# Transition Frequency Compensation

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**The simple equalizer circuits described make it possible to correct any magnetic or crystal pickup for the various turnover frequencies used in recording.**

EVERY RECORD ENTHUSIAST has found certain records that sound fine with one system, but fail dismally on another. Yet another album may sound entirely out of balance on the first system, but reproduce perfectly on the second. Assuming that both systems are reasonably free from distortion and are comparable in other characteristics, this anomaly may cause some concern.

Since the recording characteristics of the various manufacturers are not yet standardized — and it seems doubtful that they ever will be — the reproducing equipment must be made sufficiently flexible to ensure satisfactory performance with all makes of records. At present, we are faced with transition or turnover frequencies of 500 and 800 cps on records of American manufacture, while the English Decca ffrr disks are reputed to be recorded with a 300-cps turnover. Obviously, no single equalization can compensate perfectly for these variations.

It is general practice for the recording characteristic to be essentially flat above the transition frequency. Below this point, a droop of 6 db per octave is normal, but this may vary somewhat in practice. The curve does not make a sharp bend at the turnover point, fortunately, on account of the simple means used to achieve the bend. Consequently, a simple means of equalization is sufficient for satisfactory correction.

Reproducing characteristics vary between magnetic and crystal pickups, so the type of equalization varies considerably. Both will be discussed here, with actual tested circuits.

### Compensation for Magnetic Pickups

The high-quality, low-level magnetic pickup, such as Audax, Pickering, and GE, require that some preamplification be supplied, and this provides a suitable place for the equalization.

A 6 db/octave boost requires at least 20 db of equalization for the entire range. When using *RC* circuits, a total loss (in the unequalized band) of 40 db is usually sustained to secure a net boost of 20 db, such as from 500 cps to 50 cps. If the output of the pickup cartridge is of the order of 50 millivolts, let us say, the loss due to equalization gives a *net* output voltage of 1/100th of this amount, or 0.5 mv. To get a 1-volt output signal to feed an ordinary amplifier requires a voltage gain of 2,000, or approximately 45 per stage for a two-stage preamplifier, indicating the use of high-mu triodes. The equalizer circuit may be inserted between them.

A single-section *RC* network, such as that of *Fig. 3(A)*, gives a rise of slightly over 3 db/octave at an insertion loss of 20 db. Putting two such circuits in series as at (*B*) doubles the boost, and doubles the insertion loss, of course. Thus, with proper choice of values for *R* and *C*, the required equalization can be obtained. The transition frequency is controlled by the size of the capacitors; the amount of equalization by the ratio between $R_2$ and $R_1+R_2$.

*Figure* 1 shows a complete equalized amplifier suitable for use with a high-quality magnetic pickup. $V_1$ and $V_2$ may

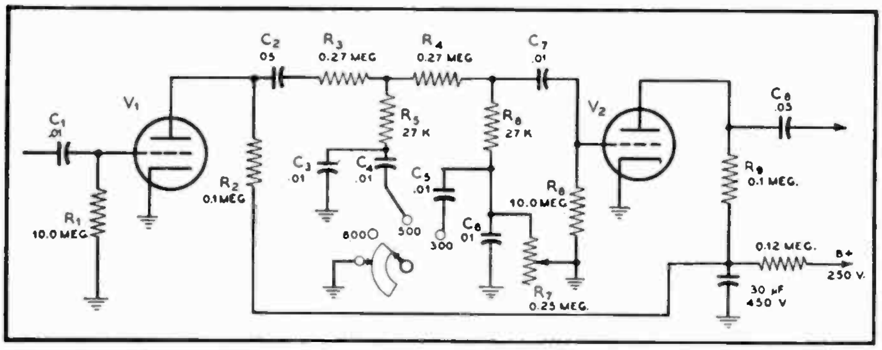
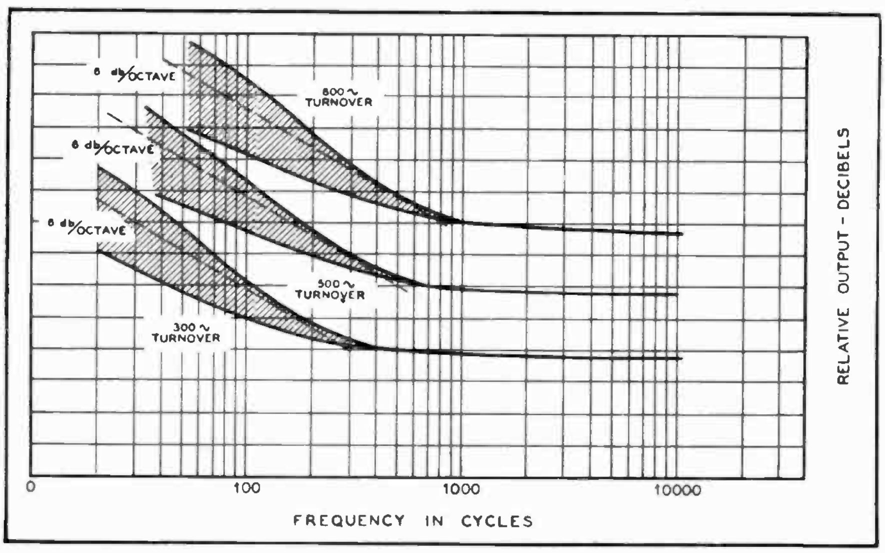


Fig. 1. Equalized two-stage amplifier suitable for low-frequency compensation for modern high-quality, low-level magnetic pickup cartridges.

Fig. 2. Equalization ranges obtainable with circuit of Fig. 1



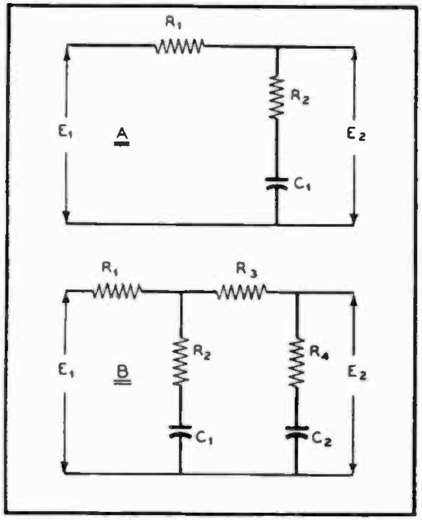



**Fig. 3. (A) Single-section RC network used to provide low frequency boost at the rate of 3 db/octave. (B) Two sections are necessary for a boost of 6 db/octave.**

be the sections of a 6SL7, 6SC7, or 7F7; or they may be two separate high-mu triodes such as 6SF5's, or two duo-diode triodes such as 6SQ7's, or 6AQ6's. with the diode plates strapped to the cathodes. The values shown will give a total boost of approximately 7 db/octave, with the switch lowering the transition frequency by adding more capacitance.

Shunting the capacitance of one of the *RC* sections with the potentiometer $R_7$ provides a controllable boost ranging from 3 to 7 db/octave. This potentiometer has an audio taper for smoothest action, the connection being made so that clockwise rotation of the knob increases the resistance across the capacitors, and thus increases the bass boost. *Figure* 2 shows the possible equalizations obtainable with this circuit.

The plate-load resistors $R_7$ and $R_8$ may be varied between 50,000 and 270,000 ohms to adjust the total gain of the preamplifier, and the output is intended to feed a 0.5 to 2.0 meg volume control.

## Crystal Pickup Equalization

The problems are entirely different when a crystal pickup is used. These devices normally give a flat output over the frequency range up to the transition point, and droop at the rate of 6 db/octave beyond. The low-frequency response is dependent somewhat on the total load into which the cartridge works, but if this load is greater than 1.5 megohms, the bass may be assumed to be normal.

Since a droop of 6 db/octave corresponds to a loss of 20 db for a frequency ratio of 10:1, the insertion loss must be at least 20 db to compensate for the range from 300 to 3,000 cps for the lowest turnover frequency. An additional 10 db would carry the compensation to 9,000 cps, which is a reasonable upper limit for this type of reproducer. However, most amplifiers used with crystal pickups do not provide sufficient gain to permit the use of this much equalization, so a circuit for a maximum of 20 db will be presented.

If the total insertion loss at low frequencies is to be 20 db, the resistors $R_1$ and $R_2$ of *Fig.* 4 must provide it. Therefore,

$$I.\ L.\ (\text{db}) = 20 \log \frac{R_1 + R_2}{R_2}$$

Since $R_2$ may very well be a 0.25 meg potentiometer used for the volume control, and since $(R_1 + R_2)/R_2$ must equal $\log^{-1}$ 1.0, or 10.0, $R_1$ is 2.25 megohms.

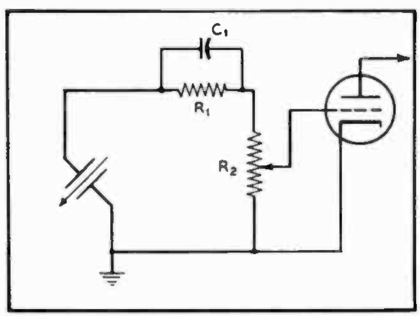



**Fig. 4. Type of equalizer used with crystal pickups to provide proper compensation for high-frequency droop inherent in capacitance generator.**

The capacitor across $R_1$ may be calculated for any desired transition frequency. The circuit of *Fig.* 5 shows a complete equalizer, using a 1.0-meg potentiometer in series with a 1.2-meg resistor for $R_1$, thus permitting the control of the amount of high-frequency boost, while the switch $S_1$ controls the transition frequency. $S_2$ is used to control the low-frequency response, providing a variety of load resistances for the pickup to work into, with the attendant change in bass output.

## Conclusion

These circuits may be useful to the experimenter, engineer, or record enthusiast for providing a wider range of control for record reproduction. Once the correct settings for the equalizer controls are determined for each individual record or album, they may be marked on the records to facilitate future use. Proper equalization will do more toward making the reproduction a realistic performance than any other single influence, when used with good quality equipment.

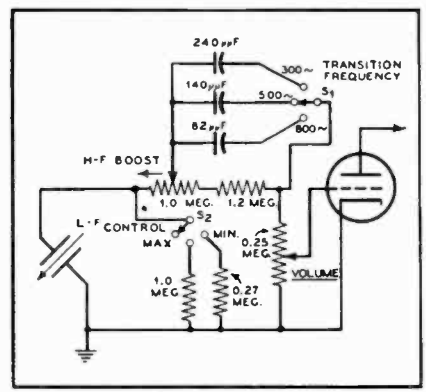



**Fig. 5. Complete equalizer circuit to be used between crystal pickup and grid of first tube, making use of both low- and high-frequency compensations.**