with safety its load between the points of support, acting as a continuous girder of a span equal to the distance of the points of support apart, or rather twice that distance, so that in case any one should fail or give way, the rail would still be able to carry over the increased span with safety. Theory therefore points to a deep rail having a comparatively thin web, with upper and lower flanges, the upper flange being rounded to the proper shape to receive the wheels of the moving load, allowing sufficient width of bearing surface to prevent crushing under the action of the wheels, but not more than necessary, as the friction would otherwise be increased; and the lower flange shaped to adapt it to the mode of support adopted. In England, where iron chairs of peculiar kind are used to carry the rail the lower flange is made of a similar form to the upper, while on the continent of Europe and in America, the lower flange is made flat, to rest on a timber tie or sleeper. The width of this flange should be such that the load will not cause the rail to sink into the timber. The web of the rail must be sufficiently thick to give stiffness sideways and prevent the load bending the top of the rail over and crushing it. The section of the rail is made symmetrical about a vertical axis, allowing of reversal , if desired, when the inner edge has become seriously worn by the wheels.

As to the proper depth and weight of the rail, it will readily be seen that this depends upon the distance that the supports are placed apart, and the load carried. The loads carried on first class American railways are no lighter than those carried on European railways. Class K Engine, as used on the Pennsylvania Railroad, has a total weight in working order of 92,700 pounds, distributed on a wheel base of 22 feet 7½ inches, and a weight on the first pair of drivers of 33,600 pounds. Class L Engine, on the same road, has a total weight of 124,100 pounds, on a wheel base of 31 feet 4 inches, with a load on the main pair of drivers of 32,500 pounds. Class M Engine has a total weight of 87,500 pounds on a wheel base of only 10 feet 8 inches, and a weight on the first pair of drivers of 33,400 pounds. But in Europe, where timber is expensive, the ties or sleepers are placed farther apart than they are in America and therefore heavier rails are required. So long as timber is cheap in this country light rails will be used, but there is a tendency on some lines to heavier rails.

In assuming the proper load to be used in calculating the proportions and weight of a rail, it is not sufficient to take the static weight from the heaviest wheel, but an amount must be added to this on account of the load being a live or moving load, and also for impact, the tendency of a rapidly moving train, particularly with the driving wheels of the engine, being to pound down, as it were, upon the track making sudden applications of heavy loads. The percentages of addition thus required to the dead load cannot be determined theoretically, but must be assumed more or less empirically, depending upon the results of practical experience. The rails, when fastened firmly to their supports, must also possess sufficient lateral stiffness to resist all deflection sideways from the swinging motion of the train, centrifugal force on curves, etc.

The author is indebted to the courtesy of the Cambria Iron Company, Johnstown, Penn., for the standard sections of steel rails shown on plate I, as adopted and in use on a number of American roads. These will represent pretty fairly the general practice throughout the country. In comparing these it must be borne in mind that the service on some lines is not so severe as on others, also that the same railroad company uses lighter sections on its branch lines than on its main stem, on account of the difference in service. Sections that are quite suitable in one case are not so in others.

The numbers by which the several sections are designated are those of the Cambria Iron Iron Co. Where the roads using any section are noted, and the date is given, it simply means that this section was rolled for that railroad at that date. It does not follow that the railroad in question may not have changed its section, at some other mill since then, but this is a matter that could not be ascertained and its probability is not very great.

The Grand Trunk Railway of Canada uses the Sandberg pattern of T rail, weight 65 pounds per yards.

The Chicago & North Western Railway Co. is using 30 feet rails, the weight on main lines since 1882 being 65 pounds per yard, on less important lines 60 pounds per yard, and some 56 and 50 pound rails on branches.

The material of which rails are formed requires great care in selection. It must be sufficiently strong to sustain as a girder, tough to avoid all brittleness and danger of breaking under sudden shocks, and at the same time compact in texture and having hardness in the top to resist wearing action under service. With iron rails it is sought to arrange for these qualities in the packing or building up of the masses of iron from which the rails are rolled, taking advantage of the well-known principle that the different parts of the mass keep their same relative positions in the section of the bar when rolled out as in the original pile. Harder material is put in the top of the pile and softer in the bottom. Steel rails however are rolled from solid ingots and as a consequence they are of a homogeneous texture throughout. They do not split like iron rails, which sometimes show the result of imperfect welding between the separate pieces of which the original pile, from which the rail was rolled, was formed.