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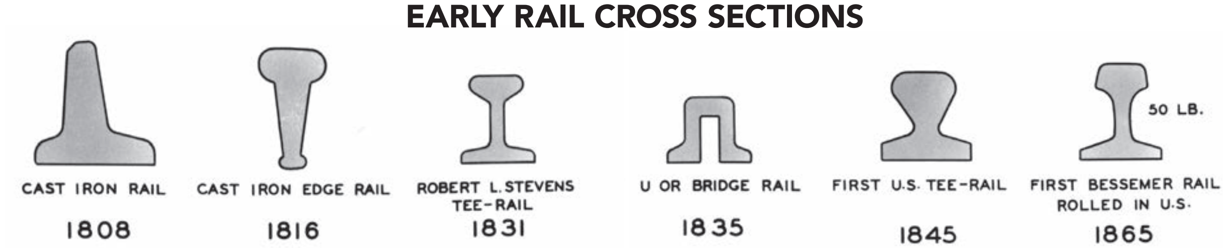
Signs along a weed-grown Milwaukee Road track near Milwaukee in 1973 include a flanger post (black flags on a reflective white background on a wood post) and a crossing alert. *Gordon Odegard*

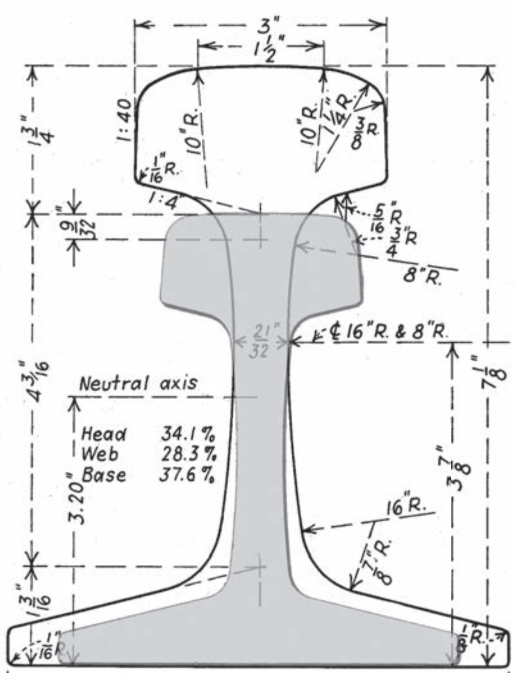
Not all track is well maintained. The jointed rail and turnouts in the Rock Island yard at Dallas, Texas, in 1977 is definitely slow-speed territory. Note the lack of ballast, as the track has sunk into the ground. *Lee Langum*

Early rail was often secured to stones instead of wooden ties. This is from a stretch of Camden & South Amboy dating to the 1830s, with 40-pound T-rail (rolled in England). The C&SA became part of the Pennsylvania Railroad. *Pennsylvania Railroad; courtesy Association of American Railroads*

EARLY RAIL CROSS SECTIONS



Many styles of iron rail were tried before modern steel T-rail appeared in the mid-1860s. *Bethlehem Steel Co.*



RAIL HEIGHT VARIATIONS

Rail height varies by weight. The shaded rail is 90-pound ARA-A rail (5-3/8") and the tall rail is 132-pound RE rail (7-1/8"), which is also about an inch wider at the base. *American Railway Association*

Gauge

The standard track gauge (the width between inside edges of the railheads) in North America is 4'-8½", but the early days of railroading saw railroads using a wide variety of gauges. Five feet was common in Southern states, with 6 feet on some Northern lines—notably the Erie. Many narrow gauge lines were built with gauges of 2 feet (primarily in Maine) and 3 feet.

As railroad mileage grew and equipment became larger, more and more labor was required to transload freight between railcars of competing railroads with differing gauges. The importance of being able to exchange freight cars became apparent, and a movement began to unify track gauge among railroads.

The current standard gauge was effectively established with the Pacific

Railway Act of 1862, which chartered the first transcontinental railroad. Construction began the following year, and was completed in 1869. Although most northern lines adjusted to match this, many railroads in the South remained at 5 feet for another two decades. It wasn't until 1886 when these lines agreed to change, a project largely accomplished over two days (May 31-June 1) of that year.

Most narrow gauge lines were abandoned or converted to standard gauge by 1900, but they remained in some areas, primarily in the Rocky Mountains and Maine.

Components

There's a lot more to the design of rails, ties, and other components than is first apparent. The nature of steel wheels on steel rails creates high dynamic forces, as each wheel of a modern freight car delivers nearly 18 tons of pressure to the railhead on an area smaller than a dime. And that's standing still—add forces that cause cars to rock and wheels to move laterally, or factor in the forces of a train in motion on a curve, and the stresses greatly increase.

To handle this stress, track must be slightly flexible: its components must allow some movement under load to distribute forces (watch a train roll along, and you'll see deflection of the rail under the wheels). Track also must be firm: too much flexion and individual components can crack or develop fatigue, or the track can become unstable.

As railroad equipment has evolved and become larger and heavier and train speeds increased, track components have likewise grown and evolved to handle the increased weights and forces. Let's start with a look at each of the track components.

Rail has evolved substantially since the 1800s, increasing in size as loads have become heavier. And although it can't be seen, it has changed with advances in metallurgy and steel production to be produced with the best composition for hardness and resistance to wear and stress.

The first rails of the early 1800s were iron straps fastened to longitudinal timbers. Even with the light equipment of the early 1800s, this didn't work well, as the iron straps tended to separate from the timbers and curl up as cars passed over them, often with disastrous results if the straps broke into the car interiors.

The solution was solid iron rails with a T-shaped cross-section, which first appeared in England in 1831 and were first rolled in U.S. mills in 1845. The first steel rails began appearing in 1865.

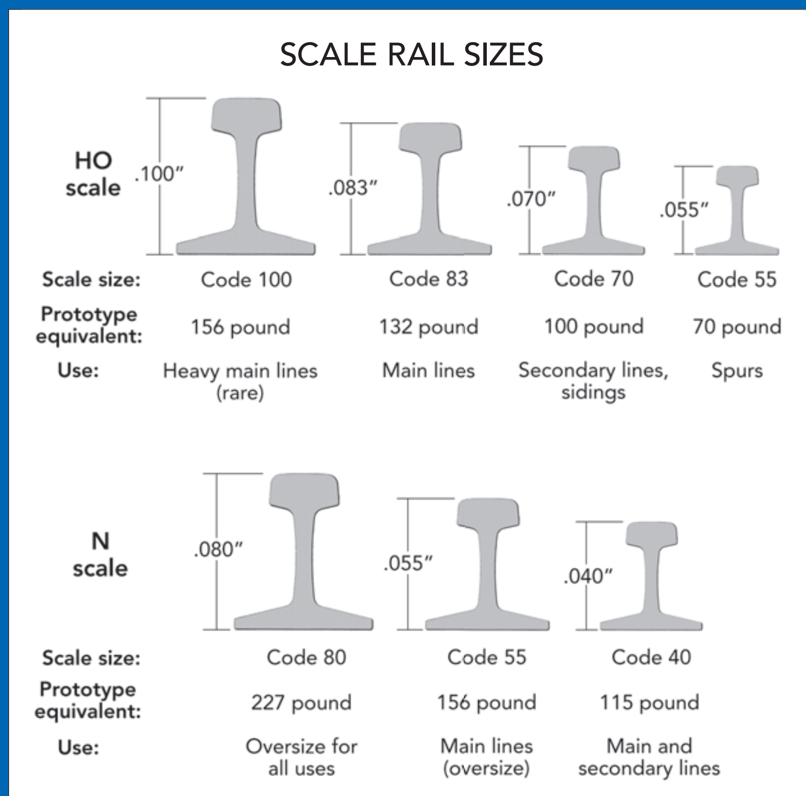
The basic rail shape, or cross-section, has remained similar since the mid-1800s. The large, flat bottom is the base; the vertical section is the web, and the wide part at the top upon which the wheels ride is the head. The size of the rail has increased substantially, with heavier (wider and taller) rail able to support heavier loads and faster train speeds.

Rail size is rated by weight, in pounds per yard. Early rail was light, only 36 to 60 pounds per yard. By 1900, mainline rail was typically 90 pounds, with 112-pound rail by the mid-1930s. In 1921, the average rail weight on Class 1 railroads was 82.8 pounds; by 1956 it was 105 pounds.

MODELING TIP

Model rail sizes: Breaking the "code"

Regardless of scale, rail size for model track is specified by "code." This isn't a top-secret formula: code simply refers to the height of the rail in thousandths of an inch. Thus code 83 track has rail .083" tall, code 70 is .070" tall, and so on. The accompanying chart lists common rail sizes in each scale, along with the corresponding prototype rail each represents. Note that some model track scales out to be extremely heavy (code 100 in HO is oversize for almost all prototype rail; code 80 in N is grossly oversize for all prototypes). Using different sizes is a good way to differentiate the apparent purpose of model track: for example, in HO, using code 83 for the main line and code 70 for spurs and sidings.



CHAPTER THREE

Turnouts, switch stands, and crossings

A Wabash freight waits in a siding for a meet at Holliday, Mo., in the 1950s. The siding turnout is manually operated with a high-profile switch stand, including a classic oil lantern switch light above the target. The small boxes on the headblock ties lock the switch electrically and provide information to the signal system on the turnout's alignment. *Wallace W. Abbey*

Turnouts and crossings are key track elements, as they allow trains to follow multiple routes. Their components and moving parts require sturdier construction than conventional track, and they have many related details, including switch stands, switch motors, locks, heaters, and other devices.

On a stub switch, the switch stand moves the approach rails, aligning them end-to-end with a route (the track to the left in this case). A misaligned rail is a serious problem. *Paul H. Schmidt*

The split-point turnout has two moving rails (points), with ends tapered to match the outside (stock) rails. They allowed higher speeds and eliminated the alignment issues of stub switches. *Gordon Odegard*

Turnouts are often featured prominently in model railroad scenes, especially at junctions, with signals at the ends of passing sidings, and in yards. Understanding how prototype turnouts work and how their components relate to modeled versions will help in modeling them more realistically.

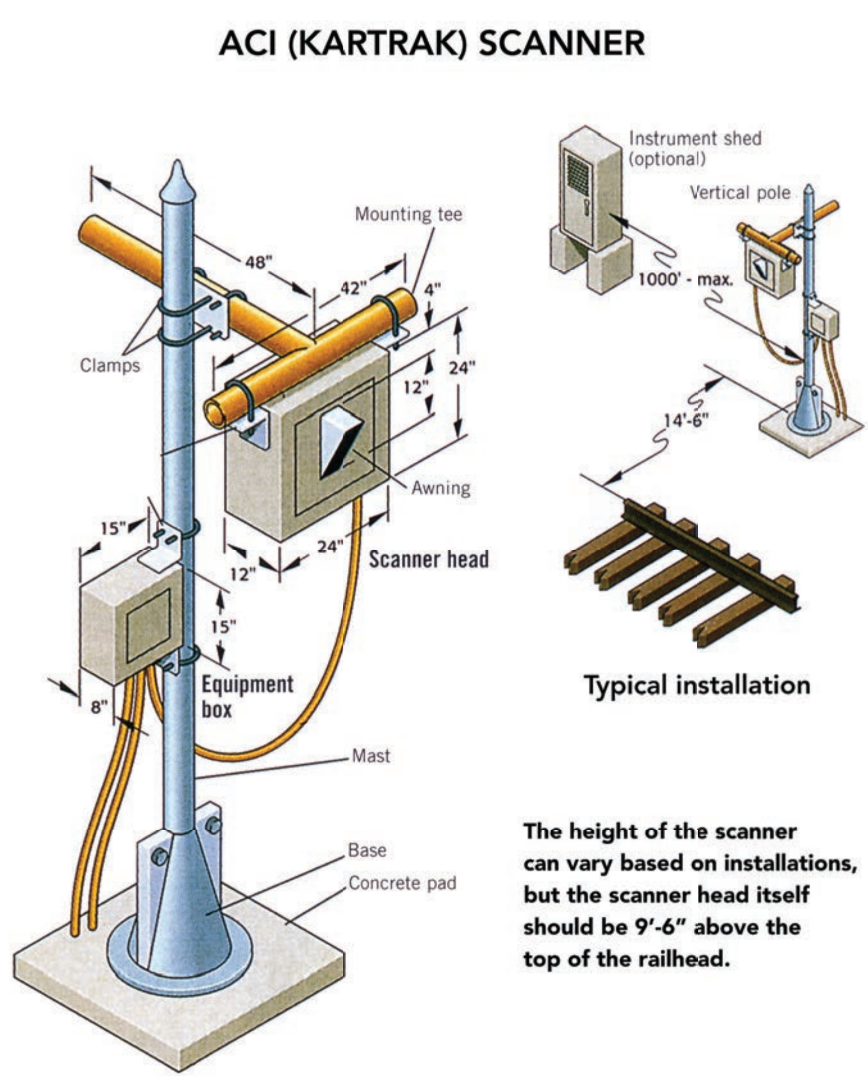
Turnout design

Getting trains from one track to another was a challenge on early railroads. The first popular method of doing this was with a "stub switch." These were controlled by moving the butt ends of the approach rails side-to-side to align with rails of either the main or diverging route (see the photo at the top of this page). This was the most common design used through the 1870s.

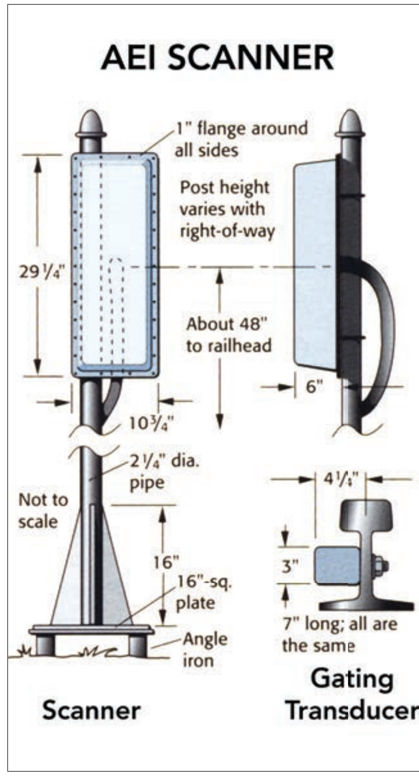
Stub switches required precise alignment to operate correctly. If the approach rails were off even slightly, the result was rough operation as the wheels hit the joint, or at worst, a derailment. Keeping them in alignment required regular maintenance, as wheels continually battered the rail ends, causing downward rail deflection (especially as equipment became heavier). Summer heat could cause expansion that closed the operating gap and either stuck the rails in one position or didn't allow enough clearance to move into the other position.

They required slow-speed operation, and new designs rendered them obsolete for most mainline use by the late 1800s. Some could still be found on seldom-used track, including industrial spurs, into the mid-1900s.

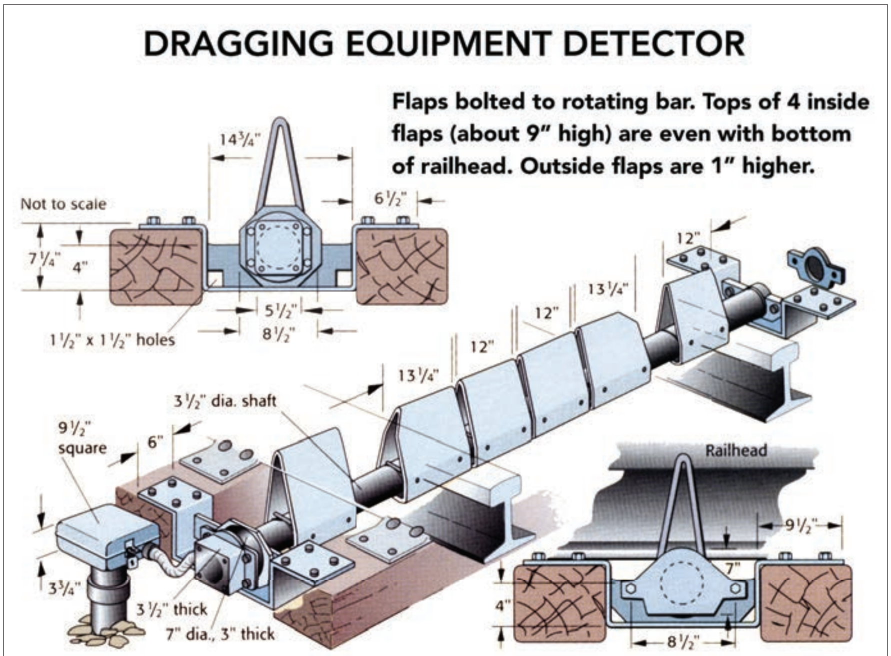
The solution was the split (or split-point) turnout. This design, which became standard in the late 1800s, eliminated the moving butt joints, instead using a pair of moving rails



The height of the scanner can vary based on installations, but the scanner head itself should be 9'-6" above the top of the railhead.



The AEI (Automatic Equipment Identification) system has been in use since the mid-1990s. Scanners use radio waves to get information from the passive-radio receivers mounted on each freight car. *Kalmbach Media*



percent of cars were equipped but the fail rate was 20 percent—not efficient enough to make the system worthwhile. Although most scanners were soon removed from service, labels remained on cars and could still be found well into the 2000s, when cars of that era were being retired.

The next attempt at an automatic scanning system was much more successful. Adopted in 1991, the AEI (automatic equipment identification) system uses passive radio signals instead of optics, meaning dirt and grime were no longer an impediment to operation.

Data tags are affixed to the frame on each side of all freight cars. Each tag is an unpowered (passive) radio transponder that, in its circuitry, includes reporting marks, car number, and equipment type. The devices are enclosed in hard-plastic housings roughly 3 x 10 inches, with tapered ends, and are usually left unpainted gray.

The trackside AEI scanners project

MODELING TIP

Motor-car setout

Motor-car setouts are easy to model. This HO example is simply two pieces of scale 10 x 10 stripwood, stained, glued in place at right angles to the track, with additional vertical stripwood posts for support. Thin stripwood is glued between the rails. The speeder model is a white-metal kit from Durango Press. Typical setout locations include interlocking towers, ends of sidings, junctions, and at block signals.

A motor car ("speeder") rests on a setout next to the interlocking tower at Portage, Ill., on my old HO scale Chicago, Burlington & Quincy. *Jeff Wilson*

a radio signal to reflect and modulate the information back to the reader. Readers are boxy structures mounted on stands; they're often located near other detector equipment.

Railroads began applying tags to cars in early 1992, with a goal of having all cars tagged by the end of 1994. More than 3,000 trackside scanners were in service by 2000. The system has been extremely successful, with an accuracy rate of nearly 100 percent.

Defect detectors

Through most of the steam era, detecting mechanical problems with moving trains—such as overheated bearings, broken wheels, and dragging or broken equipment—was dependent upon on-board crews' observations. Station operators and other employees were also required to provide rolling inspections to passing trains and give a highball signal to the caboose crew as the train passed if all was well. Unfortunately, crews and trackside observers were often unable to detect problems until damage had already occurred.

The solution was a series of in-track and trackside detectors that could automatically check passing trains for various defects. Since the 1940s, this has included a combination of dragging-equipment detectors and hot-bearing ("hotbox") detectors, and modern devices can analyze a variety of data on moving trains. Automated detectors became especially important after the elimination of cabooses from the 1980s onward, as crew members no longer keep an eye on the train from the rear.

Dragging-equipment detectors began appearing in the 1940s, and improved designs led to their increased use in the 1960s and later. They're designed to identify any obstruction hanging from the train—such as broken brake gear, a loose brake shoe, a broken wheel, or a derailed car—as all present a serious hazard. Initial designs used a thin, breakable bar between the rails just below railtop level—called a "brittle bar"—that carried a low-level electrical current. A low-hanging

This BNSF installation in 2014 includes a dragging-equipment detector (paddles in foreground) as well as a hot-bearing detector (outside the rail at left) and a pair of wheel counters (inside the rail opposite the bearing detector. *Tom Kline*