Calculating Power Output

Continued from Last Week

By "Cathode"

WE have now reached the part of the subject which the reader will probably have most difficulty in grasping; namely, the means of securing and calculating the maximum output available without exceeding the limit of second-harmonic distortion previously mentioned as being permissible, i.e., five per cent. Involved in this question is that of the determination of the load resistance necessary for maximum output.

There are two cases to be considered. Firstly, the case in which the voltage approaches the maximum permissible, and the output is limited by the plate dissipation. Secondly, the case where the plate voltage is low and the most suitable load can be used without overrunning the valve.

In the first case, the initial operating point can readily be determined in the manner previously described. As a refresher examine the plate voltage plate current family for the UX842 in Fig. 3. Here the permissible plate dissipation is 12 watts and the maximum safe plate voltage 425; with this voltage the plate current must not be greater than 28 milliamps if the rated dissipation is not to be exceeded. To keep the plate current at this value with the plate voltage specified a negative grid bias of 93 volts is shown to be necessary by the curves.

There are two limits which must be observed to avoid distortion: the grid must not become positive and so draw current, and it is necessary to operate on the straight portion of the curves. Fig. 3 seems to indicate that it would be inadvisable to permit the plate current to fall much below 10 milliamps at its maximum, as the "curves" begin to justify their name below this value. If the filament of the valve is heated with direct current, the grid will start to draw current at zero grid voltage; but if the filament is heated with alternating current, it will not be possible to go to zero voltage but the point at which grid current commences to flow will be approximately 4 volts negative (the UX842 has a 7.5 volt filament).

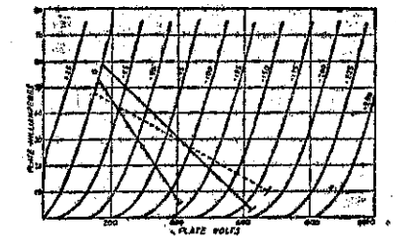
Assuming d.c. on the filament, and utilising the whole of the grid base, it is clear that a bias of 93 volts will permit a swing from 0 grid voltage to twice 93, or 186 volts. No curve for a negative grid voltage of 186 is shown in Fig. 3, but its position may be judged and the lower plate current point set on this curve at the value of 10 milliamps previously determined as the probable lower limit for distortionless operation. A straight line is then drawn from this point through the operating point previously plotted and continued to the 0 grid-voltage curve. This line is shown dotted in Fig. 3.

It is now necessary to determine the percentage of second-harmonic distortion, for the figure of 5 per cent. must not be exceeded. Percentage distortion is usually calculated from the equation:

$$\frac{\frac{1\ max. + 1\ min.}{2} - 1\ mean}{1\ max. - 1\ min.} \times 100$$

Where 1 *max.*=plate current at least negative grid voltage, 1 *min.*=plate current at most negative grid voltage, and 1 mean=steady plate current with no signal input (initial operating condition).

In the present case, of course, 1 *mean* is 28 milliamps, 1 *min.* 10 milliamps, and 1 *max.* is seen from the intersection of the dotted line with the curve corresponding to zero grid voltage to be just short of 48 milliamps. Calculation will show that the second-harmonic under these conditions is less than 1 per cent., so, as the permissible amount is 5 per cent., a lower minimum value of plate current can be chosen and the load characteristic line redrawn. Actually, in this case, a minimum plate current of 3 milliamps may be used without generating too great a second-harmonic, and the solid load line (upper) of Fig. 3 is the result.



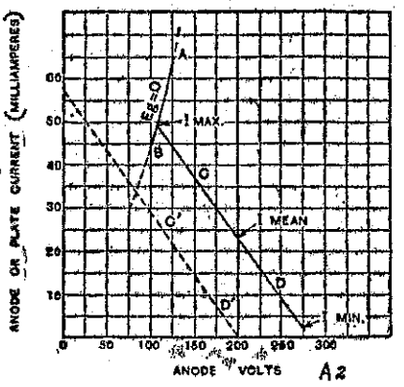


Fig 3.—Plate Voltage-plate Current Family for the 842.

The grid voltage at which the curves were made are shown on them. The oblique dotted line is the preliminary load line drawn through the operating point and the 10-milliampere current point at twice the operating grid voltage. The distortion under these conditions was quite small and a lower limit of minimum plate current was chosen. The most suitable line for a plate voltage of 425 is the solid one passing through the same operating point as the dotted line. The other load line is for a plate voltage of 300.

Diagram 4, lower.

THE process of trial and error involved in the above method may be considered unduly laborious. The work may be rendered easier by the use of a new device known as a "five-per-cent. distortion rule." This piece of apparatus is nothing but a short rule which may be conveniently made from a scrap of white cardboard. At a point not far from the centre a zero is marked, and from this zero divisions are marked off on either side; the size of the divisions is immaterial, so long as they can be conveniently read, but their relation one to the other is important. The divisions on the right-hand side of the zero are 9-11ths of those on the left. That is to say, if the divisions on the left-hand side are each 1.1 inches, the divisions on the right-hand side will each be 0.9 of an inch (in practice the centimetre is a more convenient measurement than the inch).

The operation of the rule is simplicity itself. The two plate-voltage plate-current curves corresponding to zero grid voltage and twice the operating grid voltage are first distinctively marked (say with coloured ink). The central zero of the distortion rule is then placed on the predetermined operating point and the rule rotated about this point until the readings on each side of the rule where its edge intercepts the two distinctively marked curves are the same. The load-line is then drawn in along the edge of the rule. The convenience of this little instrument is particularly marked where, instead of having the initial operating point determined by the plate dissipation, a plate voltage considerably lower than the maximum permissible is employed; in such cases, a quite extended process of trial and error is necessary to determine the best bias and load, and the distortion rule eliminates most of the labour and calculation involved.

(To be continued next week.)

Useful Hints

Handling Components.

IN the handling of wireless components generally it is not unusual for familiarity to breed, if not contempt, at least a certain amount of carelessness. Coils of the standard plug-in type, for instance, should always be gripped by the plug portion when inserted in or withdrawn from a holder. Care is also needed in handling low-loss coils on "skeleton" formers, since ebonite is notoriously brittle material. A skeleton cylindrical former, for example, should preferably be grasped by the ends, if not too long for the span of the hand. Too firm a grip round an interchangeable coil of this type may displace the winding or may even break the former, especially if the coil is tight in its mount and tends to come away rather suddenly when withdrawn.

Preventing Corrosion.

A PASTE that will prevent corrosion at battery terminals may be prepared very cheaply at home. Corrosion is checked by the use of grease or vaseline, but although this prevents creeping of the acid, some alkaline preparation should be used in connection with either to neutralise the acid. Fill a ½-pint cup with a cheap grade of vaseline, transfer this to a pan and melt it over a slow fire. When melted, add three tablespoonsful of common baking-soda, remove the pan from the fire and stir the mixture until the soda is thoroughly dissolved. Spread the paste over the battery terminals after they have been thoroughly scraped and cleaned. Any acid solution that has been sprayed over the top of the battery when charging, or spilled when a hydrometer reading is taken, should be carefully removed with a rag moistened with a weak solution of household ammonia.