THE "I-DON'T-BUILD-TRACK-FOR-A-LIVING" TRACK BOOK

by

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I. INTRODUCTION

Railroad track, per se, looks pretty simple when it's assembled. The ties, evenly spaced, support two rails which are placed a uniform distance apart. The ribbons of T-shaped steel stretch smoothly off into the distance, to support countless thousands of steel wheels. Meeting trackmen does little to alter the initial impression of simplicity; many trackmen were, and are, poorly schooled, and often came from poorer ethnic groups as well. "Anybody can build track," most people would say; one long-time member of an established museum termed track work "idiot work", and his museum's track did indeed look the part!

Actually, anybody can build track. At most operating museums, track is the universal and perpetual project, "every man's dog no man's dog," as it were. The results are widely variant, but many of the finished products fall short of what might be called good track. Building track is like most manual skills: the merest basics are easy to acquire and use, but the fine points, which make the difference between passable and good, take a lot longer to learn.

This book is dedicated to the proposition that good track is a product of skilled labor. Think of the forces afflicting the steel roadway we all know and love: the roadbed is softened by rain or agitated by springtime frost heaves; the ties are alternately drenched by rain and parched by the sun, or are gouged by insects, all the time being compressed by train weight or strained by lateral forces; the rails contract and expand by turns, bearing up under the combined stresses of bending moments, shearing moments, and compressive forces of incredible magnitude, as well as high-frequency vibration. If humans are not prepared for stresses, they "break" mentally or physically; track doesn't become paranoid, but it does become fungoid. No one would voluntarily raise a child poorly equipped to meet the challenges of society; yet many museums throw their track into place and forget it, until a car or engine discovers a bad joint or wide spot and points out the defect in an unmistakable manner!

I have undertaken this modest but wordy text to collect and present a sort of "how-to" of basic trackwork. The intent of this text is not to make the reader into a track expert overnight. Rather, it is to give the thoughtful museum track worker a solid grounding in track construction and maintenance (a "thoughtful museum track worker" is one who is primarily occupied with track work above all else). Nor is it aimed at the newer museums exclusively, but at every group that uses the steel wheel rolling on the steel rail as a primary source of amusement and revenue.

Track work, at an operating museum, need not be the exclusive province of the strong and muscular. Typical museum membership is drawn from all walks of society, and members' elbows may lift crates, shovels, or pencils in their daily occupations. Competence is more to be desired than brute strength, and the moderately strong man who can learn and employ common sense is more valuable in the long-term track effort. A museum track program should be guided by a conscientious hard worker. The range of things to do on track can successfully involve any member. Consider the number of tasks inherent in track construction and maintenance: ties must be set out and spaced (and plugged, if second-hand), hardware must be gathered, joints must be made up, and spikers supplied with spikes and tie plates to minimize lost motion. Ties must be held up to rails for spiking, and final gauging, aligning, and tamping require a plethora of hands, strong or otherwise.

The track area of endeavor should be of recognized importance in a museum's organization. Ideally, Track (or Way, or Maintenance of Way, as you will) should hold departmental status in its own right, lest it be partly neglected in favor of another area of concern. Some museums do have a Track Department, whose sole concern is track construction and maintenance. One large museum has a Way & Structures Department with no designated head at present; its last head, although most earnest and concerned, was often diverted from trackwork owing to his professional expertise as a licensed civil engineer, thus effectively leaving a vacuum. The "Structures" function is nonexistent, as structures are under the cognizance of a planning committee and concerned department heads. The absence of a full-time track boss hampers an otherwise excellent museum effort, leading to sins of omission (erratic policy) and commission (track has become "everybody's project", and conditions have verged on chaotic at times). A recent addition to the circle of operating museums has at the moment a dual leadership directing its trackwork: its very able General Manager is the sparkplug, but he also leads equipment restoration efforts, no small part of the museum's program; other

75# rail at Orange Empire, which had nearly the same overall height, but a different web height, so that a <u>tight</u> joint was impossible without a compromise joint. I have seen compromise joints (or "step joints") to join 132# rail to 132# rail, one rail being new and the other worn 3/32"! The New Haven used 60#, 74# and 78# rail that could be joined by angle bars of the same thickness, but the bases and overall heights of each weight of rail were different. Branford obtained a specialwork ladder from the Johnstown trolley system, which was fabricated in five-inch girder rail; it developed that this rail would join to 70# T-rail with <u>normal</u> joint bars! More such anomalies are extant in the field, so you are well advised to <u>know</u> what you have and what you're getting.

Examine rail for wear. If it's straight rail, check the overall wear; compare the head thickness with your cross-section drawing. If the rail is on a curve, check the degree of wear on the gauge side; be sure also to note if the rail has been turned, to put an already worn side on the outside -- you might be getting some really poor rail. The amount of wear determines how much use you can get from the rail as well as <u>where</u> you should use it. Be sure that the rail size is sufficient for your equipment: Branford is all-trolley, and 78# or 80# rail is quite enough; the Connecticut Electric group has run small steam engines over 60# rail; Tennessee Valley will be moving large steam engines (2-8-2, 2-8-0, 2-10-0) over their line, so they've set an 80# <u>minimum</u> for operating tracks. Bethlehem recommends using rail that is of a size determined by multiplying 10#/yard by the tons of weight on a wheel. <u>Your</u> situation is your best guide.

Groups getting rail from city streets should examine the base with extra care. Even bonded rail undergoes some electrolysis. Rail that was buried in dirt and used by electric equipment should fall in this category also. A drawing from the San Diego system (see next page) shows part of a 60# rail base that lost 34% of its area, bonding notwithstanding, during ten years in service. The Orange Empire group obtained a lot of rail from the Pacific Electric shops at Torrance, which turned out to have piece of boiler plate welded to the base!

Examine the rail thoroughly, preferably at the pickup site, for flaws and cracks. Check that the web is not badly rusted or cracked, especially at ends and where extra bolt holes may have been cut. I once examined a seemingly innocent crack along the head of a rail on the <u>outside</u> rail of an <u>unguarded</u> tight-radius curve; it turned out to extend through the head to the head-web fillet, effectively separating the head from the web. Every car that passed lengthened the flaw by a measurable amount, and in time it would have separated completely, after some "mystery" derailments (the gauge would be correct until the head was forced outward by centrifugal forces which were not offset by a guardrail!).

<u>Ties</u> are your basic foundation, so look them over with care. Note the general appearance: small cracks may be no problem, but a large crack at one end may cause the tie to split when spikes are driven nearby. A brown color usually indicates a moist tie, while greyish ties have been out in the air and sun. Check moist ties carefully for rot. Consider the source of the ties: were they in the street (check for rot carefully), or buried in dirt, or nestled in rock ballast (well-drained), or sitting on top of the ground? A grey tie may be pretty old, or possibly <u>un</u>treated or poorly treated.

Check the rail seats (where the tie plate sits on the tie) for wear. Are the seats badly worn down, or not? Are there old spike holes, indicating that these were second-hand when they were installed or that there was a rerailing project? Too many holes can "spike-kill" a tie, guidance is provided by a railroad civil engineer/museum member. Another established museum reportedly has no track department at all; responsibility for track work is assumed and delegated informally. These examples are mentioned to point up variances and potential weaknesses in museum structure, which can appear later in the track.

By now, you may wonder about the writer's qualifications. A bit of information on myself and my experience is in order. I've been a train buff since I could talk and walk. I first encountered an operating museum in 1955, when I visited the Branford museum. I joined Branford in 1956, and was active there until late 1966, when I went off to fly Navy fighters. I joined the Orange Empire Trolley Museum in 1968, and the Tennessee Valley Railroad Museum in early 1970. Most of my Branford years were spent working on track, with a long-time (40 years) New Haven Railroad trackman, during a time when Branford rebuilt its entire main line with good rail and new treated ties, after a period of "false starts" with untreated or second-hand ties, to meet a steady rise in visitor operation (Branford was one of the first museums to operate seven days a week during its entire summer season). My experience was put to use at the Orange Empire museum, who entered their second decade and began to face a requirement for reconstruction and expansion of their trackage (similar to that at Branford) with somewhat less expertise than necessary, considering their comprehensive collection (3'6" and 4'8½" trolleys, plus heavy interurbans, heavyweight railroad equipment, and steam locomotives). I am presently stationed at the Naval Air Station in Meridian, Mississippi, where I am a Navy jet flight instructor. I go up to the Tennessee Valley Railroad Museum at least once a month if possible (a 310-mile trip). TVRM has learned from others, and thus is proceeding with trackwork in a correct and careful manner to escape the pitfalls of defective track later on (a wise decision in light of their handsome stable of equipment, which includes renowned Southern Railway 2-8-2 #4501).

I feel that a short exposition of some solid and basic track wisdom would benefit the entire museum "industry". This booklet has been published under the auspices of the Association of Railway Museums, as I feel that ARM is the best means for dissemination of information between operating rail museums. I hope, in succeeding chapters, to lay out "the word", as I know it or as I have had it shown to me, with tips and pictures to better equip the museum "gandy dancer" for his long and arduous tasks. I will use technical terms (although one man's "technical terms" may be another's slang) and note any regional terms if I have heard them. I would recommend, in addition, that every museum track boss get a copy of Bethlehem Steel's Mine and Industrial Trackwork, which has considerable reference value over and above the Bethlehem sales propaganda. I own a copy of the 1905 edition of Camp's Notes on Track, a large tome covering every tiny facet of track work, replete with many fascinating old photographs; similar works exist, and I encourage a fairly thorough perusal of them. For full-time museum trackmen, I recommend carrying a pocket notebook containing useful information; this also comes in handy for noting the names of helpers and the day's accomplishments, to be chronicled in the museum newsletter to boost worker morale (who doesn't like to see his name in print?) and document progress.

Enough introduction; let's get on with it. The full-time trackman may find much that is elementary as he reads; but everyone reading this book should find it of interest, and there will probably be some trackwork trick that will be a revelation to the "old pro" reader. The neophyte is urged to read carefully, because the information that follows is gathered from many sources; my Uncle Harry once said, "Don't be ashamed to learn from the mistakes of others; you won't live long enough to make them all yourself!" With that in mind, get your tools, and let's go!

BILL YOUNG
"Windmill"
Meridian, Mississippi, 1970

REFERENCES:

1) I've gotten, and still get, my hands dirty at Branford (Director-Member #758), Orange Empire (Member #556), and Tennessee Valley (Member #0309).
2) I also armchair with Connecticut Electric (Military Member), ERA (#2817), NRHS (Tenn.Valley Chapter), and ARM.

-B.Y.

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II. MATERIALS

A. Acquisition. There is a recipe for rabbit stew which begins, "First, catch your rabbit." Likewise, to build track, first gather the parts. This chapter will deal with techniques of gathering materials for your track.

The actual gathering of materials is by purchase or by gift. The first method includes purchase of new material, or purchase of relay or scrap material. Purchase of new track material is, of course, the ultimate to be desired for a museum: it looks good, it smells good, and it is good! If you are fortunate enough to have a goodly sum of money (this means a balance around five figures), you have it made. There are a few things to check when purchasing new stock, however. Branford bought new spikes in twenty-keg lots from Bethlehem, as the per-keg price was less, as were the freight costs. When buying new ties (this is mainly for groups with creosote plants within fifty miles or less), buy in lots that offer a good per-tie price (probably multiples of 100), and arrange for your ties to season at the plant awhile before treatment. Check on quantity rates for track bolts also. I haven't heard of a museum group buying new tie plates (they don't wear much, so second-hand plates are fine), although a matched set of switch tie plates (see Mine and Industrial Trackwork, or a railroad's Book of Standard Plans) might be purchased. Likewise, no group has bought new rail from the mill; however, Branford recently bought a #2½ turnout from Bethlehem because no such was anywhere available, nor could they successfully fabricate one.

Purchase of relay or "scrap" material has a few pitfalls. Go and inspect what you buy, because the stuff might be no more than scrap, especially if it's rail that's been removed from a street, or ties that were gathered by a bulldozer! Many "scrap" deals have been most fortunate, especially if you're dealing with a friendly firm or scrap dealer. Some sellers are notoriously profit-motivated, while others have reportedly been quite reasonable if approached gently (the Southern Railway allows museum groups to bid on an equal basis with scrap dealers for material). A better course is to buy "scrap" from the concern on whose land it rests. A contractor may let you extract specialwork (as in the case of the Orange Empire museum's Pico & Georgia project in Los Angeles) for no more than your expense in extraction and transport. Again, look it over, check company records if you have them, and be sure it fits your needs. Often a new sewer can uncover old material, as was the case in Pasadena, California: the Orange Empire group obtained many truckloads of ties for a very low price, and, although some were of very poor quality, the bulk of the ties aided track expansion and reconstruction, with unusable ones being sold for home use nearby.

Donation is a really nice way to obtain material. It doesn't cost you anything, and everybody's happy. Under section 501(c)(3) of the Internal Revenue Code, trolley and rail museums are tax-exempt organizations, and donations of money and materials thereto are tax-deductible. One of your most personable members should approach the prospective donor, armed with facts, figures, and your guidebook, point out the tax advantages, and give every assistance in establishing the "fair market value" for the material. That weed-grown or asphalt-encrusted siding might be a good boost for your museum project!

Now that you are the owner of this material, you'll probably have to transport it to your site. New material can be shipped to you; if it's spikes or bolts, it can be trucked in, but ties in large quantities and lengths of rail are a bit heavier. If you are blessed with a rail connection, like the Tennessee Valley, Orange Empire, California Railway Museum, Ohio Railway Museum, and Illinois Railway Museum groups, rail shipment might be best. If you buy relay rail in any great amount, it will probably come by rail. "Scrap" or donated material, I expect, is "as-is-where-is", located fairly near your site, so trucking is indicated. Unless the tax laws change radically, you may be able to persuade a trucker to loan you a vehicle, giving him an official receipt for the value of the mileage (which he can use as a tax deduction), and saving yourself a good bit of money.

Extracting the material is fairly straightforward, but be prepared for an underwhelming member response. Pulling up track isn't half the fun that assembling it can be, and it's often in remote areas (like the slopes of Cajon Pass, or the green, hidden valleys of Tennessee, or a gravel pit in Illinois). Disassemble the track completely and carefully; use the cutting torch as a last resort, unless you're picking up a specialwork from your city street, which may be rusted or Thermit-welded together! Save all the pieces. After the rail is removed, clean the hardware off the ties to aid in stacking, and sort it as you go.

When you reach your site with your rusty treasure (and I'm assuming that you have at least your museum site for storage, and possibly some right-of-way as well), unload it to best fit in with your plans. Set ties and rail along your right-of-way, at or near their point of intended use, neatly; keep the smaller hardware in containers until you're ready to install it. If your right-of-way is inaccessible, store the material neatly at your site. I can appreciate the need for hasty unloading, when there is much to get or it's late, but don't leave it in a heap. A tumbled pile of ties is a safety hazard if some child plays "king of the mountain" thereon. The intangible value of neatness comes from many sources: public image (neat piles of otherwise unattractive material), member morale (the seldom-seen members are favorably impressed with results, as are visiting benefactors), inventory (you know how you stand, just by counting stacks of material), and it is a job a couple of members can do at their leisure while the "shock troops" gather more.

B. Quality Control. All the above thoughts, of course, skip over the area of quality control of your materials, which should not be a forgotten item. You are, hopefully, obtaining material with the intent of operating on it some day; so it behooves you to make sure you don't load up with unusable material -- unusable due to wear (too much), defects, or oddness.

Rails should be checked for size and condition. Use the cross-sectional drawings in a rail book to ascertain the exact size, as well as its compatibility with any rail you may already have. Most rail has "mint marks" which tell a lot. These marks are generally like these samples:

90AS B S Co STEELTON 8 67 CC

This rail is 90# ASCE section, rolled by Bethlehem's Steelton plant in August, 1967, and was control-cooled.

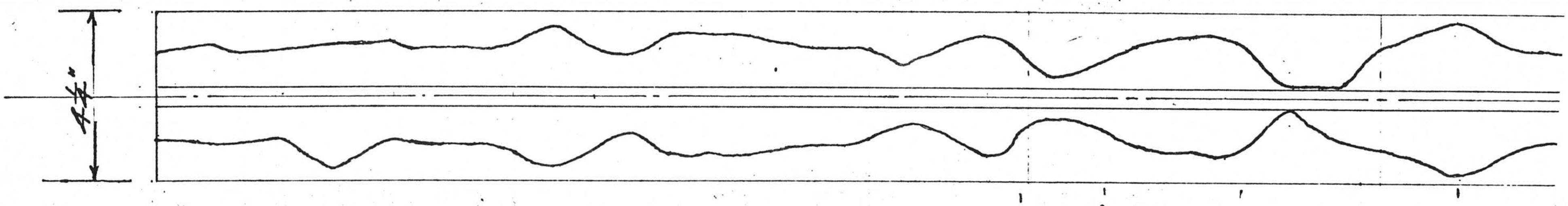
7503 ILLINOIS SOUTH WKS 1904 IIIII (or V)

This rail is 75#, section #75-03, rolled by Illinois Steel's South Works in May, 1904.

When obtaining rail, it's best to get it with matching joint bars, as you may later encounter quaint little oddities which add to the fascination of it all. I encountered two different cross-sections of

25 ft Rail lengt

Scales: Long: 3/4" = 1



Original Area of base 1275 Sq. ins.

Present Area of base 841 Sq. ins. = 66%

Area of Rail lost by corrosion 34%

Weight of Metal lost = per. yd. 5.2#

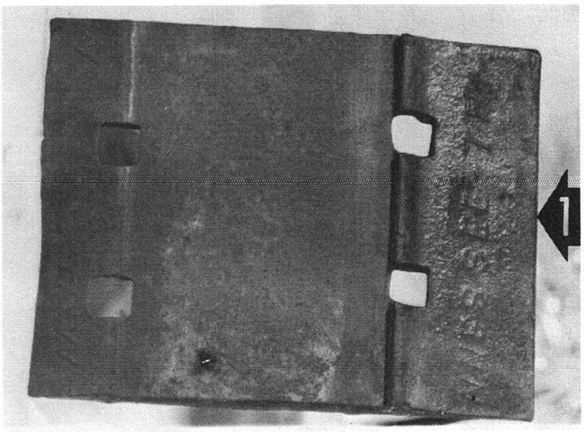
Weight " " " from wear 1.4#

Average wt of corroded rail per. yd. 53.4#

Note: Rail is South Rail of South Track on University Ave., in the 30th St. intersection.

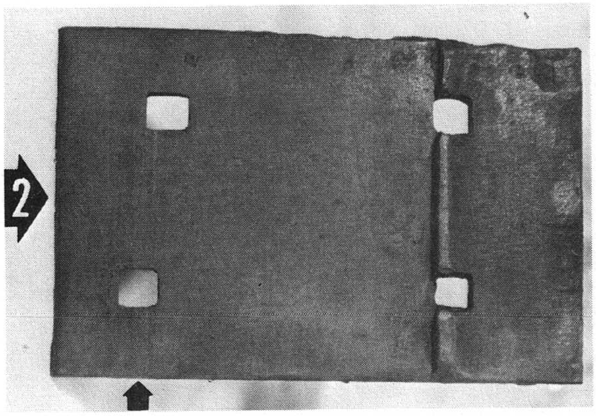
Job No 151 Completed Nov., 15, 1907.

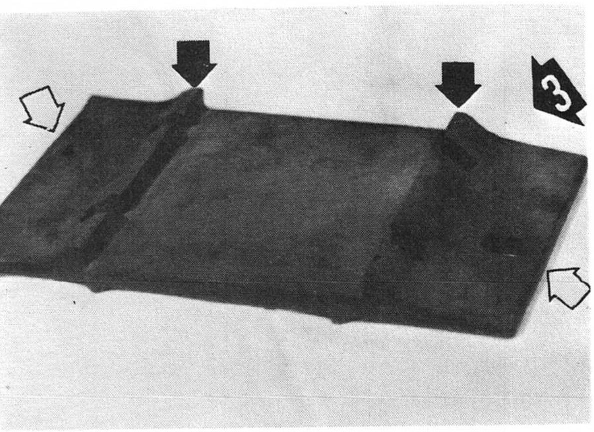
FOI.



TIE PLATE #1 IS A "NORMAL" TIE PLATE. NOTE THAT THE HOLES ARE NORMAL SIZE AND IN LINE. USE THIS PLATE FOR NORMAL TRACK AND UNDER JOINTS MADE UP WITH SLOTTED JOINT BARS (see bar #2 on the preceding page). THIS PLATE IS GOOD FOR ONLY ONE SIZE OF RAIL -- REMEMBER THAT THE SPIKE HOLES MUST TOUCH THE RAIL BASE; RAIL 5# HEAVIER THAN THE OPTIMUM FOR THIS PLATE MAY BE LAID ON THIS PLATE -- RAIL BASES INCREASE BY 3/16" IN WIDTH PER 5# WEIGHT INCREASE; SPIKE THE BIGGER RAIL CAREFULLY. COMPARE THIS WITH THOSE THAT FOLLOW!

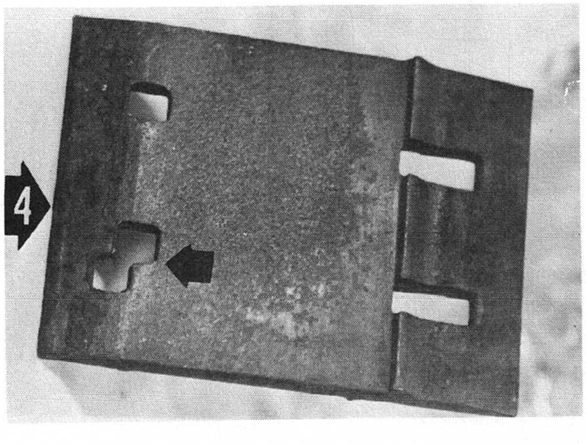
TIE PLATE #2 IS PUNCHED TO ACCOMODATE TWO WEIGHTS OF RAIL. NOTE THAT THE HOLES ON THE FLAT SIDE OF THE PLATE ARE NOT IN LINE, SO THAT IS USABLE UNDER DIFFERENT BASES (review page 9 of the text). IF IN DOUBT, SIZE-CHECK THE PLATE UNDER THE RAIL YOU PLAN TO USE; THE SPIKE HOLES MUST BE SO THAT THE DRIVEN SPIKES CAN AT LEAST TOUCH THE RAIL BASE WITHOUT BEING BENT IN TOWARD THE BASE. WATCH FOR THESE PLATES WHEN YOU'RE GATHERING MATERIAL OR LAYING TRACK, AND KEEP THEM TOGETHER IN A SEPARATE PILE.

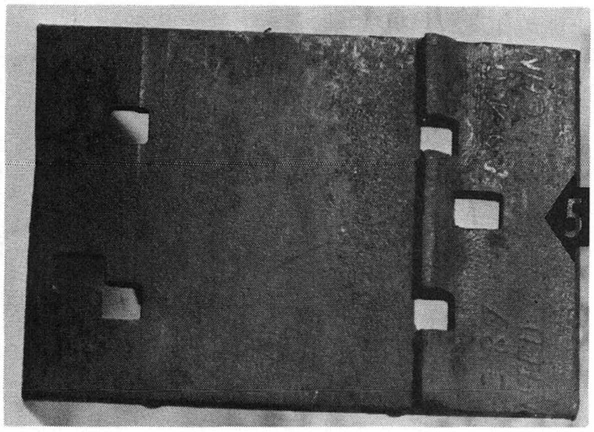




TIE PLATE #3 IS USABLE UNDER ONLY ONE WEIGHT AND CROSS-SECTION OF RAIL, OWING TO THE TWO RIDGES (dark arrows) INSTEAD OF THE USUAL SINGLE RIDGE. GET THESE WITH RAIL TO MATCH, OR SWAP THEM -- LARGER RAIL WON'T FIT, AND SMALLER RAIL WILL SHIFT ON THE PLATE, AS THE SPIKE HOLES WON'T ALLOW THE SPIKES TO TOUCH THE BASE OF A RAIL SMALLER THAN THAT DESIGNED TO FIT IN THIS PLATE.

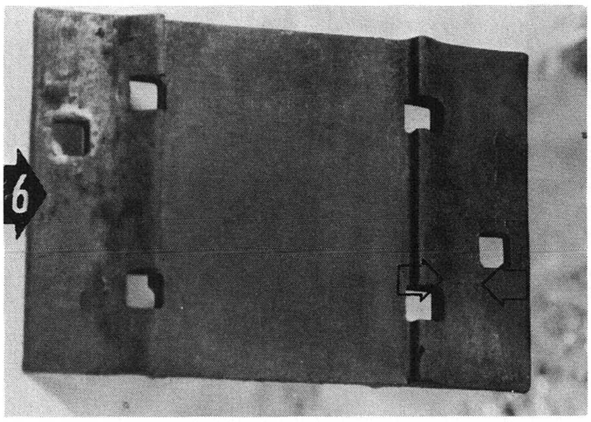
TIE PLATE #4 HAS AN EXTRA HOLE PUNCHED ON THE FLAT SIDE (dark arrow) AS WELL AS SLOTTED HOLES ON THE RIDGE SIDE. THE EXTRA HOLE IS NOT OUT FAR ENOUGH TO ALLOW SPIKING OVER A JOINT BAR FOOT (compare with #3, #5 and #6). DON'T USE THESE PLATES ON OUTSIDE RAILS ON CURVES, AS THE SLOTS DON'T HELP PREVENT RAIL SPREAD LIKE NORMAL SPIKE HOLES WOULD. THIS PLATE IS USEFUL UNDER DIFFERENT RAIL SIZES, HOWEVER -- SIZE CHECK IT!

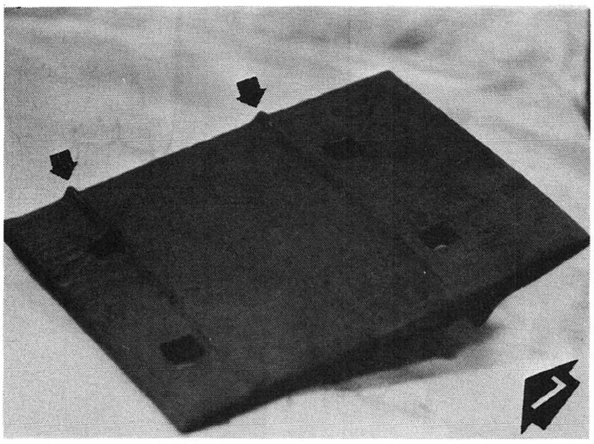


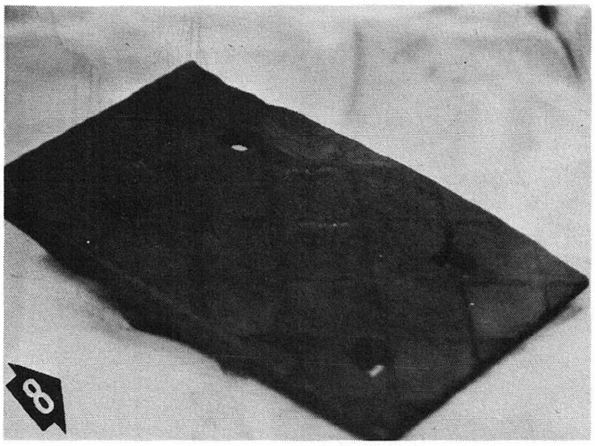


TIE PLATE #5 HAS EXTRA HOLES TO ALLOW SPIKING OVER THE FEET OF JOINT BARS LIKE BAR #1 THAT HAVE SHORT FEET. COMPARE THIS PLATE CAREFULLY WITH #6 BELOW. SAVE THESE "SPECIAL" PLATES FOR THE JOINT TIES, AS THE EXTRA HOLES ENABLE YOU TO SECURE AN UNSLOTTED JOINT BAR TIGHTLY. COMPARE THE LOCATION OF THE EXTRA HOLE ON THE FLAT SIDE WITH THAT OF PLATE #4 (preceding page) BE SURE THAT PLATES LIKE THIS ARE INSTALLED WITH THE RIDGE SNUG AGAINST THE RAIL BASE, JUST AS IN NORMAL INSTALLATION -- THE EXTRA HOLES WILL THEN BE SNUG AGAINST THE JOINT BARS.

TIE PLATE #6, LIKE #5, HAS EXTRA HOLES FOR SPIKING UNSLOTTED JOINT BARS. INSTALL THIS TYPE OF PLATE AS YOU WOULD PLATES LIKE #5. NOTE THE SPREAD BETWEEN THE NORMAL HOLES AND EXTRA HOLES (light arrows) AND COMPARE WITH THE HOLES ON #5. ALSO COMPARE IT AGAINST #4. THIS TYPE OF PLATE IS FOR UNSLOTTED JOINT BARS LIKE BAR #1 THAT HAVE FULL-LENGTH FEET AS SHOWN IN THE PICTURE OF JOINT BAR #1. IF YOU LOOK CAREFULLY, YOU CAN SEE THAT THIS PLATE IS REALLY PLATE #3, WITH TWO RIDGES. IN ANY CASE, USE IT AT JOINTS, WHETHER IT HAS ONE OR TWO RIDGES.

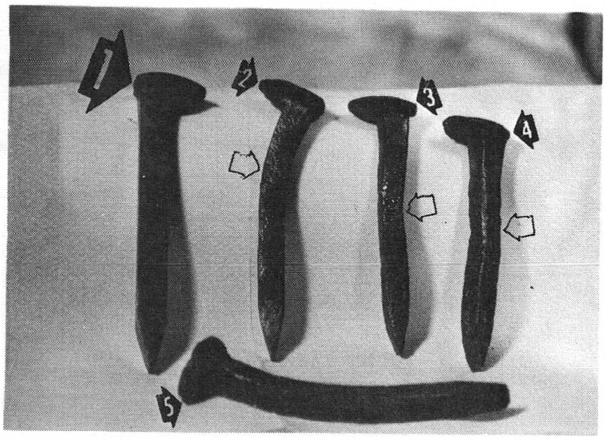




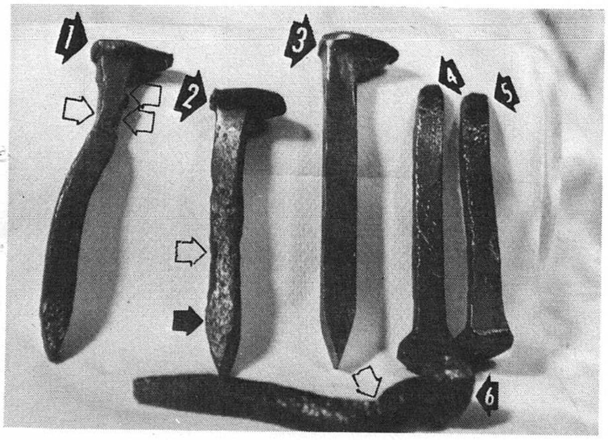


PLATES #7 AND #8 SHOW DIFFERENT TIE PLATE BACKS. #7 IS A STANDARD BACK. THE RIDGES BITE INTO THE TIE AND HELP ANCHOR THE RAIL AGAINST SPREADING. IF YOU'RE TIGHT ON PLATES, USE THESE RIDGED PLATES ON OUTSIDE CURVE RAILS FIRST. PLATES WITH "DIAMOND" BACKS LIKE #8 ARE AN OLDER MODEL, AND CAN HELP ANCHOR TRACK AGAINST BOTH SPREADING AND CREEPING. REVIEW THE TEXT FOR BEST PLATE USES.

ALL TRACK HARDWARE SHOWN ON THESE PHOTO PAGES IS COURTESY OF TENNESSEE VALLEY RAILROAD MUSEUM AND IS NOW INSTALLED IN TVRM'S TRACKAGE. PICTURES ARE COURTESY OF CAPTAIN W.A.(Buz) KNIGHT, U.S. MARINE CORPS, WHO GAVE HIS TIME TO HELP OUT A SQUADRON-MATE (W.B. YOUNG); THE HELP WAS MOST COMPETENT AND IS MUCH APPRECIATED!



TYPICAL SECOND-HAND USABLE SPIKES. #1 IS A NEW SPIKE. #2 IS MERELY BENT (see arrow). #3 IS USABLE, BUT IS A BIT RUSTED IN THE MIDDLE (arrow), SO CARE IN DRIVING IS NECESSARY. #4 IS JUST LIKE #3; TAKE CARE NOT TO BEND IT! #5 IS ALSO BENT, BUT IT HAS A GOOD POINT. #1 AND #2 ARE MAIN LINE QUALITY, WHILE #3-#5 WOULD BEST BE USED IN YARDS OR STORAGE TRACKS, AS THEY ARE SMALL AND WON'T HOLD QUITE AS WELL. COMPARE THESE SPIKES WITH THE ONES SHOWN BELOW. THIS IS WHERE QUALITY CONTROL IS IMPORTANT, AS PUTTING POOR SPIKES INTO GOOD TIES IS A WASTE, AND USING SMALL-SIZE SPIKES, NOT UP TO A LOT OF FORCE, ON TIGHT CURVES COULD BE ASKING FOR TROUBLE, ESPECIALLY IF THE CURVES ARE NOT EQUIPPED WITH GUARD RAILS. BE SURE THAT SPIKES LIKE #3-#5 ARE DRIVEN IN NEW WOOD -- THEY ARE THE SAME SIZE AS TIE PLUGS, AND THUS WON'T HOLD WELL IF DRIVEN IN A PLUGGED HOLE.



TYPICAL SECOND-HAND DEFECTIVE SPIKES. FIRST COMPARE THEM WITH #3, A BRAND-NEW SPIKE. THEN SEE WHY EACH IS BAD OR UNUSABLE:

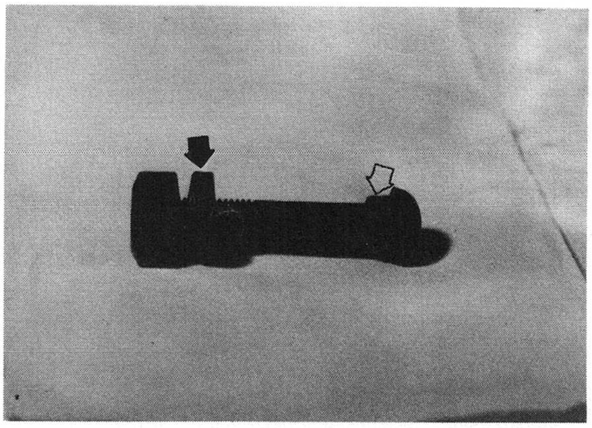
#1: THIS SPIKE IS BADLY CUT UNDER THE HEAD, IN TWO PLACES. THIS HAS EFFECTIVELY REDUCED THE THICKNESS TO ABOUT 1/3 ITS USUAL SIZE. THE CUTS WEAKEN THE HEAD, AND SPIKING WILL WEAKEN IT FURTHER, LEAVING NO EFFECTIVE HOLDING POWER WHERE IT IS MOST NEEDED! THROW IT OUT, AS IT'S ABSOLUTELY USELESS FOR ANY TRACK THAT ANY EQUIPMENT WILL HAVE TO MOVE UPON, NO MATTER HOW FREQUENTLY OR INFREQUENTLY.

#2: THIS SPIKE HAS CORRODED AT ITS MIDDLE (light arrow) AND NOW THE POINT IS NOTICEABLY THICKER THAN THE SHAFT (dark arrow). THIS WILL RESULT IN A SPIKE BEING LOOSE IN ITS HOLE, WITH RESULTANT LOWERED HOLDING POWER AND CHANCE FOR SPIKE FAILURE. IF YOU'RE DESPERATE, USE IT FOR STORAGE TRACKS ONLY, AND IN SECOND-HAND TIES; USING A SPIKE LIKE THIS IN A NEW TIE WILL WASTE THE TIE, AS THE MOTION OF THE SPIKE DUE TO THE LOOSENESS WILL WIDEN THE SPIKE HOLE AND ADMIT MOISTURE AND INSECTS.

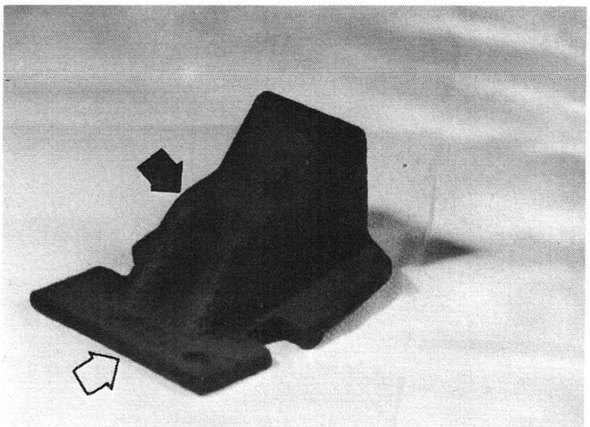
#4: IT'S NOT OBVIOUS, BUT THE POINT ON THIS SPIKE IS CORRODED BEYOND USEFULNESS. THE ROUNDED EDGES ARE VISIBLE NEXT TO THE ARROW, AND GENERALLY A SPIKE WITH ROUNDED CORNERS ON THE POINT WILL HAVE A DULL OR ROUNDED POINT AS WELL. THIS WILL BE A TOUGH SPIKE TO DRIVE, AS YOU'LL HAVE TO FORCE IT THROUGH THE TIE FIBERS SINCE THE POINT WON'T CUT THEM. FORCING IT THROUGH THE FIBERS WILL NOT RESULT IN FULL HOLDING FORCE, AS TORN FIBERS DON'T ACT AS "SPRAGS" AS EFFICIENTLY AS CUT FIBERS. THIS SPIKE WILL DRIVE IN A SOFT TIE QUITE NICELY, BUT IT WON'T HOLD VERY WELL! YOU'LL PROBABLY BE ABLE TO PULL IT OUT BY HAND WHEN YOU REPLACE THE TIE.

#5: THIS SPIKE ALSO HAS A BAD POINT, BUT THE PICTURE UNFORTUNATELY DOES NOT SHOW IT WELL. #4 AND #5 CAN BE SCRAPPED WITH NO REGRETS.

#6: THIS SPIKE IS BENT BEYOND REDEMPTION (light arrow), IN TWO AXES. EVEN A NOVICE SHOULD SEE THAT THIS SPIKE IS GOOD ONLY TO FEED A STEEL FURNACE!

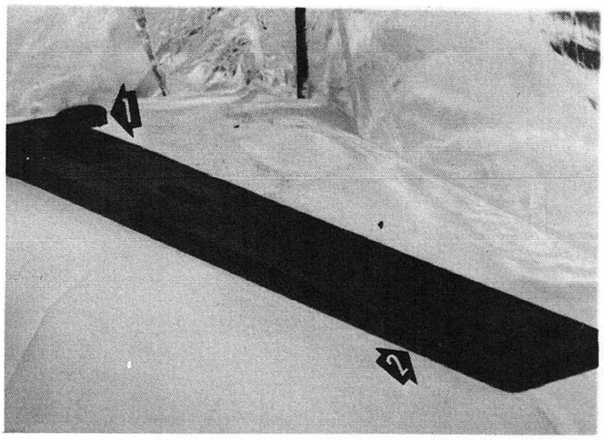


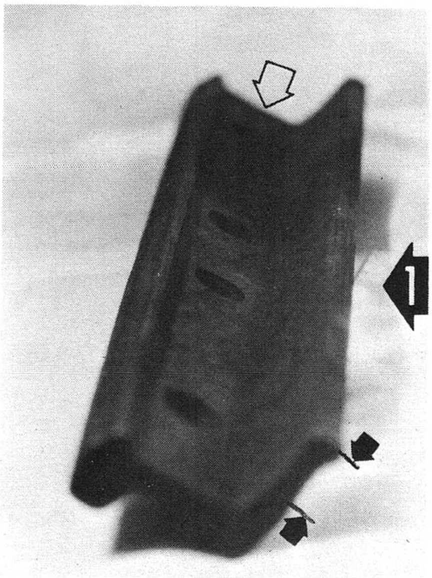
TYPICAL TRACK BOLT. NOTE SHOULDER (light arrow) AND LOCK WASHER (dark arrow). BOLTS ARE BEST STORED WITH WASHER AND NUT.

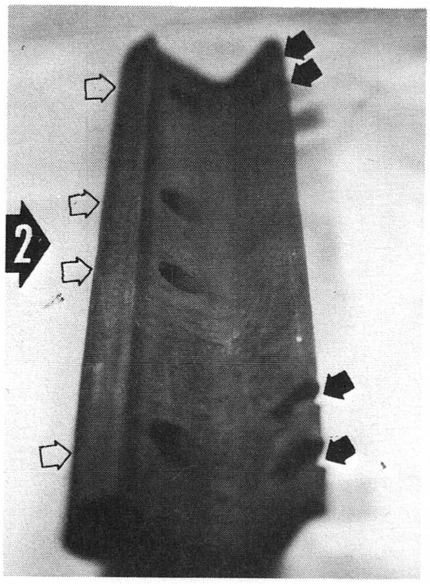


TYPICAL RAIL BRACE, USUALLY FOR SWITCHES. CONSULT A STANDARD SWITCH HARDWARE PLAN FOR LOCATION. WEIGHT AND CROSS-SECTION OF RAIL WILL BE EITHER ON THE BASE (light arrow) OR ON THE BACK (dark arrow). THESE FIT INTO THE #1 SWITCH PLATES AND ARE SPIKED OR RIVETED IN PLACE. THEY MUST FIT SNUGLY TO GIVE FULL SUPPORT!

"HOOK-TWIN" TIE PLATE FOR USE IN SWITCHES. THEY ARE USED TWO PER TIE, WITH THE HOOKS (#1) TIGHT OVER THE RAIL OR FROG BASE, AT ALL POINTS WHERE CONVENTIONAL TIE PLATES CAN'T FIT. THEY COME IN LENGTHS FROM 20" TO 31", SO BE SURE YOU HAVE PLATES LONG ENOUGH FOR YOUR JOB. ONE HOOK GOES ON EITHER SIDE OF THE FROG OR DIVERGING/CONVERGING RAILS, TO HOLD THE ENTIRE ASSEMBLY BETWEEN THE TWO HOOKS. PLATE LENGTH IS USUALLY STAMPED AT THE LOCATION MARKED #2.



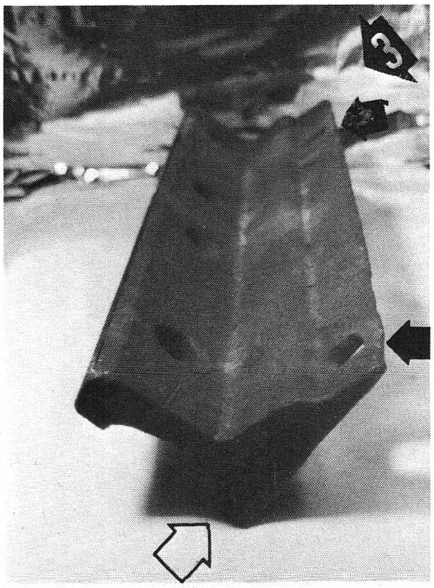


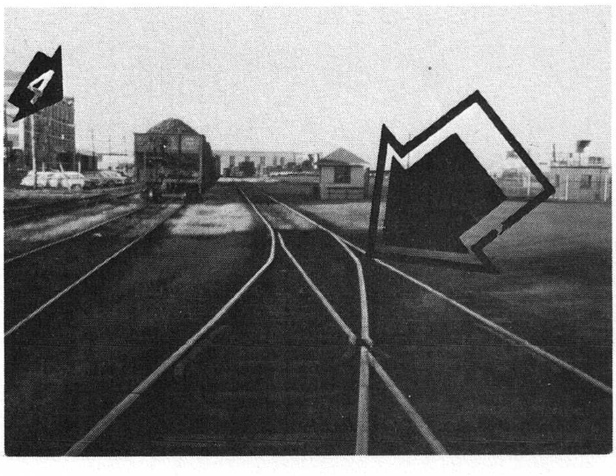


#1 IS A TYPICAL JOINT BAR WITHOUT SPIKING SLOTS. IN FITTING THE BAR, INSURE THAT THE WEB OF THE BAR (light arrow) IS PARALLEL TO THE WEB OF THE RAIL, WHICH WILL RESULT IN BEST SUPPORT OF THE JOINT. OFTEN THE "FOOT" OF THE BAR WILL BE SHORTER THAN THE ONE IN THE PICTURE, WITH THE PART INDICATED BY THE DARK ARROWS MISSING. USE WITH TIE PLATES LIKE #3, #5 AND #6 (shown on next pages). #2 IS LIKE #1 EXCEPT IT HAS SLOTS IN THE FOOT FOR SPIKING (dark arrows). BE SURE THAT THE JOINT IS SUPPORTED, SO THAT A TIE IS UNDER EACH END OF THE JOINT. NORMAL TIE PLATES (#1, #2 or #4 on next pages) ARE USED WITH A SLOTTED JOINT BAR. THE SLOTS HELP PREVENT RAIL CREEPING AND TIE SKEWING, IF THEY ARE INSTALLED WITH SPIKES IN THE SLOTS! BE SURE THE TIE PLATE HOLES ALIGN WITH THE SLOTS -- IF YOU GOT THE PLATES AND THE JOINT BARS FROM THE SAME TRACK, THEY WILL COINCIDE.

NOTE THAT THE BOLT HOLES ARE UNEVENLY SPACED. THIS IS UNIQUE, SO FAR AS I KNOW, TO THE SOUTHERN AND L&N RAILROADS (pictures are of Southern bars).

#3 (below) IS A "WRAPAROUND" JOINT BAR. THESE ARE NOT VERY PREVALENT IN THESE DAYS OF SIX-BOLT JOINTS AND RIBBON RAIL, BUT IF YOU GET SOME, USE THEM! NOTE THE INSET FOR THE RAIL BASE (light arrow); CLEAN THIS THOROUGHLY BEFORE INSTALLATION. THE JOINT BAR, IN PAIRS, IS ITS OWN TIE PLATE; TO THIS END, SPIKE HOLES (dark arrows) ARE PROVIDED, WHICH MUST BE USED. THEY HAVE THE SAME EFFECT AS SLOTS IN PREVENTING RAIL CREEP AND TIE SKEWING; HOWEVER, YOU MUST HAVE A TIE IN POSITION UNDER EACH END OF THE JOINT. WRAPAROUND JOINT BARS ARE BEST USED ON THE OUTSIDE RAILS OF CURVES, AS THEIR DESIGN PROVIDES CONSIDERABLY MORE RIGIDITY AND RESISTANCE TO BENDING THAN THAT OF THE NORMAL JOINT BAR. AVOID AT ALL COSTS "DOG-LEG" JOINTS SUCH AS SHOWN IN #4 (right, below). THAT JOINT IS AN INVITATION TO RAIL WEAR AND DERAILMENTS. USE OF WRAPAROUND JOINTS CAN AVERT BENT RAIL JOINTS AND GIVE A BETTER, SMOOTHER RIDE!





(picture by W.R. Young)

a plate with the standard four holes will have the gauge-side holes (i.e., the side opposite the ridge on the plate) staggered: the New Haven had plates like this, usable with 74#, 78# and 80# rail; the North Shore had plates usable under 80# or 100# rail; the Tennessee Valley group recently collected a number of plates, which, on examination, proved to be usable under 90# ASCE, 100#, and 112# RE rail!

Joint bars (also known as angle bars, fishplates, or joiner bars) should be assembled in pairs. Get a matched pair, and put two track bolts through the pair to keep them together until you need them; it is awfully grim to be faced with a mismatched pair of joint bars out on the job! Ideally, these joint bars come with rail to match, so that the bolt holes all line up. If you obtain joint bars separately, check their cross-section (is it 100#PS? 90#IRT? 107#NH? 80#ASCE? 112#RE or TR? 136# LV? 61½# KRUPP?) with sample rails (bits of broken rails, representative of your stock, can be a fast check), and measure the hole spacings to determine compatibility. I've seen four-bolt joints on both coasts with evenly-spaced holes, while Southern and L&N space the holes unevenly.

When you get the hardware to your site, sort it out. Put the small stuff in containers and set the containers on old ties to aid drainage. Having bolts, washers and spikes in the same container may be all right during collection, but segregate the different hardware at some time before use, to reduce lost time on the job when you're laying track. Again, sorting eases your problem of inventory (how much, of what, do you have? It's easy to tell if it's sorted), boosts morale through a squared-away appearance, and is a good job for the younger or less hardy members. Get the stuff ready to use! And again, weed out the poorer material for use in storage tracks.

C. Miscellaneous. In general, take everything usable, and, if you can, tidily, leave behind the rotten ties, broken or defective hardware, and the broken rails. If you have to "clean up" a siding, remember that you can sell bad hardware and rail for scrap, or maybe swap it weight-for-weight with a scrapper for good stuff (be prepared to take a small weight loss, but you're still ahead). If you can't use those 132# joint bars or that 74# rail, maybe another group can; pass the word through APM and help other groups progress.

Even the far-out material is important. Compromise joints (also called step joints) are worth their weight in gold -- if not to you, to someone. Insulated-joint hardware is useful mostly for trade, over and above any visions of signal systems that you may have (if you are blessed with someone like Orange Empire's Darrel Woodward or Connecticut Electric's Walter Sheffield); OET acquired a great quantity of insulated-joint hardware for 75# and 90# rail, most of which would not be needed at OET, so some of this material was traded to a contractor, who needed it, for some more-useful hardware (and good will, for the timely help). Also, the extra-long bolts were invaluable for installing guard rails. Cast guard rail spacers are especially sought by museums operating around tight street-railway curves. Switch parts are always usable, and most of them are virtually indestructible; that funny-looking hunk of steel may be a point guard for a switch or a head-rod clip for switch points! Gauge rods are also a nice item to get and use. Experience will tell you what you need and what is useful to you.

By the way, when you're digging up track or ties, scratch around a bit to find stray hardware. The rails may have been removed in a hurry, and the associated hardware may still be at the track site. Use a spike to root around in the dirt or cinders; often you will strike "gold".

When possible, museums with some track already in place should use rail-borne vehicles. This includes simple pushcars, motor cars, flatcars and motor flat cars. Motor vehicles are admittedly more flexible; but what is good for the track gang is also good for other work forces, and a track crew dependent on a truck may be without it at crucial times. Motor vehicles may not have the capacity needed: a pickup truck is not readily capable of carrying rail (although it can <u>drag</u> rail, which is feasible, but does little for your image) or many crossties, and few museums have ready access to flatbed trailer or stake trucks. Then, too, your right-of-way may not be easily accessible by motor vehicles. A nice solution is to load material on a pushcar and run it to the end of track where it is needed. If you have motive power and a flatcar, a large load of supplies can be set out and drawn from, without wasting time in transporting many small loads of material during the work session. Branford has what may be an ideal vehicle: a small trolley motor flat car that can carry up to thirty crossties on its deck, which is less than three feet above ground, making lifting quite easy. In any case, you are building a <u>rail</u> museum, so why not use your <u>rail</u> equipment?

<u>Ties</u> may be laid alongside the right-of-way, either by twos and threes or in large piles of about 25, if motor vehicles deliver the ties. Be careful, when distributing the ties, not to pile too many in one area, or rehandling will be necessary during construction. Rail delivery of ties to the railhead will necessitate a longer hand-carry of the ties; careful coordination of effort can keep this to a maximum of a rail length, if track is laid for a length and the railborne supply car is moved forward with the crew. Pushcars don't require <u>completed</u> track to move on.

Lay out and space the ties in accordance with predetermined standards. If second-hand, lay them with the used side up for plugging. A common tie spacing is 24 inches, but heavy-duty trackage, and switches, may require closer spacing (see diagrams 1-3). This is a good job for a less muscular member: stretch a string line half a standard (8'0" or 8'-6") tie-length from centerline and line the ties along the string, spacing them evenly. A few minor adjustments to support joints will have to be made as the rail is laid. <u>Plug</u> the ties before setting the rail, preferably before track construction commences in earnest. Plugged ties should be laid with their used side <u>up</u>, to help avoid old spike holes; however, ties with sound but well-worn seats should be plugged and then turned over to assure even rail support. Plugs should be driven in as far as possible, then cut off flush with the seat surface; use two plugs if an old spike hole is enlarged.

If you are one of those affluent and fortunate museums using new ties, lay them out as outlined above. If, however, you wish to make a little more headway with available resources, and second-hand ties are also available, put new ties at intervals: two new ties under each joint in both rails, and a pair of new ties halfway between each pair of new joint ties, with good second-hand ties in between. This sets your finished track a bit above track that has exclusively second-hand ties, and gives more mileage with the resources you have; a tie-replacement program can be undertaken in time.

<u>Rails</u> present their own problems. Laying them out is more arduous, and must be carefully monitored. If your rail is delivered by motor vehicle, try and lay it out end-to-end along your right-of-way. Since the average rail length can weigh half a ton, theft will not be a problem! If immediate layout upon delivery is not possible, store the rail neatly at your materials area: stack the rail on timbers or ties, one layer at a time, with wood spacers between layers.

Some tie plates have <u>two</u> ridges on their top side. These plates are only usable with one rail base, and are usually only punched for one size of rail. If you are installing rail that matches those plates, well and good; otherwise, sell or trade those specialized plates. If your stock of plates is a large collection of various second-hand plates, check, on the rail to be installed, that two spike holes lie next to the rail base. This means <u>touching</u> the rail base! If the spike holes line up so that one hole is <u>slightly under</u> the base, you can still use the plate, <u>if</u> the overlap is 3/16" or less (in which case you can drive a normal spike with a bit of finesse and force).

Tie plates under joint bars present a small problem. If you are using joint bars that just fill the rail web, with no "foot", you'll have no problem with spike hole lineup. But if your joint bars have "feet" with slots cut in them, be sure that the spike holes in the tie plate align with <u>both</u> slots in the joint bars (one on each side); otherwise, you'll have trouble spiking the rail to that end of the tie! <u>Use</u> the slots and "slot-spike" the joint bars, to help prevent the rail from creeping; it may be necessary to try several tie plates before you get one that fits. Be sure and shift the tie to place both spike holes well near the middle of the tie, to avert splitting. If you, however, <u>cannot</u> find a tie plate with holes that match your joint bar slots, set the plate so that one hole coincides with one of the slots, and the other hole is against the rail base at the end of the joint bar. This will have the same effect as if you'd used both slots; of course, adjust the tie to get both spikes well away from the edges. Some tie plates have additional spike holes or elongated spike holes which allow spiking at the joint bar, through the plate's holes, if the joint bar's "foot" has no slots. Watch for these plates and use them at your joints!

If you are desperately short of tie plates, use them <u>first</u> on the outside rails of curves, and then on the inside rails of curves. Only after that should you begin using them on tangent track. Of course, you can install them later as tie replacement proceeds.

<u>Spiking</u> is a topic in itself. Most fans have seen men driving spikes and many may have driven a few themselves. There are right and wrong ways of doing even so simple a thing as driving spikes!

Railroad spikes exert a powerful holding force, reportedly 3000 to 4000 pounds in a good tie. They hold in an interesting manner: that chisel point on the spike cuts the fibers of the tie, and, as the spike penetrates, the cut fibers are bent downward, forming hundreds of powerful "sprags" or ratchets resisting the withdrawal of the spike. Thus, using spikes with pointed points in a tie not pre-drilled can cause a split tie, since those points spread the fibers instead of cutting them. Pre-drilling allows the "pointed" spike to cut some fibers, thus exerting a holding force. And any spike driven into a plugged spike hole will not hold as well: the fibers in the tie plug are parallel to the spike, and thus no fibers are cut to act as "keepers" for the spike.

Spiking must be done right, to tie the track securely together. If spikes are not tight against the rail base, the rail can creep. If spikes are driven down too far, the heads are bent and weakened, but if they are not driven far enough, they don't do much good in holding the rail to the tie. And if the spike itself is defective, it may not hold as well.

<u>Don't</u> drive spikes in old spike holes! As I noted above, the tie fibers must be cut to exert any holding force at all; and plugged holes are not as strong as a fresh section of wood. One museum was busy laying track, and some poorly-informed members took the second-hand ties, turned them over, and drove spikes in <u>without plugging the old holes</u>,

from the other side. They were quite surprised when some spikes only required two or three blows with a maul to be driven all the way! Take the second-hand ties and plug all the spike holes (an excellent job for less-strong members to do in advance of the spikers). If the rail seats are not badly worn, leave the used side up and spike in the unused wood. This may require some shifting of the tie plates to achieve both fresh wood for spikes as well as keeping the spikes from being driven too near the edge of the tie; but the slight extra time is worth the effort. If the tie has many spike holes in it already, change it out on the spot in favor of a less-used one; if you aren't abundantly supplied with ties, try and drive in new wood where possible, being alert for incipient splits, and keep the tie in mind for replacement when better stock becomes available.

The actual driving of spikes is difficult to put into words. First, set the spike in the tie with a few smart taps of the maul. The spike must be driven exactly vertical to achieve maximum holding power; if you lean the spike, the holding force vector is reduced by the angle of lean, causing outward forces on the rail to exert a resultant loosening force on the spike. Drive the spike straight into the tie, placing it so as to crowd the rail base slightly. I use a half-choke grip on the spike maul, for better accuracy; as the spike is driven further in, I bring my hands closer together, toward the end of the maul handle. I advise museum trackmen against a "roundhouse" swing, with both hands at the end of the maul handle, until they are very experienced; this gives a gain in head energy at the possible expense of a great deal of accuracy. For the average museum worker, the half-choke swing is best; bring the maul up over the head to about 10° behind the vertical. Being right-handed, I place my right hand halfway toward the head of the maul, to guide it and give the driving force. My left hand stays at the end of the handle; during the upward swing, I force my left elbow to a straight and locked position to assist in raising the maul, then bend it as the downward swing progresses. While driving spikes, keep your feet firmly set in a comfortable stance; if you are tending to bend the spike away from you, move toward the spike slightly, and if you're bending the spike toward you, step back slightly. Drive spikes while standing on the opposite side of the rail from the spike. When you have driven the spike about two-thirds of the way into the tie, strike the back of the head once or twice to bend the spike in toward the rail; then finish driving the spike. Drive the spike until the lip underneath the head is tight against the rail base; do not drive the spike until the back of the head rests on the tie plate, as that indicates the head is bent and weakened, and future removal of the spike will be most difficult if you can't get a spike puller under the head!

As most museum groups have a single-track right-of-way, here is a tip on spike layout. Spike the ties to "cross-bind" them, so that they cannot shift when the rail tries to creep under traffic or expansion.

Always drive the spikes holding a rail to one end of a tie diagonally across from each other, to prevent splitting the end of the tie. When one rail is spiked down as detailed above, spike the other rail in the same fashion, but set the other rail's spikes so that the diagonal line through the second two spikes is at or near a right angle to the diagonal line through the first pair of spikes. If the diagonals are parallel, the tie can twist; if the spikes are cross-bound, the tie cannot twist, and, if the spikes crowd the rail firmly, a powerful force opposes any creeping tendencies.

Judicious use of the "crowding" procedure can rectify small errors in gauge. I have altered track gauge as much as a quarter of an inch in the process of driving one spike! To do this, spike one end of the tie normally; then drive the first spike in the other end according to which way you desire to shift the gauge: tight gauge means drive the inside spike first, while wide gauge requires you to draw in the outside spike first. Drive the "draw" spike about a third of the way into the tie; strike the back of the head once or twice, then drive the spike one or two more blows, and repeat the process. Monitor the gauge continuously. Then drive the other spike so that the shaft of the spike just touches the rail base (as opposed to crowding the base with the point when you start spiking).

Proceeding with tracklaying, spike one rail down completely to serve as the line rail. Then set the other rail to gauge, and spike it to gauge: spike every third tie to exact gauge, using a track gauge, and then go over the section and spike the balance of the ties without need of the gauge. The better spikers should do the gauge spiking. Your less-strong members play an important role in the spiking process: they keep the spikers supplied with spikes, and also hold the ties up to the rail during spiking. Insure that the ties are held up tightly against the rail base! Another labor-saving method is the two-man spiking procedure: the men both stand across the rail from the spike in question; one man sets the spike, and when he begins spiking in earnest, the other spiker hits the spike as the first spiker is raising his maul to the start position, and both men work at their normal speed. It is best if two competent spikers work together, since a novice may have basic accuracy and technique problems, resolution of which is impeded by the close presence of another (better) spiker. The good spiker may be hampered, in turn, by the ineptness of the novice.

Joints must be done with care, as joint-associated problems are the bane of every trackman's existence, whether in a museum or elsewhere. A little time taken when the joints are installed will save considerable effort later, and provide a safer and smoother ride.

Put tie plates under every joint, except under "wraparound" joint bars. Remember the "slot-spiking" procedures (review page 15). New joint bars installed on new rail require a minimum of preparation. If either the joint bars or the rails are second-hand, and therefore rusty or worn, more time is necessary for preparation. Use a wire brush to clean off scale and rust on the rail web, the underside of the railhead, and part of the rail base next to the web. Also brush the top and bottom edges of the joint bars as well as the inside, or rail-web side. Apply a good coat of No-Oxid to the brushed areas; if No-Oxid is outside your means, I suggest a heavy grease, having had good luck myself with a brand of auto grease that contained molybdenum. This preparation will give a tighter fit to your joint, with attendant better electrical conductivity and smoother ride; residual grease will get on the bolt threads to ease the work of tightening the bolts.

Before going on with installation, brushing, and so on, recheck the hole spacings! Make sure that at least four holes line up, at least two of which must be next to the joint itself. Slight offsets (1/8" or so) can be overcome by judicious tinking with the bolts and bars. A track being built for nothing but storage and very low-speed operation may have less bolts at its joints, if you're not placing very heavy equipment thereon; but insure that at least two bolts are in each joint, one in each rail preferably, and preferably next to the rail joint itself.

In making up a joint, first line up all the holes. Jigger the rail ends to adjust the holes for lineup. If small offsets still plague you, insert all the bolts that line up and install nuts and washers loosely; then shift the rail and both joint bars to fit the remaining bolts. It may be necessary to hammer a bolt home (i.e., with the head tight up to the joint bar, with the bolt's shoulders inside the oval hole) with well-aimed maul blows. Slight scraping of the bolt threads may be necessary and is permissible, but do not damage the threads too much, or the nut will not thread. Experience is the best guide here. If, when all the holes are filled with bolts, there is a gap between the rail ends, so be it: Bethlehem, for one, punches its joint bars and rails to allow a 1/8" gap between rail ends. A gap may be due to contraction. To allow for expansion, use the following formula, from <u>Notes on Track</u>: (Highest anticipated temperature in $^{\circ}$F) - (present temperature in $^{\circ}$F), divided by 400, yields a result in inches. Expansion should be no problem, unless you're laying rail on a 0° day, and expect a 120° summer!

Insure that the joint bars are <u>straight</u>. If they are bent, adjust by pairing one bent bar with a straight one if you are tight on supplies of joint bars; otherwise, use only <u>straight</u> joint bars. On curves, set the joint bars so that their bend is opposed to the curvature of the rail; the tightened joint will tend to straighten both the rail <u>and</u> bars.

If bolt holes do not line up at all, use the following methods, in descending order of preference: drill the rail; cut wider holes in the joint bars (being sure to preserve the oval shape for the bolt shoulders) and cut new or wider holes in the rail (<u>least</u> preferred, as it heat-stresses the rail and accelerates future failure, and the joint can open wider when the rail contracts and widened holes allow the bolts to move).

For joints between dissimilar sizes of rail, use more care than normal. In addition to the procedures outlined above, try and have compromise joints opposite each other; otherwise, the ties will not be firmly under the rail bases until both rails are the same size.

The best course in making up compromise joints is to use compromise joint bars (called "step joints" in some circles, including Bethlehem Steel). If the joint is to be in busy operating track, you will be better off to purchase a proper pair of step joints. You can fabricate your own compromise joint bars, if you have a <u>good</u> welder available who can work at the site. Weld up the joint bar, and, if possible, anneal the entire bar before installation. Compromises between "T" rail and girder rail can be similarly fabricated; however, homemade joint bars for such a joint will be extremely difficult to fabricate, owing to the offset required in the horizontal <u>and</u> vertical planes to accomodate both rails. Welding a girder-to-T joint is best; again, use a good welder, #7018 or #7018-Al rod, and official railroad procedures, which entail cutting away a bit of both railheads, and leaving both rails about 3/16" apart.

If the differences are small, you may be able to grind a joint bar to fit, or use shims (which are available for just such a purpose); I have seen shims for use with 131# joint bars when 132# rail was to be joined to 131#. <u>Do not</u> shave a joint bar with a torch, as a smooth surface is very difficult to cut. You may cut most of the difference with a torch, but grind the remainder <u>smooth</u>. <u>In no case cut away the underside of the railhead</u>! You may have to "ramp" the joint if you use a homemade compromise joint, to ease the travel of the wheel over the bump and save battering of the rail ends. <u>Never cut away part of one railhead to lead down to another</u>! Joining rails of the same weight, but a different cross-section, will require use of the same methods.

Joints on curves require careful makeup. The best means of insuring smooth joints on curves is to <u>make the joints up on a straight line</u>! Lay the rails out straight, aligned in all axes, and then make up the joint to final tightness, as outlined below. The actual making-up of a joint begins by tightening all the bolts firmly; I recommend tightening the bolts nearest the joint first, and then the bolts at the extremities of the joint bars. Be sure that the nuts on your track bolts have their flat sides against the lock washers. If you are not using lock washers in initial construction, have the side of the nut with rounded corners against the joint bar. After all the bolts are firmly tightened, strike the bolt heads and the joint bars smartly with a spike maul, and retighten all the bolts as noted above. Camp's rule for tightness of a bolt is that it be drawn tight with an 18" wrench by a man standing on both feet. Many museums have longer track wrenches, and I concur with the "feet on ground" guideline, as I have seen 7/8" track bolts wrung unto failure by a strong man using a 36" track wrench. A tight joint helps make smooth track; a smooth curve will result also, since the rail lengths thus joined will bend as one piece of rail, without a "dog-leg" at the joint.

Curve layout can be rather easy: here you are, and there is where you want to go. A table of offsets may be used, and judicious measurements will establish the exact curve you need. Again, a civil engineer/member type can be of value here, but urge him to rapid and precise layout, to minimize lost time. A quick-and-dirty curve layout can be to lay the ties to the approximate curvature desired, then join enough rail lengths together (review the section on joints) to make up the entire curve. Knowing your destination point, you can throw the rail to any curve desired. I have in my pocket notebook a table of middle ordinates and corresponding radii from a Barbour-Stockwell catalogue, which are determined by measuring with a ten-foot string; for example, a 1/16" middle ordinate yields a 2400' radius curve, a ¼-inch M.O. gives a 600' curve, a ½" M.O. is on a 300' curve (about 19°), a 3/4" M.O. is on a 200' curve, and a 1" M.O. will be found on a 150' radius curve. A 2" M.O. will mark a 75' radius curve. A variant method is to determine the degree of curve, and then throw the rail to correspond: use a 62-foot string, and measure the middle ordinate (distance from the rail to the midpoint of the string, perpendicular to the string and perpendicular to the tangent to the curve at the point of measurement). The length of the middle ordinate in inches, if RAILROAD Magazine is to be believed, equals the degrees of curvature of the curve. Find a table of corresponding radii, and determine your curve (Camp's Notes on Track has such a table). Extremely sharp, street-railway-style curves, if they are part of a large complex, are best laid out by a trained engineer; but a practiced trackman can "eyeball" most curves, using a string line and tape measure to lay out the line.

Use your best ties on curves. Here most of your new ties as well as your best second-hand ties should be concentrated, because curves are where most of your derailments are prone to occur, and a firmer foundation will avert many problems.

The question of widened gauge on curves is much debated among trackmen. Camp asserts that the average curve does not need a widened gauge if four-wheeled equipment is operated exclusively, including small four-drivered steam locomotives. I feel that sharper curves may be widened ¼" or 3/8" at the most for streetcar operations, especially if you have cars with long-wheelbase trucks such as Standard C-series trucks, North Shore-style interurban trucks, or single-truck cars. "Sharper" curves are 200' radius or less, and must have guard rails installed, for reasons I will detail later. For museums with steam locomotives, Camp has a formula to determine the amount by which the gauge must be widened:

<u>Given</u>: S=required extra width, inches a,b=wheelbase spacings, feet
D=degree of curve. If D is 20° or more, use <u>960</u> as denominator; if D is 30° or more, use <u>966</u> as denominator.

$$S = ((Dab/956) - 3/8"), \text{ in inches.}$$

Reworking that formula yields the sharpest curve that a given locomotive can negotiate with no widening of the gauge:

$$D = 360/ab$$

Southern Railway practice, adapted from AREA standards, is to use 4'8½" gauge on tangents and curves less than 8°. 4'9" is used on curves 8° or sharper. This is fine if you have all MCB wheels and heavy equipment; but museums with both wheel contours should take care to maintain good gauge, so that the "narrow" tread wheels do not go astray at wide points.

As I noted earlier, rail will bend to a smooth curve, even a curve of extreme radius. Tighter curves will require some work with the bender to <u>insure</u> a smooth curve in the rails. During construction of the curve, remember to make up joints well in advance of the spikers, to insure a smooth, continuous joint. Spike about one-third of a rail, and then join the next length of rail to the first length. Make up the joint <u>firmly</u>. Then, and <u>only</u> then, spike the rest of the first rail and part of the next rail, repeating the pre-jointing process as often as required around the curve. Many museums have spiked down all but the last few feet of a rail and joined another length to it, and then learned the hard way that it is very difficult to bend four feet of rail to a smooth curve without a bender! Pre-jointing will give you more leverage to throw the rail to the desired curve, since you will have an effective length of much more than 30' to move, which will act like one long piece of rail if it has been joined <u>tightly</u>.

Use gauge rods judiciously in curves. <u>Mine and Industrial Trackwork</u> has diagrams of best spacing. Briefly, place one gauge rod on each side of every joint in the outside rail of a curve. Gauge rods should be installed close to one tie. Gentle curves should have an additional gauge rod at the point halfway between joints in the outside rail; tighter curves (300' radius or less) should have rods at the halfway <u>and</u> quarter points between outside-rail joints, for a total of five rods per rail. The rod hook goes on the outside rail, and the nut on the inside of the curve. A pair of gauge rods are also recommended at the toe of a switch. You <u>do not</u> need gauge rods on tangent track!

I noted earlier that rail can be bent by hand to any curve. For tighter curves (150' radius or less) I strongly recommend using a bender to <u>fix</u> the curve in the rail. This will help keep the curve smooth, regular, and in line. Give special attention to the last six feet at either end of the rail length. In a pinch, bend in the required curve at the ends of the rail, and let the middle of the rail be curved by installation, especially if you're extending an existing curve, or changing a rail in a sharp curve. For <u>tight</u> specialwork curves (less than 100' radius), bend the entire rail at about two-foot intervals. A portable hydraulic bender costs about $100 or so, and it is a Godsend for rail bending, especially if you have ever used a hand-turned "Jim-Crow" bender! Branford has a loop with a constant 65' radius; on that job, rails were bent to the desired curve, using a portable hydraulic bender, almost as quickly as they were later spiked in place!

Curve superelevation is vital in curve installation. All curves that will be in operating trackage should be superelevated, <u>especially</u> the tight-radius curves. Prototype street railway companies superelevated leaving you no place to drive spikes firmly. If there are old spike holes, were they plugged? Unplugged holes admit moisture, dirt, and insects, and ties buried in dirt or street that had rails removed, then were buried again, may have rotted rail seats. Your knowledge of the time involved (when were the ties installed? How long have they been in since the rail was removed?) will aid your decision as to usefulness.

Tie rot is very sneaky at times. Old pros can sound a tie: a clear "donk" usually is from a sound tie, while a soggy sound may indicate a thoroughly wet and rotten tie. Weight alone is not a guide, as most new ties I've seen are lighter than the ones they replaced! One quick test is to lift a tie over your head (two men do this) and drop it across a rail: if it bounces back, it's good, but if it seems to lose interest, or pieces fall off, or it splits, you just saved yourself further effort! However, rotten ties are good for cribbing or ramps, especially ties with bad seats but good middles. The Orange Empire group has disposed of second-rate ties to persons needing fence posts or yard dividers; in addition, a tie with a bad seat for standard-gauge track can be used by OET for its 3'6" Los Angeles trolley trackage. Unless you have no need for ramps (like the lucky groups with rail connections) or cribbing (and nearly every group needs cribbing for something; use bad ties to stack track hardware off the ground), take all the ties that are intact, if feasible.

Hardware covers several items. Spikes, track bolts, tie plates, and joint bars fall under this heading. These are the things that hold your track together!

Spikes should be examined quickly, as any defects are readily obvious. Are the spikes badly rusted? Are the spikes rail-cut, that is, is there a pronounced indentation under the head, which shows that the head is weakened? Are the heads beat up badly? Are the spikes severely bent (my own rule is to throw out spikes which are bent or twisted more than seems reclaimable)? Make sure the spike points are good (see the next page for pictures of typical spikes). A railroad spike must have a good chisel point if it is to drive well and hold firmly. If the point is rusted or broken, it may be unusable. Spikes with pointed points are for use with pre-drilled ties (holes drilled to accommodate a standard tie plate and spike layout), which are almost unheard of among museums to my knowledge. These pointed points will tend to split a normal (i.e., undrilled) tie when driven, and they will not hold as well (more on how a spike holds in the next chapter). Thus, they are probably not what you can use, but maybe you can sell them for scrap, or swap weight-for-weight for something you need.

Track bolts are unmistakable. They have an oval shoulder under the head. Check the thread condition: if melted by a cutting torch, scrap the bolt. Damaged threads may be reclaimed by use of a rethreading "mule". Mate each bolt with a nut that fits it properly, and a lock washer as well, to keep all the components together for better utilization and storage. Note the general condition of the bolts (are they rusted badly, to the point of failure?).

Tie plates are, thankfully, almost indestructible. I have seen a few tie plates that were badly rusted or bent, but virtually all the plates you get will be very usable. You may come upon tie plates cut in half: these are used for "quick and dirty" rail support in switches when proper switch tie plates are unavailable. Tie plates are heavy! A strong man is hard put to carry eight or ten plates at once. Watch for multiple punchings: if a plate has more than four holes, it may be of more use than the average plate (see pictures on preceding page). Often many of their street trackage curves; an example that comes to mind is the San Diego Electric Railway's Coronado Ferry Terminal loop curve, which had a good two or three inches of superelevation, on a curve of 60 to 70 feet in radius. There are several guides for the amount of superelevation; Paul Dieges, a licensed civil engineer and Orange Empire member, provided me one such table:

Max Speed	Chord	Max Speed	Chord
10mph	16'	35mph	56'
15	24'	40	64'
20	32'	50	80'
25	40'	60	96'
30	48'	63	100'

Chord=length of string to use
Superelevation required = length of middle ordinate, in inches.

Camp has a simpler rule of thumb: If the maximum speed around a given curve is 30 miles per hour, raise the outer rail ½" per degree of curve, to a maximum of four inches. If the maximum speed is 45, use 3/4" per degree, to a maximum of five inches. For speeds greater than 45, use 1" per degree, to a maximum of six inches. Runout of the superelevation, according to Camp, should be 40-50' per inch in yard trackage, and 80-100' per inch on main line trackage, varying as the operating speed. Superelevate all operating curves. A curve that is exactly level will give your passengers the sensation of leaning the "wrong way" as the car rounds the curve; a superelevated curve gives a better and safer ride -- safer, because the centrifugal force of the car is offset by the superelevation, thus putting less strain on the rails and track gauge (which is important if you don't have any gauge rods in the curve, or your ties are not of the best quality!).

Hand in hand with superelevation goes the use of guard rails on curves. Most steam-only museums don't need them in the same degree that streetcar museums need them; I have seen guard rails on steam railroads, but they are set well away from the running rail, mainly to keep the train, if derailed, in the general vicinity of the track. Use of guard rails is not a function of wheel cross-section; it is a function only of the sharpness of the curve. The Connecticut Company put guard rails on all curves of 300' radius or less; the mighty Pacific Electric, with full-size MCB-contoured wheels, used guard rails on curves of 250' radius or less. Guard rails are a safety feature -- they help keep the car from forcing the gauge wider and wider, and, in fact, preserve the gauge, since the same force pushing the outside rail also tends to move the inside rail (by pressure against the guard rail) the same distance, thus preserving the gauge. Guard rails are effectively "something for nothing". The backs of the wheels wear against the guard rail; since most guard rails are set slightly higher than the running rails, it is the back of the thick part of the wheel that is worn. A guard rail lessens wear on the flanges by eliminating the tendency of outside flanges to wear against the outside rail. Wear on the outside rail is cut also, owing to the wearing forces being distributed between two rails. By the time an outside rail on a guarded curve is ready for replacement due to wear, it's really ready; the outside rail on an unguarded curve can wear very quickly, and be old before its time. A worn outside rail on an unguarded curve is a definite hazard: with the gauge side of the rail head worn down, wheels have a greater chance of going astray, and one day the car will climb the rail at a curve, with consequent wasted time for rerailing and adverse effect on museum image!

Switches are another topic on which books are written. Consult professional publications for detailed information: Bethlehem's Mine and

Industrial Trackwork has tables, and books such as Camp's Notes on Trac have a full selection of tables for regular switches, crossovers, and ladder switches, as well as detailed instructions for switch constructi Diagrams 1 to 9 show typical switch details, drawn in accordance with A standards. Switches are a very exacting and crucial area of track construction!

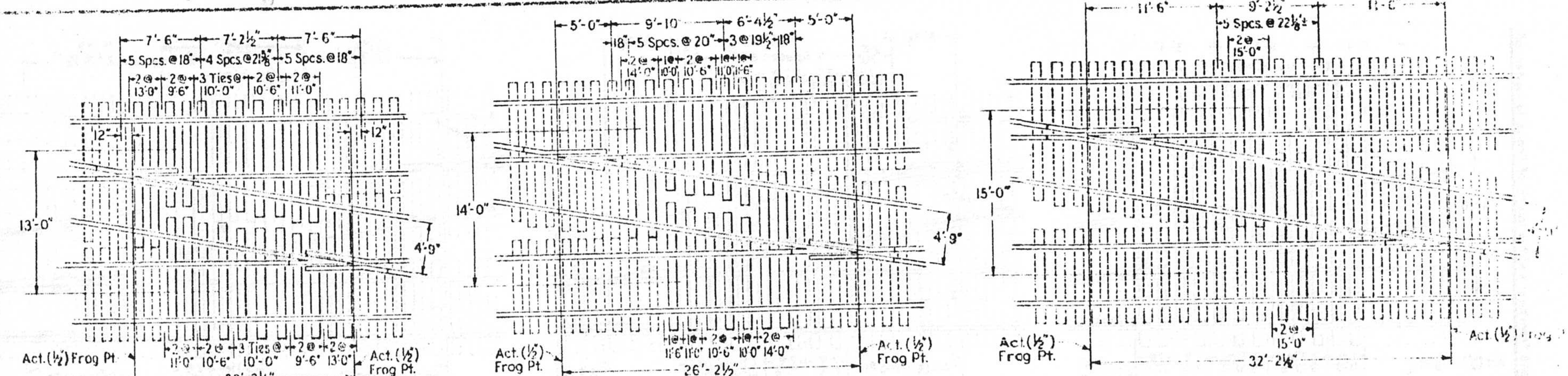
First, use switch ties for switches. This may sound pretty dumb, b there exist museum people who don't see the need for those extra-long, extra-heavy ties in switch construction. Switch ties are very expensiv But they are also very necessary: they hold the entire switch together relation to itself as well as the abutting tracks. If a switch gets ou of alignment with itself, derailments can become all-too-frequent occurrences, and little annoyances, like an inability to throw the switch points, can crop up. Use sound ties for the head ties, which support th switch stand; moving switch points requires considerable force, and a rotten head tie can allow the stand to shift, causing the points to spread from the stock rails. Of course, use a stand that has a lever lo enough to allow moving the points with some degree of ease. One museum installed a derail stand to throw a switch; the points were heavy, and were both attached to the stand. This poor little stand had a one-foot lever, linked to two points of about eight feet in length, each weighing about two hundred pounds! The museum couldn't understand why the switch didn't work well, and a pry-bar was routinely used, since the throw rod was buried in sand as well. It was replaced with a standard low-level switch stand, which presented a new problem: short head ties had been used, which put the new stand in close proximity to the track, so close as to constitute a clearance hazard; long ties were in short supply, so the target stem was shaved off the low-level stand (as the switch was in the yard area), and no further problems have been encountered (see photo #1 at the end of this section).

If you are very short of switch ties, you can interlace normal-length ties in constructing a switch, remembering to replace them as soon as suitably long ties are available. Do not interlace under the switch frog or under the points, or at the halfway point between the points and the frog; here you must use switch ties, as these are critical areas of the switch, and maximum rigidity is needed, for maintenance of gauge and switch integrity (see picture #2 at the end of this section). Interlacing, to any great degree, is not good procedure, and is not recommended except in isolated cases.

Be sure to use proper hardware in your switches! Consult Bethlehem's book, or any railroad's track specifications books, for details of hardware required (see diagrams 4-9). There are graduated, extra-long tie plates and slide plates to be used under switch points, and there are long plates with hooks for use in the frog area. Switch tie plates come in sets, made up for a particular switch number with a given point length, and often right- or left-hand switches will have slightly different plates. These plates have insets for the stock rail base, to keep it fixed firmly in the point area, where spikes cannot be driven on the point side, and to keep the rate of divergence of the stock and closure rails at a prescribed rate, to lead smoothly to the frog. They are numbered, with numbers in ascending order that begin with #1 at the points and go to #11 or greater; #1, #2 and #3 have provision for point movement, while #4 and greater have insets for both the stock and closure rails, to help keep their divergence rigid and constant. Plate #1A is a special plate, with an extra spike hole for spiking the point to line the switch. These numbers, along with the rail weight and switch

DIAGRAM 1

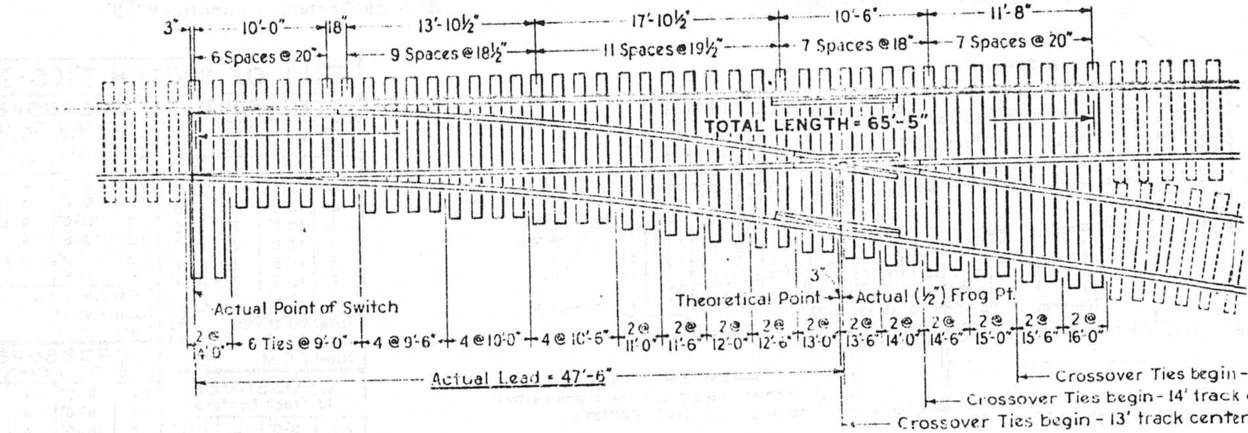
REVISIONS: (1) Dimensions from heel and toe joints of frogs to center of adjacent switch ties deleted.



CROSSOVER
13' Track Centers — Length = 115'-2½"

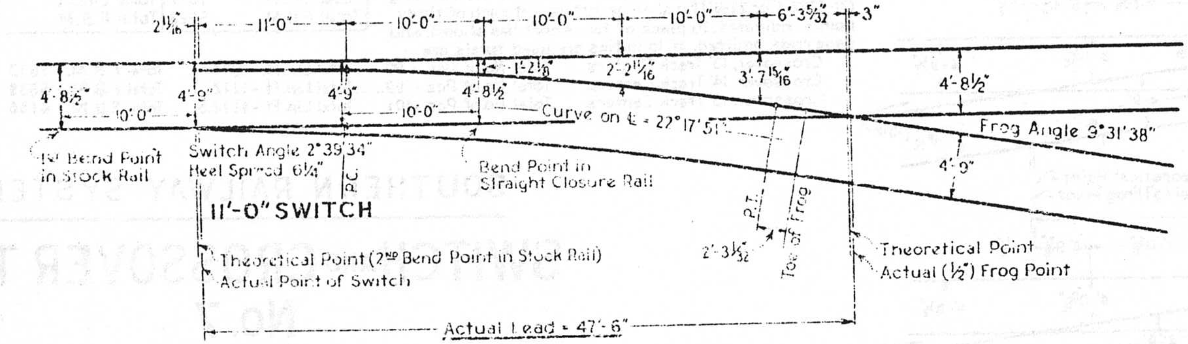
CROSSOVER
14' Track Centers — Length = 121'-2½"

CROSSOVER
15' Track Centers — Length = 127'-2½"



Closure Distances (Heel of Switch to Toe of Frog):—
Straight Rail.....33'-3"
Curved Rail.....33'-6"

No. 6 TURNOUT



OFFSET DIAGRAM
Note:- Offsets measured from gage side of stock rail to gage side of turnout rail.

BILL OF SWITCH TIES-7"x9"

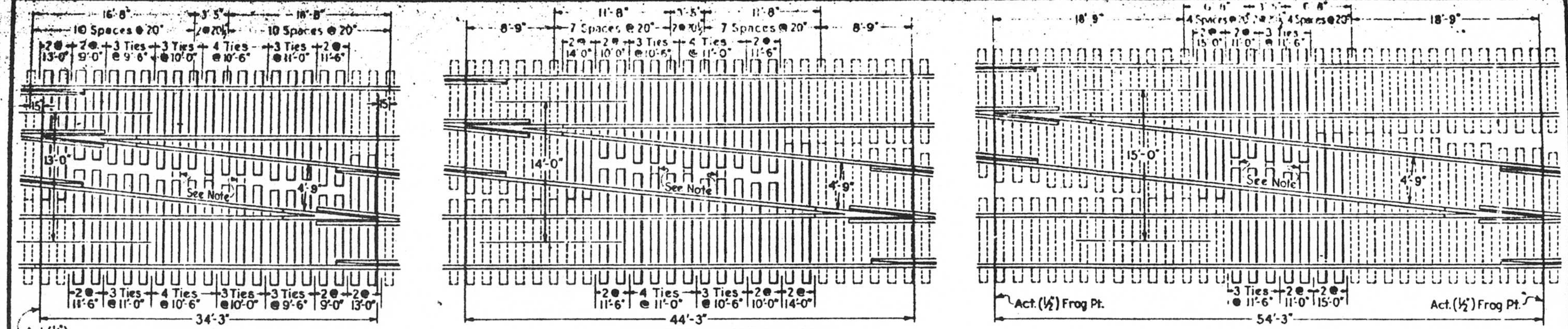
TURNOUT				CROSSOVER 14' Track Centers			
No. of Pcs.	Length	No. of Pcs.	Length	No. of Pcs.	Length	No. of Pcs.	Length
6	9'-0"	2	13'-0"	12	9'-0"	4	13'-0"
4	9'-6"	2	13'-6"	8	9'-6"	4	13'-6"
4	10'-0"	4	14'-0"	10	10'-0"	12	14'-0"
4	10'-6"	2	14'-6"	12	10'-6"		
2	11'-0"	2	15'-0"	6	11'-0"		
2	11'-6"	2	15'-6"	6	11'-6"		
2	12'-0"	2	16'-0"	4	12'-0"		
2	12'-6"			4	12'-6"		
Total No. of Pcs. 42				Total No. of Pcs. 82			
Total Lin. Ft. 499				Total Lin. Ft. 917			
Total F.B.M. 7670				Total F.B.M. 4815			
CROSSOVER 13' Track Centers				CROSSOVER 15' Track Centers			
12	9'-0"	4	12'-6"	12	9'-0"	4	12'-6"
12	9'-6"	8	13'-0"	8	9'-6"	4	13'-0"
14	10'-0"	4	14'-0"	8	10'-0"	4	13'-6"
12	10'-6"			8	10'-6"	4	14'-0"
8	11'-0"			4	11'-0"	4	14'-6"
4	11'-6"			4	11'-6"	8	15'-0"
4	12'-0"			4	12'-0"		
Total No. of Pcs. 82				Total No. of Pcs. 80			
Total Lin. Ft. 880				Total Lin. Ft. 932			
Total F.B.M. 4620				Total F.B.M. 4893			

SOUTHERN RAILWAY SYSTEM

SWITCH AND CROSSOVER TIES
No. 6

JUNE 9, 1948. Rev. Nov 1, 1951 (1)

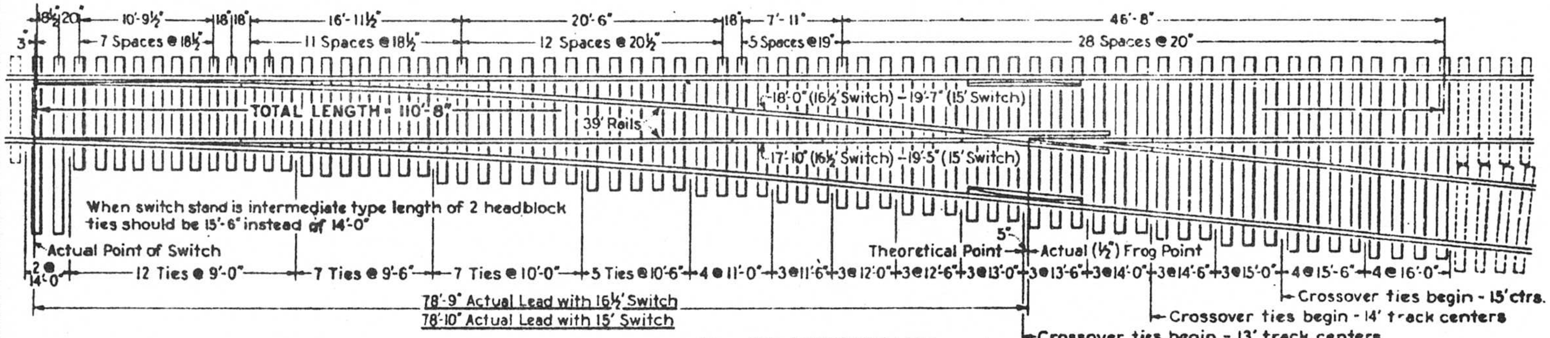
OFFICE OF CHIEF ENGINEER
WASHINGTON, D.C.



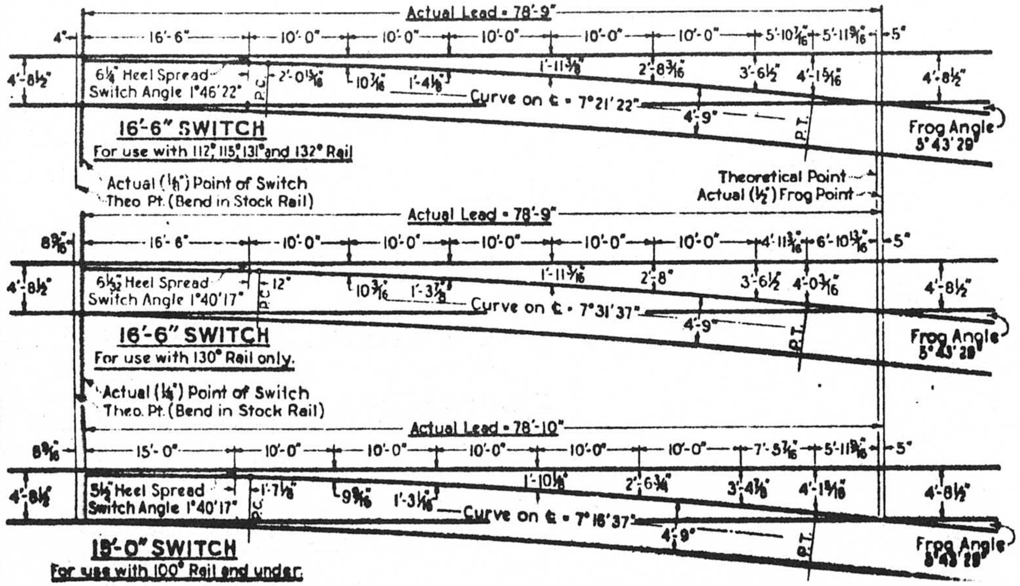
CROSSOVER 13' Track Centers – Length = 191'-9" (with 16½' Switch) 191'-11" (with 15' Switch)

CROSSOVER 14' Track Centers – Length = 201'-9" (with 16½' Switch) 201'-11" (with 15' Switch)

CROSSOVER 15' Track Centers – Length = 211'-9" (with 16½' Switch) 211'-11" (with 15' Switch)



No. 10 TURNOUT



Closure Distances (Heel of Switch to Toe of Frog):–

	15' Switch	16½' Switch
Straight Rail	58'-5"	56'-10"
Curved Rail	58'-7"	57'-0"

BILL OF SWITCH TIES - 7"x9"

TURNOUT

No. of Pcs.	Length	No. of Pcs.	Length
12	9'-0"	3	13'-0"
7	9'-6"	3	13'-6"
7	10'-0"	5	14'-0"
5	10'-6"	3	14'-6"
4	11'-0"	3	15'-0"
3	11'-6"	4	15'-6"
3	12'-0"	4	16'-0"
3	12'-6"		

Total No. of Pcs. 69 · Total Lin. Ft. 813 · Total F.B.M. 4269

CROSSOVER 13' Track Centers

No. of Pcs.	Length	No. of Pcs.	Length
28	9'-0"	10	11'-6"
20	9'-6"	6	12'-0"
20	10'-0"	6	12'-6"
18	10'-6"	10	13'-0"
14	11'-0"	4	14'-0"

Total No. of Pcs. 136 · Total Lin. Ft. 1433 · Total F.B.M. 7524

CROSSOVER 14' Track Centers

No. of Pcs.	Length	No. of Pcs.	Length
24	9'-0"	6	12'-0"
14	9'-6"	6	12'-6"
18	10'-0"	6	13'-0"
16	10'-6"	6	13'-6"
16	11'-0"	14	14'-0"
10	11'-6"		

Total No. of Pcs. 136 · Total Lin. Ft. 1490 · Total F.B.M. 7823

CROSSOVER 15' Track Centers

No. of Pcs.	Length	No. of Pcs.	Length
24	9'-0"	6	12'-6"
14	9'-6"	6	13'-0"
14	10'-0"	6	13'-6"
10	10'-6"	10	14'-0"
12	11'-0"	6	14'-6"
12	11'-6"	10	15'-0"
6	12'-0"		

Total No. of Pcs. 136 · Total Lin. Ft. 1547 · Total F.B.M. 8122

USE OF GAGE RODS OR LONG TIES:

If desired, 3 gage rods may be used in crossover track between frogs. For crossovers under heavy traffic one long (21'-6", 22'-6" or 23'-6") tie shall be installed at each of three points indicated, in place of two short ties shown, and gage rods omitted. If long ties are used totals are:–

Crossover, 13' Track Centers...... Total No. of Pcs. – 133 ...... Total Lin. Ft. – 1435.5 ...... Total F.B.M. – 1537
Crossover, 14' Track Centers...... Total No. of Pcs. – 133 ...... Total Lin. Ft. – 1492.5 ...... Total F.B.M. – 7836
Crossover, 15' Track Centers...... Total No. of Pcs. – 133 ...... Total Lin. Ft. – 1549.5 ...... Total F.B.M. – 6135

IONS: ①Headblock ties spaced 21"-19"; Offset Diagram for 16½'-130 Switch added; To supersede Plan 2-4 dated Feb. 23, 1944, rev. Mar. 3, 1947. ②Dimensions from heel and toe joints of frogs to center of adjacent switch ties deleted. ③Headblock ties spaced 18½"-20".

DIAGRAM B

SOUTHERN RAILWAY SYSTEM

SWITCH AND CROSSOVER TIES No. 10

SEPT. 14, 1940① Rev. Nov 1, 1954.②

DIAGRAM

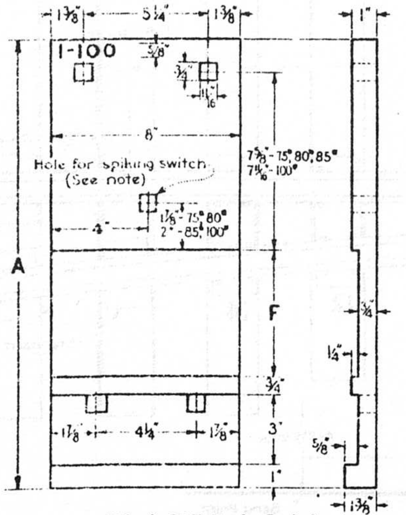
CNS: Change plate marking by eliminating switch length from all plates and adding turnout number to Plates 3 to 14 inclusive.

PLATE NUMBER	NUMBER REQUIRED	75# A.S.C.E. RAIL								
		A	B	C	D	E	F	G	K	L
1	10	19"					4 7/8"			
1A	2	19"					"			
2	2	18"					"	12 1/2"		9 3/8"
3	1	18"					"	11 11/16"		9 3/8"
4	1	18"					"	11 3/4"		9 3/8
5	1	17 3/4"	12 3/4"	15/16"			"		7/32"	
6	1	18"	12 15/16	15/16"			"		1/4"	
7	1	18 3/4"	13 7/8"	7/8"			"		1/4"	
8	1	19 1/4"	14 1/8"	7/8"			"		17/64"	
9	1	20"	15 1/16"	13/16"			"		17/64"	
10	1	20 1/2"	15 7/16"	13/16"			"		19/64"	
11	1	21 1/4"			7 29/32"	8 3/16"	"			
12	1	21 3/4"			8 1/8"	8 7/16"	"			

PLATE NUMBER	80# A.S.C.E. RAIL								
	A	B	C	D	E	F	G	K	L
1	19"					5 1/16"			
1A	19"					"			
2	18"					"	12 1/2"		9 3/16"
3	18 1/4"					"	11 7/8"		9 7/16"
4	18 1/4"					"	11 15/16"		9 7/16"
5	18"	12 15/16"	15/16"			"		7/32"	
6	18 1/4	13 1/8"	15/16"			"		1/4"	
7	19"	14 1/16"	7/8"			"		1/4"	
8	19 1/4"	14 5/16"	7/8"			"		17/64"	
9	20 1/4"	15 1/4"	13/16"			"		17/64"	
10	20 3/4"	15 5/8"	13/16"			"		19/64"	
11	21 1/2"			8"	8 9/32"	"			
12	22"			8 7/32"	8 17/32"	"			

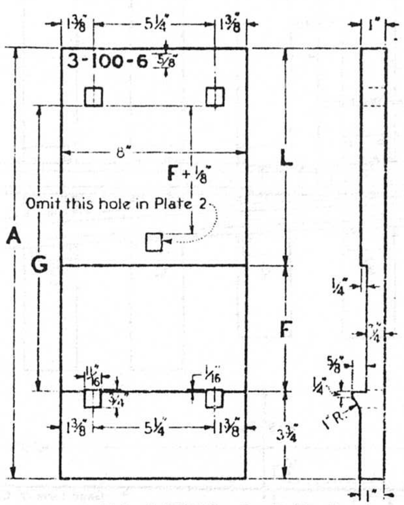
PLATE NUMBER	85# A.S.C.E. RAIL								
	A	B	C	D	E	F	G	K	L
1	19"					5 1/4"			
1A	19"					"			
2	19 3/4"					"	14 1/4"		10 3/4"
3	18 1/2					"	12 1/16"		9 1/2"
4	18 1/2"					"	12 1/8"		9 1/2"
5	18 1/4"	13 1/8"	15/16"			"		7/32"	
6	18 1/2"	13 5/16"	15/16"			"		1/4"	
7	19 1/4"	14 1/4"	7/8"			"		1/4"	
8	19 1/2"	14 1/2"	7/8"			"		17/64"	
9	20 1/2"	15 7/16	13/16"			"		17/64"	
10	21"	15 15/16"	13/16"			"		19/64"	
11	21 3/4"			8 3/32"	8 3/8"	"			
12	22 1/4"			8 5/16"	8 5/8"	"			

PLATE NUMBER	R.E. SECTION 100									NUMBER REQUIRED
	A	B	C	D	E	F	G	K	L	
1	19 1/4"					5 7/16"				10
1A	19 1/4"					"				2
2	19 3/4"					"	14 1/4"		10 9/16"	2
3	18 1/2"					"	12 1/4"		9 9/16"	1
4	18 3/4"					"	12 5/16"		9 9/16	1
5	18 1/4"	13 5/16"	15/16"			"		1/4"		1
6	18 1/2"	13 1/2"	15/16"			"		1/4"		1
7	19 1/2"	14 7/16	7/8"			"		1/4"		1
8	19 3/4"	14 11/16"	7/8"			"		17/64"		1
9	20 1/2"	15 5/8"	13/16"			"		17/64"		1
10	21"	16"	13/16"			"		19/64"		1
11	22"			8 3/16"	8 15/32"	"				1
12	22 1/2"			8 13/32"	8 23/32"	"				1
13	23 1/2"			8 7/8"	9 3/16"	"				1
14	24"			9 1/8"	9 15/32"	"				1

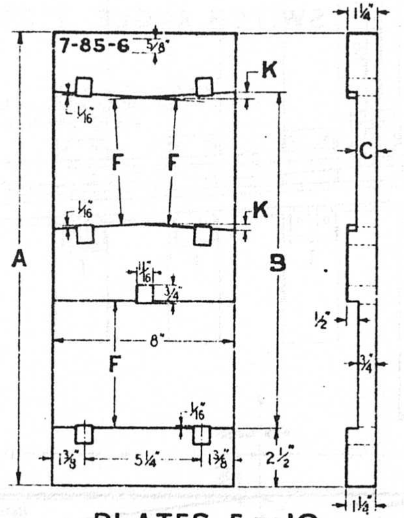


PLATES 1 & 1A

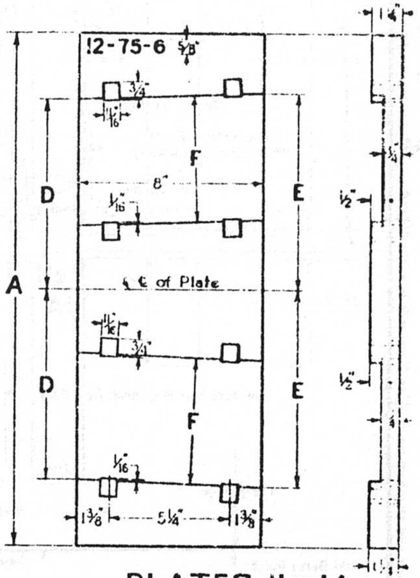
Note: Plate 1A has hole for spiking switch. Plate 1 omits this hole.



PLATES 2, 3 & 4



PLATES 5 TO 10



PLATES 11 TO 14

NOTES:
- All spike holes to be 11/16" x 3/4".
- Each plate to be die stamped, letters 3/8" high, to show plate number and weight of rail.
- Plates 3 to 14 inclusive must also show turnout number (6).
- Plates to be of medium steel, A.R.E.A. Specifications for Steel Tie Plates, latest issue.
- Plates 1, 1A and 2 are identical with plates of same numbers designed for 15' and 24' switches.

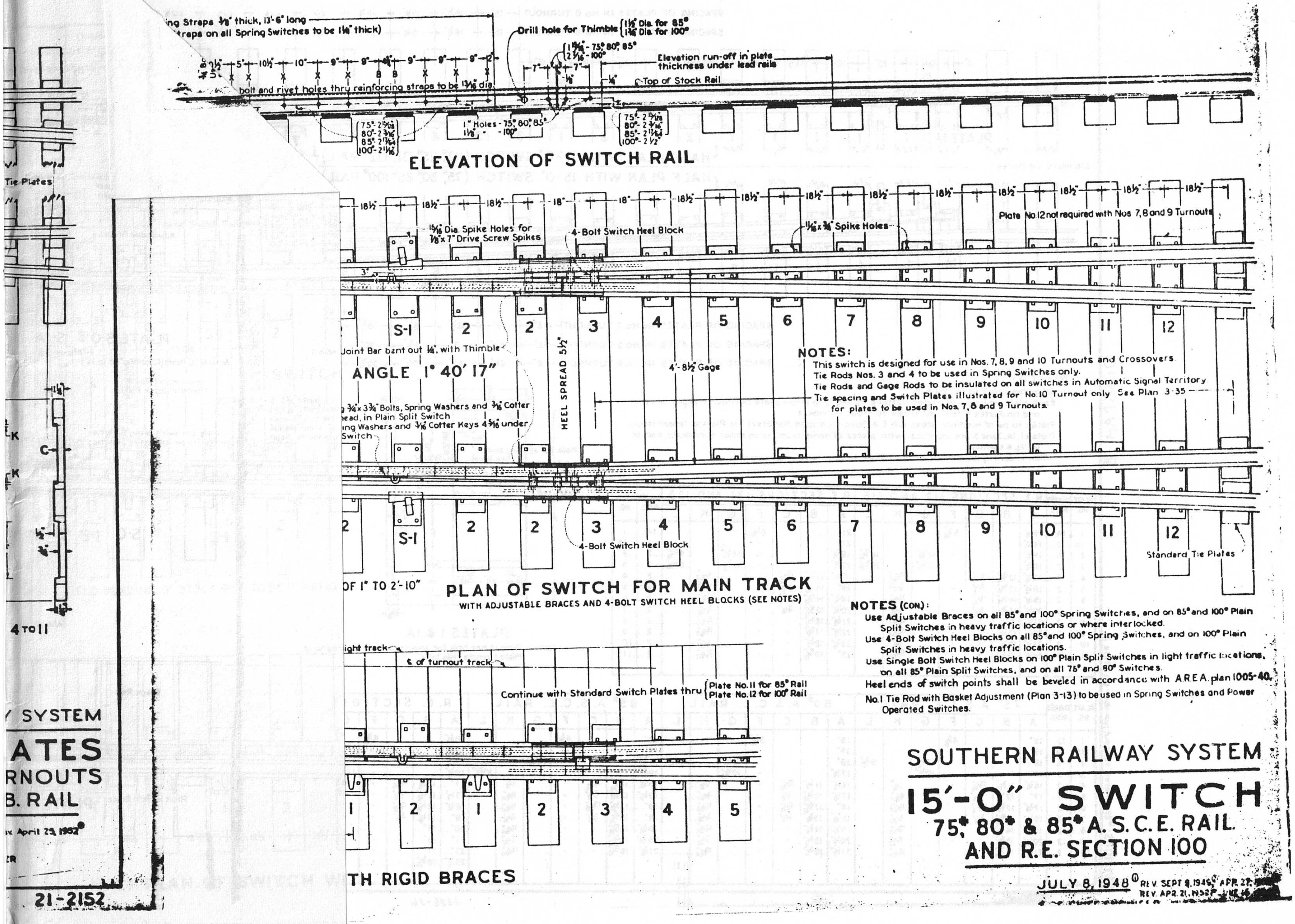
SOUTHERN RAILWAY SYSTEM

SWITCH PLATES

11'-0" SWITCH – No. 6 TURNOUT

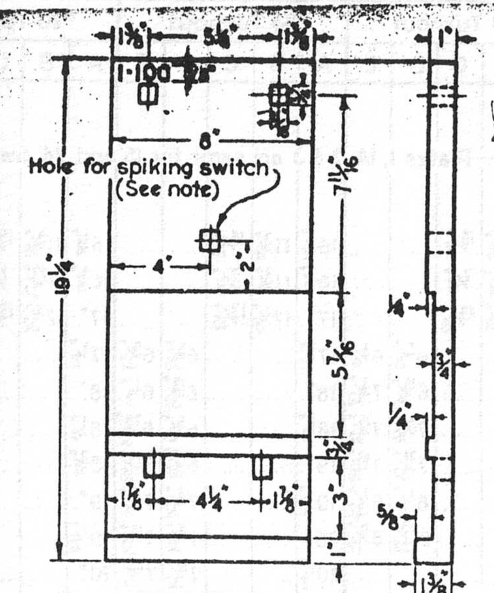
75#, 80#, 85# A.S.C.E. AND R.E. SECT. 100

JUNE 23, 1948



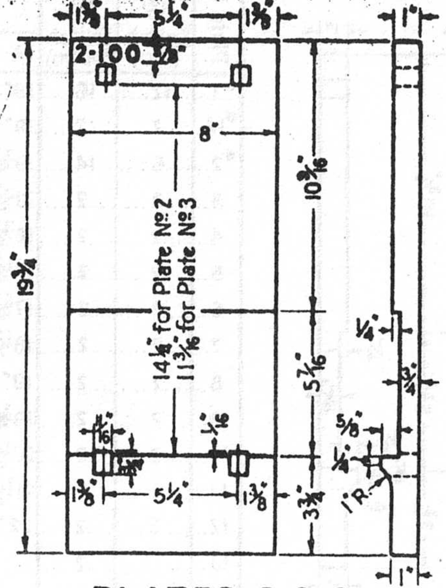
Straps on all Spring Switches to be 1⅛" thick)
Drill hole for Thimble
Elevation run-off in plate thickness under lead rails
bolt and rivet holes thru reinforcing straps to be 13/16" dia.
Top of Stock Rail
1" Holes - 75, 80, 85
ELEVATION OF SWITCH RAIL
Tie Plates
15/16" Dia. Spike Holes for 7/8"x 7" Drive Screw Spikes
4-Bolt Switch Heel Block
11/16" x 3/4" Spike Holes
Plate No.12 not required with Nos 7, 8 and 9 Turnouts
Joint Bar bent out ¼", with Thimble
ANGLE 1° 40' 17"
HEEL SPREAD 5½"
4'-8½" Gage
Standard Tie Plates
PLAN OF SWITCH FOR MAIN TRACK
WITH ADJUSTABLE BRACES AND 4-BOLT SWITCH HEEL BLOCKS (SEE NOTES)
NOTES:
This switch is designed for use in Nos. 7, 8, 9 and 10 Turnouts and Crossovers.
Tie Rods Nos. 3 and 4 to be used in Spring Switches only.
Tie Rods and Gage Rods to be insulated on all switches in Automatic Signal Territory.
Tie spacing and Switch Plates illustrated for No.10 Turnout only. See Plan 3-35 for plates to be used in Nos. 7, 8 and 9 Turnouts.
NOTES (CON):
Use Adjustable Braces on all 85° and 100° Spring Switches, and on 85° and 100° Plain Split Switches in heavy traffic locations or where interlocked.
Use 4-Bolt Switch Heel Blocks on all 85° and 100° Spring Switches, and on 100° Plain Split Switches in heavy traffic locations.
Use Single Bolt Switch Heel Blocks on 100° Plain Split Switches in light traffic locations, on all 85° Plain Split Switches, and on all 75° and 80° Switches.
Heel ends of switch points shall be beveled in accordance with A.R.E.A. plan 1005-40.
No.1 Tie Rod with Basket Adjustment (Plan 3-13) to be used in Spring Switches and Power Operated Switches.
℄ of turnout track
Continue with Standard Switch Plates thru Plate No.11 for 85° Rail, Plate No.12 for 100° Rail
TH RIGID BRACES
SOUTHERN RAILWAY SYSTEM
15'-0" SWITCH
75, 80 & 85 A.S.C.E. RAIL AND R.E. SECTION 100
JULY 8, 1948
REV. SEPT 8, 1949; APR 21, ...
REV. APR. 21, 1952
Y SYSTEM
ATES
RNOUTS
B. RAIL
April 23, 1952
4 TO 11
21-2152

REVISIONS:- ① To show plates for #14 Turnout: ② To show spike holes in Plates 1 & 1A referred to end of plate only; #14 plates to fit 115'-2 3/8" lead.
③ 4 No.1 Plates with rigid braces changed to No. 2 Plates (15' Sw.) and 8 No.1's to No. 2's (24' Sw.).
④ Plate marking changed by eliminating switch length from all plates and adding turnout number to plates 4 to 17 inclusive.

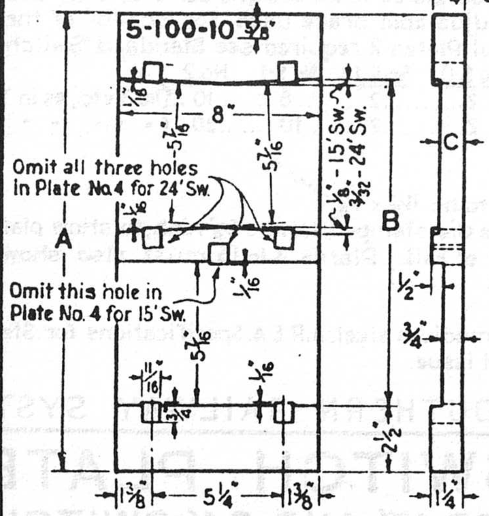


PLATES 1 & 1A

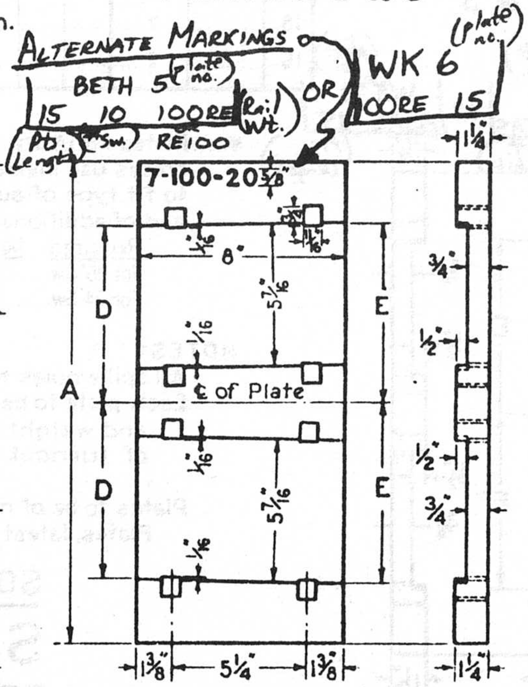
Note: Plate 1A has hole for spiking switch.
Plate 1 omits this hole.



PLATES 2 & 3



PLATES 4, 5 & 6



PLATES 7 TO 17

Plate	15' Switch (#10)	24' Switch (#14-#20)	#10 Turnout A	B	C	D	E	#14 Turnout A	B	C	D	E	#20 Turnout A	B	C	D	E
*1	12	20	19 1/4"	Plates 1, 1A, 2 & 3 are same for 15' and 24' Switches.													
*1A	2	2	19 1/4"														
*2	6	10	19 3/4"														
3	2	2	19 3/4"														
4	2	2	17"	11 15/16"	15/16"			16 1/2"	11 9/16"	15/16"			16 1/2"	11 1/2"	15/16"		
5	2	2	17 1/2"	12 7/16"	7/8"			17"	11 15/16"	7/8"			17"	11 29/32"	7/8"		
6	2	2	18"	13 1/16"	13/16"			17 1/4"	12 5/16"	13/16"			17 1/4"	12 9/32"	11/16"		
7	2	2	18 1/2"			6 23/32"	6 27/32"	17 3/4"			6 9/32"	6 3/8"	17 1/2"			6 7/32"	6 5/16"
8	2	2	19 1/4"			7 1/32"	7 3/16"	18 1/4"			6 1/2"	6 19/32"	18"			6 7/16"	6 17/32"
9	2	2	20"			7 13/32"	7 9/16"	18 1/2"			6 23/32"	6 13/16"	18 1/2"			6 5/8"	6 23/32"
10	2	2	20 3/4"			7 3/4"	7 29/32"	19"			6 15/16"	7 1/32"	19"			6 27/32"	6 15/16"
11	2	2	21 1/2"			8 5/32"	8 5/16"	19 1/2"			7 3/16"	7 9/32"	19 1/4"			7 1/32"	7 1/8"
12	2	2	22 1/2"			8 9/16"	8 3/4"	20"			7 7/16"	7 9/16"	19 3/4"			7 1/4"	7 11/32"
13		2						20 1/2"			7 11/16"	7 13/16"	20"			7 15/32"	7 9/16"
14		2						21 1/4"			7 31/32"	8 3/32"	20 1/2"			7 11/16"	7 25/32"
15		2											21"			7 29/32"	8"
16		2											21 1/2"			8 5/32"	8 1/4"
17		2											22"			8 3/8"	8 15/32"

(No. required)

* ..... Plates 1 & 1A are for use with rigid rail braces only. With adjustable braces use instead plates to be designated S-0, S-1A and S-1, to fit type of adjustable brace used. For location of these plates and of additional Plates 2 required see Standard Switch Plans.

Required	No. S-0	No. S-1A	No. S-1	No. 2	
For 15' Sw.	2	2	8	10	(No. 3, etc., as in Table above.)
For 24' Sw.	2	2	10	20	(" " " " ")

NOTES:

All spike holes to be 11/16" x 3/4".

Each plate to be die stamped, letters 5/8" high, to show plate number, and weight of rail. Plates 4 to 17 must also show number of turnout.

Plates to be of medium steel, A.R.E.A. Specifications for Steel Tie Plates, latest issue.

SOUTHERN RAILWAY SYSTEM

SWITCH PLATES

FOR 15' AND 24' SWITCHES
R. E. SECTION 100

JANUARY 10, 1944, Rev. June 15, 1944 ①
" Aug. 2, 1946 ②
" Sept. 9, 1949 ③
" July 15, 1952 ④

OFFICE OF CHIEF ENGINEER
WASHINGTON, D.C.

numbers, are stamped at one end of the top side of the plate; consult a specifications book for details of tie spacing to lay out the switch properly. Switch point joints employ a special joint bar set, with a "thimble" through one hole to allow point movement, and one joint bar bent for such movement; these should be used, and not regular joint bars! Rail braces are also needed in the point area of the switch. Switches with sprung frogs require guard rails slightly longer than normal opposite the sprung wing. Guard rails have their own unique mounting hardware. Guardrail flangeways should be the same as for guard rails on curves: commonest is 1 3/4" for MCB wheels, or about 1½" for street-railway wheels (street railways with "compromise" tread widths somewhere between street-railway and MCB contour need about 1 5/8" -- Los Angeles 3'6" cars have these, for example). Southern Railway uses a 1 7/8" flangeway, and a 2 3/8" flangeway on curves of 8° or more. This is for heavy MCB-wheeled equipment with long wheelbases (SD-35's and so on); museums with tight curves should use whatever is necessary and compatible with the equipment to achieve the necessary guarding power.

Spiking down a switch follows procedures for regular track. The frog should be laid to exact gauge; spike the heel and throat of the frog to exact gauge, followed by the rest of the frog, before other rails joined to the frog are spiked. In bending the curved stock rail, be sure and commence the bend about seven to nine inches in advance of the end of the effective point (the end of the point as far as the wheels are concerned).

Want a quick-and-dirty method for finding a frog number? Take a hand unit of measure -- your handspan, a stick, or a spike. Measure one "unit" wide, from gauge side to gauge side of the frog, at right angles to the bisector of the frog; then measure the number of "units" from that point to the theoretical point of the frog (the theoretical point is not the actual frog point; it is where the gauge lines intersect). The number of "units" is the frog number. The corresponding angle in degrees can be found in an appropriate publication: for example, a #4 frog is 14°15'00", a #2½ frog is 22°37'12", and a #8 frog is 7°9'10".

Trolley specialwork switches are extreme examples, but they require the same procedures in installation as do regular switches. These tight single-point switches will require regular switch ties, but will not require some of the usual switch hardware like slide plates and special heel-joint angle bars. Gauge is extremely crucial, as these switches include a pointless mate, which can divert wheels rightly or wrongly, according to the care with which you install the switch; frog placement is also quite important (and a #2 frog, with a 28°4'21" angle, coincides with a radius of 33') as far as gauge and alignment are concerned. Even a slight (¼" or less) miscue can cause excessive wear on the switch castings. If faced with a typical multitude of degrees of wheel wear (as Branford has been), you may have to adjust mate placement to provide the least number of flange-mate point collisions: on one switch at Branford, some cars hit the mate only when going straight, others only when diverging, and still others not at all! You should also install a 6-8' guard rail on the straight lead of the curved stock rail, leading up to the switch casting.

One museum with a unique problem is Orange Empire, whose trackage includes several dual-gauge switches, for the operation of both standard- and 3'6"-gauge equipment. One future installation will see the 3'6" track diverging from the standard-gauge track entirely (as at several locations in Los Angeles); there, only a pointless mate will be installed and 3'6" cars will only take the curve (gauge will be very important here, obviously), while standard-gauge cars will only proceed straight, with a guard rail to keep their wheels away from the mate's point. Another neat piece of specialwork that OET will soon fabricate is a 90° crossing of dual-gauge trackage by two 3'6" tracks! So museums with onl one gauge are luckier than they suspect. For a prototype installation, see the Carrollton Shops of the New Orleans system, where 4'8½" and 5'2½ dual-gauge specialwork is still in place!

D. Alignment. Once your track is put together, you must align it. Now is when you can correct all those little uncertainties in the track. Take pains to align the track properly; a low joint can become a proble joint, a low curve can spread quickly, and a sag in the track might become a river ford at times of heavy downpours!

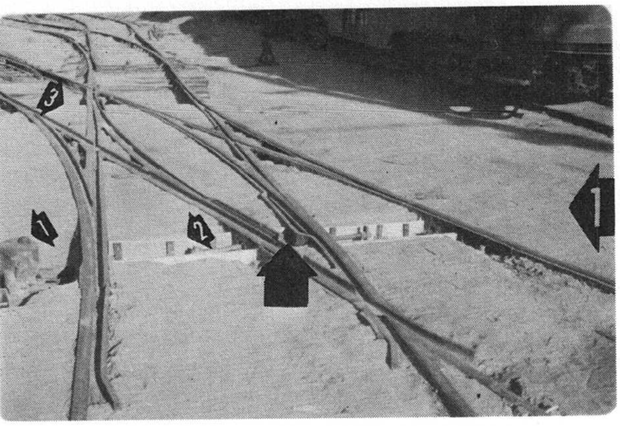
Lining the track will take care of the lateral axis of alignment. Your civil engineer and his transit can provide really exact alignment of tangents. Line your curves to conform to the stakes your engineer laid out. Alignment by eye requires a good eye. To find points of divergence, have one man take a pry-bar or long, thin stick and stand besi the rail. Then, without bending, the man should lay the stick or bar across the outside of the rail (or opposite side of the railhead from where he stands). Now have him walk slowly, moving the stick with him, until you see the stick at the point of greatest divergence. Set up you lining gang evenly on either side of that point; with you calling the moves, shift the track to the desired line. New track can be shifted by four average men working together. I don't recommend use of a bulldozer to line track unless the track is seriously out of line; bulldozers are difficult machines with which to effect small, precise corrections. I recommend the lining gang use pry-bars for lining: spike pullers have a heavy end which is unhandy to contend with; pry-bars, with chisel point are lighter in weight and better for getting a "bite" in the roadbed. Another method is to use track jacks to line the track: set them, one under each rail at the out-of-line point, with their bases resting on a slanting base (a rail brace on a tie plate is good). Raise both jacks a the same time, and shake the track over after every two clicks of the jacks.

Line one rail only. If the track is in good gauge, the other rail will be in line also; but check both rails just the same after lining is complete. Track should be put together tightly. Tight joints will probably not loosen after lining and tamping; go over the joint bolts after some operation has taken place over the aligned track.

Lining a curve is rather tricky. You can generally detect any irre ularities in a constant curve, with some practice. Use of engineer-set guide stakes will eliminate most of the guesswork in lining.

Tamping track will take care of vertical alignment, as well as preventing movement around a rolling axis (where one rail sags but the oth does not). There are arguments among, and within, museums as to the re ative merits of rock ballast versus all others. If you are desirous of using rock ballast, I strongly recommend you have available mechanical tamping equipment; tamping with hand tamping bars is one of the dreariest jobs in trackwork! Thus, for most museums, dirt or cinder ballast is indicated. Your selection should depend on what is available, what is already at the site, how big and strong a work force you have, what mechanical equipment is available, and how much money you have. Rock ballast should be 1½" or smaller, to assure good drainage and a firm foundation.

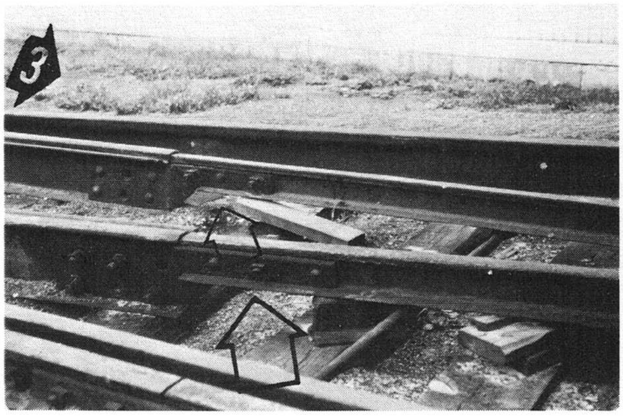
Dirt or cinder ballast is fine for the great majority of museums.

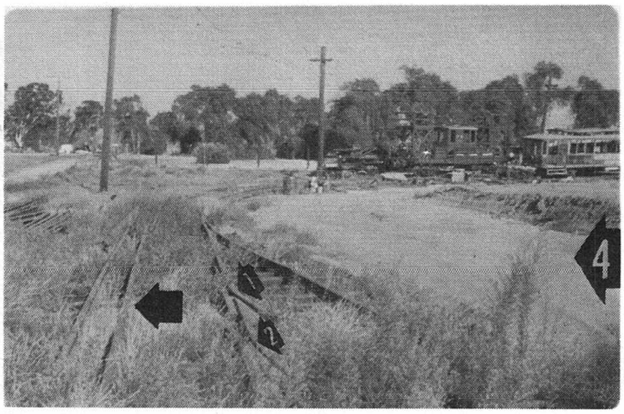


THIS PICTURE SHOWS THE DOUBLE-SLIP SWITCH AT ORANGE EMPIRE. NOTE THE STAND WITH NO STEM (#1) INSTALLED TO PROVIDE BETTER THROW-ABILITY FOR THE TWO HEAVY POINTS (black arrow) THE TRENCH (#2) WAS DUG AND WALLED TO KEEP SAND FROM HINDERING SWITCH OPERATION, AS WAS THE WALL AT #3. A GOOD "MAINTENANCE" PROJECT TO EASE OPERATIONS (THIS SWITCH IS THE ENTRANCE TO A FOUR-TRACK YARD AND A TAIL TRACK) AND UPGRADE AN ORIGINAL INSTALLATION THAT WAS MARGINAL AT BEST.

PICTURE #2 SHOWS A LESS-THAN-IDEAL SWITCH TIE LAYOUT. IT IS A HOMEMADE THREE-WAY SWITCH FOR TROLLEY CARS. NOTE THAT THERE ARE NO EXTRA-LONG SWITCH TIES UNDER THE FROGS, WHICH WILL ALLOW THE SWITCH TO SHIFT AROUND RELATIVE TO ITSELF; IN A TIGHT-RADIUS INSTALLATION LIKE THIS, A SHIFT OF A HALF INCH CAN CAUSE PROBLEMS. A BETTER COURSE HERE WOULD HAVE BEEN TO INSTALL A PAIR OF LONG TIES UNDER EACH FROG AT A MINIMUM, TO INSURE RIGIDITY.

PICTURE #3 IS A SIDE VIEW OF THE AREA SHOWN IN PICTURE #2. NOTE THE TWO UNSUPPORTED JOINTS (arrows) WHERE T-RAIL JOINS TO GIRDER RAIL. IN BOTH THESE CASES, PROPER COMPROMISE JOINT BARS ARE IN USE, BUT THE END OF THE RAIL IS HANGING IN AIR, WITH ONLY A PARTIAL SUPPORT -- A GOOD LOCATION FOR A FUTURE BREAK. IF FACED WITH A PROBLEM LIKE THIS, TRY LAYING A SOUND HALF-TIE LENGTHWISE UNDER THE RAIL FOR SUPPORT, AND WELD OR BOLT ON A GAUGE ROD OR TWO TO HOLD THE TRACK IN GAUGE. THEN JUGGLE TIES TO GET THEM UP TO THE RAIL BASE, OR PLAN THE JOINTS TO PLACE BOTH COMPROMISES OPPOSITE EACH OTHER.





HERE IS AN EXAMPLE OF AN ARRESTED PROJECT THAT COULD HAVE CAUSED A DERAILMENT. A SWITCH WAS SUPPOSED TO DIVERGE HERE, BUT PLANS CHANGED, LEAVING UNGUARDED FROGS (#1 and #2) IN PLACE ON THE COMMON RAIL (note the two other rails indicated by the arrow). A GOOD MAINTENANCE PROJECT IS EITHER TO INSTALL GUARD RAILS OR REMOVE THE FROGS (they were removed and replaced with straight rail a few months after this picture was taken).

PICTURES BY W.B. YOUNG, AT ORANGE EMPIRE TROLLEY MUSEUM (#1 and #4) AND MAGEE MUSEUM (#2 and #3).

IV. MAINTENANCE

A. Know Your Line. Once the track is constructed, you can relax briefly. Assuming that you followed sound track building practices, you: track will hold up nobly under traffic. But don't rest on your laurels forever! Track, no matter how well constructed, develops defects in tim and early correction is far preferable to waiting for a minor problem to become so major as to require an emergency program. Perhaps parts of your track are supported by poor-quality ties that were well-used before you got them. Perhaps there is a compromise joint that you "faked" together as best you could. Some joints might be without lock washers, ar some ties without tie plates. Perhaps there is a stretch of track that was laid on marshy ground, and thus is more prone to settle (such as the Warehouse Point group has had to contend with). There is always somethi to do on track. How well you keep up with the day-to-day problems will affect the long-run quality of your track; a couple of hours put to judicious and timely use may save a whole day later.

Get out and look over your line! Railroads at one time employed trackwalkers, who covered an entire section of track and checked for loo bolts, bad ties, broken rails, and so forth. You should get out and wal your line at least every other week, and more frequently if your museum operates a heavy schedule. Your group probably operates cars or trains, so take a ride -- it's an excellent time for you to enjoy operation, because that's one big reason why we're in the museum hobby field, isn't i Riding will help you find the misaligned track -- the sags or lateral "wowies" have a definite effect on operation as well as taking their tol of the track. That "clunk" at a rail joint will bear closer investigation -- perhaps it is a battered rail end, or a broken end, or a broken joint bar! In times past, a roadmaster might ride one of the faster trains on his line to check track quality: in better days, one New Haven Railroad roadmaster rode a fast special over the line, with a brimful glass of water on a table in one car, and wherever water sloshed over th edge he would note the milepost for future correction!

Check your joints for general condition. Examine the rail ends whil you're tightening the joint bolts, or as you pass by. Check for battere rail ends, which are precursors of a broken rail end. If the joint has been jouncing your operation, look and see if it's low -- sight along th rail, in the same fashion as that used to initially line the track. If it's not low, maybe it's loose. Maybe it's cracked, bent, or broken. Maybe a bit of the rail end has failed and is loose or missing. Once, while raising a low joint, I was striking the joint bar smartly with a maul to set it prior to giving the bolts their final tightening turns. A flaw suddenly appeared, running from the top of the joint bar, right a the rail joint, down toward the bottom of the bar. Each successive maul blow lengthened the flaw; as operating over a joint can have the same effect, the maul treatment may have saved a later failure which might have been disastrous!

Look over your ties. Check for ties that are not firmly tamped or tightly spiked. New ties won't require as much scrutiny as second-hand ones, especially the second-hand ties that were really used when you pu them in. Check for rot by use of simple tools: on straight track, lift the end of the tie with a bar, and if the tie end is springy and rises more than the rest of the track, change it out. On curves, drive a pic point into the tie end next to the outside rail to check soundness. Be committed to replacing bad ties as soon as possible!

Look over your rail for wear and defects. Your rail will probably be second-hand, and therefore already worn; if it is old rail (rolled in the early 1900's), be especially vigilant for cracks and defects, as ste was made a bit more crudely then. As I noted before, look over the rail ends for battering. Examine the outside rail on your curves for wear on the gauge side, especially if the curve has no guard rail. It doesn't take long, under steady operations, to wear down a good rail on a sharp, unguarded curve: Branford rerailed a curve, but was delayed in replacing the guardrail; the curve is about 200' in radius, and the outer rail became so worn in two years that it had to be turned (a hard job, but important)!

Check gauge, especially on curves. Gauge on tangents can generally be checked by eye, especially if you were there when the track was laid originally; use a track gauge for exactness. Incidentally, <u>measure</u> you track gauge to ascertain just what gauge it is built to determine -- the well-worn gauge bar might gauge your track 56¼" (as happened at Branford or it might have been the gauge used on curves, and therefore be extra-wide! Curves, especially unguarded curves, will be the most likely poin of spreading, so check them carefully. Watch for dog-leg joints, as the can effectively widen the gauge an inch or more if left uncorrected. Gauging is even more critical if you are operating equipment with street car-contoured wheels, which tend to have slightly smaller flange depths and tread widths than MCB wheels. There may be times when you must not allow the track to get more than <u>½" wide</u>, to keep your cars on the rails

B. <u>Odd Jobs</u>. This topic, like others, can be a volume in itself. Here, I am drawing largely from museum experience, mostly my own, to set forth some projects that you will probably have to undertake as a museum trackman. Many are the same jobs done by "real railroads", and they are done for the same reasons; museums will have other little tasks to do, as museum track often begins with a conglomeration of old and new material. Often a line is built at a museum without tie plates, lock washers compromise joints, sufficient bolts in the joints, or bonds, because the material just was not available, or sometimes out of sheer ignorance. Every operating museum has undoubtedly had to go through a lean period i funds, materials, and knowledge; however, later years afford an opportunity for vital catching up, and rectifying the mistakes of an earlier time. One now-prosperous museum used to take untreated ties, paint them with tar, and install them, expecting a service life comparable to that of treated ties (it wasn't)! Another large museum had partly installed one switch, and partly removed another, leaving <u>unguarded frogs</u> (see picture #4 at the beginning of this section) in a stretch of busy operating track! Still another group is only now changing out the 40# and 50 rail that initially made up its main line.

A "full-time" museum trackman should, as I have already mentioned, b primarily concerned with the construction and maintenance of the track a his museum. He should be one of the leading workers on track, and be capable of training new crew members in the skills necessary in track work. A track boss should also:

-- Be able to use a cutting torch competently.
-- Be a capable arc welder. Ramping joints, fabricating compromise joints, bonding rails, building up specialwork -- all require welding ability. Streetcar museums are especially blessed in thi regard, as welders that operate from the 600v overhead are available!

one, plate it, spike it, and tamp it. Two or three ties can be done wi one withdrawal trench, by digging it at the middle of the pack; clean out the whole area between the ties to be removed, and slide them out tl one trench you dug. Multiple tie replacement is an excellent time for installing ties to proper spacing as the job proceeds, especially if they're under track joints that have one end hanging over thin air (a bad installation). Of course, in multiple replacements, check track gauge carefully (you are probably concerned about gauge anyhow, because you're putting in better ties!).

Joints will require several skills. Low joints, of course, must be tamped to level. Dog-leg joints on curves should be brought to a smoot curve. In addition to the gauge-spreading tendency noted previously, t sudden "dog-leg" is an extreme point of wheel wear, and thus an invitat to have a wheel climb the outer rail, since the accelerated wear will reduce the head contour quickly to an unsafe shape. The ride in a car passing over such a joint is pretty jerky as well. Drawing in such a joint can be done by placing gauge rods on either side of the joint and tightening them to bring the track to gauge. However, if you are not well-supplied with gauge rods, you may use one rod as your regauging to set the rod right at the joint. Prior to tightening the gauge, pull th spikes from the joint ties and two or three ties on either side of the joint. Plug the inside spike holes before drawing in the gauge. Draw the gauge in as necessary; tighten the joint, and, if the joint bars a: badly bent, you might reverse them (put the inside bar on the outside, and vice versa, if the joint holes permit), or replace them with "wrap-around" joint bars which are less prone to bend. Plug the outside spik holes, then respike the section, driving the outside spikes first and drawing them inwards. Finish spiking, and then remove the gauge rod.

Joints require periodic tightening, especially joints on busy operating track. If you have lately come into a supply of lock washers, sta installing them as your tightening proceeds, being sure to rethread the nuts with their flat side against the washers! If you obtain a supply (gauge rods, start installing them as outlined on page 20.

Museums operating electric equipment will need to bond their joints. No matter how tight a joint may be, its electrical conductivity is poor unless a bond is welded to the outside of the railheads. Coordinate wi your power and signals departments in bonding: they may want cross-bonding at certain points, or impedance bonds (with corresponding insulated track joints) installed. Here is where your welding skills are useful. Welding ability will also be needed for "ramping" a low joint, where th rails are of the same cross-section but have heads worn to different degrees, or the rails are of dissimilar size and are joined by a "faked" joint. Joints with battered rail ends are bumpy, and continued poundin will tend to break off the rail ends or loosen the joint. Build up the ends of the rails, making a pad in the low spots, and then a ramp to ea the wheels up onto the new metal. Grind the welds smooth. Early detec ion of poor joint will probably require only a "ramp" job, as well as filling in any dents or battering in the end of the higher rail.

Switches will utilize your welding ability also. Frog points becom worn through normal use, and some judicious welding will restore them t a comfortable level. Don't forget to build up the flared ends of the wing rails as well! Street-railway switches have three cast pieces tha require periodic building up: the frog, the point (build up the sides a top, being careful to avoid heat-warping, so that the wheels are moved laterally enough to avoid picking the mate), and the mate (build up the point to assure a smooth ride). Use a good facing rod for this; I use pressure to build a lot of track with minimum-quality standards, as this will only lead to long, drawn-out trouble in the future. The <u>best</u> course is: DO IT ONCE, AND DO IT RIGHT; OR REDO IT RIGHT THE FIRST CHANCE YOU GET!!

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