Signal Training Bulletin

COMMITTEE G: Education & Training
Communication & Signal Section, AAR

B-7 Rectifiers

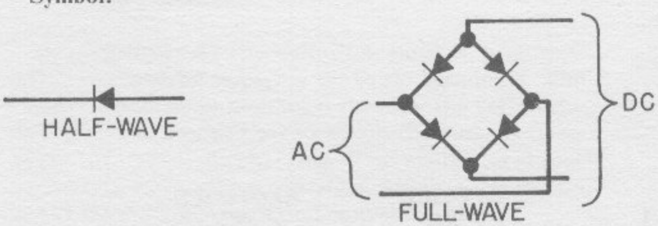
Approved October 1973

Definitions: (a) Rectifier: A device which converts alternating current into unidirectional current by virtue of a characteristic permitting appreciable flow of current in one direction only.

(b) Half-Wave Rectification: Rectification permitting only one-half of the alternating current cycle to be transmitted as unidirectional current.

(c) Full-Wave Rectification: Rectification in which both halves of the alternating current cycle are transmitted as unidirectional current.

Symbol:



Description: The basic component of the rectifier is a diode. They are produced in several forms: e.g., semi-conductor, metallic, vacuum tube, and mercury tube diode.

A diode consists of two major parts, namely the anode and cathode. The current enters the device at the anode and leaves at the cathode.

Purpose and Application: Purpose of the rectifier is to convert readily available ac to unidirectional power for charging batteries, operating dc relays and other dc devices.

General Information: Many railroads have instructions outlining installation, maintenance and inspection procedures with regard to rectifiers. It is most important that maintenance personnel become familiar with their company's instructions.

Detailed Operation: Semi-Conductor Diodes: A semi-conductor diode is constructed of two dissimilarly treated sections of the same semi-conductor material which will allow current to flow in only one direction across the junction of the two sections.

The semi-conductor diode, unlike the vacuum tube diode, does not require any heating to function. It is always ready to function without any warm-up time.

The fact that semi-conductor diodes come in various sizes allows their use in circuits having current flows of from a few milliamperes to several hundred amperes.

Metallic Diodes: A metallic diode is constructed of two different materials which will allow the effective flow of current in only one direction.

Vacuum Tube Diodes: A vacuum tube diode possesses an anode and cathode contained in a vacuum and

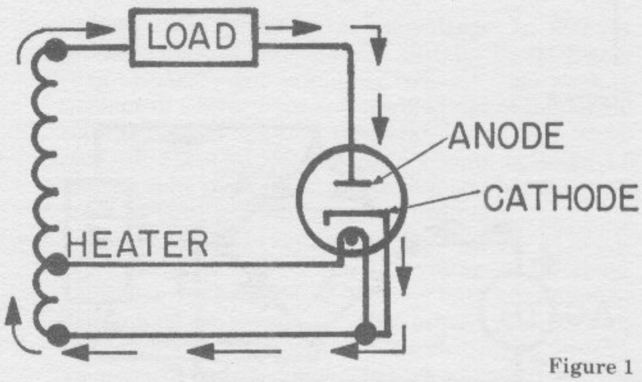


Figure 1

rectifies alternating current by attracting emitted electrons from its cathode to its anode.

The cathode is constructed of a material which, when heated, will emit electrons that are needed to permit current to flow when voltage of proper polarity is applied to the diode. The cathode may be self-heated, in which case, it is constructed of one or more loops of fine wire. This type of cathode is quite similar to the filament used in lamps, and is referred to as a filament. The indirectly heated cathode consists of a cylinder which contains a heating filament that is inactive insofar as electron emission is concerned.

A typical half-wave circuit using a vacuum tube diode is shown in Figure 1.

When the polarity of the ac to be rectified is as shown, and the heater is hot, the tube will conduct. When the polarity is opposite to that shown, the cathode cannot emit electrons and the tube will not conduct. If the heater has failed, the tube will not conduct, regardless of the ac polarity.

The diodes can be arranged in the rectifier circuit in several configurations depending on the type of ac supplied (single — or three-phase), and the degree of rectification desired (half or full-wave).

A typical circuit for half-wave rectification is shown in Figure 2.

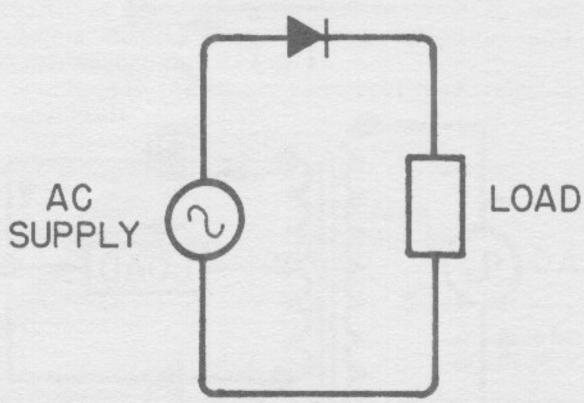


Figure 2

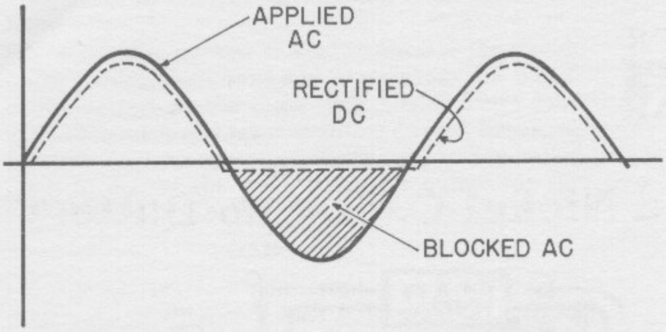


Figure 3

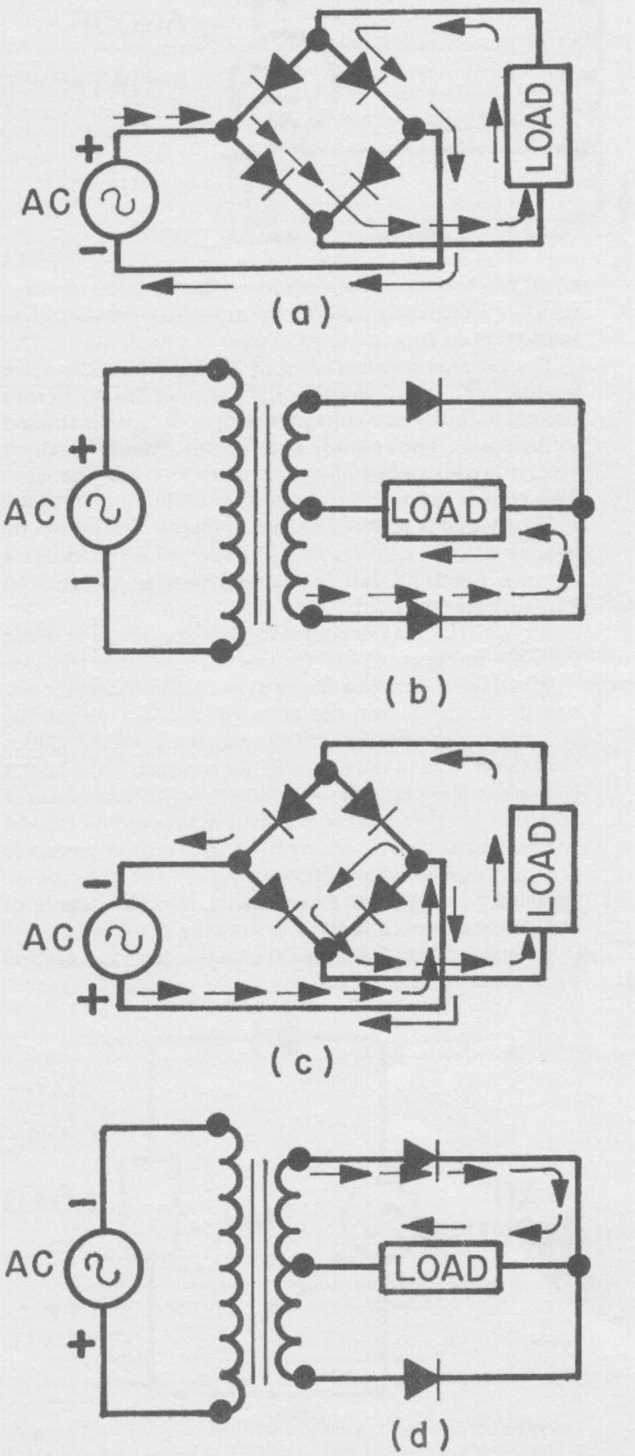


Figure 4

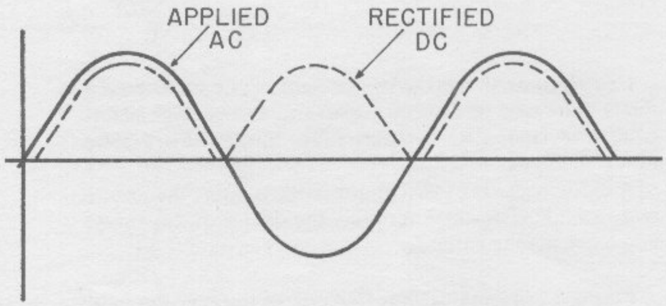


Figure 5

This type of circuit, unfiltered, has the characteristic of supplying a dc voltage less than the impressed ac voltage. The reason for the lesser value is that only half of the ac wave is being used. The other half is blocked by the diode. (See Figure 3).

The half-wave rectification circuit, because of its low efficiency, is used in non-critical applications requiring low currents.

Typical circuits for full-wave rectification are shown in Figure 4.

Full-wave rectification can be achieved utilizing either of two configurations. When designed properly, their outputs will be almost identical. The voltage across a resistive load will be twice that of a half-wave circuit. Also, if a diode were to fail open in the full-wave circuit, a half-wave output would result.

When the AC polarities are as indicated on Figures 4(a) and 4(b) one pair of diodes on 4(a) and diode on 4(b) will allow current flow in the path indicated. Conversely, during the other ac half cycle, when the polarities are opposite, the other diode (s) in each figure will conduct as shown in Figures 4(c) and 4(d). During either half cycle, the rectified current flows in the same direction through the load. The input and output wave forms will be as shown in Figure 5.

The full-wave rectifier circuit may be used in any rectification circuit. It is commonly used in battery charging circuits.