Q. 1. What is a transistor audio power amplifier ?

Ans. Transistor audio power amplifier

A transistor amplifier which raises the power level of the signals that have audio frequency range is known as **transistor audio power amplifier**.

A practical amplifier always consists of a number of stages. The first few stages in this multistage amplifier have the function of only voltage amplification. However, the last stage is designed to provide maximum power. This final stage is known as *power stage*. The amplifier used in this stage is called power amplifier and employs transformer coupling in order to transfer maximum power to the output device (*e.g.* speaker). Fig. 13·1 shows the block diagram of an audio power amplifier. The early stages build up the voltage level of the signal while the last stage builds up power to a level sufficient to operate the loudspeaker.

Fig. 13·1

The power amplifier differs from all the previous stages in that here a concentrated effort is made to obtain maximum output power. A transistor that is suitable for power amplification is generally called a *power transistor*. It differs from other transistors mostly in size ; it is considerably larger to provide for handling the great amount of power.

(*i*) **Class A power amplifier.** *If the collector current flows at all times during the full cycle of the signal, the power amplifier is known as* **class A power Amplifier.**

Obviously, for this to happen, the power amplifier must be biased in such a way that no part of the signal is cut off. Fig. 13·3 (*i*) shows circuit of class *A* power amplifier. Note that collector has a transformer as the load which is most common for all classes of power amplifiers. The use of transformer permits impedance matching, resulting in the transference of maximum power to the load *e.g.* loudspeaker.

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Fig. 13·3 (*ii*) shows the class *A* operation in terms of a.c. load line. The operating point *Q* is so selected that collector current flows at all times throughout the full cycle of the applied signal.

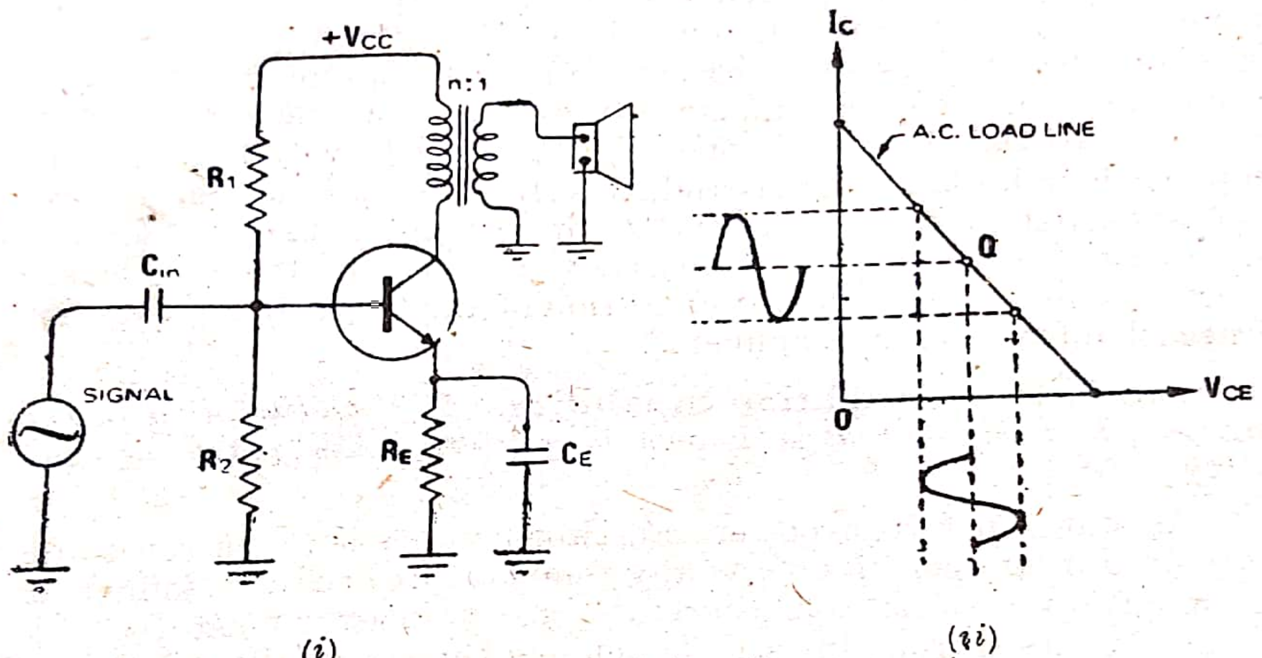


Fig. 13·3

As the output wave shape is exactly similar to the input wave shape, therefore, such amplifiers have least distortion. However, they have the disadvantage of low power output and low collector efficiency (about 35%).

Ans. Push-pull Amplifier

The push-pull amplifier is a power amplifier and is frequently employed in the output stages of electronic circuits. It is used whenever high output power at high efficiency is required. Fig. 13·9

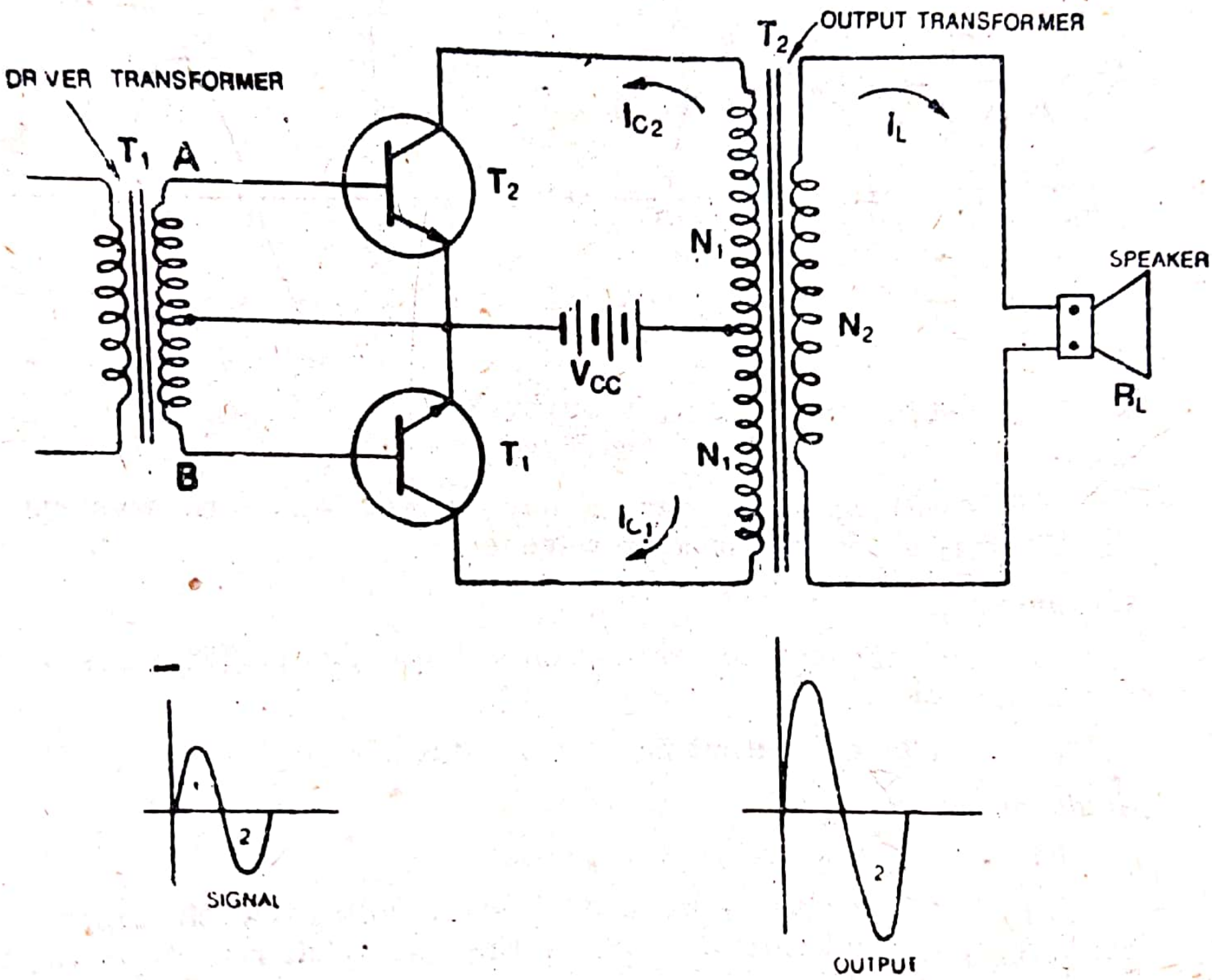
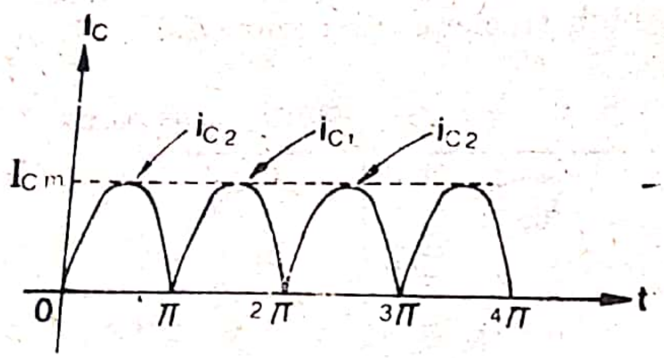


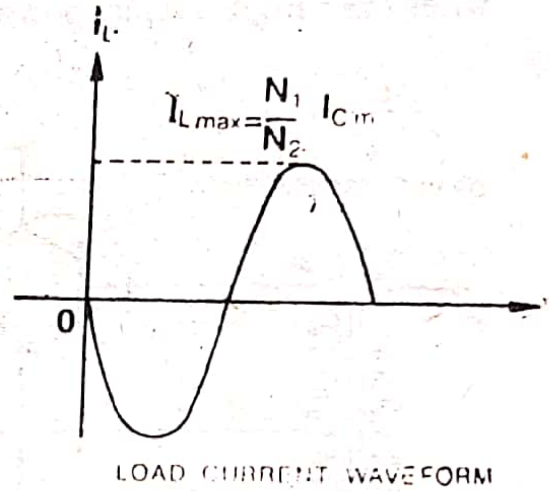
Fig. 13·9.

shows the circuit of a push-pull amplifier. Two transistors T_1 and T_2 placed back to back are employed. Both the transistors are operated in class *B* operation *i.e.* collector current is nearly zero in the absence of the signal. The centre-tapped secondary of the driver transformer supplies equal and opposite voltages to the base circuits of two transistors. The output transformer has the centre-tapped primary winding. The supply voltage V_{CC} is connected between the bases and this centre tap. The loudspeaker is connected across the secondary of this transformer.

Circuit operation. The input signal appears across the secondary *AB* of the driver transformer. Suppose during the first half-cycle of the signal (marked 1), end *A* becomes positive and end *B* negative. This will make the base-emitter junction of T_2 forward biased and that of T_1 reverse biased. The circuit will conduct current i_{C2} due to transistor T_2 as shown in Fig. 13·9. On the second half-cycle of the signal, the roles are reversed *i.e.*, T_2 is reverse biased and T_1 is forward biased. The circuit will conduct current i_{C1} due to transistor T_1. The centre-tapped primary of output transformer combines the two collector currents to form sine wave output in the secondary.



(*i*) POWER SUPPLY CURRENT WAVEFORM



(*ii*)

Fig. 13·10.

Fig. 13·10 (*i*) shows power supply current waveform whereas Fig. 13·10 (*ii*) shows load current wave form.

Advantages

(*i*) The efficiency of the circuit is quite high ($\simeq$75%) due to class *B* operation.

(*ii*) A high *a.c.* output power is obtained.

Disadvantages

(*i*) Two transistors have to be used.

(*ii*) It requires two equal and opposite voltages at the input. Therefore, push-pull circuit requires the use of driver stage to furnish these signals.

(*iii*) If the parameters of the two transistors are not the same, there will be unequal amplification of two halves of the signal.

Ans. R-C coupled transistor amplifier

This is the most popular type of coupling because it is cheap and provides excellent audio fidelity over a wide range of frequency. It is usually employed for voltage amplification. Fig. 12·7 shows two

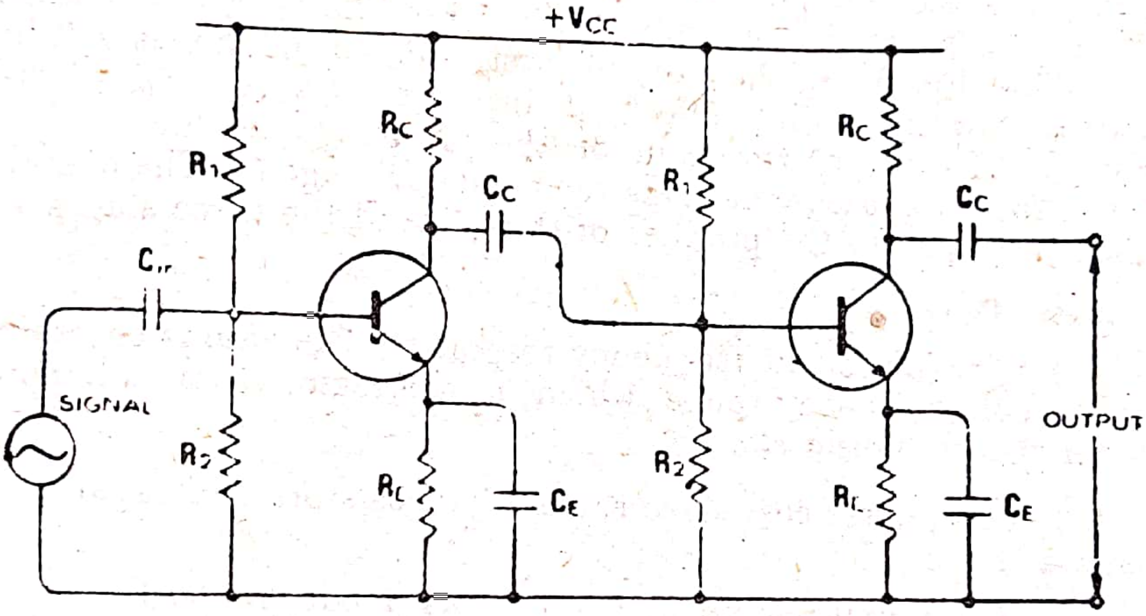


Fig. 12·7

stages of an *R-C* coupled amplifier. A coupling capacitor C_C is used to connect the output of first stage to the base (*i.e. input*) of the second stage and so on. As the coupling from one stage to the next is achieved by a coupling capacitor followed by a connection to a shunt resistor, therefore, such amplifiers are called ***resistance-capacitance coupled amplifiers.***

The resistances R_1, R_2 and R_3 form the biasing and stabilisation network. The emitter bypass capacitor C_E offers low reactance path to the signal. Without it, the voltage gain of each stage would be lost. The coupling capacitor C_C transmits a.c. signal but blocks d.c.

This prevents d.c. interference between various stages and the shifting of operating point.

Operation. When a.c. signal is applied to the base of the first transistor, it appears in the amplified form across its collector load R_C. The amplified signal developed across R_C is given to base of next stage through coupling capacitor C_C. The second stage does further amplification of the signal. In this way, the *cascaded* (one after another) stages amplify the signal and the overall gain is considerably increased.

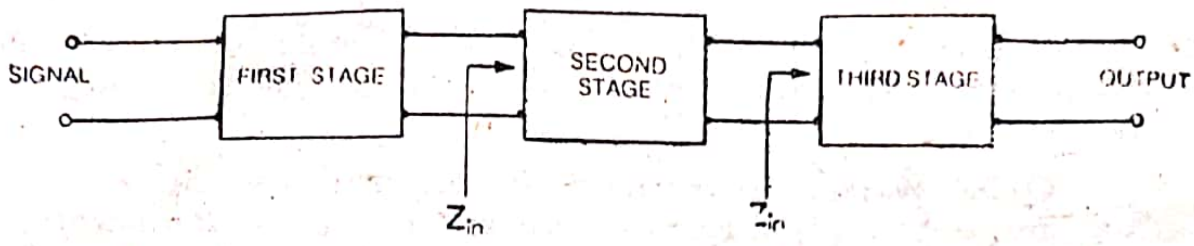


Fig. 12·8

It may be mentioned here that total gain is *less* than the product of the gains of individual stages. It is because when the second stage is made to follow the first stage, the *effective load resistance* (*i.e.* a.c. load) of first stage is reduced due to the shunting effect of input resistance of next stage. For example, in a 3-stage amplifier (see Fig. 12·8), the gain of first and second stages will be reduced due to the loading effect of input resistance (Z_{in}) of the next stage. However, the gain of the third stage which has no loading effect of subsequent stage remains unchanged. The overall gain shall be equal to the product of the gains of the three stages.

Advantages

(*i*) It has excellent frequency response. The gain is constant over the audio frequency range which is the region of most importance for speech, music *etc.*

(*ii*) It has lower cost since it employs resistors and capacitors which are cheap.

(*iii*) The circuit is very compact as modern resistors and capacitors are small and extremely light.

Disadvantages

(*i*) The gain of an R-C coupled amplifier is comparatively small because of the loading effect of next stage.

(*ii*) They have the tendency to become noisy with age, particularly in moist climates.

(*iii*) Impedance matching is poor. It is because the output impedance of R-C coupled amplifier is several hundred ohms whereas that of a speaker is only a few ohms. Hence, little power will be transferred to the speaker.