Testing 9 types of track

Rating metal rails for traction and electrical resistance

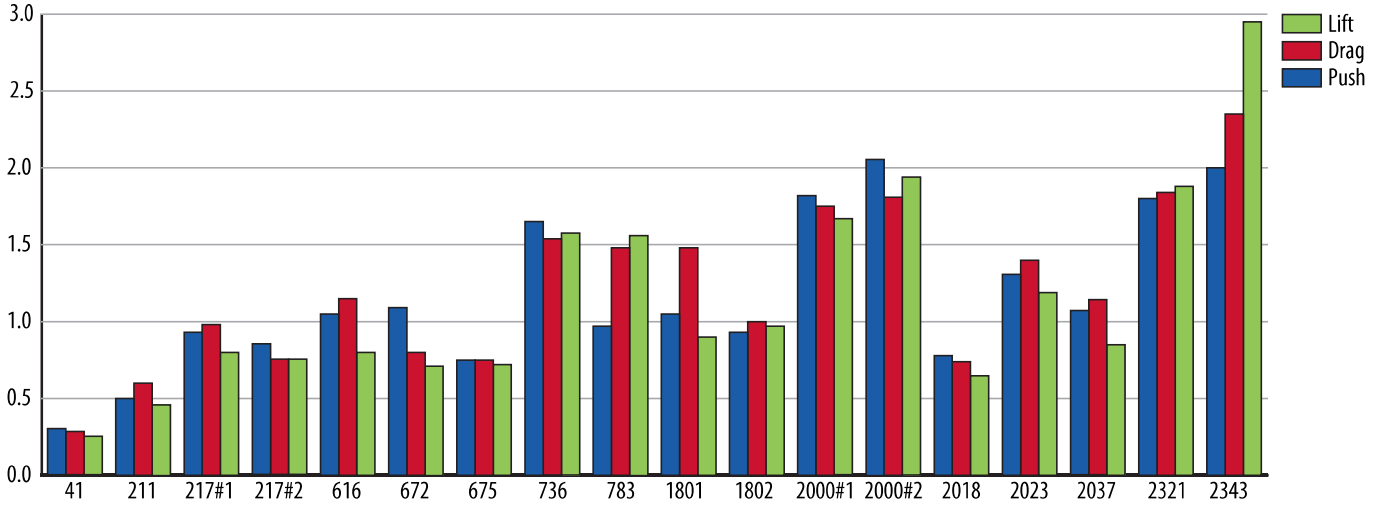
by Phillip Hays | photo by Jim Forbes

One day, I took my two favorite Lionel postwar Geeps to a friend's layout, where I learned a clear lesson about the differences in O gauge track. A train powered by my two locomotives ran without problems on the lower part of his layout, but on a grade leading to the upper level my Magne-Traction-equipped Geeps began to spin their wheels.

I noted that the lower level consisted of Lionel O gauge sectional track, with a tin-plated steel design perfect for Magne-Traction wheels, while the grade was built from non-magnetic track. Even without an attached train, my Geeps seemed like they were running on butter up the hill!

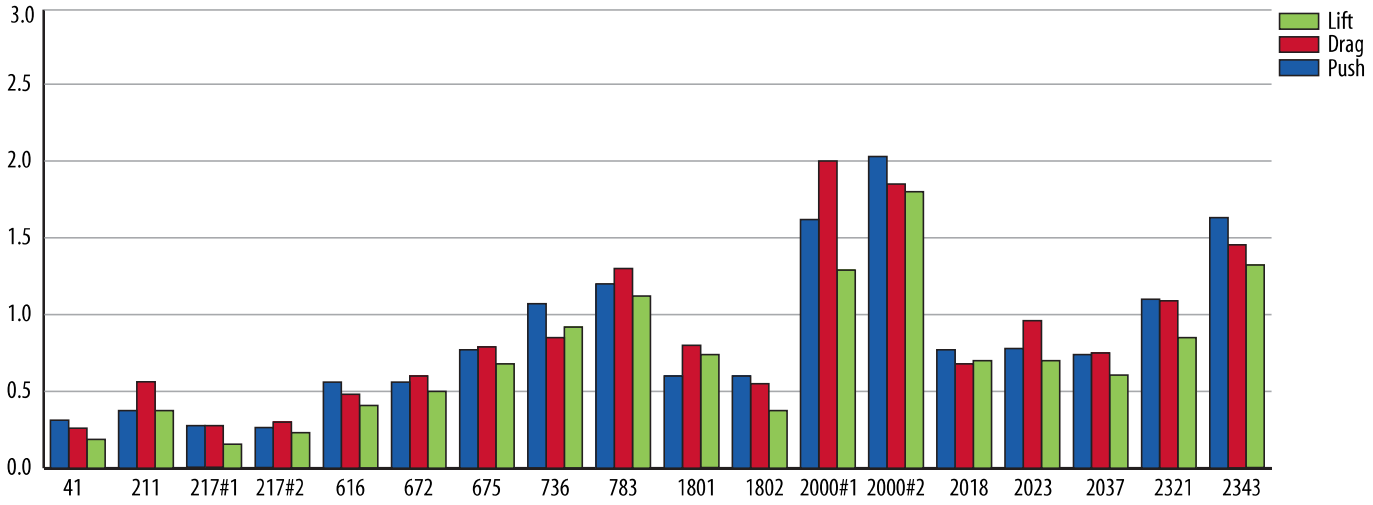
This experience got me thinking. In planning my own layout, I needed to know which track would work best for my motive power.

Chart 1 Atlas steel



Note: for a more complete description of the locomotives listed by cab numbers in charts 1 and 2, see page 71.

Chart 2 Atlas nickel-silver



Illustrations by Kellie Jaeger

I considered four factors when selecting a type of track: electrical resistance, traction efficiency, appearance, and cost.

Two of the factors – resistance and traction – can be tested. So I conducted my own tests.

As it turned out, I ended up making a fairly serious study of O gauge track. I employed 19 locomotives and several forms of measurement to determine the performance of nine types of track, repeating each test several times. In all, I conducted between 1,500 and 2,000 tests.

Extensive though it was, my testing isn't all inclusive. With more than two dozen track systems available to O gaugers – including some new ones like Lionel's FasTrack, which hadn't yet hit the market when I completed my tests – I couldn't cover all the territory possible.

Nonetheless, my results were enlightening. Mind you, these are my testing procedures using my locomotives and methods, but I've tried to maintain a scientific approach throughout.

5 different tests

In deciding which track types to test, I focused on those that are readily available in hobby shops as well as some used Lionel track so that I could compare new and old.

The track sections tested were Atlas O (nickel-silver and steel), GarGraves (regular and stainless steel), K-Line O-27 tubular, Lionel O-27 tubular (new and mid-1950s), Lionel O tubular (late 1940s), and MTH RealTrax.

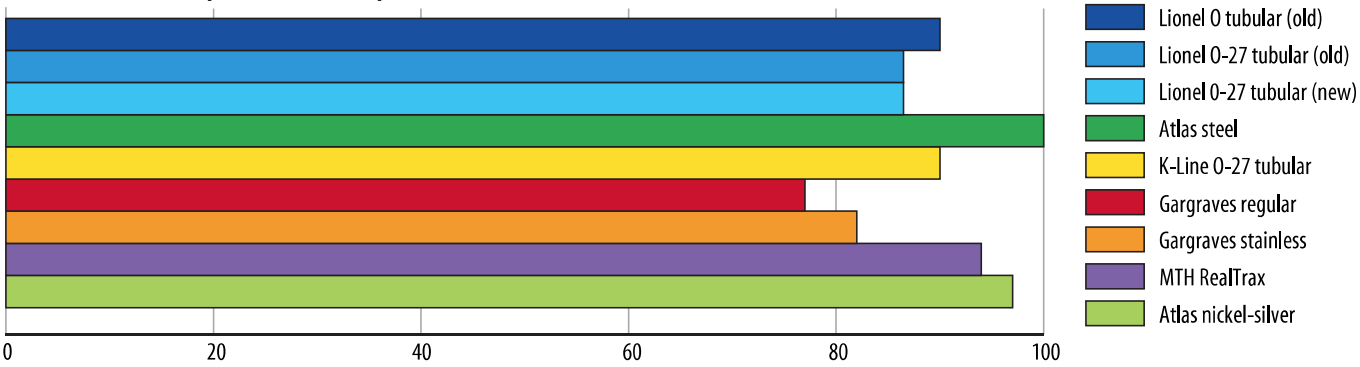
My test locomotives (see the chart on page 71) are all made by Lionel, but they differ in important ways. The engines were manufactured from the 1940s through the 1990s. They include everything from lightweight, single-motored O-27 units to heavy, dual-motored O units. Most – but not all – have Magne-Traction, Lionel's system of magnetizing wheels to increase a locomotive's traction. Of the remaining locomotives, some have rubber traction tires and some have nothing more than metal wheels.

I performed five different tests:

Locomotive push: A measure of the force generated by the locomotives on each track. I placed each locomotive in contact with an electronic strain gauge and then applied power. In this test, the engines could not move along the track as I adjusted track voltage to measure the maximum push force.

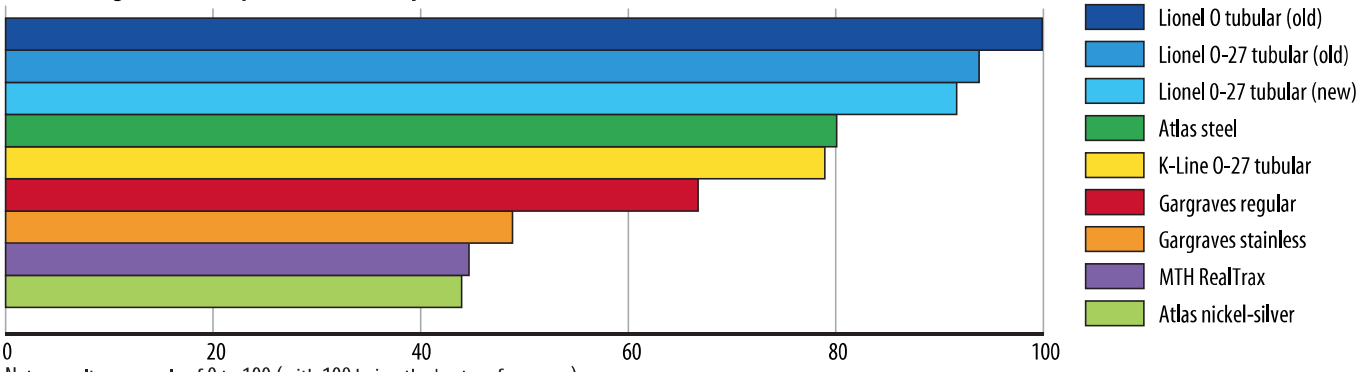
Locomotive drag: A measure of the friction between wheels and track. I positioned the engines on the track (without power), then attached a weight bucket with a cord running

Chart 3 Traction tire performance comparison



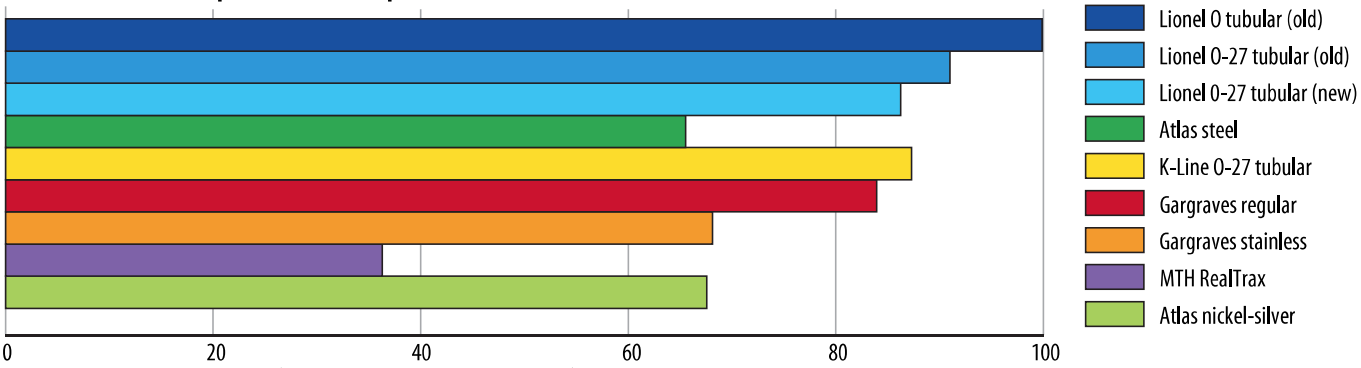
Note: results on a scale of 0 to 100 (with 100 being the best performance)

Chart 4 Magne-Traction performance comparison



Note: results on a scale of 0 to 100 (with 100 being the best performance)

Chart 5 Metal wheels performance comparison



Note: results on a scale of 0 to 100 (with 100 being the best performance)

over a low friction pulley. I added weights to the bucket until the locomotives slid along the track 12 inches or more.

Locomotive lift: A measure of how much weight a locomotives can lift on each track. I used the same bucket setup as in the drag test, only this time I applied power to the track so that the locomotives could try to lift whatever weight was in the bucket. I added weight incrementally to the bucket and repeated the test until the engine could no longer lift the load a full 12 inches.

Magnetic merit: A measure of the magnetic "strength" of each track. Instead of hooking a locomotive to the string attached to my weight bucket, I attached the line to a magnet so that each pole touched a different rail. I added weight to the bucket until the magnet broke free from the track. For tubular track, I performed this test at the metal ties and again halfway between the ties to see if the ties play a significant role in the effects of Magne-Traction.

Electrical resistance: A measure of how well electricity flows along the metal rails. I determined the electrical resistance using a sensitive four-wire measurement accurate to 0.0001 ohm. I also put together sections of each type of track to measure resistance across that included one or more joints.

For comparison's sake, I used bar graphs to display the results of my tests, which I've broken down into three groups: traction, track-magnetic merit, and electrical resistance.

Sorting the locomotives

First, to get a sense of how my locomotives stacked up with each other, I gave each the push, pull, and drag tests using magnetic (steel) and non-magnetic (nickel-silver) versions of the same brand of track, in this case, Atlas O.

The push, pull, and drag results usually were within 10 percent of each other for each of my locomotives. Charts 1 and 2 show how they did on Atlas O steel track and Atlas O nickel-silver track. (In two instances, I had two identical locomotives with the same number, so I tested both separately and listed

Weight vs. pulling power

Locomotive pulling capability is related to weight. In other words, heavier engines have better traction than lighter engines. But can you simply add more weight to a locomotive to make it pull better?

I tested three Lionel postwar locomotives to see what effect adding weight would have on maximum pulling power.

My Lionel test units consisted of a lightweight no. 211 Alco FA (weighing 28 ounces with a single motor, four drive wheels with one traction tire, and no Magne-Traction), a lightweight no. 217 Alco FA (28.5 ounces with a single motor and four Magne-Traction drive wheels), and a heavy no. 2321 FM Train Master (82 ounces with two motors and eight Magne-Traction drive wheels).

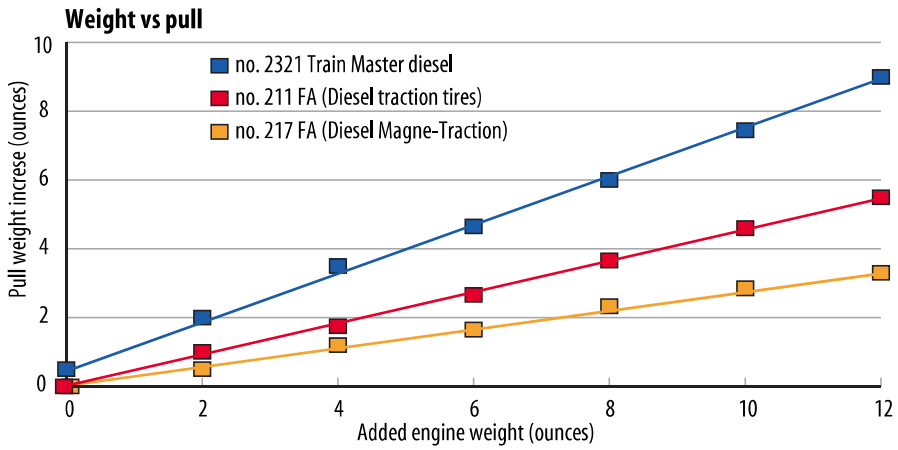
When I added weight to each locomotive, the 211 and 217 showed about the same increase in traction: a 1-ounce gain in pull for every 3 ounces of added weight. The 2321 Train Master scored double that of the Alcos, with a 2-ounce gain in pull for every 3 ounces of added weight. The increase in pull is due to increased friction between wheel and rail and is proportional to the weight added and the number of driven wheels. The type of drive wheel – whether metal, rubber, or Magne-Traction – makes no significant difference.

A consequence of adding weight is that heavier locomotives suck up more power. I recorded a 15 to 20 percent increase in amperage for every 4 ounces of added weight. This caused a significant increase in heat in the motors.

I had to stop the test with my Train Master at 12 additional ounces because the motor started smoking. On the other hand, I added 24 ounces to the 217 without it overheating and saw a 33 percent improvement in pulling power.

So, if you add weight, watch what you're doing. For postwar locomotives, I recommend limiting current to 2.5 amps per motor.

Heavier locomotives typically draw this much current at maximum load, so you can't add much weight. Because light engines draw much less power, you can increase their weight quite a bit. – *Phillip Hays*



each result separately in these two charts.)

In general, Magne-Traction-equipped locomotives worked best on steel rails, pulling 33 to 50 percent of their weight. Locomotives with traction tires pulled more than locomotives without traction tires on non-magnetic rails, pulling about 25 to 33 percent of their weight. Locomotives with steel wheels only (no Magne-Traction) performed about the same on either track type, pulling about 20 percent of their weight.

Since my tests were focused on the merits of each type of track, and not the performance of my individual locomotives, I've intentionally omitted charts showing the locomotive traction results on the other seven types of track.

Traction-test results

Next, I wanted to see how locomotives of the three traction designs – traction tires, Magne-Traction, and plain metal wheels – performed on the nine types of track.

Charts 3, 4, and 5 show the relative merit of each track for locomotives belonging to each of the three locomotive traction designs. Rather than using raw numbers, I've set up these three charts on a percentage scale of 0 to 100.

I used the sums of data from the push, drag, and lift tests to create this comparison ranking.

Chart 3 shows that locomotives with fresh traction tires worked about equally well on all types of rails, with only a 22 percent range in performance from best to worst.

For locomotives without traction tires, the type of rail is far more important, as Charts 4 and 5 show. A locomotive's pull may vary from 50 to 70 percent, depending on track type. In general, tracks made of nickel-silver or stainless steel seem to be more "slippery" for locomotives without traction tires, including those without Magne-Traction. Steel track, not surprisingly, provided a significant improvement in pulling power for engines equipped with Magne-Traction.

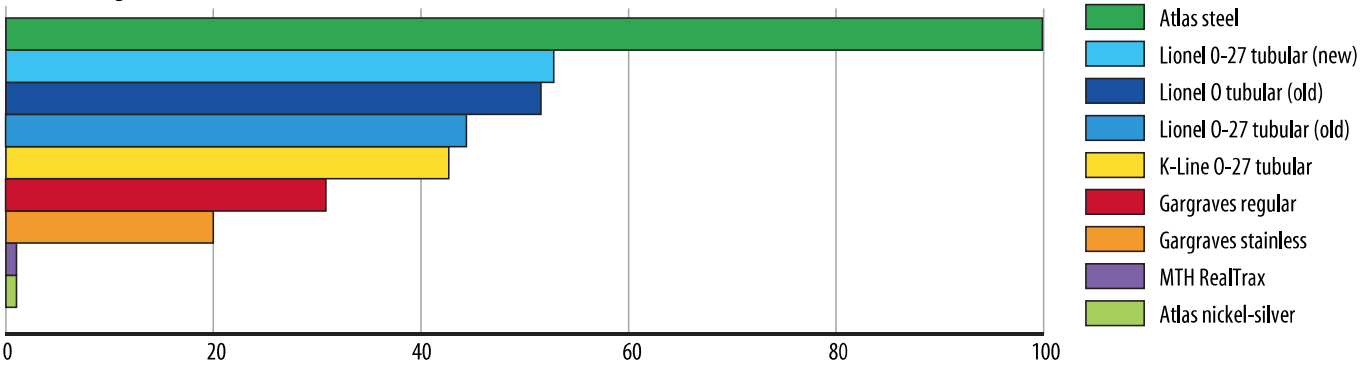
Two examples not spelled out in Charts 4 and 5 also illustrate the difference between locomotives equipped with traction tires and Magne-Traction on different types of track.

My modern-era Lionel PA-1s (two motors, eight drive wheels, four traction tires) worked about equally well on all nine types of track. On Atlas O nickel-silver track, they averaged 1.77 pounds of pull and on Atlas O steel track they averaged 1.82 pounds. On MTH RealTrax they pulled 1.73 pounds, and on postwar O gauge track they pulled 1.67 pounds. In practical terms, the differences I found translate to the differences in pulling 51 postwar freight cars and 56 postwar freight cars along straight track – not much difference at all.

In contrast, my postwar Lionel no. 2343 F3 (two motors, eight drive wheels with Magne-Traction) pulled only 1.45 pounds on Atlas O nickel-silver (non-magnetic) track, but pulled 2.69 pounds on Atlas O steel (magnetic) track. Both types of track have the same cross section and the same wheel contact area. My calculations show the difference in pulling capability equates to the differences in pulling 45 or 83 postwar freight cars along straight track.

On MTH RealTrax, my 2343 pulled a meager 1.23 pounds, but on Lionel postwar tubular O gauge track it pulled more than 3 pounds. That difference equates to the difference between pulling 38 or 92 postwar freight cars.

Chart 6 Magnetic attraction



Note: results on a scale of 0 to 100 (with 100 being the best performance)

Chart 7 Resistance of metal track (ohms per foot)

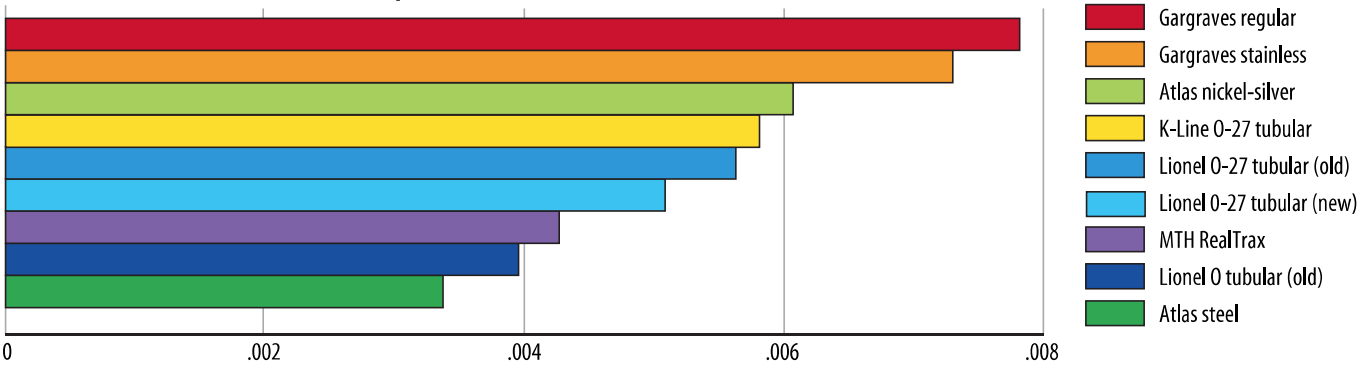
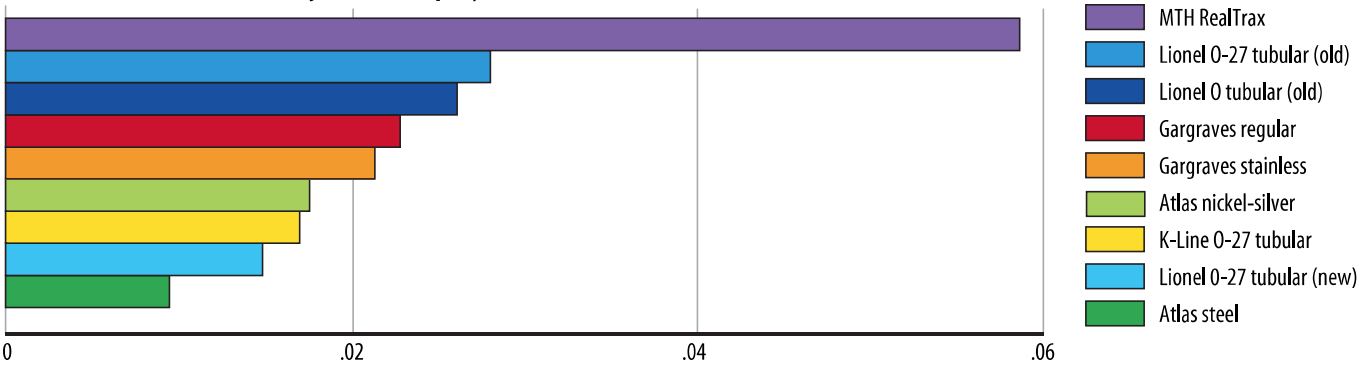


Chart 8 Resistance of track and joints (ohms per yard)



Magnetic-merit results

The magnetic-merit test is a measure of how strongly the wheels of locomotives equipped with Magne-Traction are attracted to the rails.

I found that Magne-Traction accounts for 33 to 50 percent of the total traction force on the rails for lightweight locomotives (primarily diesels), 25 percent for heavier diesels, and 10 to 20 percent for heavy die-cast metal steam locomotives.

Since traction is related to the force on the wheels (see sidebar on page 69), Magne-Traction represents a clear gain in pulling capability, especially for lightweight engines.

Chart 6 shows that Magne-Traction performs quite differently on different types of track.

The Atlas O steel track, with a T-shaped profile that provides the largest contact patch between the wheels and the rails, clearly was the champion of my tests. Common tubular track with metal ties performed 43 to 53 percent as effectively, while GarGraves track was 20 to 30 percent as effective in my tests. Atlas O's nickel-silver track and MTH's RealTrax, both non-ferrous, produced near zero magnetic adhesion.

I tested Lionel tubular track at the ties and between the ties and found that Magne-Traction was about 6 percent stronger directly over the ties.

Electrical-resistance results

The electrical characteristics of the rails may be more important than traction. After all, locomotives with the best rail/wheel combinations don't go anywhere without power.

The basic resistance of the track metals varies by a factor of two, as Chart 7 shows. A single section of Atlas O steel track has the lowest resistance (the best for conducting electricity), scoring less than half that of GarGraves track. However, in practical applications, all of the track sections I tested had very low resistance.

But most toy train layouts aren't built from a single piece of track. They have plenty of rail joints, and that greatly affects

Lionel test locomotives

Number	Description	Year
41	U.S. Army switcher	1955-57
211	*Texas Special* Alco FA	1962-66
217*	Boston & Maine Alco FA	1959
616	Santa Fe NW2	1961-62
672	Wabash 4-6-2 Pacific	1986-87
675	Lionel Lines 2-6-2 steamer	1947-49
736	Lionel Lines 2-8-4 Berkshire	1950-66
783	NYC 4-6-4 Hudson	1984
1801	repainted no. 2328 Geep	1955
1802	repainted no. 2338 Geep	1955
2000*	Santa Fe PA-1	1997
2018	Lionel Lines 2-6-4 steamer	1956-61
2023	Union Pacific Alco FA	1950-51
2037	Lionel Lines 2-6-4 steamer	1954-63
2321	Lackawanna Train Master	1954-56
2343	Santa Fe F3	1950-52

*Two locomotives with the same cab numbers were used in track tests.

resistance on all track brands.

Chart 8, which shows resistance per yard instead of per foot of track, reveals that resistance becomes a bigger issue when sectional joints are taken into consideration. The resistance of each joint in sectional track is about equal to the resistance of a foot of rail. In my tests, the Atlas O steel track was again champion, recording the lowest resistance of the nine types of track when accounting for track joints.

As track ages, the electrical connections at joints deteriorate. This is probably the reason that the older Lionel tubular track had significantly greater resistance per yard than new Lionel and K-Line tubular track. Though made of relatively high-resistance steel, GarGraves 37-inch track sections don't need any joiners to create a yard-long section of track. So per yard, it has a lower overall resistance than MTH RealTrax sectional track, even though the individual MTH sections are made of very low-resistance metal.

Notes and conclusions

Outside of the test results, the types of track I examined provided me with other visual information that I couldn't or didn't measure scientifically, but which I feel deserve mention.

I noticed two minor problems. First, the non-tubular tracks were typically made of softer metals than the steel tubular track. Consequently, if an engine with metal wheels stalled, the spinning wheels tended to cut a groove into the tops of the rails. These softer metal alloys appear to wear much faster than hard steel.

Second, tracks with blackened center rails showed definite effects of high current arcing when my locomotives stalled under high loads. The black coating visibly burned off the center rails. This was especially noticeable in tests with my dual-motored locomotives.

Also, for my tests, I started with fresh traction tires. Keep in mind that results change – I found as much as 20 percent – as traction tires age through use.

Lastly, the profile of the rail also made a difference in my tests. Flat-topped rails, like those used by Atlas O and MTH, provided the biggest contact patch for the wheels of my locomotives. Tubular rails have smaller contact patches. I can only conclude that this helped my sample pieces of Atlas O steel track score highly in my tests.

As I wrote earlier, my tests aren't all inclusive. Other combinations of wheels and rails may give very different results, and the future may deliver even more track and train variables.

But it is fair to say that the choice of track depends upon four things: electrical resistance, traction efficiency, appearance, and cost.

Appearance and cost, both of which vary widely on track brands, are purely matters of personal choice.

Electrical resistance can be offset with adequate wiring, such as providing additional track feeder wires.

That leaves traction efficiency. So take stock of your roster today, think about the types of locomotives you may buy tomorrow, make sure the brands you are looking at are produced in the curve diameters you need, and use my test results to help determine which track type is best for you. CTT

Other track choices

Other types of O gauge track are available besides those tested by author Phillip Hays.

Lionel FasTrack, which had just entered the market when Phil completed his tests, uses roadbed like MTH RealTrax. But instead of solid rails, FasTrack has sheet-metal steel rails that in profile look like an inverted "U." Electrical connections are made using flattened pins that slip into the rail ends. Early FasTrack production featured a blackened center rail; later production did not. FasTrack would produce test results similar to those of traditional tubular track in traction and magnetic attraction.

Ross Custom Switches makes sectional track, in addition to a variety of track switches. Both the track and the switches use steel rails and connection pins almost identical in material and sectional profile to GarGraves track and would produce similar test results. Curtis Hi-Rail Products track is also quite similar to GarGraves.

Besides RealTrax, MTH makes ScaleTrax which has a lower profile and does not come with simulated roadbed like RealTrax. ScaleTrax uses solid non-steel running rails, a blackened blade-like center rail, and copper tabs to connect sections electrically. ScaleTrax would produce traction and magnetic-attraction test results similar to those of RealTrax.

K-Line Shadow Rail and SuperSnap track both use tubular track similar in material and sectional profile to Lionel regular O gauge track. Shadow Rail has a blackened center rail and plastic ties, but uses traditional metal track pins. It would test much like to Lionel tubular track.

SuperSnap track also uses tubular rails, but without pins (although the holes for pins are still present). Sections snap together, and electrical contact is made through tabs at the ends of each section of track. The tab design is similar to MTH track. SuperSnap's traction and magnetic properties would be similar to Shadow Rail, but its use of tabs for electrical connections would give it a different score from Shadow Rail. – *Neil Besougloff*