Grid Bias for A.C. Receivers

Three Distinct Methods

BY "CATHODE"

THE problem of providing grid-bias for the now popular a.c.-operated receiver is one that at some time or other has exercised the minds of most designers. The simplicity and the technical advantages of deriving bias from dry batteries are largely discounted by the popular prejudice against what is regarded as a compromise, and indeed there is much to be said for the elimination of a battery whose modest dimensions render it apt to be forgotten, and whose unnoticed failure involves also the probable failure of an expensive set of valves.

As to the possible methods of biasing without batteries, there seem to be three methods which may be adopted, one of these methods, as wi be explained, being capable of a number of modifications, while one provides bias for the last stage only, leaving the previous stages to b biased by one of the other two methods or by batteries.

Separate Rectifier Filter.

THE three methods are:—

(1) Employing a separate rectifier-filter combination similar to that commonly employed for plate-current, or B supply, but connected in reverse; that is to say, the terminal which would ordinarily be used for supplying plate current at maximum potential is connected to the filament circuit of the receiver, while the various negative biases are tapped off at suitable intervals along a potential divider connected across the output. Fig. 1 illustrates the arrangement, also showing the method of by-passing with condensers and series resistances to avoid back coupling. This method of securing grid-bias is one that can be thoroughly recommended, its principal drawback being the expense involved in providing the additional rectifier and filter; another slight drawback is that, in the absence of a very high resistance voltmeter, it is difficult to determine with any accuracy just what negative voltages are available at the various tappings.

A Variation.

METHOD two is really a variant of the above, but, since its expense renders it practicable only in high-power work where bias voltages of the order of 100 or more are required for power valves of the UX250 or LS6A type, it will not be treated in detail. The separate rectifier and filter of Method 1 is here used to provide plate current for all stages but the last, for which it still provides grid bias. This is accomplished by connecting the filaments of all stages but the last to the negative end of the small separate rectifier-filter, the transformer winding for feeding the filaments of the last stage, however, being very highly insulated and connected to the positive terminal of the separate rectifier-filter. It will be clear that bias for the last stage can be obtained by tapping the resistance a suitable distance down from the positive terminal, while plate supply for the previous stages is secured by tapping, the same resistance at suitable distances up from the negative terminal; in certain circumstances the same tapping would be C— for the last stage and B+ for the prior stages.

Technically, this system is ideal for high-power work, but it suffers from two slight disadvantages: firstly, expense, and secondly, the output voltage of the separate rectifier-filter is added to that of the big rectifier-filter for the last stage, the combined voltage requiring some care in handling. Further, of course, the problem of providing bias for the prior stages still requires to be dealt with; the third method might well be made use of for this, however.

Bias through Voltage Drop.

THE third method, however, whatever may be its claims technically, certainly heads the list so far as popularity is concerned. Practically all the commercial A.C. receivers use it in one or other of its modifications. Briefly expressed, it consists in utilising the drop in voltage occasioned by the passage of the "B" current through a suitable resistance to provide negative bias; the "B" voltage is lowered by whatever maximum negative bias is required, so that the rectifier-filter combination has to be rated to deliver a voltage that much higher than would otherwise be necessary.

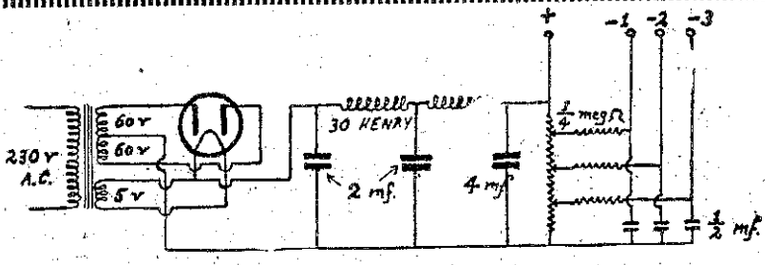

FIG. 1.—Diagram of Unit for supplying Grid-bias for an A.C.-operated or other Receiver.

Terminal marked + is connected to negative of B supply and to centre — taps of all filaments of receiver valves.

Terminal marked —1 supplies bias for high-frequency amplifying valves.

Terminal marked —2 supplies bias for audio-frequency amplifying stage.

Terminal marked —3 provides high bias for power stage employing 171 or similar valves.

Considering the diagram of a conventional unit for supplying B and C current to an A.C. receiver employing a 171 type valve in the power stage (see figure 2), it will be seen that if the centre taps of the filament windings for all valves are connected to the point marked —B, the whole of the plate current drawn by the receiver passes through that portion of the tapped resistance between the points marked —B and —40 volts.

The method employed to determine the value of the resistance required to produce any given voltage drop (and consequent bias) is a simple application of Ohm's Law. In its common form:

$$I = \frac{E}{R}$$

it is not very convenient for our purpose, so we multiply through to turn it to the form

$$R = \frac{E}{I}$$

We wish to obtain in the first instance 6 volts negative bias for a group of 226 type valves, and we will assume that a measurement (or a calculation) of the total "B" current (including the few milliamps that are "wasted" by passing right through the tapped resistance) shows its value to be 48.9 milliamps or .0489 amps. Knowing that the resistance required is found by dividing the m.f. in volts by the current in amperes, we put

$$R = \frac{6}{.0489} = 123 \text{ ohms.}$$

So that to secure the six volts bias required we must put a resistance of 123 ohms between the point marked —B (and to which the filaments are connected) and that marked —6 volts. To obtain the additional 34 volts negative bias to make the required total of 40 volts negative we require

$$\frac{34}{.0489}$$

or 695 ohms resistance between the points marked —6 volts and —40 volts.

But it is not essential that the whole of the plate current should pass through one resistance in this manner and, in fact, there will be less chance of undesirable interaction if this is not the case, (incidentally, an A.C. circuit embodying the 226 type of valve in R.F. and first audio). Fig. 3 shows in a practical manner the method of biasing a receiver employing a 171 or similar type valve in the last stage, an indirectly heated type 227 or similar detector, and a number of type 226 valves, of which only two are shown. It will be seen that here R4, connected between the filament centre-tap of the 226 valves (obtained by the centre-tapped resistance) and B—, is virtually in parallel with R5, which similarly bridges the centre tap of the 171 filament and B—. Thus, in calculating the value of R4, the total plate current of the 226 type valves only would be taken into consideration, while the basis of calculation for R5 would be the plate current of a single 171 type valve.

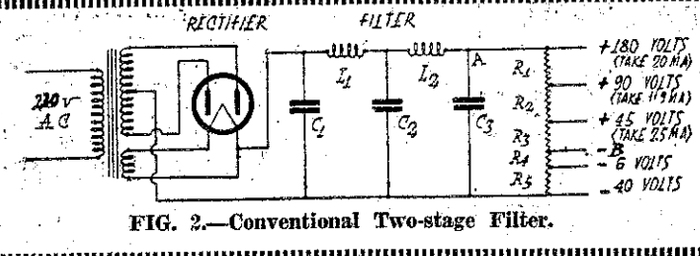

FIG. 2.—Conventional Two-stage Filter.

The Cathode Valve.

THE introduction of the indirectly heated cathode valve renders it possible to go still further in the