

capacity of the tube, thus rendering it impossible for the tube to supply its own excitation. For complete neutralization it is necessary, therefore, that the neutralizing voltage be opposite in phase to the voltage through the grid-plate capacity of the tube and be equal to it in value.

The out-of-phase voltage can be obtained quite readily by using a balanced tank circuit in either grid or plate, taking the neutralizing voltage from the end of the tank opposite that to which the grid or plate is connected. The amplitude of the neutralizing voltage can be regulated by means of a small condenser, the "neutralizing condenser," having the same order of capacity as the grid-plate capacity of the tube. Circuits in which the neutralizing voltage is obtained from a balanced grid tank and fed to the plate through the neutralizing condenser may be called "grid-neutralizing" circuits, while if the neutralizing voltage is obtained from a balanced plate tank and fed to the grid of the tube, the circuit is known as a "plate-neutralized" circuit.

A neutralizing circuit is actually a form of bridge circuit, the grid-plate capacity of the tube and the neutralizing condenser forming two capacitive arms, while the halves of the balanced tank circuit form the other two arms.

Plate-Neutralizing Circuits

Several plate-neutralizing circuits are given in Fig. 818. In the circuit shown at A the tank coil is center-tapped, with the tank condenser connected across only the upper half of the coil. The neutralizing portion of the coil is connected back to the grid of the tube through the neutralizing condenser,  $C_n$ . The circuit of B is similar, differing, however, in that the tank condenser is connected across all of the tank coil. This method of connection is preferable in that it tends to keep a better voltage balance over a range of frequencies. The only reason for using the circuit of A is to get as high impedance as possible in the part of the tank circuit included between the filament return and plate for the sake of efficiency.

In both the circuits already described the division of r.f. voltage between plate and neutralizing portions of the circuit has been by balancing the tank coil. The balance also can be capacitive, by the use of a split-stator tank condenser with grounded rotor, as shown in Fig. 818-C. The r.f. potential across the tank coil divides in the same way, a node (point of zero voltage) appearing at its center. Hence the plate voltage is introduced at the center of the coil. The r.f. choke in the plate voltage lead is for the purpose of isolating the center of the coil from ground for r.f., since a ground through a by-pass condenser, if not exactly at the point

of zero potential, might cause circulating currents which would reduce the plate efficiency of the amplifier.

The push-pull neutralizing circuits shown at

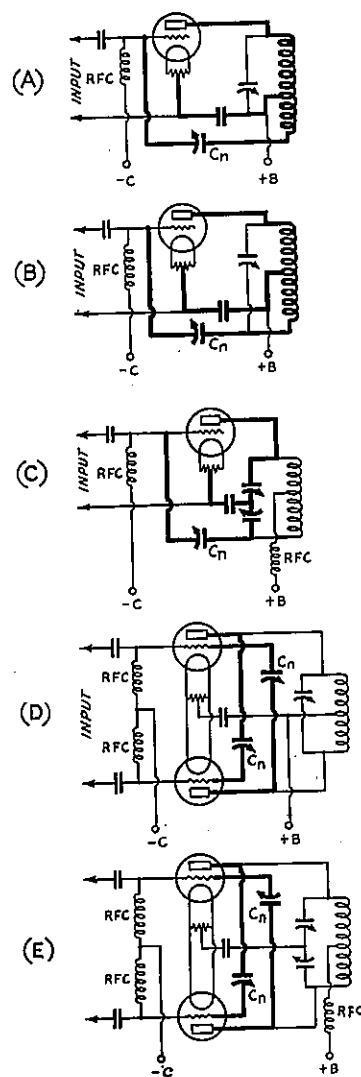


FIG. 818 — PLATE NEUTRALIZING CIRCUITS

D and E are known as "cross-neutralized" circuits, the neutralizing condensers being cross-connected from grid of one tube to plate of the other. With proper physical arrangement of parts, a more exact balance can be obtained with push-pull than with a single tube because both sides of the circuit are symmetrical. Hence these circuits often are easier to neutralize than single-tube circuits. The split con-

denser circuit of E is to be preferred for push-pull amplifiers.

Grid Neutralization

Typical grid-neutralizing circuits are shown in Fig. 819. They resemble closely the plate-neutralizing circuits except that the neutraliz-

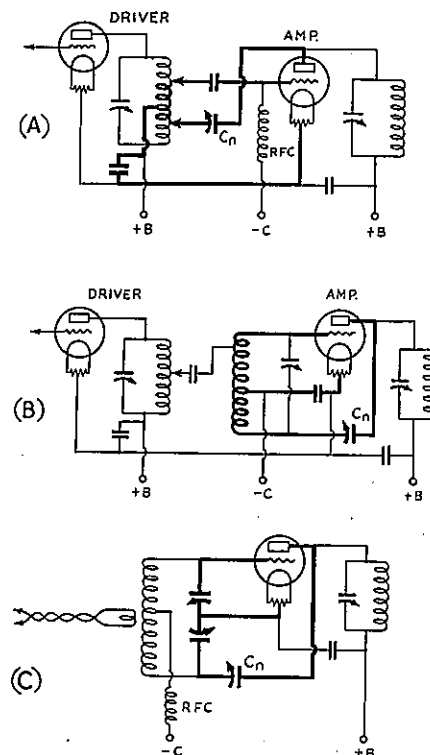


FIG. 819 — GRID NEUTRALIZING CIRCUITS

ing voltage is obtained from a balanced input tank and fed to the plate of the tube. Circuit A is used with capacity coupling between driver and amplifier. The grid coupling condenser, being large in comparison to the tube and neutralizing capacities in most circuits, will have negligible effect on the operation of the neutralizing circuit.

Grid neutralizing systems are well adapted to use with transmission line or link-coupled amplifiers, since the separate grid tank offers a ready means for obtaining the neutralizing voltage. It may be somewhat harder to drive a tube with a balanced input tank, however, because only half the r.f. voltage developed in the tank is available for the grid-cathode circuit of the amplifier. This can be overcome to some extent by using the largest possible L-C ratio in the grid tank in order to build up the r.f. voltage to the highest possible value. An

advantage of the grid-neutralizing systems is the fact that the single-ended plate tank circuit has higher impedance, and hence gives greater plate efficiency, than a balanced plate tank in which the plate-cathode circuit is connected across only half the turns or half the capacity.

Values in Neutralizing Circuits

In all these circuits, by-pass condensers and parts not particularly a part of the neutralizing arrangement will have the usual values. In most cases the neutralizing voltage will be equal to the r.f. voltage between the plate and grid of the tube so that for perfect balance the capacity required in the neutralizing condenser theoretically will be equal to the grid-plate capacity of the tube being neutralized. If, in the circuits having tapped tank coils, the tap is more than half the total number of turns from the plate end of the coil, the required neutralizing capacity will increase approximately in proportion to the relative number of turns in the two sections of the coil.

The paragraph above should make it clear that the neutralizing capacity required at  $C_n$  will depend upon the type of tube and the choice of circuit. For those tubes having grid and plate connections brought out through the bulb, such as the 800, 852, 50T, 150T and a few others, a condenser having at about half scale a capacity equal to the grid-plate capacity of the tube should be chosen. Where the grid and plate leads are brought through a common base, the  $C_n$  capacity needed is greater because the tube socket and its associated wiring adds some capacity to the actual inter-element capacities. In such cases a slightly larger condenser should be used. For most small triodes, a condenser having a minimum of about 5  $\mu$ fd. and a maximum of approximately 20  $\mu$ fd. will suffice. Such condensers are readily obtainable in the midget sizes.

When two or more tubes are connected in parallel, the neutralizing capacity required will be in proportion to the number of tubes.

Neutralizing Adjustments

The procedure in neutralizing is the same regardless of the tube or circuit used. To do the job satisfactorily it is essential that some form of fairly sensitive r.f. indicator be available; a flashlight lamp with its terminals connected to a loop of wire, a neon bulb, or a thermo-galvanometer connected to a wire loop are suitable.

The first step in neutralizing is to disconnect the plate-voltage from the tube. Its filament should be lighted, however, and the excitation from the preceding stage should be fed to its grid circuit. Couple the r.f. indicator to the plate tank circuit (if a neon bulb is used, sim-