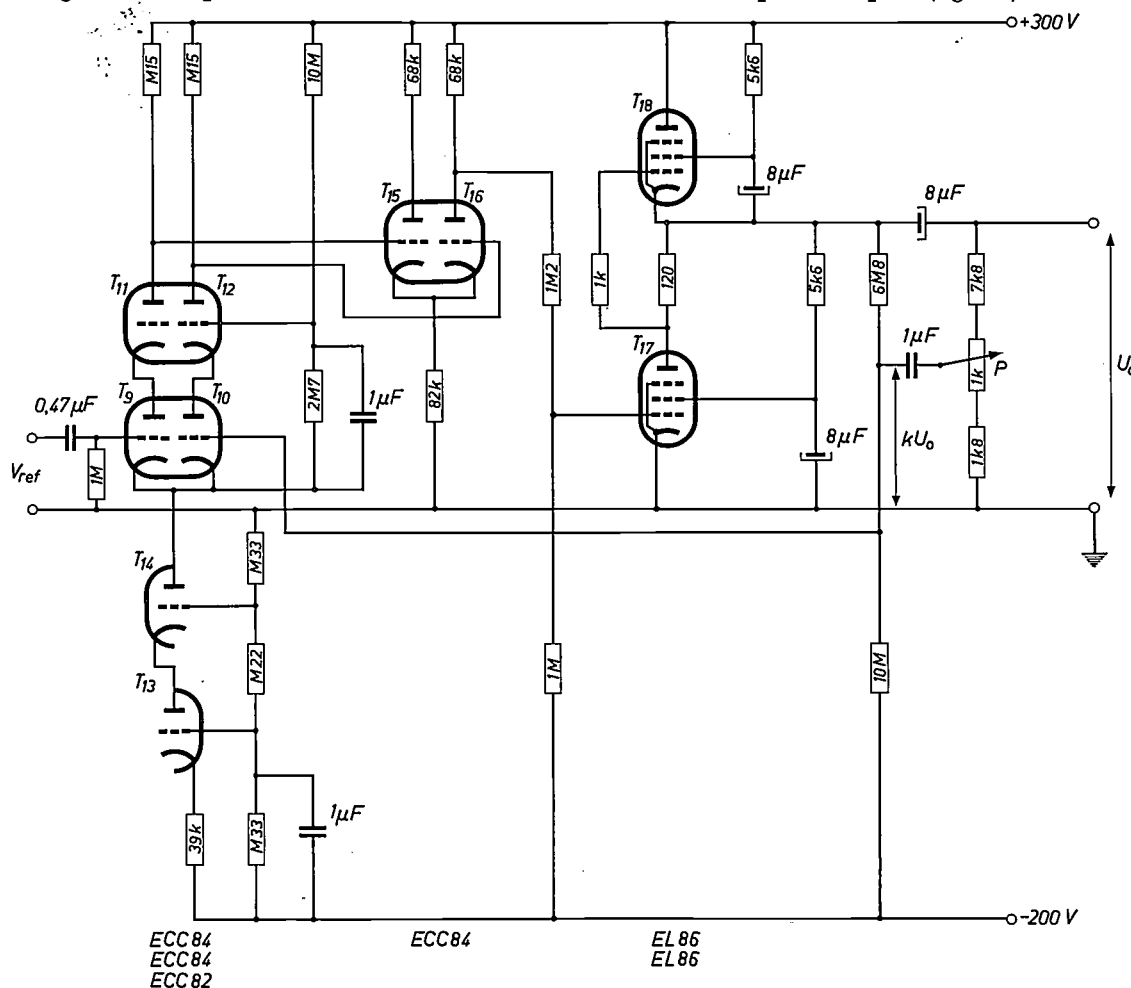


Fig. 6. Diagram of the output stage with two-stage driving circuit.

*Driving circuit.* First stage: difference amplifier with high rejection and high discrimination factors, consisting of cascodes  $T_9$ - $T_{11}$  and  $T_{10}$ - $T_{12}$  in push-pull with the cascode  $T_{13}$ - $T_{14}$  in the common cathode lead. Second stage: simple difference amplifier, consisting of triodes  $T_{15}$ - $T_{16}$  in push-pull, with a resistance of 82 kΩ in the cathode lead.

*Output stage:* single ended push-pull arrangement of pentodes  $T_{17}$ - $T_{18}$ .

In the first stage of the driving circuit the part  $kU_0$  of the output voltage ( $k$  being adjustable from  $\frac{1}{6}$  to  $\frac{1}{4}$  with potentiometer  $P$ ) is compared with the reference voltage  $V_{ref}$  of 10 V. (The connection between the grids of  $T_{11}$  and  $T_{12}$  is lacking in the figure.)

## Results

The following harmonic content was measured in the output voltage with a load consisting of a resistance of 1000 ohms:

second harmonic	$2.0 \times 10^{-5} \times U_0$ ,
third harmonic	$3.5 \times 10^{-5} \times U_0$ ,
fourth harmonic	$3.3 \times 10^{-5} \times U_0$ ,
fifth harmonic	$0.56 \times 10^{-5} \times U_0$ .

current has the form of a sine wave with a superimposed peak (fig. 7c). The distortion in this current was measured by analysing the voltage across the series resistance of 10 ohms (fig. 7a).

For each of the higher harmonics the internal resistance  $R_i$  can be determined by dividing the relevant voltage component by the corresponding current component. For the second to fifth harmonics the results obtained, as the averages of measure-