ing throughout the length and width of the flanges of the plates.

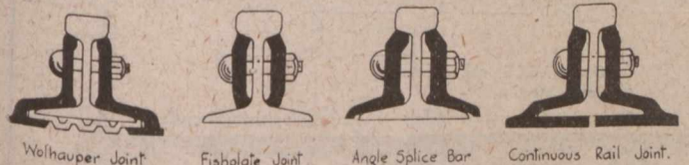
In a paved street where the rail is not exposed to any great change of temperature, it is a common practice to weld the joints. This class of joint has the advantage of being more permanent, costs less to maintain and makes a better conductor for the return current. It is made by three methods: (1) The Thermit process, which depends upon the heat from the chemical reaction of aluminum and oxide of iron; (2) the cast-iron joint, made by pouring molten cast iron around the joint; and (3) the electrically welded joint, made by welding two plates to the web of the rail.

The following tabulation of the different types of track joints in use in North American cities was compiled several years ago and as the total number of joints used in each city is not given, the comparison is only approximate:—

Riveted welded, ...	3.0%
Bonzano continuous, ...	5.8%
Nichols composite, ...	6.0%
Electric welded, ...	8.8%
Angle bars, ...	11.7%
Cast weld, ...	17.7%
Continuous, ...	47.0%
Total, ...	100.0%

Bonding

It is generally recognized that a good bond is important from the standpoint of operation, power economy and electrolysis migration. A poor bond lowers the voltage beyond the defect, thus making it more difficult for the motorman to make his run on time. Considering the bond from the standpoint of power economy, George H. Eveland, in a paper read before the American Electric Railway Association, states that he has measured drops around joints as high as 6 volts, and that one poor bond can waste $5 worth of energy in a year for every dollar that it would cost to rebond the joint. The resistance of a joint is usually expressed in terms of feet of rail, and a bond provided equal to the resistance of the rail being used. For instance, when a bond becomes so



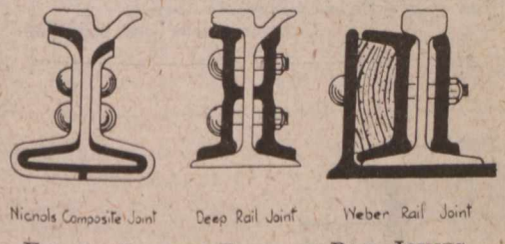


FIG. 5—VARIOUS TYPES OF RAIL JOINTS

defective that its resistance is equivalent to 12 ft. of rail, then it should be rebonded. Many cities use a shorter length of rail as the maximum allowed before rebonding.

The most common form of rail bond has terminals which are inserted in holes drilled through the web or flange of the rail, and the best results are obtained when the points of contact between the rails and terminal are perfectly clean. In order to insure that this will be the case, the rails are drilled for bonding 1/16 in. smaller than required, and reamed out immediately before the bond is to be made. The bonds most commonly used have round copper terminals with a flexible body made up of thin, narrow ribbons of sheet copper. After the bond hole has been reamed out, the terminal is riveted in place, either by hand or preferably by a mechanical compressor which ensures that the hole is completely filled.

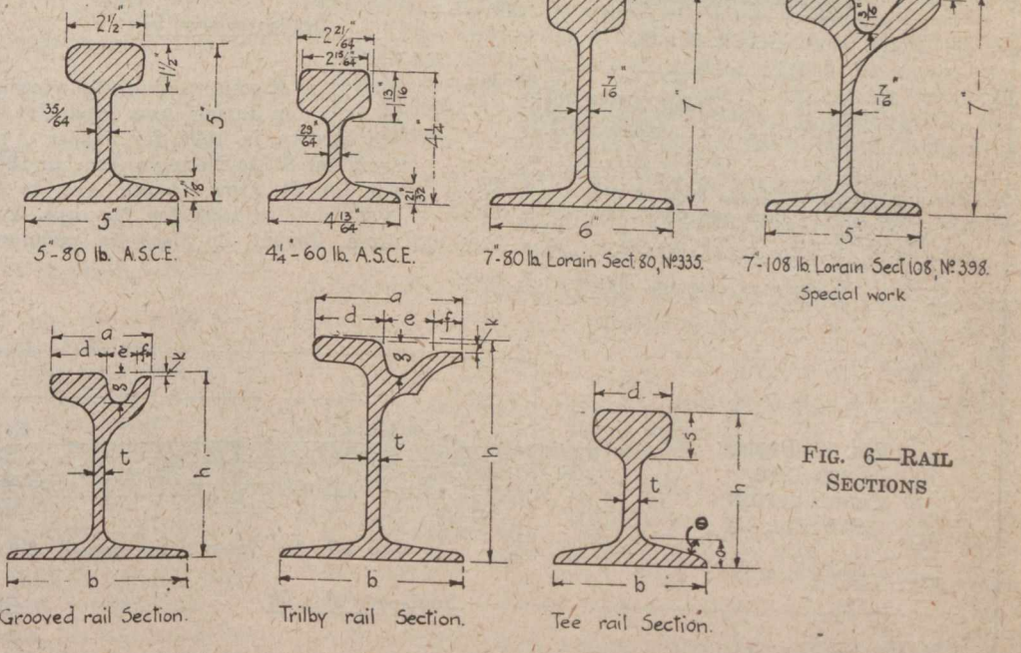


FIG. 6—RAIL SECTIONS

Bonds are sometimes made by soldering a short piece of cable to the web or flange, across the joint. This practice is not used extensively, because it is claimed to be a difficult matter to make this kind of joint "mechanically strong and electrically perfect." There are, however, cases reported where satisfaction has resulted from soldered bonding. E. J. McIlraith, superintendent of ways and structures, Puget Sound Traction, Light & Power Co., Seattle, Wash., in describing their twelve years' experience with soldered bonds, states that "of the 40,794 bonds on the 203 miles of track, less than one-quarter of one per cent. have proved defective or have been stolen. On most tracks a resistance per bond equivalent to 12 ft. of rail is the maximum allowed before rebonding, but on tracks of heavy current flow, 10 ft. is used."

In addition to bonding joints, it is practically essential that there should be "cross-bonding" between rails, as otherwise a break in one rail would deaden its side, and a break in both rails would cut off the return current altogether. This same principle may be applied to double track construction, and bonds carried across the devil strip to the nearest rail of the other track. The standard practice in Edmonton is to use 4/0 cross bond between the rails every 400 ft., and 4/0 cross bonds in the devil-strip every 500 ft.

Track Drainage

Track drains, which are provided to catch the rain and melting snow that runs along the track allowance and carry it into the sewer system, should be placed at least every 800 ft. on a long grade, and at the intersection of descending grades.

Fig. 12 shows the older type of track box built in Edmonton previous to 1915, in which the grill casting was made in two pieces, with the grills at right angles to the traffic. The water drops into a concrete box with an outlet pipe to the silt well, which is connected to the sewer.

The silt wells may be built of concrete blocks, brick or vitrified cull tile pipe. It has been found that excellent results may be obtained by using three pieces of 22-in. or 24-in. vitrified tile pipe standing on end in a concrete base.