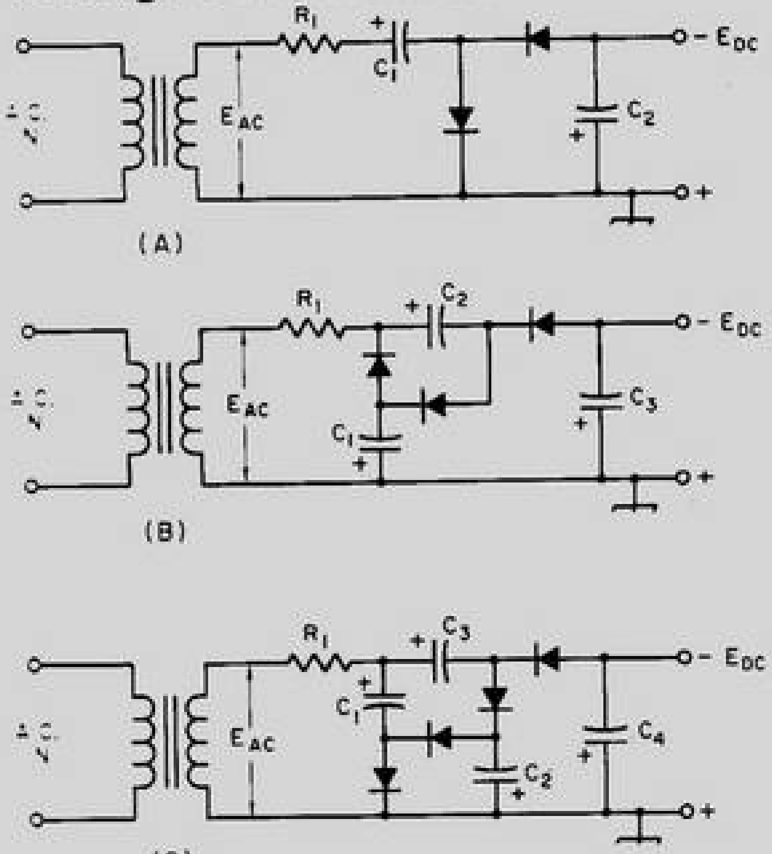

Fig. 12-20—Voltage-multiplying circuits with one side of transformer secondary grounded. (A) Voltage doubler (B) Voltage tripler (C) Voltage quadrupler.

Capacitances are typically 20 to 50 μf., depending upon output current demand. D.c. ratings of capacitors are related to E_{peak} (1.4 E_{ac}):

C_1—Greater than E_{peak}
C_2—Greater than $2E_{peak}$
C_3—Greater than $3E_{peak}$
C_4—Greater than $4E_{peak}$

of the a.c. cycle; the other rectifier is nonconductive during this time. During the other half of the cycle the right-hand rectifier conducts and C_2 becomes charged; they see as the source the transformer plus the voltage in C_1. By reversing the polarities of the capacitors and rectifiers, the − side of the output can be grounded.

A voltage-tripling circuit is shown in Fig. 12-20B. On one half of the a.c. cycle C_1 is charged to the source voltage through the left-hand rectifier. On the opposite half of the cycle the middle rectifier conducts and C_2 is charged to twice the source voltage, because it sees the transformer plus the charge in C_1 as the source. At the same time the right-hand rectifier conducts and, with the transformer and the charge in C_2 as the source, C_3 is charged to three times the transformer voltage. The − side of the output can be grounded if the polarities of all of the capacitors and rectifiers are reversed.

The voltage-quadrupling circuit of Fig. 12-20C works in substantially similar fashion.

In any of the circuits of Fig. 12-20, the output voltage will approach an exact multiple (2, 3 or 4, depending upon the circuit) of the peak a.c. voltage when the output current drain is low and the capacitance values are high.

VOLTAGE STABILIZATION

Gaseous Regulator Tubes

There is frequent need for maintaining the voltage applied to a low-voltage low-current circuit at a practically constant value, regardless of the voltage regulation of the power supply or variations in load current. In such applications, gaseous regulator tubes (0C3/VR105, 0D3/VR150, etc.) can be used to good advantage. The voltage drop across such tubes is constant over a moderately wide current range. Tubes are available for regulated voltages near 150, 105, 90 and 75 volts.

The fundamental circuit for a gaseous regulator is shown in Fig. 12-21A. The tube is connected in series with a **limiting resistor**, R_1, across a source of voltage that must be higher than the **starting** voltage. The starting voltage is about 30 to 40 per cent higher than the operating voltage. The load is connected in parallel with the tube. For stable operation, a minimum tube current of 5 to 10 ma. is required. The maximum permissible current with most types is 40 ma.; consequently, the load current cannot exceed 30 to 35 ma. if the voltage is to be stabilized over a range from zero to maximum load current.

The value of the limiting resistor must lie between that which just permits minimum tube current to flow and that which just passes the maximum permissible tube current when there is no load current. The latter value is generally used. It is given by the equation:

$$R = \frac{(E_s - E_r)}{I}$$

where R is the limiting resistance in ohms, E_s is the voltage of the source across which the tube and resistor are connected, E_r is the rated voltage drop across the regulator tube, and I is the maximum tube current in amperes, (usually 40 ma., or 0.04 amp.).

Fig. 12-21B shows how two tubes may be used in series to give a higher regulated voltage than is obtainable with one, and also to give two values of regulated voltage. The limiting resistor may be calculated as above, using the sum of the voltage drops across the two tubes for E_r. Since the upper tube must carry more current than the lower, the load connected to the low-voltage tap must take small current. The total current taken

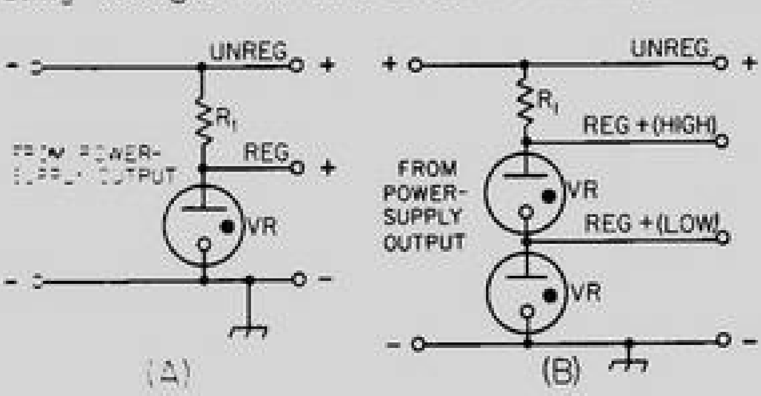

Fig. 12-21—Voltage-stabilizing circuits using VR tubes.