ENGINEERING HANDBOOK for Recreational Railroaders

INTRODUCTION

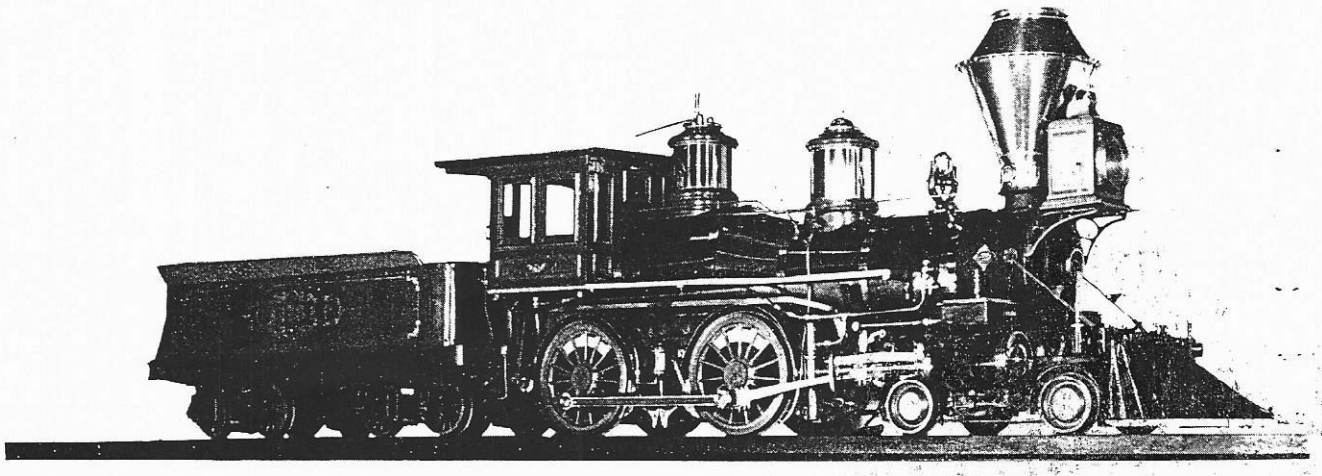
Because we had numerous questions when we first became involved in Live Steam we, by necessity, had to make many inquiries. Over the years we have listened intently and compiled ideas and answers that have further enhanced our enjoyment of the hobby.

This engineering handbook is our attempt to pass along additional information to those in the hobby. It is intended to be used in conjunction with other references such as "LIVE STEAM" magazine and Joe Nelson's book "So You Want To Build A Live Steam Locomotive". We hope that the ideas and solutions printed here will be as helpful to you as they have been to us.

Happy Railroading

Chet Peterson

Nick Edwards



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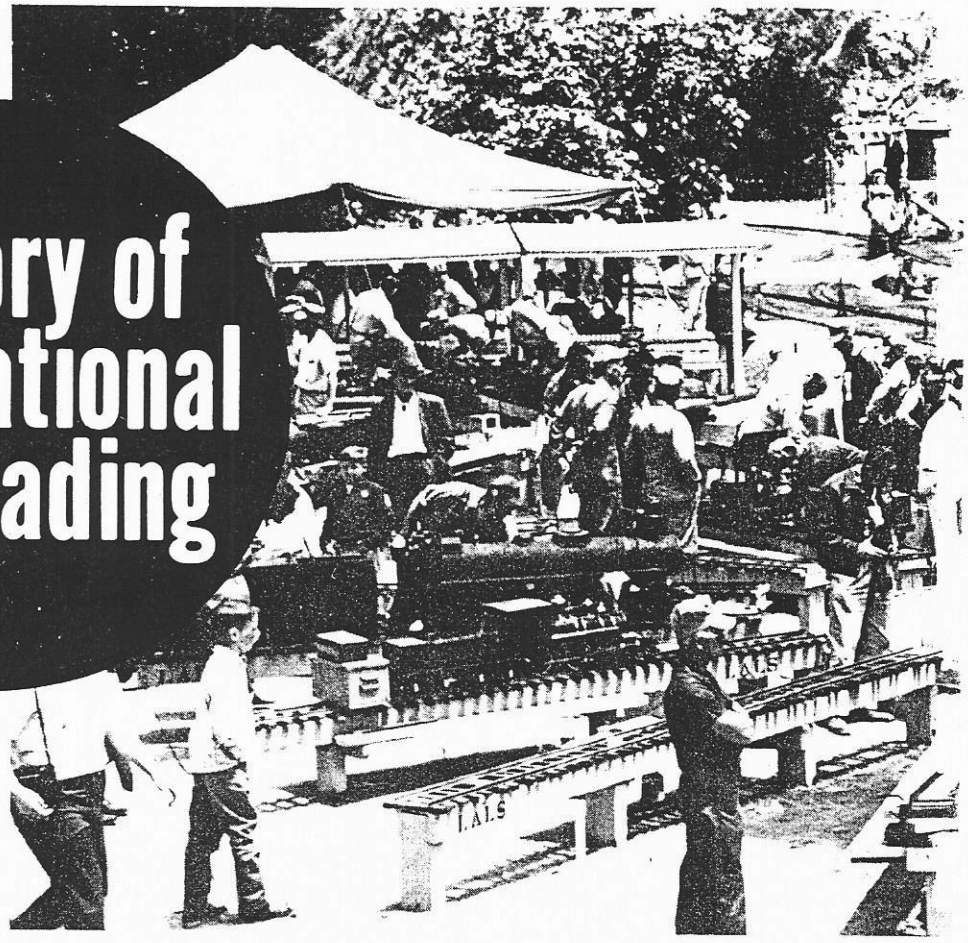
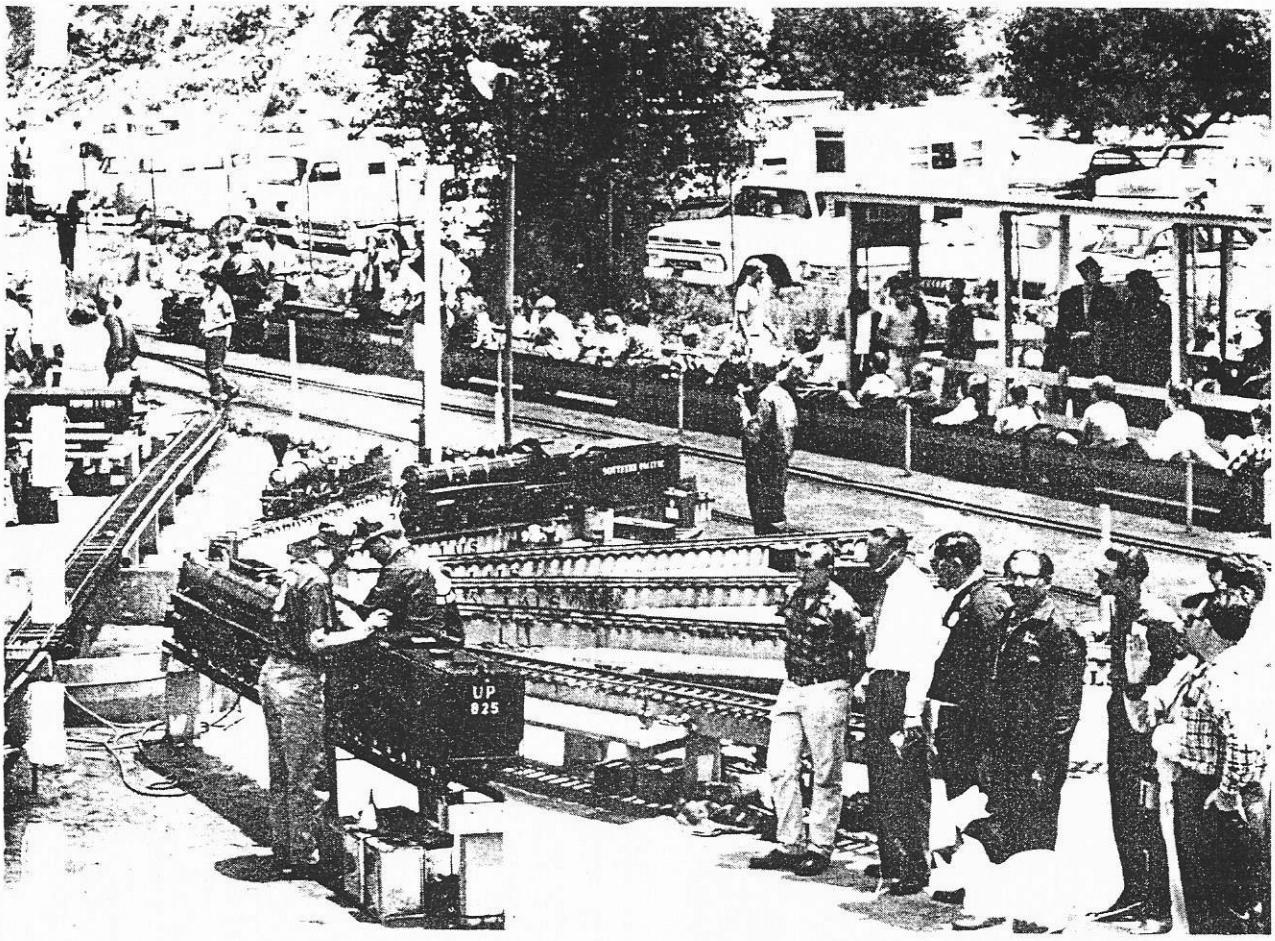
History of Recreational Railroading



Before the turn of the century men were building models of steam locomotives and by 1898 there was enough interest in the hobby to warrant the publication of a periodical in Great Britain. The activity gradually spread to this continent and by the middle of the 1920's there were numerous models under construction, and the first commercially available castings were offered to potential live steamers. Prior to that time all materials were either secured from supply firms in England or made by the modeller for his own use.

The first generally accepted models were built to a scale of $\frac{1}{2}$ inch = 1 foot 0 inches and were operated at first as free-running equipment. Gradually, though, the full realization of the power generated by these models became more apparent and riding cars were developed, permitting the operator to ride behind his locomotive.

Scale (which is the proportion of the model in relation to its prototype) gradually changed as the challenge of building larger and more powerful locomotives grew. The early $\frac{1}{2}$ inch scale models operated on $2\frac{1}{2}$ inch gauge track (the distance between the rails) so the next trend was to $\frac{3}{4}$ inch scale for more stability for the rider and passengers. $\frac{3}{4}$ inch scale ($3\frac{1}{2}$ inch gauge) is enjoying a continuing interest and many Live Steamers work in that scale today.



General view of steaming bay of Los Angeles Live Steam Club at Griffith Park

Up to this point most Live Steam models operated on tracks built on trestles about two feet above the ground. This provided a greater degree of comfort when operating or riding on this equipment. With the advent of 1 inch scale ($4\frac{3}{4}$ inch gauge), track could be laid on the ground in much the manner of full-size railroads with ballasted roadbed.

Although locomotives had been modeled in all scales and gauges from the very beginning, the popularity of each new scale brought out the urge for a little bit larger equipment. This in turn, brings us up to the $1\frac{1}{2}$ inch scale which permits the operator and rider to sit within the equipment and now offers a wide range of commercially available parts and kits. $1\frac{1}{2}$ inch scale railroading is about the largest size that permits transporting of equipment from place to place with any degree of convenience and many Live Steam clubs around the country have track for this size equipment. Most $1\frac{1}{2}$ inch scale equipment will fit a station wagon or car trunk. With $1\frac{1}{2}$ inch scale equipment, the builder should give consideration to an important regional difference. In the northeastern part of the United States and Canada, $7\frac{1}{4}$ inch gauge is used while generally the rest of the country operates on $7\frac{1}{2}$ inch gauge track. Technically, neither is correct: $7\frac{1}{16}$ inch gauge would be exact!

Club membership helps you get acquainted with others who are active in this wonderful hobby and bring together men who can answer your questions or give you a hand as you get involved in construction.

If you are a new-comer to the hobby or an old-timer you should become a member of the Brotherhood of Live Steamers. If you are seriously contemplating the construction or purchase of a Live Steam model you are eligible to join. There are no dues or fees and the purpose of the organization is to put one Live Steamer with a question in touch with another Live Steamer who is apt to have an answer. The only stipulation is that a stamped, self-addressed envelope be enclosed when writing to one of the secretaries for information. These men serve on a voluntary basis and theirs is a labor of love. They will do their best to help you with your problem.

As Steam Locomotives vanish from the railroads, the desire to hear the chugging of a locomotive and sniff the smell of coal smoke, steam and valve oil seems to increase. Live Steamers enjoy these thrills regularly and in increasing numbers. You are cordially invited to join us.

Of the many questions we are asked by people who know nothing about the railroad hobby the three most frequent are: Who builds the working locomotives? What do they do with them once they are completed? Who rides them? The answer is, anyone who loves to work with his hands and create a useful and beautiful piece of craftsmanship. People from all walks of life, Doctors, Lawyers, Musicians, Actors, Clergymen, Machinists, Brick Layers, and virtually every occupation, professional and non-professional are represented in this world of Model Railroading. You do not have to be a machinist to build these locomotives. Many who enjoy the hobby learn to operate machine tools by attending night courses in machine shop work at their local schools. Some buy rough castings and do all the machine work and assembly themselves, some do just part of the machine work, and some purchase them all built ready to run. The actual operation can be enjoyed by the whole family and their friends. Many of the wives and children learn to operate the locomotives which really turns it into a family project.

Our recommendation – LIVE STEAM MAGAZINE is published monthly and contains technical articles and Live Steam Club news. This is suggested reading material for all Railroad Enthusiasts.

Smooth Railroad Operations

Having supplied over 300 locomotives, 1000 cars and 5000 pair of trucks along with more than 100 real miles of track and having worked on movie & TV props for shows such as King Kong, Swarm, Emperor of the North, NBC's Supertrain, ABC's Salvage I and CBS's Time Express, along with many others, we have been exposed to numerous operating problems, most notably derailments. These are the bane of any operation, and if excessive, ruin the fun of operation. The reasons for these derailments, we feel, fall into three categories:

A. LOCOMOTIVES, ROLLING STOCK & EQUIPMENT
B. TRACK
C. PASSENGERS

The first, we as individual builders, can do something about. As operators we often have less control over track as most of us do not own our own facility. Finally, as engineers we have the least control over passengers. Unfortunately all three of these interact and a summary of our experience and corrective measures follow:

A. LOCOMOTIVES & ROLLING STOCK

When a particular piece of rolling stock is prone to derailing we generally check for some critical items:

1. Trucks
2. Truck mount to the body
3. Couplers
4. Basic weight distribution

1. Trucks

Even though the most obvious thing to look for in trucks is the gauge of the wheels, this is becoming a rarer cause with increased attention being paid by builders. Often overlooked however, is the back-to-back gauge of the wheels which is unimportant except at switches. At this point too thick a wheel flange which decreases the back-to-back gauge can cause picking the open switch points or riding up over the frog. Conversely, too narrow a flange resulting in too wide a back-to-back gauge reduces the effectiveness of the frog guard rail, enabling the wheel to pick the point of the frog. This problem is most prevalent in the eastern U.S.A. where back-to-back gauge standards are not completely settled. This back-to-back gauge problem may be more significant as 1½" scale tracks are designed to accommodate both 7¼" and 7½" gauge equipment.

The next item to look for is how flexible are the trucks, or how good is the equalization. Fundamentally, trucks should be as loose as practical to remain in contact with uneven track. As covered in detail in a later section, truck design in miniature trains is complicated by the significant variation in weight they must support, as cars may run light at 50 lbs. and loaded at 900 lbs.

Therefore, if trucks that are equalized are also sprung, these springs should be stiff enough to hold the required weight, but yet when running light the springs should just touch the bolster and the frame.

2. Truck Mounting

One of the most common causes of derailment, especially when running light, is that the trucks are mounted too rigidly to the car. If there is any "corkscrew" effect in the track, one pair of wheels in a truck may lift off of the track causing a derailment. The "milk-stool" principle covered in the section on Trucks is the design approach to reduce this problem and should be closely monitored as equalization will *not* correct this problem.

3. Couplers

Couplers generally rank as the third problem in derailments. The primary problem here is that the knuckle action is too tight, effectively clamping two cars together causing them to derail when entering curves or when encountering "S" curves. The next problem occurs when curves are "too tight" and the couplers hit the side of the coupler pockets.

4. Weight Distribution

Occasionally a non passenger-carrying car has a badly skewed weight distribution over the wheels which causes derailment. This occurs on short locomotives such as diesel switchers where much of the weight is over one pair of wheels or trucks and is correctable by adding lead weights to balance the locomotive. If the problem occurs on a steam locomotive with over four drivers, the problem is with the equalization. Finally, if it is a pilot truck that is derailing, this could be due to lack of proper weight or to using just coil springs for weight in lieu of swing links so that the extra weight is on the outside wheels in a curve.

B. TRACK

The importance of good track with respect to both gauge and levelness is obvious. When laying 1½" scale track, we recommend adding up to an 1/8" extra gauge for curves under 100 ft. radius to accommodate locomotive drivers. Therefore the following gauges are recommended.

	Track	
Straight	7-1/4"	7-1/2"
Curve	7-3/8"	7-5/8"

There are three less apparent areas, however, that do cause derailments: railjoints, a low track or rail, and minimum radius.

1. Rail joints, especially on curves, can cause havoc, if they are not a continuous curve, if they dip at the joint or if the track is misaligned. Since this condition can develop over a period of time, it is important that rail joiners be of extra strength to compensate for the cut rail. This would suggest using steel vs aluminum rail joiners.

2. Low spots or dips in the track or rail will only give trouble and should be avoided, as it could cause one side of a truck to lift if the truck is not properly mounted to a car. Unfortunately superelevation on curves accentuates this problem. Therefore, the superelevation should begin on the straight portion of the track, and not as it enters a curve.

3. Curve radii can become a problem in derailments. First, too sharp a radius can cause both trucks and couplers to bind. Next, excessive "S" curves can also cause derailments as couplers do not have the flexibility to handle the lateral motion. This is especially true on longer cars. We generally find these problems on home layouts where space is at a premium.

C. PASSENGERS

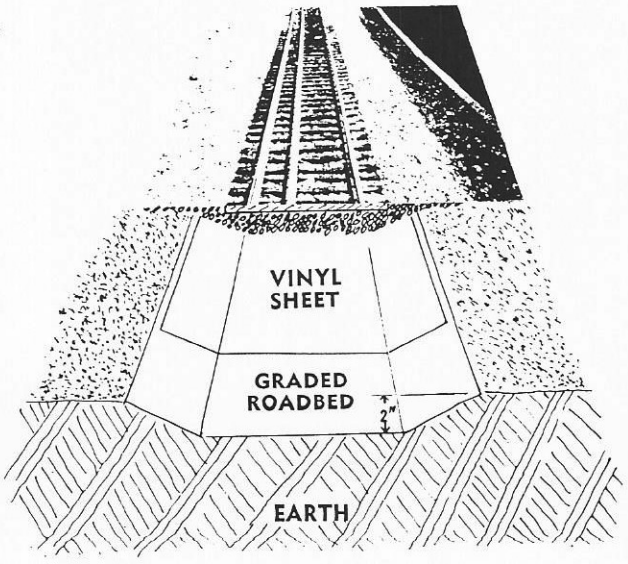
The other major cause of derailment is passengers primarily not distributing their weight properly. Excluding the obvious of leaning too much to one side, many passengers are not careful where they sit in a car. If a passenger is alone in a car, he should sit in the center. If there is a second passenger they should occupy a balanced point so that approximately equal weight is on the trucks. Finally, if an adult and a child sit in a car, the adult should sit in front of the child so that the weight is better distributed. This last one is most commonly observed on weight mismatch as the adult generally sits behind the child and he quite often is sitting over the rear truck or in fact, behind it.

TRACK

Road-Bed Layout

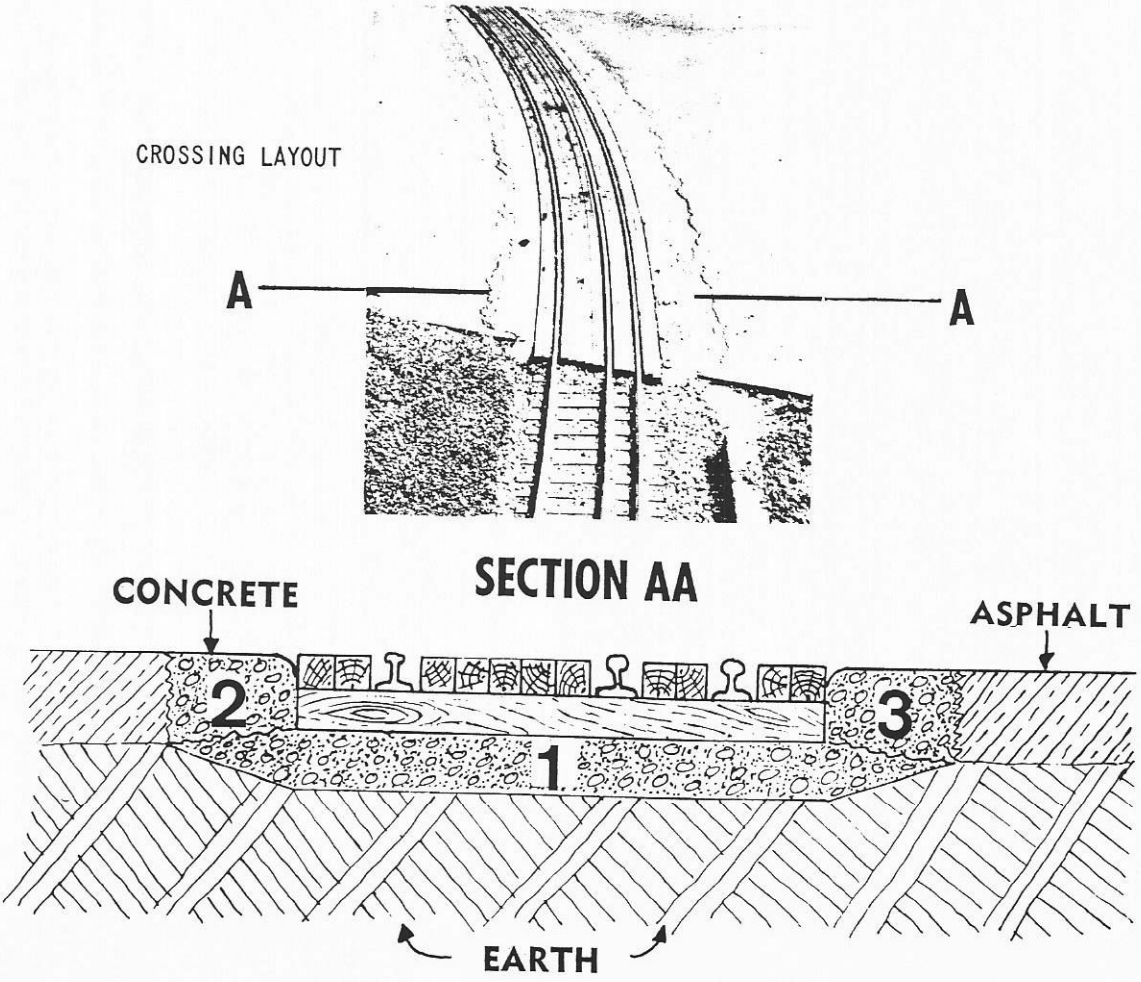
1. Level the ground to desired grades and/or radii. It is advisable to keep radii as large as possible and grades away from the curves. Use of tight radii can cause excessive rail wear, and prohibit use of larger cars and locomotives. Use of steep grades will reduce hauling capacity, and grades of greater than 1% on curves should be avoided.
2. Lay out the track center-line using any convenient method. Powdered chalk or lime may be used, as well as stakes or any method which the builder selects.
3. Construct a graded channel as shown, making the depth 2 inches, base 12 inches in width, and top 18 inches in width (for 1½" scale) following the track centerline layout. A wooden form in the shape of the trench may be helpful in maintaining uniformity. For double track use 5 feet for 1½" scale.
4. As a grass and weed controller, lay 20 thousandths vinyl sheet in the channel, and punch small drainage holes in the bottom about 6 inches apart.
5. Fill channel with 3/8 inch crushed rock and rake out level.
6. Lay preassembled track on top of the prepared roadbed and bolt the sections together. To allow for rail expansion and contraction, leave 1/8 inch gap between rail ends and secure the rail joiners to one rail only, allowing some slack in the other end of the rail joiner.
7. Shovel more rock on top of the track and then, by using a broom, brush away rock from on top of ties.
8. Track can be leveled by sighting down the railhead and raising lower spots to level. Tamp ballast between ties to lock the position of the track. Track can be lowered by removing ballast and tamping. By using a level, curves can be banked. Finally, some "settling" of trackage is normal with age, and trackage may need releveling occasionally.

This process of laying track gives a very solid and durable road bed, with the added feature of keeping grass and weeds out of track, thus giving the true look of a Railroad bed.

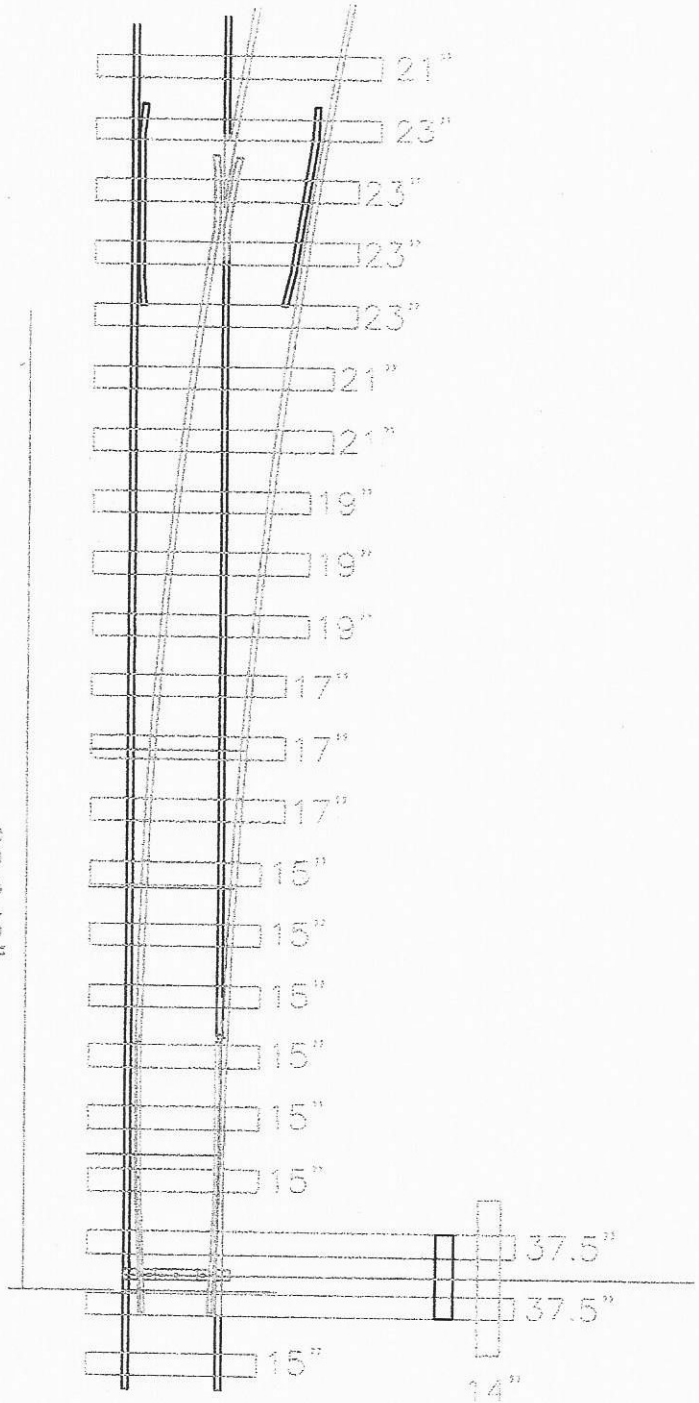


Crossing Layout for Asphalt Driveway

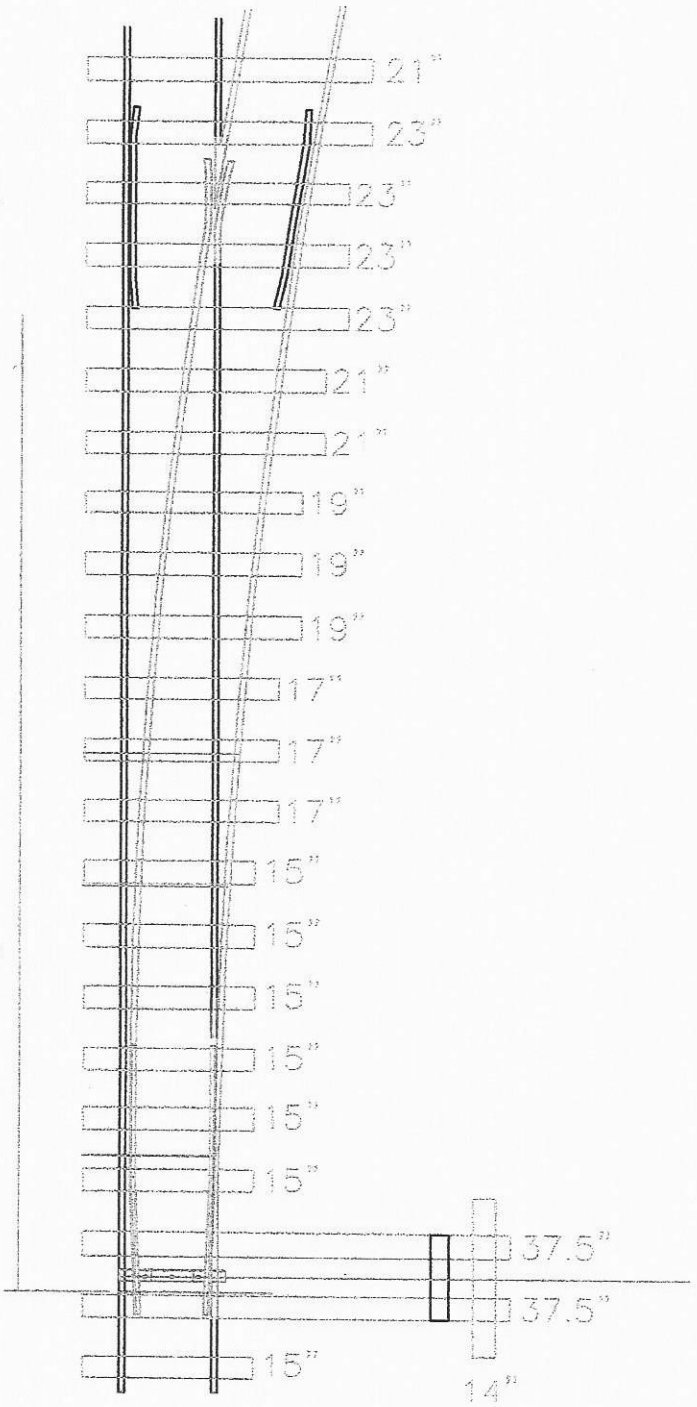
1. Lay out, with chalk, the track center-line on the asphalt surface.
2. Cut away asphalt 9 inches on both sides of the center-line (for 1½" scale) to a depth of 3½ inches below the top of the asphalt.
3. Pour a layer of concrete to a depth of 2 inches below the top of the asphalt (Section #1).
4. Lay in preassembled track on the wet concrete, and bolt it to the track sections leading to the driveway.
5. Settle the track section into the wet concrete, completely straightening and leveling it before allowing the concrete to set.
6. Use creosoted 1" x 1" boards (for 1½" scale) for the grade crossing filler. Install by nailing boards next to the rail but not on top of the spikes. Nail boards at 1 foot intervals with a pattern of no more than 3 nails per tie.
7. With all grade crossing boards in place, finish pouring the concrete between the asphalt and the grade crossing boards (Section #2 and #3). After the concrete has set, paint the concrete to match the asphalt.
8. The above procedure results in a strong and durable crossing with a realistic appearance.

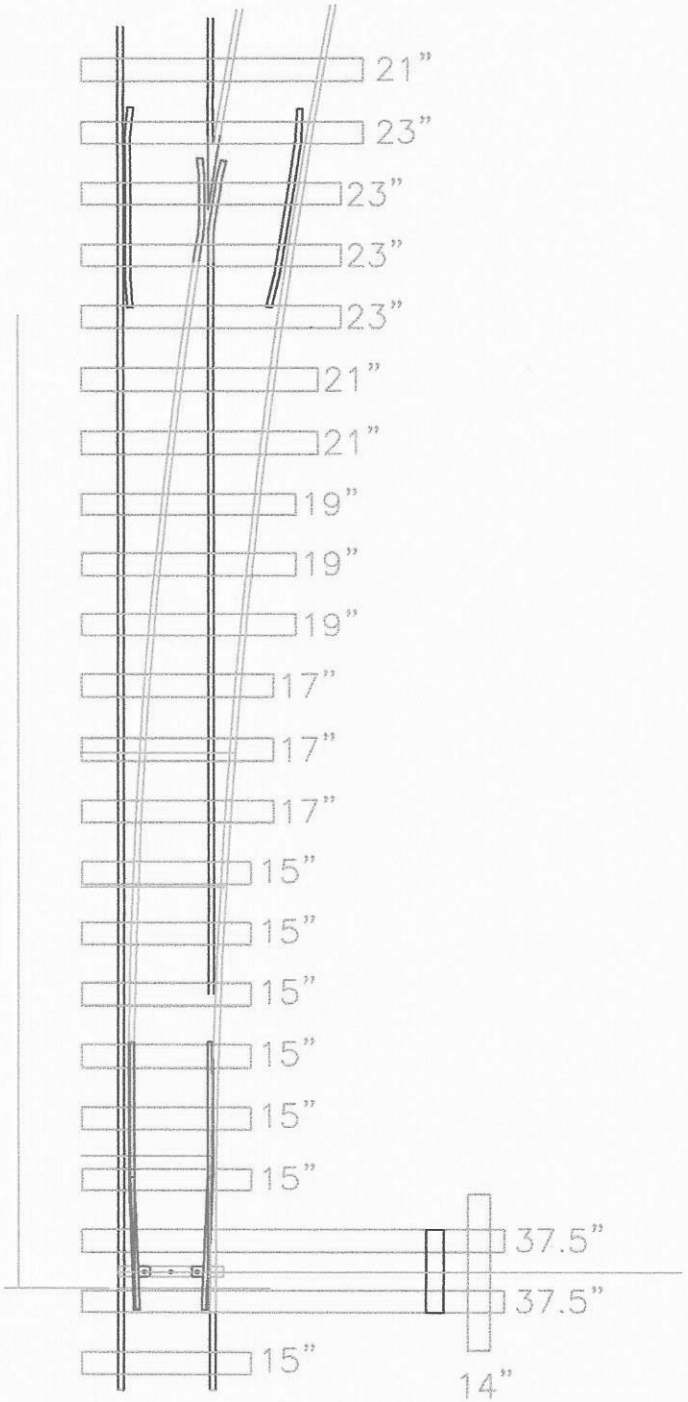


#6 SWITCH WITH 50' RADIUS



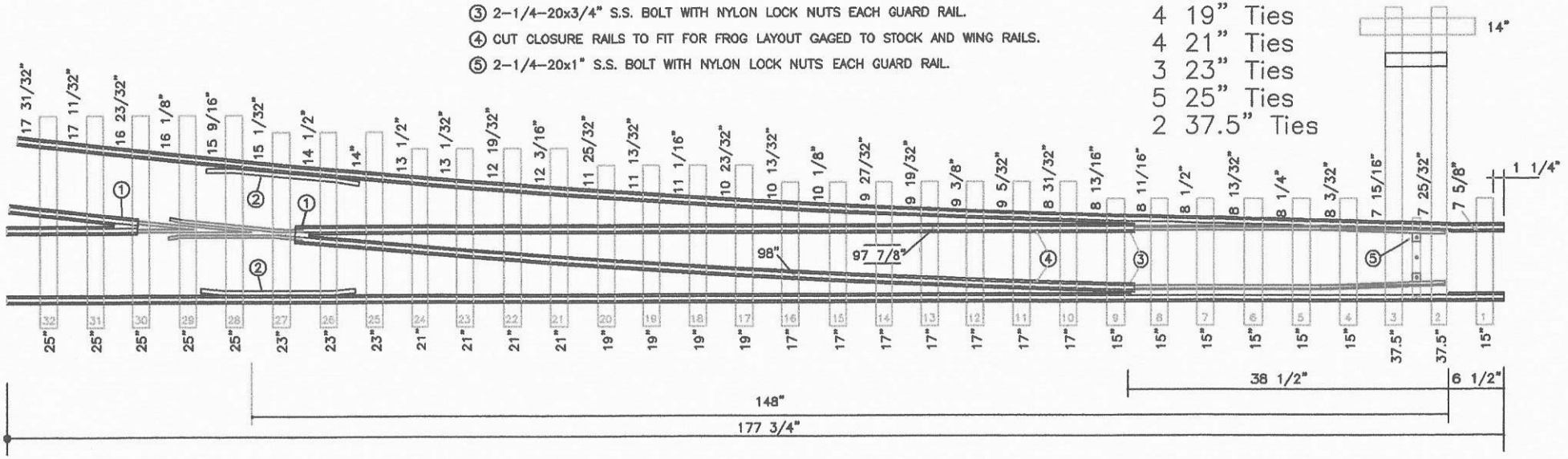
#6 SWITCH WITH 50' RADIUS




21"
23"
23"
23"
23"
21"
21"
19"
19"
19"
17"
17"
17"
15"
15"
15"
15"
15"
15"
37.5"
37.5"
15"
14"
86.948"
#6 SWITCH WITH 50' RADIUS

① 2–10–32x1 1/2" SCREW WITH NYLON LOCK NUTS EACH END OF FROG.
② 3–10–32x1 1/4" SCREW WITH NYLON LOCK NUTS EACH GUARD RAIL.
③ 2–1/4–20x3/4" S.S. BOLT WITH NYLON LOCK NUTS EACH GUARD RAIL.
④ CUT CLOSURE RAILS TO FIT FOR FROG LAYOUT GAGED TO STOCK AND WING RAILS.
⑤ 2–1/4–20x1" S.S. BOLT WITH NYLON LOCK NUTS EACH GUARD RAIL.

7 15" Ties
7 17" Ties
4 19" Ties
4 21" Ties
3 23" Ties
5 25" Ties
2 37.5" Ties

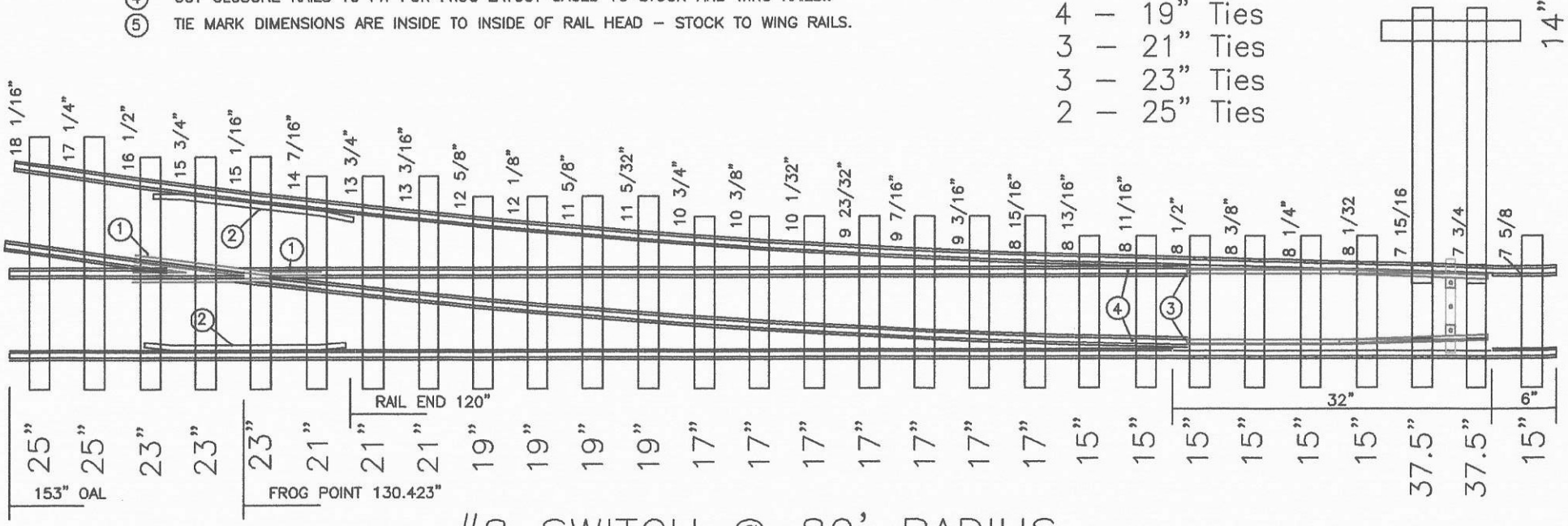


#10 SWITCH

DEMINSIONS ARE INSIDE TO INSIDE RAIL HEADS – STOCK TO CLOSURE

① 2 – 10–32x1 1/2" S.S . SCEW WITH NYLON LOCK NUTS EACH END OF FROG.
② 3 – 10–32x1 1/4" S.S . SCEW WITH NYLON LOCK NUTS EACH GUARD RAIL.
③ 2 – 1/4–20x3/4" S.S. BOLT WITH NYLON LOCK NUTS.
④ CUT CLOSURE RAILS TO FIT FOR FROG LAYOUT GAGED TO STOCK AND WING RAILS..
⑤ TIE MARK DIMENSIONS ARE INSIDE TO INSIDE OF RAIL HEAD – STOCK TO WING RAILS.

7 – 15" Ties
2 – 37.5" Ties
7 – 17" Ties
4 – 19" Ties
3 – 21" Ties
3 – 23" Ties
2 – 25" Ties



#8 SWITCH @ 80' RADIUS

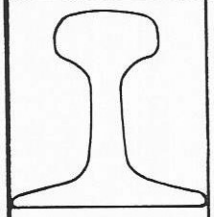
Rail

In selecting rail for track there are many varieties on the market, most offering a different prototype. Three elements of rail are critical, the head, the web, and the foot.

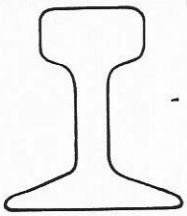
The head should be slightly crowned for better rolling characteristics as wheels are tapered. Also, the edge of the rail head should curve to match the wheel contour to reduce wear and improve tracking on curves.

The web thickness and foot width are important for stability. When a heavy locomotive goes into a curve at speed there is a tremendous overturning force against the outside rail, making both dimensions critical. The dimension across the foot also distributes the bearing load on the tie. Ties stand up much better when the rail has a wider foot.

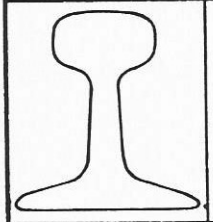
COMPARISON CHART
1½ INCH SCALE ALUMINUM RAIL
As Now Offered By: **1979**



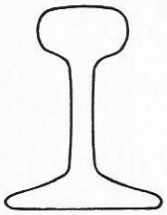
RAILROAD SUPPLY CORPORATION
6063 Alloy T-5 Heat Treat 72 Rockwell (R/E Scale)
1" High
Foot Width .940 in.
Weight per Foot .37 lbs. 100% weight of RRSC Rail



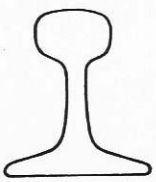
LITTLE ENGINES
618 Alloy T-5 Heat Treat 73 Rockwell
1" High
Foot Width .875 in.
Weight per Foot .35 lbs. 94%



SCALE LOCOMOTIVES
6061 Alloy T-5 Heat Treat 71 Rockwell
1" High
Foot Width .875 in.
Weight per Foot .34 lbs. 92%



KOSTER'S MINIATURE RAILROAD SUPPLIES
6063 Alloy T-2 Heat Treat 60 Rockwell
1" High
Foot Width .750 in.
Weight per Foot .25 lbs. 68%



CULP RAIL
6063 Alloy T-5 Heat Treat 70 Rockwell
11/16" High
Foot Width .672 in.
Weight per Foot .17 lbs. 46%

Hardness and alloy are also very important. We have tested all the samples on the attached chart and find them consistent with one being softer than the rest.

Since all rail is bought by the pound and sold by the foot, significant savings can be achieved by buying lighter rail. These savings however, should be viewed in light of the use the rail will see, as continuous usage on light rail by heavy locomotives could result in excessive wear or more importantly the rail might roll.

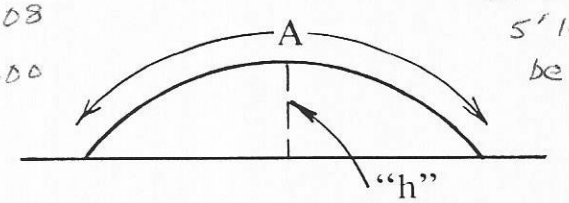
Rail Bending

In laying curved track, it is important to get a good arc for a continuous curve. A curve made by bending rail at the two ends results in a parabolic shape. Therefore, a rail bender is preferred: a drawing of the one we use is attached. The next question then becomes, how much of a bend does one put in a curve? Templates are often used, however, a simpler approach when bending 10 ft. rail is to measure the height of the arc "h" when the curved rail is placed against a wall or bench. A table follows for 10 ft. rail showing the arc height "h" for different radii.

72' Radius = 2.08

75' " = 2.00

60 Radius. 5' length of rail will be 3/4" offset.



FOR 10' RAIL SECTIONS			
Radius in feet	**Arc height in inches (to nearest .01")**	**Radius in feet**	**Arc height in inches (to nearest .01")**
10'	14.69"	40'	3.75"
12'	12.32"	45'	3.33"
14'	10.60"	50'	3.00"
16'	9.30"	60'	2.50"
18'	8.28"	80'	1.87"
20'	7.46"	100'	1.50"
25'	5.98"	120'	1.25"
30'	4.99"	150'	1.00"
35'	4.28"	200'	.75"

For those more mathematically inclined, the formula is

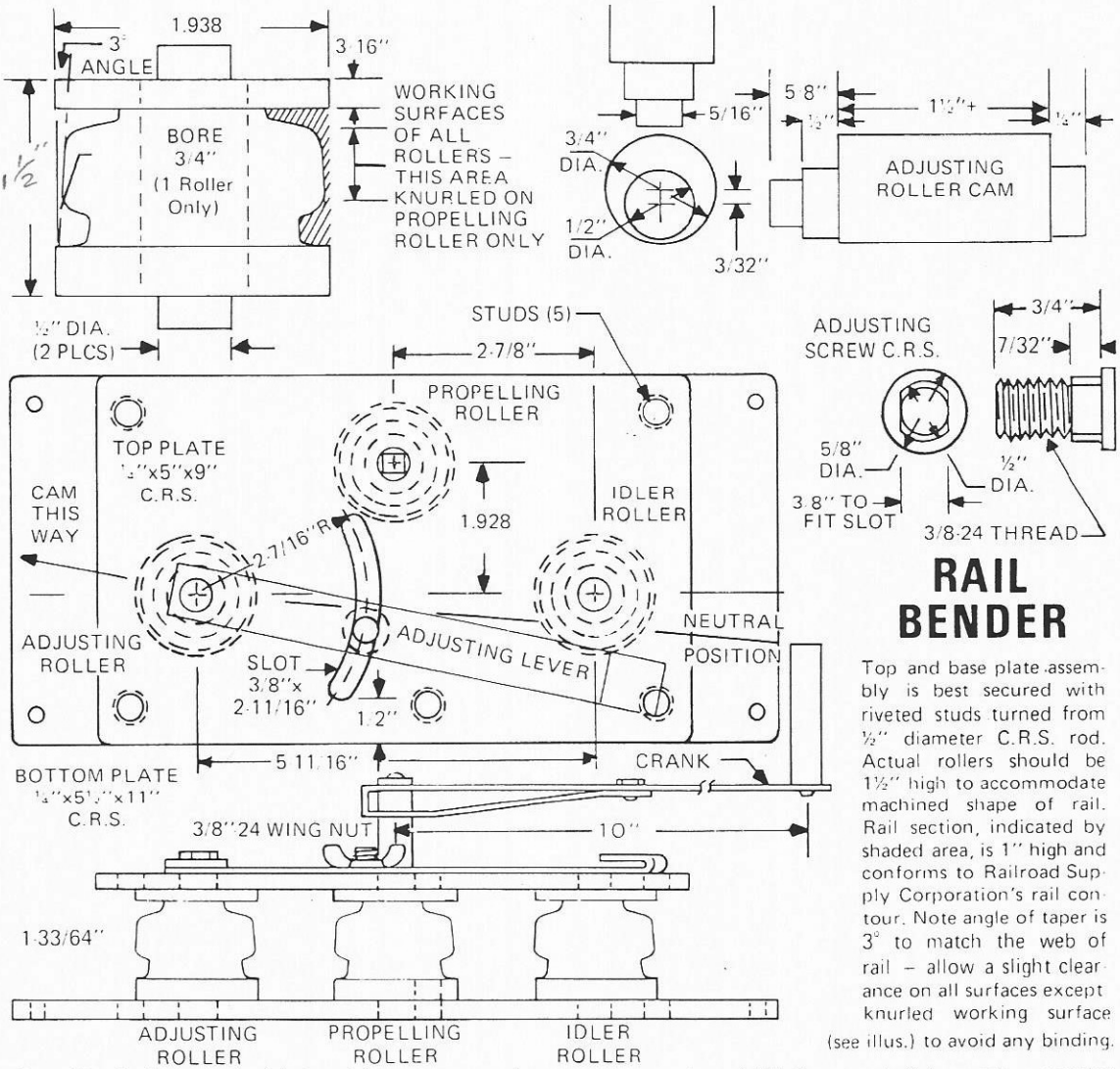
$$h = 12r\left(1 - \cos\frac{90a}{\pi r}\right)$$

where: h = arc height in inches
r = radius in feet
a = arc length in feet

For those building switches, the curved section of the switch points must be pre-bent. If the switch point is 2 ft. long, then the arc height "h" is as follows:

FOR 2' SWITCH POINTS

Radius in feet		Arc height in inches	Radius in feet			Arc height in inches
10'		.60	30'	#6	Switch	.20
12'		.50	35'			.17
14'		.43	40'			.15
16'		.37	45'	#7	Switch	.13
18'		.33	50'			.12
20'	#4½ Switch	.30	75'	#9	Switch	.08
25'		.24	100'			.06



RAIL BENDER

Top and base plate assembly is best secured with riveted studs turned from ½" diameter C.R.S. rod. Actual rollers should be 1½" high to accommodate machined shape of rail. Rail section, indicated by shaded area, is 1" high and conforms to Railroad Supply Corporation's rail contour. Note angle of taper is 3° to match the web of rail – allow a slight clearance on all surfaces except knurled working surface (see illus.) to avoid any binding.

Propelling Roller must be fabricated from longer stock to permit extension of ½" diameter shaft for crank – machine 3/8" square and 5/8" deep.

Adjusting Roller must rotate smoothly on cam. It, too, must be machined from stock long enough to accommodate Adjusting Lever.

Crank and Adjusting Lever are fabricated from 3/32"x3/4" C.R.S. Cut square hole in Crank to fit Propelling Roller shaft. Retain with washer and 10 32 screw. Cut openings in Adjusting Lever to coincide with shaft on Adjusting Roller and radius slot on top plate. Retain with 10 32 screw and wing nut as shown in illustration.

RAILWAY ENGINEERING CURVES

Radius to Center of Track in Feet.

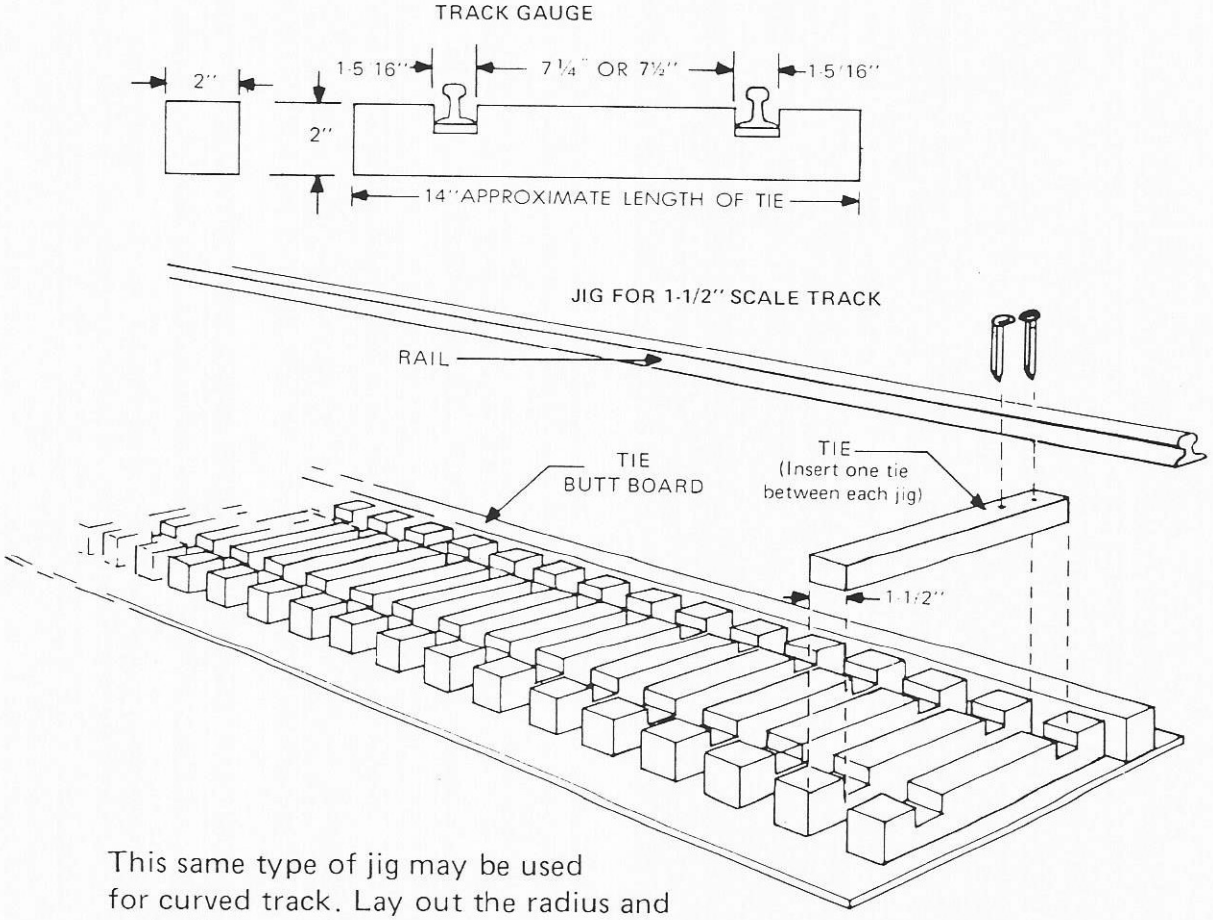
DEGREE OF CURVE	FULL SIZE	3/4° SCALE	1° SCALE	1½° SCALE	3° SCALE
1	5,730	358.12	477.5	716.25	1,432.5
2	2,865	179.06	238.75	358.12	716.25
3	1,910	119.37	159.16	238.75	477.5
4	1,433	89.56	119.41	179.12	458.25
5	1,146	71.62	95.5	143.25	286.5
6	955.4	59.71	79.62	119.42	238.85
7	819	51.18	68.25	102.37	204.75
8	716.8	44.8	59.73	89.6	179.2
9	637.3	39.83	53.12	79.66	159.32
10	573.7	35.88	47.81	71.71	143.42
11	521.7	32.6	43.47	65.21	130.42
12	478.3	29.89	39.85	59.78	119.57
13	441.7	27.6	36.81	55.21	110.42
14	410.3	25.64	34.19	51.29	102.57
15	383.1	23.94	31.92	47.89	95.78
16	359.3	22.45	29.94	44.91	89.82
17	338.3	21.14	28.19	42.29	84.57
18	319.6	19.97	26.63	39.95	79.9
19	301.9	18.93	25.24	37.86	75.72
20	287.9	17.99	23.99	35.99	71.97
21	274.4	17.15	22.86	34.3	68.6
22	262.0	16.37	21.83	32.75	65.5
23	249.0	15.6	20.83	31.0	62.0
24	238.7	14.9	19.9	29.8	59.6
25	229.0	14.3	19.0	28.6	57.2
26	220.0	13.8	18.3	27.5	55.0
27	212.0	13.3	17.7	26.5	53.0
28	204.6	12.8	17.1	25.5	51.0
29	197.5	12.3	16.5	24.7	49.4
30	191.0	11.9	15.9	23.9	47.8

Track Laying

The most common method of building track is to assemble it on a bench and then move it to the location where it is being used. After having selected the rail, the next step is to make the ties. The most common approach is to cut a 2" x 4" x 8' into seven pieces and then rip them in half. This results in a 1-5/8" square tie just over 13½" long for 1½" scale track. As an alternative, use 2 x 4's on edge for better side stability.

For straight track, this can be assembled on a jig where the ties, 3 to 4 per foot in 1-1/2" scale, are held in place for spiking. Rail ends should be staggered by at least six inches if at all possible. When the rail has been spiked in place, holes for rail joiners should then be drilled. When spiking, it is often practical to put a piece of channel iron over the railhead, especially if aluminum rail is used to save "dinging" the rail from errant hammer swings.

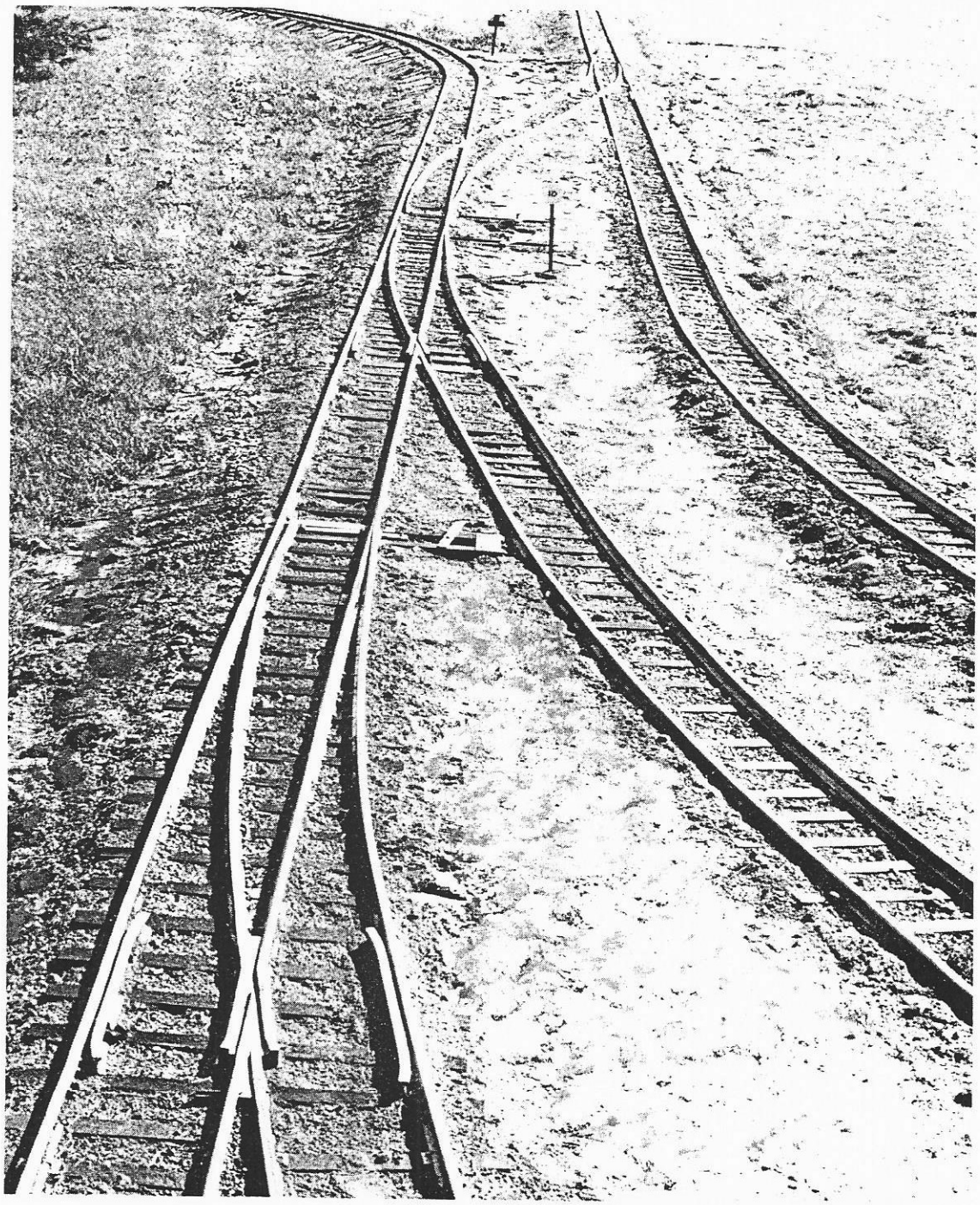
JIG FOR LAYING TRACK - 1½" SCALE



This same type of jig may be used for curved track. Lay out the radius and make jig to conform with the same type of construction. Be certain to maintain the tie width spacing between the jig on the inside radius. The gauge on the curves should increase by up to 1/8" – this must be allowed for in the construction of the jig.

For curved track, a jig is generally not used, unless a large amount of track of the same radius is being built. More often a template is used that shows different radii. When the desired radii is established, the easiest way is to tack three ties to the jig, one at each end and one in the middle. By using loose spacers to position the ties, and rail gauge blocks to hold the rail in place, the curved track can be spiked in place. Again, stagger the rails to mate with the prior sections, cut off any excess rail due to curving. Finally, drill the necessary holes for rail joiners.

The track sections can then be mounted in place on your layout.

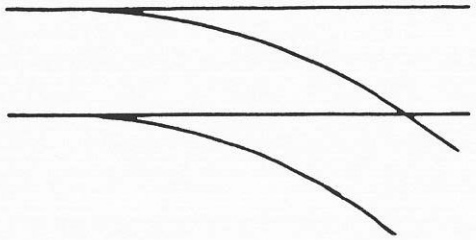


HENRY GROTH WALDBORO, MAINE

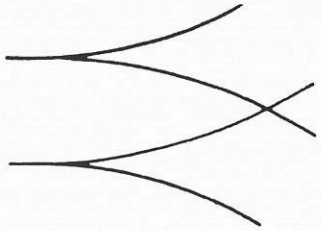
SWITCH DIAGRAMS

giving names of the main formations in trackwork

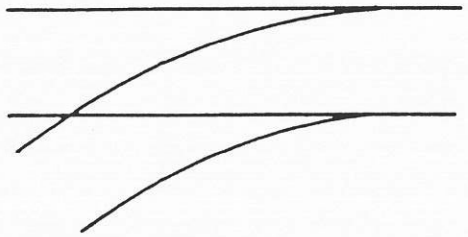
Right hand turnout



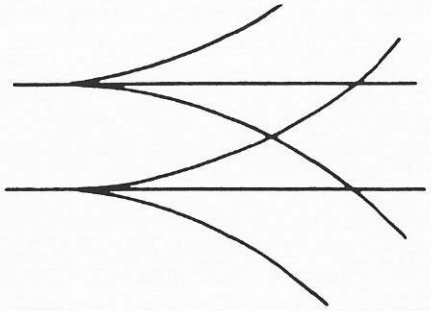
Equilateral or "Y" turnout



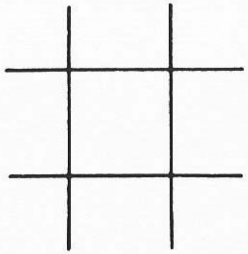
Left hand turnout



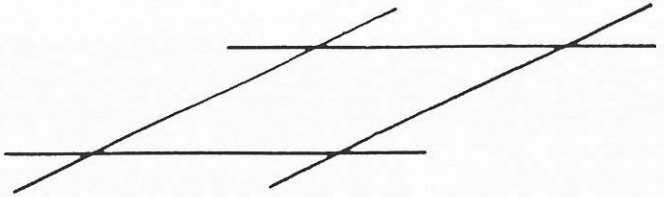
Three-way turnout



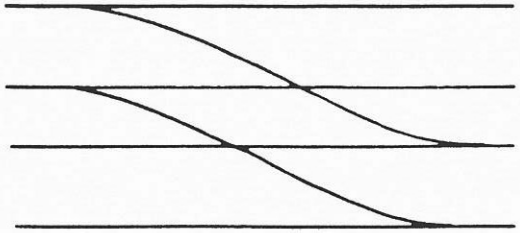
crossing



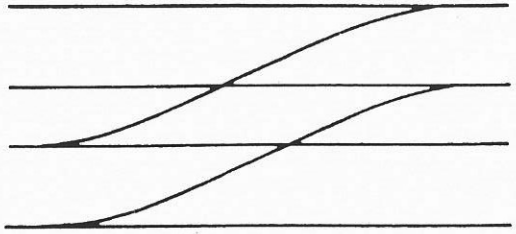
Frog-type crossing



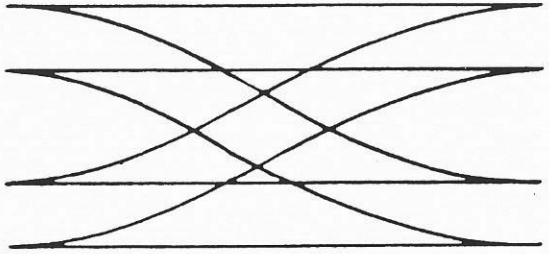
Right hand crossover



Left hand crossover



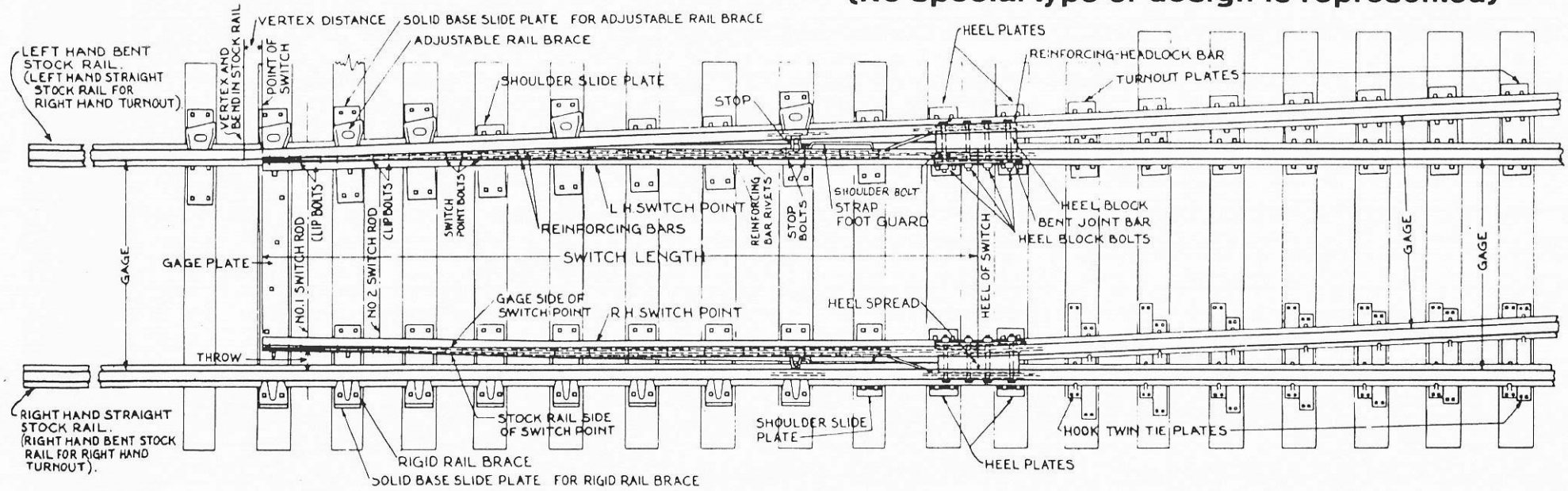
Double crossover



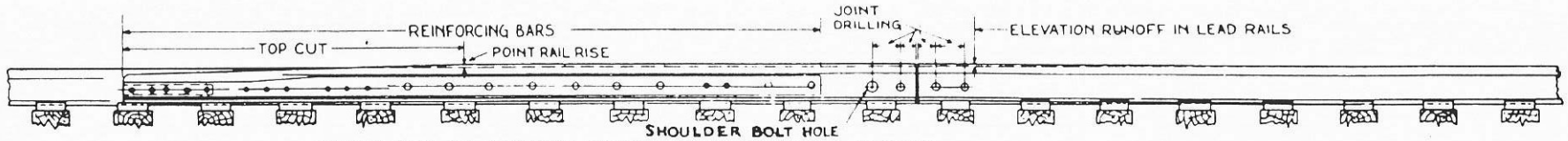
SWITCH DETAILS

DIAGRAM WITH NAMES APPLYING TO VARIOUS PARTS

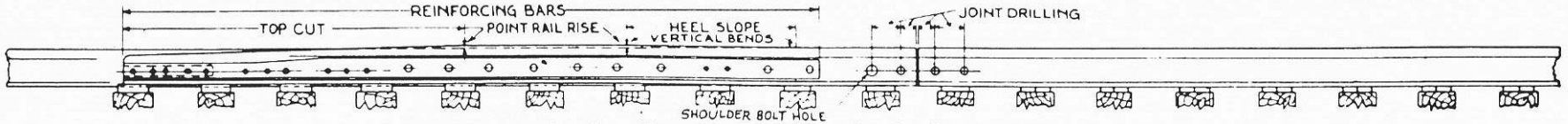
(No special type or design is represented)



PLAN VIEW INDICATING (FOR ILLUSTRATION ONLY) VARIOUS PARTS OF SWITCH LAYOUTS
DRAWN FOR LEFT HAND TURNOUT



ELEVATION OF SWITCH POINT WITH UNIFORM RISERS



ELEVATION OF SWITCH POINT WITH GRADUATED RISERS

FROG DETAILS

diagram with names applying to various parts

(no particular type or design is represented)

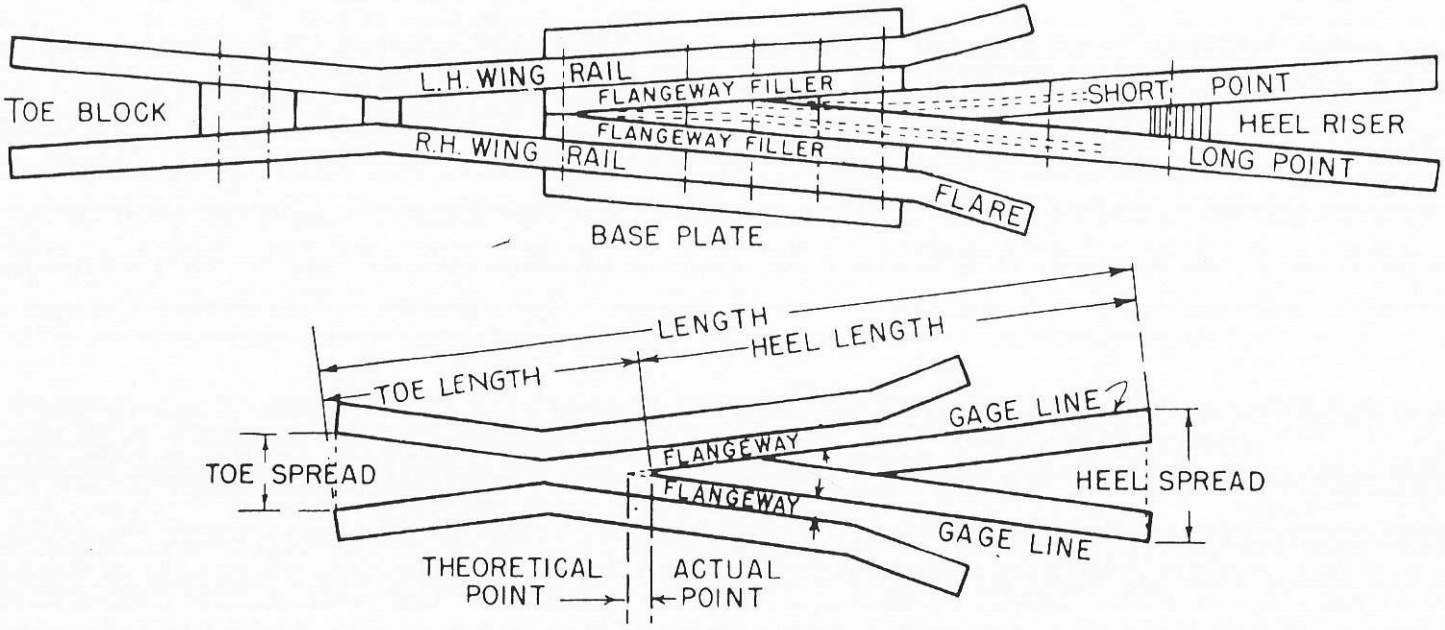
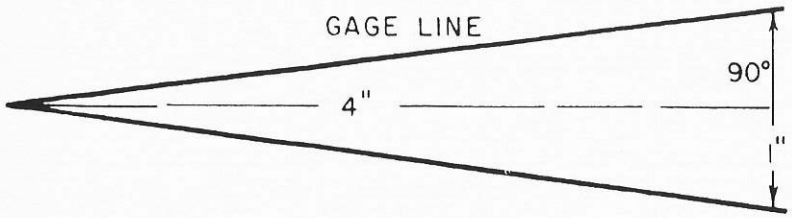


diagram showing the basis of the frog number



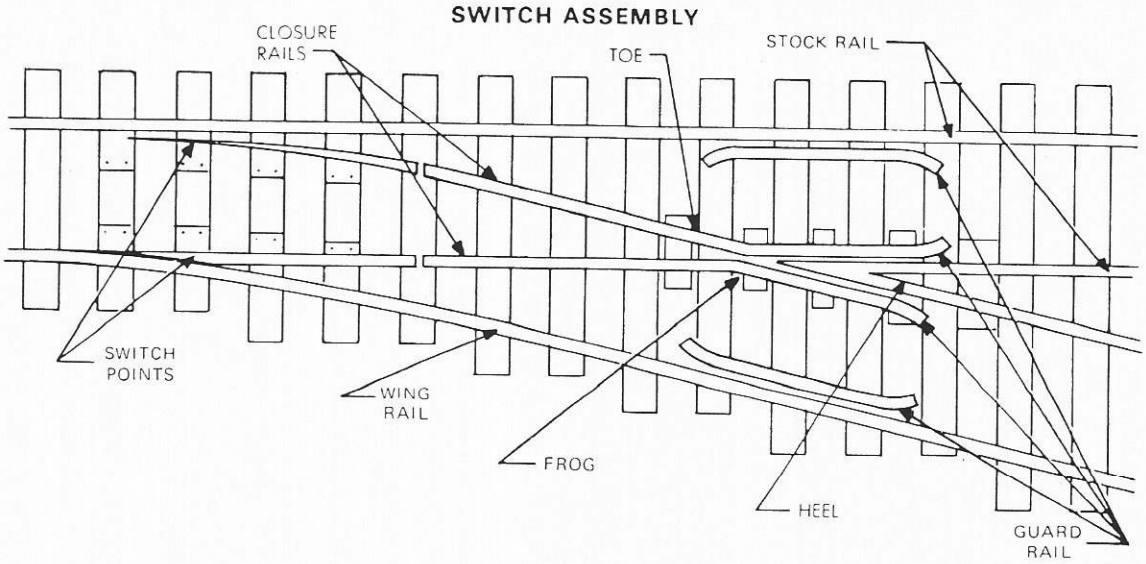
The number of a frog is the ratio of the spread to its distance from the theoretical point.

The diagram above shows a No. 4 angle as the spread is 1 inch in 4 inches; 2 in 8, 3 in 12, etc. are all the proportion of 1 to 4 and therefore produce a No. 4 angle.

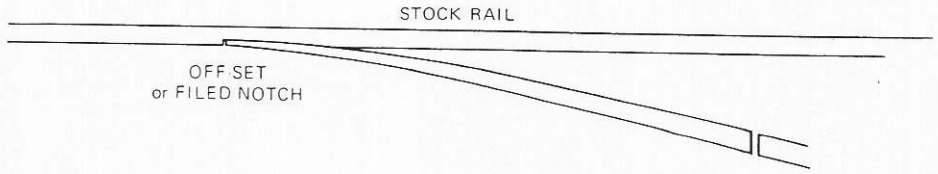
Likewise, 1 in 7 or 2 in 14 is No. 7; 1 in 5 or 3 in 15 is No. 5; 2 in 12 is No. 6; 2 in 9 is No. 4½, etc.

IMPORTANT: The spread must be at *right angles* to the center line as shown on above diagram.

TURNOUT ASSEMBLY PROCEDURE

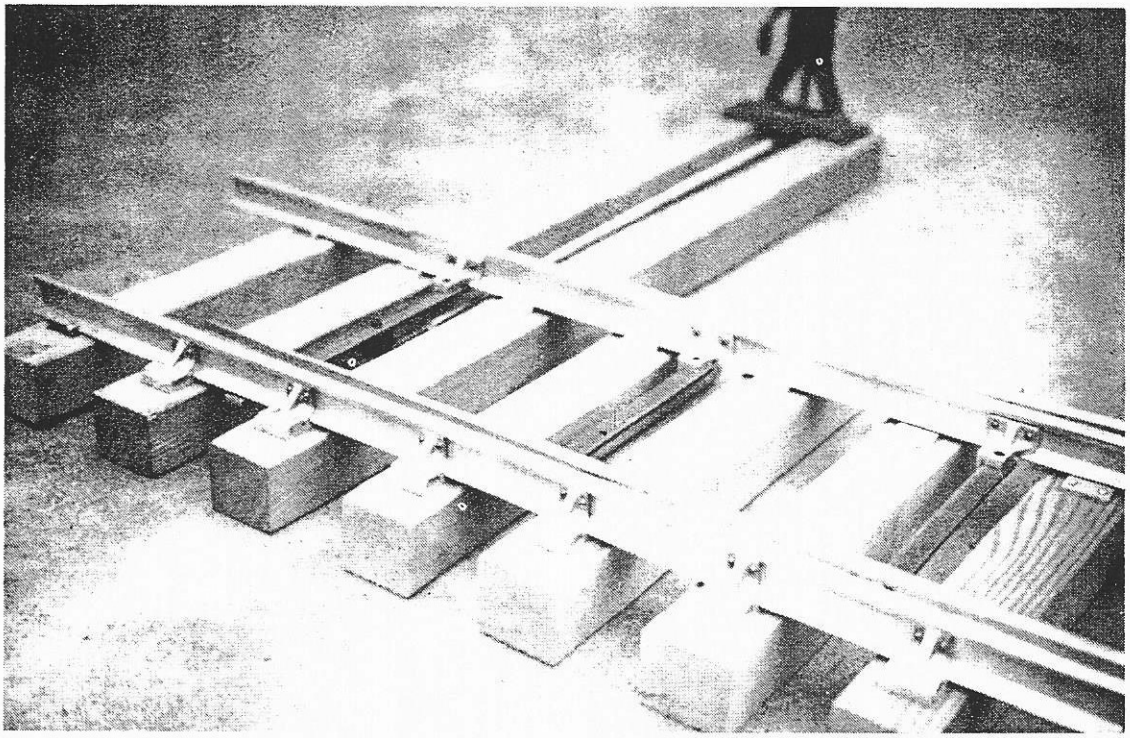


1. Switches (turnouts) may be constructed "in place" on your trackwork or prefabricated to be installed as a unit. In either case, lay out the locations of all rails on the switch ties with chalk.
2. Spike the straight outside stock rail in position. Then spike or screw the switch frog in position over the curve and straight rail intersection as shown. Make sure the frog is parallel to the stock rail and is properly gauged.
3. Bolt the inside stock rails to the heel of the switch frog and spike in place.
4. Using the chalk marks as a guide, locate the switch point against the straight stock rail and lay in position. It may be necessary to slightly notch the stock rail for a proper fit. Install the closure rail and bolt it to the toe of the frog and the end of the switch point. Screw the closure rail to the tie except for the two ties nearest the point.

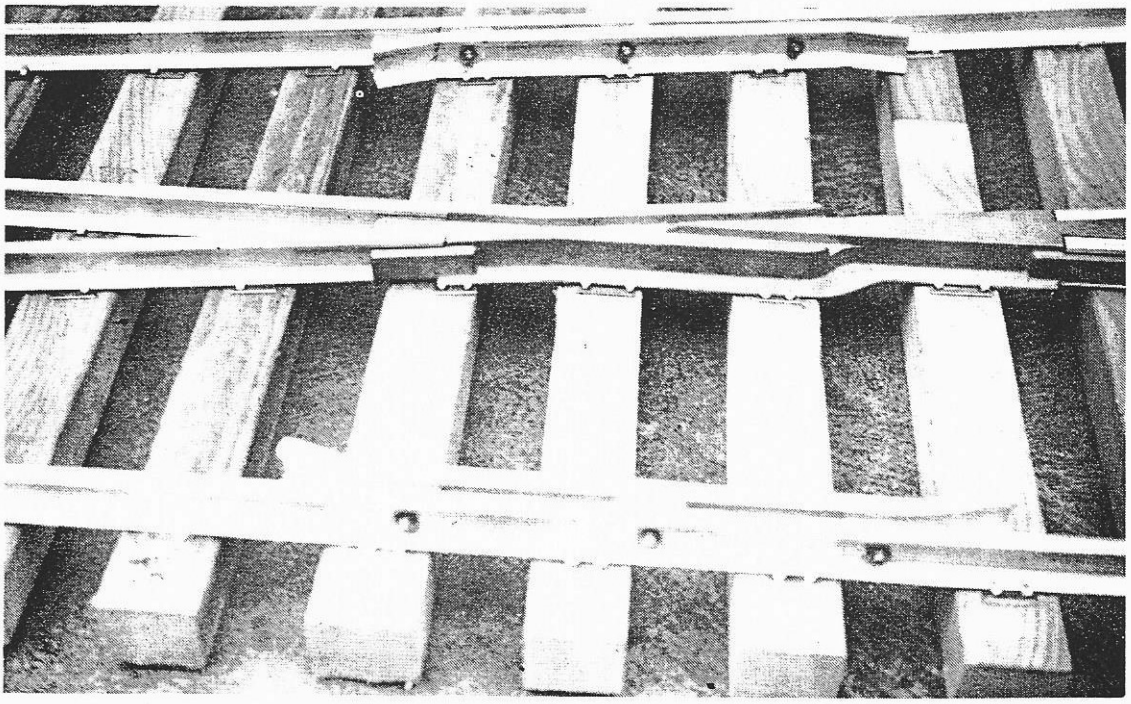


5. Using the installed point and closure rail to gauge from, install the outside wing rail and spike into position. As before it may be necessary to notch the wing rail for proper fit of the point.
6. Install the remaining switch point and closure rail using procedure #4. Attach a tie bar to the points allowing for sufficient flange clearance. The flange clearance should be ½ inch minimum for 1½" scale, and will be determined by the throw of the switch stand being used.The switch stand should be set such that the points contact the stock rails just before the switch stand reaches full stroke to allow the points to "lock" into position.

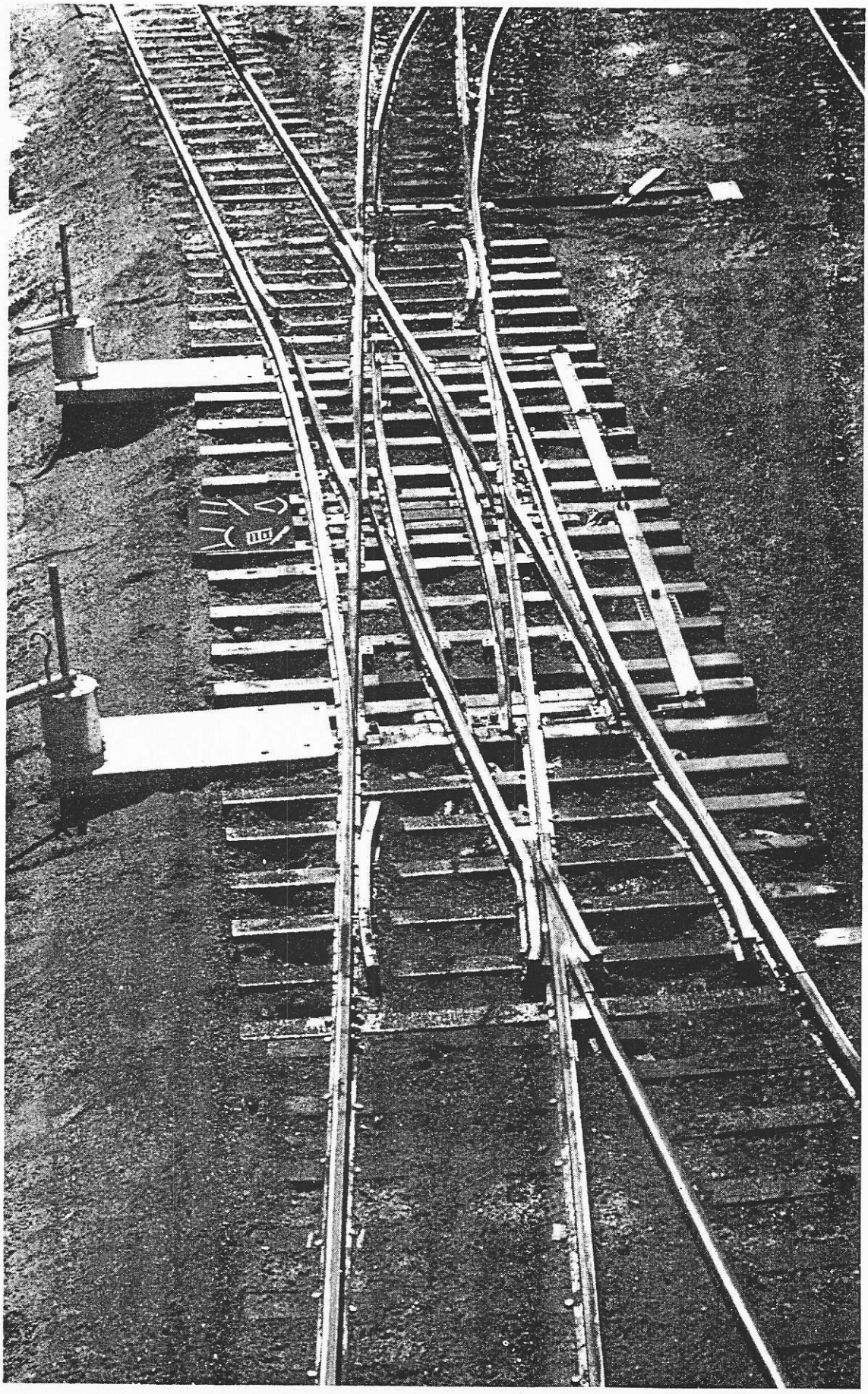
7. Position the guard rails as shown (they may be longer than shown if needed or desired). Bolt through the guard and stock rails using ½" spacers to achieve a 3/16" flangeway between the guard rail and the stock rail (for 1½" scale).
8. After laying the switch in place if it was prefabricated, finish it by ballasting and tamping as outlined in the Road-Bed Layout procedure.



SWITCH POINT ASSEMBLY – 1½ inch Scale

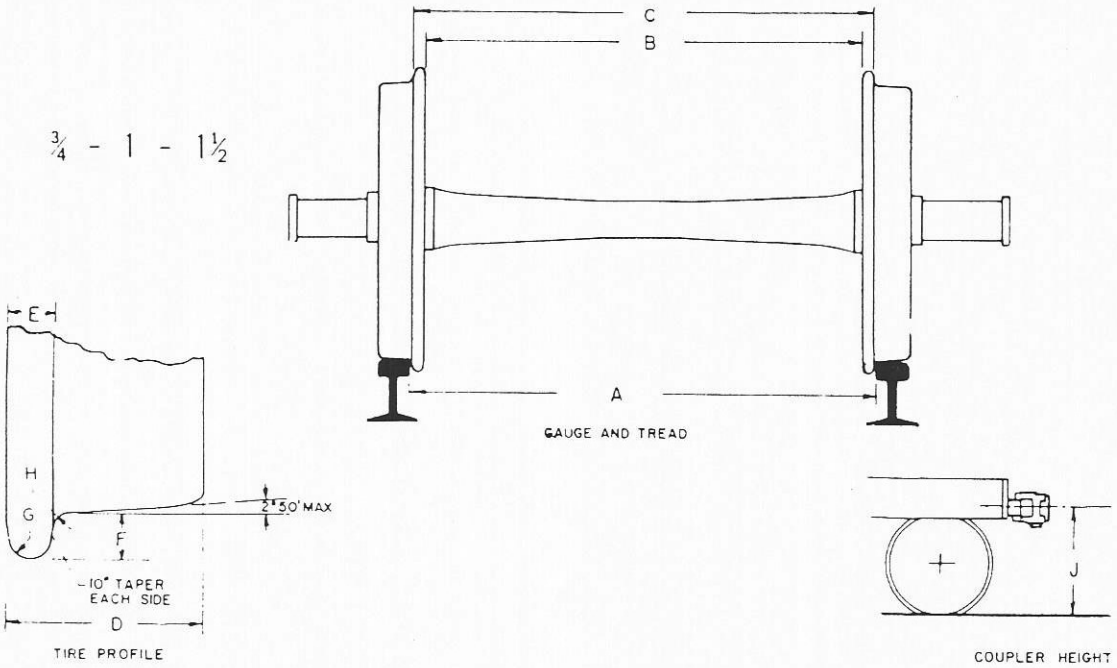


FROG AND GUARD RAIL ASSEMBLY – 1½ inch Scale



HENRY GROTH'S - SLIP SWITCH

ROLLING STOCK Wheel and Gauge Standards



	SCALE	3/4"	1"	1½" 7¼ Gauge	1½" 7½ Gauge	3"
A	Track gauge: Tangent	3.50 + .032-0	4.75 + .04-0	7.250 + 0.062-0	7.50 + .062-0	15.000 + .125-0
	Curves	3.53 + .032-0	4.81 + .04-0	7.312 + .062-0	7.562 + .062-0	15.125 + .125-0
B	Back to back of flanges	3.281 + .010-0	4.437 + .010-0	6.875 + .010-0[1]	7.125 + .010-0	14.250 + .040-0
C	Wheel gauge max.	3.375 Ref.	4.562 Ref	7.188 + 0-.010	7.437 + 0-.010	14.875 + 0-.040
D	Width of tire - min.	.406	.505	.750	.750	1.500
E	Flange thickness - max.	.094	.125	.156	.156	.312
F	Flange depth max.	.094	.140	.187	.187	.376
G	Flange radius nom.	File to Contour	File to Contour	.062	.062	.125
H	Filet radius nom.	.047 ± .008	.062 ± .010	.125[2]	.125[2]	.250
J	Coupler height nom.	2.22	2.90	4.38	4.38	8.76

NOTES: General: In every case these standards meet or exceed the proposed IBLS standards with the noted exceptions.

1. In some sections of the Northeast an old standard exists of 6¾"
2. The proposed IBLS standard is .094 ± .015. We feel the extra filet radius helps reduce track wear and improve rolling characteristics on curves.

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= International Brotherhood of Live Steamers