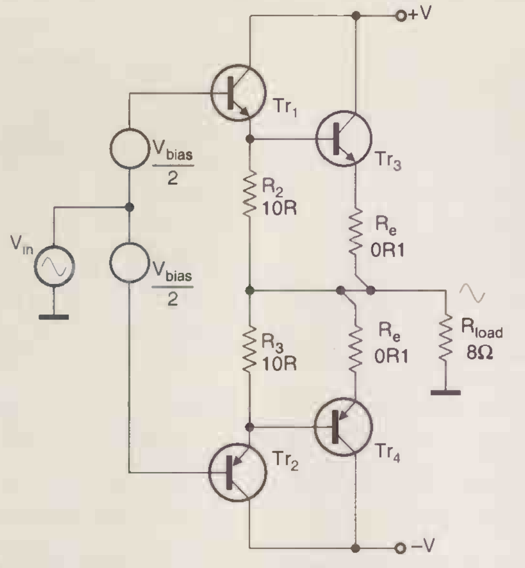

Fig. 2. Edwin type amplifier; standard Class-B except for the unusually low driver emitter resistors. Effectively B•C.

voltage. Such a section must exist – if only because the global negative feedback must be taken from one specific point – and the voltage at this point is the controlled quantity. The shunt configurations are dealt with first; see **Table 1**.

Class A•B. Class A•B describes an output stage in which the circuitry that actually controls the output is in Class-A, while a second Class-B stage is connected in parallel to provide the muscle.

The best-known example is probably the Sandman output configuration, in which the high-power amplifier A_2 is controlled by its own negative feedback loop so as to increase the effective load impedance until it is high enough for the Class-A stage to drive it with low distortion.[10]

In **Fig. 1**, A_1 is the Class-A controlling amplifier while A_2 is the Class-B heavyweight stage. As far as the load is concerned, these two stages are delivering current in parallel. The aim was improved linearity, with the elimination of the bias preset of the Class-B stage as a secondary goal.

If A_2 is unbiased and therefore working in Class-C, A_1 has much greater errors to correct. This would put the amplifier into the next category, Class A•C.

Class A•C. The power stage A_2 is now working in Class-C, the usual motivation being the reduction of power dissipation because current is flowing for less of the cycle. The absence of any bias for a Class-B-type output stage puts it in into Class-C, as conduction is less than 50% – though probably not much less.

If the bias voltage is dispensed with then a number of problems with setting and maintaining accurate quiescent conditions are eliminated. A good example of such use of Class-C is the Quad current-dumping concept. Here, the use of feed-forward error-correction allows the substantial crossover distortion from a heavyweight Class-C – i.e. underbiased Class-B – stage to be effectively corrected by a much smaller Class-A amplifier.[3]

Class B•B. At first there seems little point in using one Class-B stage to help another, as they both have inherent crossover distortion. However, since reducing the current handled by an output stage reduces both crossover and large-signal distortion, the concept can be useful.

An example is my load-invariant amplifier, which can be considered as two Class-B output stages collapsed into one.[12]

Class B•C. Here, the controlling stage A_1 is Class-B, accepting that some crossover distortion in the output will be inevitable. This approach appears to have been introduced by Crown (Amcron) around 1970.[13]

Once more two stages are combined; the drivers – usually compound – are required to deliver significant power in Class-B, while the main power devices only turn on when the output is some way from the crossover point, and are in Class-C.

Similarly, the 'Edwin' type of amplifier, Fig. 2, was promoted by Elektor in 1975.[14] It was claimed to have the advantage of zero quiescent current in the main output devices-though why this might be an advantage was not stated; in simulation linearity appears worse than usual.

Another instance of B•C is Class-G-shunt.[11] **Figure 3** shows the principle; at low outputs only $Tr_{3,4}$ conduct, delivering power from the low-voltage rails. Above a threshold determined by V_{bias3} and V_{bias4}, D_1 or D_2 conducts and $Tr_{6,8}$ turn on, drawing from the high-voltage rails.

Diodes $D_{3,4}$ protect $Tr_{3,4}$ against reverse bias. The conduction periods of the Class-C devices are variable, but much less than 50%. Class-G-Shunt schemes usually have A1 running in Class-B to minimise dissipation, giving B•C; such arrangements are often called 'commutating amplifiers'.

Class B•C•C. Some of the more powerful Class-G-shunt public-address amplifiers have three sets of supply rails to further reduce the average voltage-drop between rail and output.

The extra complexity is significant, as there are now six supply rails and at least six power devices. It seems most unlikely that this further reduction in power consumption could ever be worthwhile for domestic hifi, but it is very useful in large PA amplifiers, such as those made by BSS. Three letters with intervening dots are required to denote this mode, **Fig. 4**.

Series connection category

In the second group of configurations, voltages are summed by series connection. The intention is usually the reduction of total power dissipation, rather than better linearity.

Fig. 3. A Class-G-shunt output stage, composed of two emitter-follower output stages with the usual drivers. Voltages $V_{bias3,4}$ set the output level at which power is drawn from the higher rails. B•C.