valves. A pot' with dissimilar sections could perhaps be used, but they are very rare, especially when a logarithmic taper is required!

For most fixed bias amps a proper tracking regulator will be required, and fig. 10.22 shows a suggested circuit.

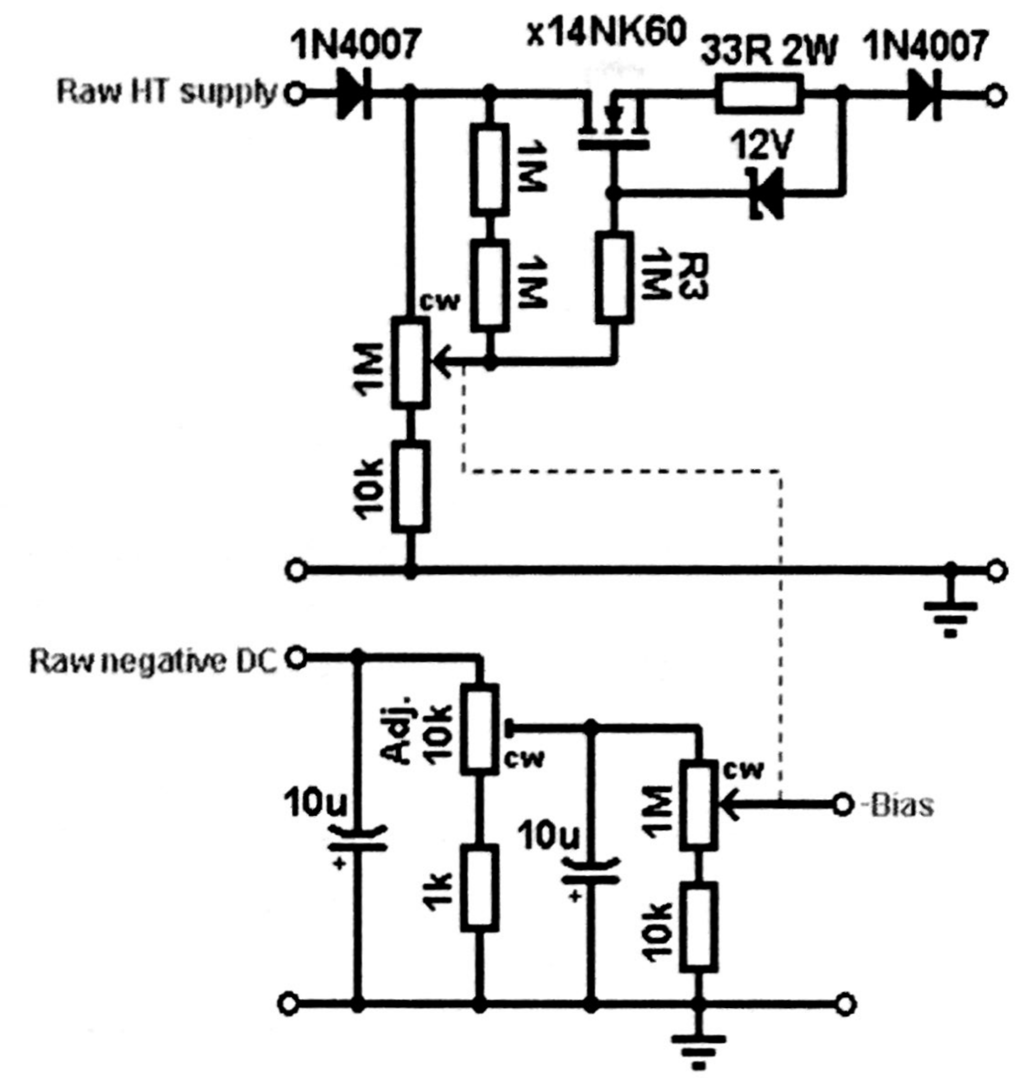

Fig. 10.21: Simplest method of bias tracking using a dual-gang pot'. This is only practicable in very low-power amps.

It should be obvious that it incorporates a differential amplifier Q1-Q2, and R1 to R3 formed a good constant-current source since they are retuned to the high voltage supply. The reference voltage at the base of Q1 is simply ground, or zero volts, so the circuit will strive to make the same voltage appear at the base of Q2.

The feedback divider sets the ratio of bias voltage to screen voltage, and trimpot P1 allows this to be adjusted (this can replace any bias adjustment circuit which might already be in an existing amp). For example, if P1 is adjusted so that the lower arm of this divider has a resistance of 30kΩ, which is one tenth the resistance of the upper arm formed by R5 to R7, the magnitude of the bias voltage will always be one tenth of the screen voltage. R8 simply prevents the bias voltage from accidentally being turned to zero, and its value could be altered. D1 prevents the base of Q2 from being pulled above ground at start up.

Bias adjustment should always be done with the power control at the maximum setting.

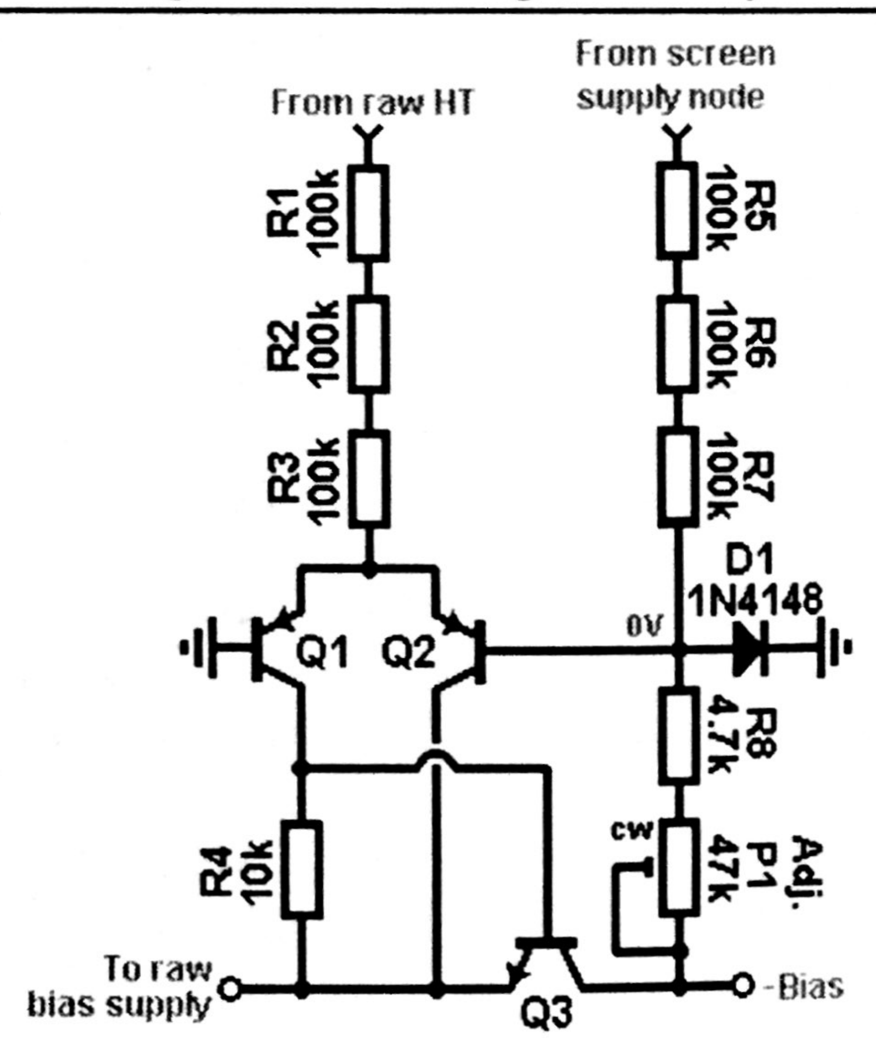

Fig. 10.22: Tracking regulator for bias voltage.

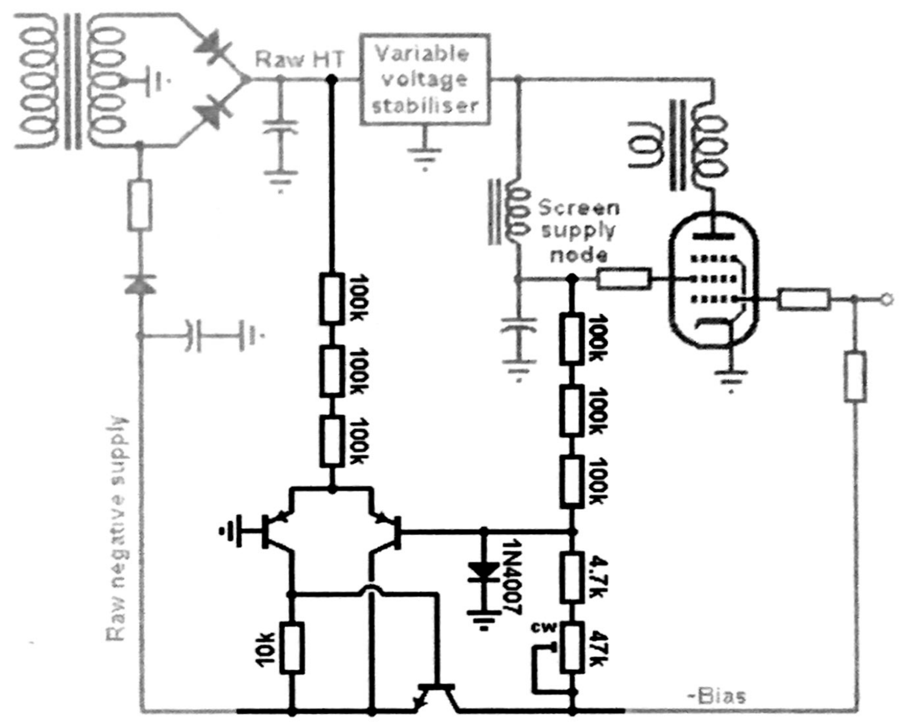

Fig. 10.23: Arrangement of the tracking regulator in a typical amplifier.

Notice that the output is taken from the collector of Q3, which is an NPN device. This is necessary so that the output voltage can be pulled all the way to zero volts, or very close, which would be difficult to achieve with a PNP pass transistor. Q1 to Q3 can be any general purpose transistors which have sufficient V_{ce} rating to withstand the magnitude of the raw negative voltage, and 100V transistors should be suitable for most applications. Examples include 2N5400/5550, ZTX653/753, etc. Again, resistances have been used in series so that ¼W devices can be used, but these could be replaced by single resistors of higher power rating.

For clarity, fig. 10.23 shows how this circuit would be used in the context of a typical amplifier circuit. The exact details of the amplifier, raw negative supply and screen-grid supply node will vary between designs of course.

Practical application of power reduction circuits:

The power reduction circuits have so far been shown in isolation, and it has been assumed that only the voltages around the power output stage will be varied, as in fig. 10.24. The preamp smoothing filters are now supplied directly from the reservoir capacitor, so the first dropping resistor may need to be be made larger than usual to bring the working voltages down to the desired levels. An additional smoothing stage may also be necessary (or a smoothing choke could be added in series with the first dropping resistor).

Since the power valves become more easy to overdrive at reduced power settings, a master gain-control immediately prior to the output stage is more-or-less obligatory with this arrangement.

However, other supply-voltage reduction arrangements are possible. A popular variant is to allow the supply voltage to the driver stage / phase inverter to vary along with the power valves, as shown in fig. 10.25. Since the driver stage will