The Toucey and Buchanan Interlocking Machine

By Prof. James Calvert, Civil Engineer – University of Denver

The interlocking machine developed by John M. Toucey, General Superintendent, and William Buchanan, Superintendent of Machinery, of the New York Central & Hudson River Railroad, deserves special mention, though it was never widely used. It was a completely novel machine, with no apparent similarity to any other. The stimulus for its creation may have been the 1870 Saxby & Farmer machine on the New Jersey Railroads. The more famous 1874 Pennsylvania Railroad interlocking plant at East Newark cannot have been the inspiration, since this would not have given time enough – even for the go-ahead team of Toucey & Buchanan to have perfected the machine.

The first example was installed in 1875 at Spuyten Duyvil Junction, at the northwest corner of Manhattan Island. This was the junction of the West Side line from the Hudson River's 30th Street station and the connecting line from the Harlem tracks to the new Grand Central Station at 42nd Street. A few years earlier, in 1869, the New York Central and the Hudson River companies had been merged under the Vanderbilt flag, which also waved over the Harlem. Wye tracks permitted a route from 30th Street to 42nd Street, as well. The lines were double-tracked, with a third freight relief track between the main lines north of the junction. Harlem and New Haven trains from Grand Central had already branched off the line at Mott Haven after crossing the Harlem River, but traffic was still heavy at this point, where the main line curved sharply around a promontory that obstructed vision, as it joined the Hudson River.

The busy lines around Grand Central were to be a constant aggravation as traffic increased beyond what could be conveniently handled by American operating practices, and in addition were beset by a dark and smoky tunnel. There was to be no solution to the problem until the Sykes Lock and Block, full track circuits, additional tracks, and electrification were adopted. Most of the accidents were minor, but nevertheless troublesome, embarrassing, and expensive. The interlocking at Spuyten Duyvil was the first effort to improve operations after the traffic was concentrated at Grand Central. Previously, three switch-tenders – one at each corner of the wye, signalmen for each of the two lines, a drawbridge tender, and a telegraph operator were required at that point. Trains had to crawl through the area, looking out for hand signals from switch-tenders. This was, indeed, the way all important junctions and terminals in the United States were operated at the time, by men running back and forth over the tracks.

The new interlocking machine meant that all the signals and switches could be controlled by one man in the signal cabin, with only the aid of a telegraph operator and a bridge tender.

Semaphore signals were erected at the approaches on each of the three routes. These signals had two arms each, one for each of the possible routes. The arms were metal frames with slats, for lightness, and carried a single red roundel. They were mounted one above the other on a lattice metal post made of angle iron and were operated by chains passing around pulleys. They were counterweighted to return to stop "horizontal" when the tension on the operating wire was relaxed. The signals were exactly those used by John Brierly of London and were probably obtained from this source.

The interlocking machine, and operations in the Grand Central area, were described and illustrated in both the Railroad Gazette and the Scientific American. The machine, installed on the second story of the signal cabin, had 26 levers operating 10 switches, 8 facing point locks, and 8 signal arms. There were no facing point locks on two trailing point switches, which must have been split switches, although the others were stub switches. Split switches were not yet fully trusted under American weather conditions for facing points. A special cast iron sleeper supported the switch and stock rails. The switch rails could slide sideways to register with either stock rails, accurately limited by stops. In either position, movable dogs were rotated up to hold the switch rails securely. This was an effective and rugged facing-point lock for stub switches, a detail for which there was no British precedent. No detector bar was provided to prevent moving a switch under a train, however.

The interlocking machine itself was constructed of wrought and cast iron. The straight levers were 8 feet long from handle to fulcrum, the tail was 1 foot long, and a heavy counterweight was provided to help reverse the levers. The handles were 4 feet 6 inches above the flat-top plate and, remarkably, had no catch handles or quadrant. Instead of this, a foot treadle was located to the right of each lever that performed the office of a catch. The levers stood back, away from the leverman, when normal, and were pulled forward to reverse them through a stroke of about 4 feet 9 inches. The levers were latched in the normal and reverse positions by notched iron plates beneath the floor, which could be tilted up to release the levers by stepping on the treadle. The lead out to switches and locks was by very neat rocking shafts and pipe, and to signals by wire rope, which was flexible enough to be shown passing around pulleys.

So far, we have no interlocking. Interlocking was provided by square shafts that ran from end-to-end of the machine arranged in two groups: One in front of, and one behind, the levers. A lever was locked by raising a cam under the back edge of its lock plate, so that the plate could not tilt to release the lever. The accompanying sketch (missing) shows lever 6, a switch lever, locking lever 11 when lever 6 is normal. If lever 6 is reversed, the link and arm attached to it rotate the lock shaft, moving the cam out from under the lock plate, and permitting lever 11 to be reversed. By putting additional cams on the same lock shaft, any of the levers could be

locked by lever 6. This is an extremely simple and effective locking system, that was used nowhere else. It possesses one of the benefits of catch-handle locking that when a lever is locked, leverage of the lever itself cannot be used to force it to a wrong position, and any reasonable amount of abuse of the treadle can easily be resisted by the mechanism.

As an example, suppose lever 6 is a facing point switch, lever 11 is a signal governing the straight route through the switch, and lever 12 is a signal governing the diverging route. When lever 6 is normal, it must lock lever 12, so the diverging route cannot be cleared. When lever 6 is reversed, it must lock lever 11, so the through-route cannot be cleared. When either of the levers 11 or 12 is reversed, it must lock lever 6, so the switch cannot be moved, as well as the other signal. Three lock shafts are required, each with two cams. You can easily sketch the necessary arrangements.

There is a fundamental difference between the locking in this machine and that found in other machines. The lock plate locks a lever either normal or reverse, indiscriminately, and is the same for all levers. In the usual interlocking, when a lever is reversed, it locks or unlocks other levers in specified states. In the present example, lever 11 reversed would lock lever 6 normal, and lever 12 reversed would lock lever 6 reversed. This reciprocal locking is much simpler than what is required in the Toucey and Buchanan machine. The major drawback of the Toucey and Buchanan machine was, in fact, this very cumbersome locking. Only a limited number of lock shafts were available, so a really complicated plant was impossible. Roughly speaking, the machine required about twice the locking of contemporary British designs.

In fact, the facing point locks were not included in the locking for this reason. The leverman could not change the switches without pulling the locks but then had to remember to replace them. If the locks would not go, then something was wrong with the switch. Although all intermediate switches were interlocked, signals were not provided for reverse movements and for routes other than the main ones. These still had to take place by hand and flag signals. Each of the switches had a target and lamp so that its position could easily be determined.

Any lever that was free to be moved could be released by stepping on its treadle, but the cams moved by that lever were not completely in their new positions until the lever had made its full stroke. The interlocking could probably have been defeated by some manipulation like this: First, step on a treadle, but move the lever only far enough to catch and hold the lock plate. Now step on a different treadle to release a conflicting lever the same way. Finally, give both levers a simultaneous sharp jerk, which should take them into their new notches, with some protest from the mechanism. Now the levers are out of correspondence, say with the signal cleared for the through-route with the switch set for the diverging route. American levermen

sometimes spent their time concocting such mischief, but probably not at such an important place as Spuyten Duyvil.

The state of the art at the time already recognized the benefits of fast locking, where all conflicting levers are locked with the first small motion of a lever, and levers to be released are not released until the lever has made is full stroke.

The Toucey and Buchanan machine – with its primitive if effective mechanism, its cumbersome and limited locking, and few refinements – was ill-equipped to compete with the mature and sophisticated Saxby and Farmer machine. If it had appeared in 1864 instead of 1874, it might have had a run for it. Its only virtue was that it was an American machine, the only one. During the Centennial Exposition of 1876, three machines were exhibited in service on the Pennsylvania at Belmont Tower, 36th Street Tower, and Hestonville Junction, but they were removed when the exposition closed. How the Pennsylvania happened to use the New York Central "interlocking" (the companies were not yet bitter rivals at this time) as told by Richard Soule, then an engineer with the Pennsylvania, much later, in the 1895 Journal of the Association of Engineering Societies. The decision to interlock was made at the last moment so there was no time to import machines from Saxby and Farmer. The patterns were lent to the Pennsylvania for making the necessary machines in their own workshops.

The Toucey & Buchanan Interlocking Switch & Signal Company was organized by 1878 in Harrisburg, Pennsylvania. Only a few sales were made even after the company was taken under the wing of Union Switch & Signal in 1882. By September 1884, the following Toucey & Buchanan machines were in service: At Fulton Junction on the Baltimore & Potomac RR; at Berea, Ohio, on the Cleveland, Columbus, Cincinnati & Indianapolis RR; and the one remaining at Spuyten Duyvil on the NYC. By comparison, Union Switch & Signal had furnished a total of 185 interlocking machines by this time. The New York Central seems to have installed a second machine at 53rd Street, but it was soon replaced by a Saxby and Farmer.