bolts. A spiral washer employed in the standard track Pennsylvania Railroad answers very well, and the arrangement used by the Cambria Iron Company, (see Pages 291 and 292), is also good. An allowance must always be made in a joint between the ends of the rails, for expansion The maximum amount will vary probably somewhat with the climate, being dependent upon the difference between the extremes of temperature at different times of the year, and the space actually allowed in the process of the track laying is of course different at different seasons. In latitude 40 degrees it is customary to give 5-16 of an inch in winter and I-16 of an inch in sum-Iron shims of the requisite thickness should be used to separate the rails in laying. The best practice places the joint of one line of rails opposite the centre of the rail on the other line of the same track. This arrangement tends to break up any tendency to a regular jolting or jumping of the cars as they pass over the joints, an effect that increases by the regular repetition and is very disagreeable on roads laid with the joints opposite. On pages 291 and 292, are shown some forms of rail fastenings, for which the author is also indebted to the Cambria Iron Company. Fig. A $F_{ig} \stackrel{\text{indebted}}{A}$ is the Cambria Patented rail joint. Fig. B, is that is that used by the Pennsylvania and other roads indicated on the plate. Fig. C, is an old form used by the Pennsylvania and other roads, but is not now standard on the P.R.R. Figs. J,K, and L, show recent peculiar forms of street rail Now being adopted, and laid, not on longitudinal stringers as has been usual with tramways, but on cross ties. On the Chicago & North West Western Railway the joints are laid opposite and suspend Railway the joints are laid opposite and Suspended, the joint ties being 6 inches apart. Angle splices are used, 22 inches long, bolted with , plices are used, 22 inches long. Plate with 4.34 inch bolts 4.1/2 inches to centres. Plate III shows the standard splice of the Pennsylvania $R_{ailroad}$

Supports for the rails where timber is very scarce or is liable to rapid decay, as in India or other tropical countries, have been adopted of iron with iron with success. In temperate climates however, timber is used almost universally, creosoting or some other preservation process being sometimes to the preservation further to sometimes employed, particularly in Europe, to increase employed, particularly in an opinion its longevity. There is a prevalent of its elasticity Opinion that timber on account of its elasticity is essential for supports in order to make a good road, but this does not seem to be borne out in fact, an it is does not seem to be borne out in fact, as iron has been used quite successfully where : where its expense has not been an objection. In American and many In America, timber is still abundant and many years years may elapse before other material is used to any extent, but the time will come when something else must take its place, and far seeing railroad railroad men are already looking forward to the future. Wrought iron or steel cross-tie of the future. Notwith Notwithstanding the experience of Europe, it is a question whether preservatives are of much use

for wooden ties in America. On roads where there is heavy service, the material often wears out before decaying; the harder kinds of wood, which are the best for service, do not absorb a preservative solution as readily as the softer and inferior kinds, which latter wear out very rapidly, and the cost of using a preservative would only be a useless expense.

On roads with very light traffic, operated by horse power, as street railways, longitudinal timbers placed under the rails have been generally used as supports, those for the same track being tied across at intervals to preserve the gauge of This arrangement however will not anstrack. wer for locomotive traffic, and even for street railways, as already intimated by the author, it is being abandoned, a form of rail being adopted that will admit of the use of cross ties. A longitudinal sleeper is very apt to split with the spikes which must be driven into it at frequent intervals in its length to hold the rail, water gets into these cracks softening and decaying the timber, and there is a great tendency in the rail to sink into the wood, the supporting power being lost. Timber will always bear a load best resting across the grain even when in first class condition ; the cross-tie system also offers great advantages in renewals, over the longitudinal stringer system, vastly increasing facilities of replacing material without delay or interruption of traffic. Even on bridges where longitudinal stringers have been used for years, on account of advantages obtained in the details of construction of the floor system, they are now being abandoned and a cross-tie system adopted. The rationale of the present almost universal method of timber cross-tie supports is therefore readily seen.

These ties are placed at frequent intervals, sufficient to properly support the rails, the latter being securely spiked to them, and the ties, in addition to giving the proper support, tie the rails together to gauge, and by their hold in the ballast below, keep the whole track in line. Hence thé American word "cross-tie," at once descriptive and appropriate. The cross tie should if possible be of what is technically termed "hardwood," and of all woods in America the best for this purpose is white oak. This is the case at least in the temperate zone. There may be some woods in the tropics, unknown to the author, that are better.

The more bearing surface ths rail has on the tie, and the more surface the tie has on the ballasting material below it, the better and more stable the track. Hence the ties should be flattened on the upper and lower sides, and a minimum width of the flat surface should be specified, less than which will not be allowed. The sides of the ties are only barked and left rounding. Sawed ties are sometimes used cut square on all sides, but hewn ties are by far the