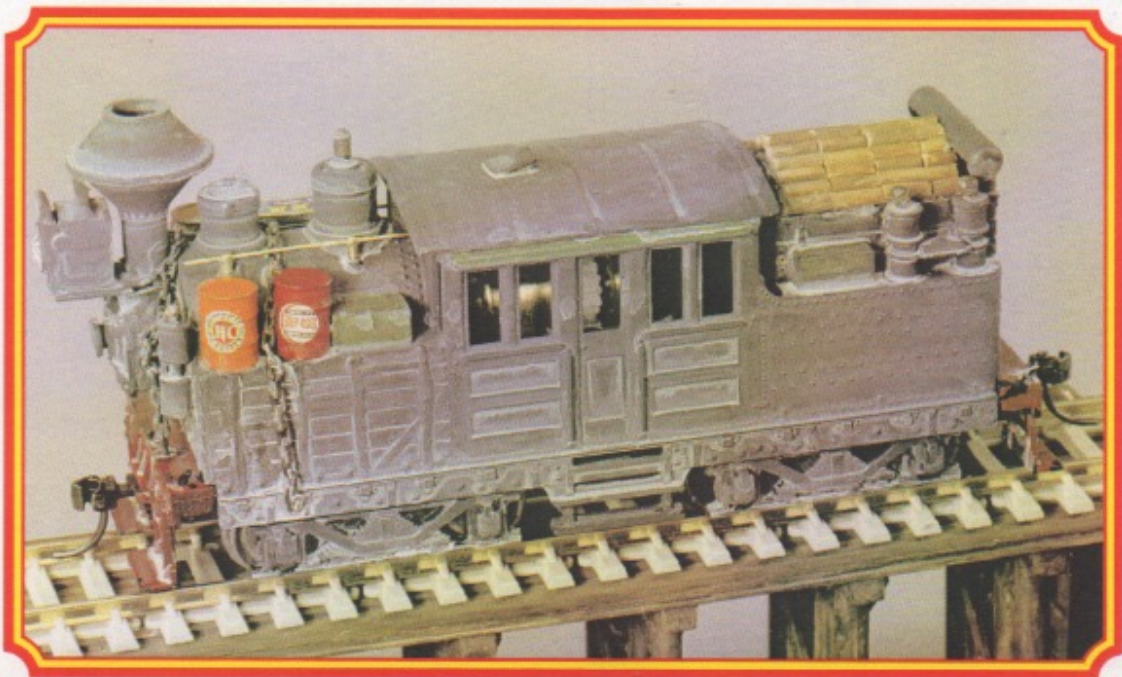


# TUNING FOR BEGINNERS

## BUILDING THE LAFEVER CLIMAX



**AUTHOR: RON LAFEVER  
PHOTOS: MONTY MATTOX**

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## FOREWORD

Thanks to my wife Peggy, who has shared my modeling interests for years.

Thanks to Norm Dudley and Ralph Emerson, both deceased. While expanding my skills, they became dear friends as well as mentors.

To Tom Bailey and other members of the East Texas Model Railroad Club at Commerce, Texas who are constantly expanding my modeling horizons. All have shared their knowledge and skills, which is what a club is all about.

Thanks to my many Internet customers, who have shared their personal skills and experience. They are more than I can list here.

Tuning Climax chassis, plus building turnkey Climax locomotives, has been a cottage industry for me the past five years. I plan on closing up shop later this year and semi-retiring from modeling.

Locomotive tuning is a dying skill. This booklet is written to help preserve some of these skills, if possible. Tuning takes in many side skills. There is no single thing, no simple procedure to work miracles. Each individual locomotive is a unique challenge.

Tuning is doing the numerous small things required that add up to a smooth running locomotive. While learning how, I also want to know why. I hope you learn something of the how and why from this book, while being entertained in the process.

Ronald LaFever



# TUNING ENGINES FOR BEGINNERS – BUILDING THE LAFEVER CLIMAX

**Author: Ron LaFever**

**Photos: Monty Mattox**

## SILENCING MDC'S CLIMAX CRITICS

I have always liked smooth-running locomotives. I have long been a firm believer in fine tuning my engines, even my N scale KATO's. When I retired, a friend built a small Climax for my HO switching layout decaled with my road name "Turtle Creek" and the road number 1. I liked the funny looking loco, but it sure was a poor runner. It clearly needed some help. I found out later that approximately 35,000 units have been sold over the past 35 years. And for 35 years critics have constantly cited them as "extremely noisy and poor performers."

But I did like it. So I decided to strip it down and see if I could improve performance and quiet it down. When finished, I was amazed at the vast improvement. The time spent in tuning the chassis paid off in a smooth running unit, plus the noise was brought down to an acceptable level. I did one for a friend, then a couple more for friends of friends. Somewhere along the tracks the nickname "LaFever Climax" stuck.

I have since 'tuned' close to 200 Climaxes with similar results. I have come to believe this small chassis is vastly under-rated. Many of my customers have asked what they can do to achieve the same results. No single problem area stands out, but there are a lot of little problems. The total accumulation of doing each individual step with attention to details should give you the same results.

While I wrote this book around the MDC Climax, a discontinued model, it is really a primer for tuning any locomotive. The example used is secondary. Every section pertains to any locomotive, not just this specific chassis. A novice can follow along at his/her own pace. An old pro might rediscover old tricks.

## REVIEWING BASICS

Increasing performance and reducing noise levels are two closely interrelated but sometimes separate goals. I believe there are seven basic steps in fine tuning any model engine.

- 1.) Improve power pickup if possible - a straight line is the surest path. If the motor is not getting the power to run, it won't run: sporadic power = sporadic running. Hard

wiring from the pickup wheels directly to the motor is essential. I rate this as #1 priority on any loco I own.

- 2.) Isolate the motor from the chassis and drive train where possible. Motors are the biggest contributors to noise in any model locomotive. They are the first things to move, and are usually the fastest moving item. Harmonics can cross feed and start other parts to resonating.
- 3.) Eliminate *unwanted* friction. Align, smooth and polish all moving parts. Everyone is familiar with 'polishing and beveling the gears'- but how about polishing the holes for shafts, or the sides? What about the shafts gears rotate on? Most commonly overlooked is ensuring the correct *alignment* of all parts/assemblies.
- 4.) Increase *wanted* friction - not all friction is unwanted. Wheel traction is wanted friction and can be enhanced by a smooth-running mechanism with proper weight and balance. Vibration at the wheels lifts them off the rails, reducing wanted friction and killing traction. Most of the tuning we will do, besides reducing power consumption and noise, also improves pulling capacity.

Traction can be further increased by adding reasonable amounts of weight. Excessive weight in the engine can reduce the pulling ability and shorten life. Balanced weight in the center third of the chassis is acceptable. An engine with balanced weight will usually out-perform one of the same weight but unbalanced

5. Balance and true all rotating parts if possible. Fifty years ago when I was taking shop this pertained chiefly to frame motors that we were required to build. The armature had to be balanced to keep the motor from vibrating badly. Today's motors are usually well balanced - but what about flywheels, gears on shafts out of round, or bent shafts?
6. Use appropriate lubricants - sparingly. Remember that the higher the viscosity, the more vibration is damped. Use grease instead of oil where feasible. Apply oil with a fine tipped brush - blot first on a piece of paper towel. Control where you apply it. Use plastic compatible lubricants except for metal-to-metal contact. Too much lubricant seems to attract and hold dirt and grit, the exact opposite of what we want.
- 7.) The shell should receive the same attention as the chassis. True, it's not often associated with performance, but a truly successful model needs both performance and appearance. A shell can rub against the chassis,

reducing performance and adding other unwanted problems. Tuning the shell and mechanism to each other should be automatic.

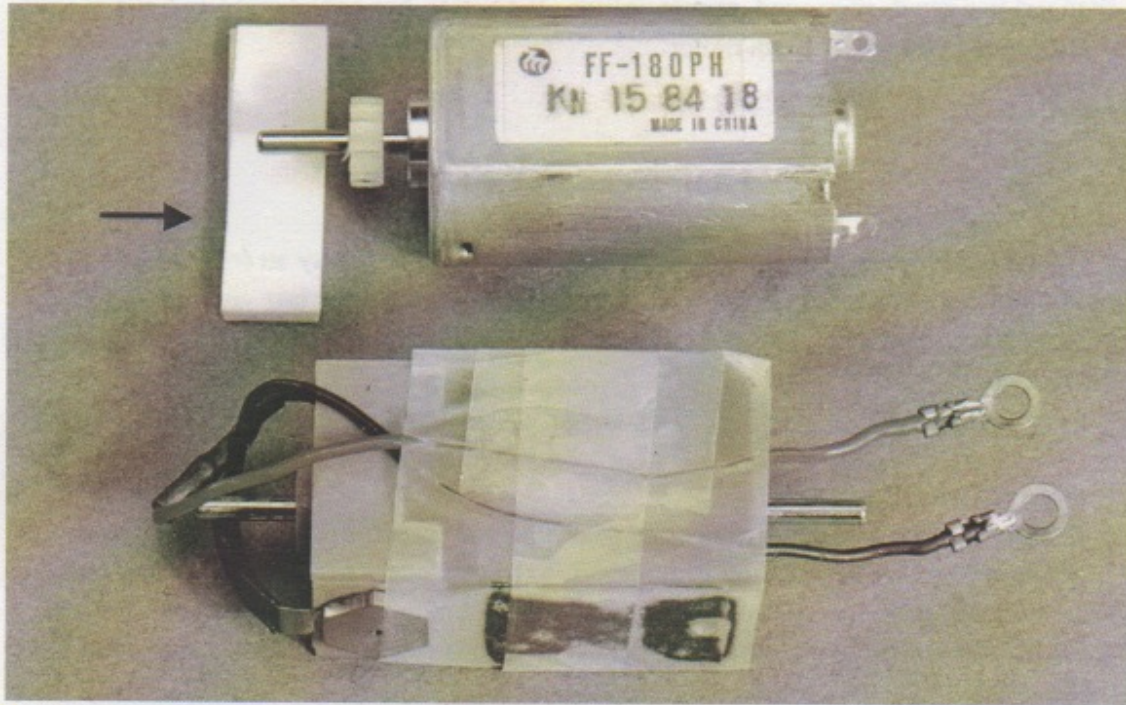


Photo #1

**Can motor off E-bay and MDC's new "Purple" motor. Open frame motors should be wrapped in tape and kept in sealed plastic bags until installed. This protects the motor. (White plastic 0.080 shim to space gear from bronze tip.)**

### OPEN FRAME VRS CAN MOTORS

This transition has been going on now for close to 20 years, and most manufacturers have recognized the superiority of can motors. I use them in all my projects and they're great. Here's why:

- \* sealed, keeping magnetic particles and dirt out.
- \* brush-less, with less arcing, noise and wear.
- \* lubed for life.
- \* readily available
- \* higher torque
- \* consume a lot less power, so they run cooler and last longer.

If you change, be sure to get a 2-mm (0.078) motor shaft. Be sure to get a 2-mm motor shaft with 12-13-mm shaft length. I get most of my can motors off e-bay, but they are widely available in hobby shops and elsewhere.

The early Climaxes came with a rough running open frame motor. About 2000, MDC changed to a much-improved purple motor. It's better, but not as good as a can motor. I recommend you go for a can motor.

### PRACTICES/DEFINITIONS

When I got into model railroading, an old timer suggested I buy an engine kit to build. I did - and can still feel my heart in my throat when I opened the box and saw all those loose parts. Most model mechanisms and all the MDC Climaxes will have one or more of the following:

- \* motor/flywheel.
- \* flexible shafts between the motor and gear box, and sometimes between gearboxes.
- \* gearboxes, where the rotation is modified for transmission to the wheels. This can take place with an array of reduction gears, often spur gears, or more elaborately cut helical gears, worms and associated worm gears which may provide additional speed reduction while changing the axis of rotation to fit the mechanism.
- \* Everywhere there is a shaft, there will be bearings, usually one at each end. This includes the axles.

Now there are some things I do automatically. Upon picking up a gear I look for missing, chipped or broken teeth. I check shafts for burrs where they were cut, for true running, and for anything unusual.

When I de-burr and polish an assembly, I automatically scrub it with a toothbrush in warm soapy water, rinse it well, and dry it. Spending time to polish something, then not cleaning off the chips and grit is a waste of time. So when I say 'wash, rinse and dry' that's exactly what I mean. Slightly or lightly means just enough pressure to barely rub - if the file, countersink or drill bit bites or digs in, that's way too much pressure. Let the tool do the work.

Grease means LaBelle's 106 Teflon grease. Why use grease where possible instead of oil? Because it stays where you put it better and we want the resonance dampening effect achieved by the higher viscosity. Oil means LaBelle 107 for metal to metal, and 108 for any plastic to metal or plastic to plastic parts. All are compatible with plastic.

I live 120 miles from the nearest hobby shop, no matter what direction I go. I suspect a lot of you don't have ready access to a hobby shop either. I kept track of what I spent on ordering modeling materials for a year - the freight alone was over 10% of my budget. So let me share some tips on possible local sources for materials mentioned in this article.

\* Save the back of writing tablets, shirt-cardboard, paper matchbook covers and 3" x 5" index cards. These are excellent shim material, can frequently be used as a substitute for styrene until you can get some in.

\* #400 grit wet/dry sandpaper available at most auto stores. Cut into a dozen 1/2" x 1" strips. Cut several strips to cover half one side of a wood Popsicle stick — make six.

\* Sanding sticks are two grit emery boards at drug stores. Revlon.

\* Puritan makes a pointed mini Q-tip with 6" wood sticks — order from a Medical Supply - Part #806 WC Pointed Mini - 100 per bag, 10 bags per box = 1000 (A penny each). Perfect for cleaning the HO wheel treads and flanges, touching up paint, etc.

\* Lumber companies carry a flexible adhesive they call "Clear Liquid Nails for Small Projects and Repairs". It comes in a 4-ounce tube and is an adhesive I've grown very comfortable with. I think it is more versatile than Walther's Goo and any other solvent-based contact cements. For this discussion, I will use the abbreviation CLN (Clear Liquid Nails) wherever a flexible adhesive is needed.

\* "Poster Putty" from school supplies aisle - useful as a third hand. A small ball will attach to a screw driver blade to form a screw-starter. Lots of usage. Pick up a bottle of Elmer's Rubber Cement while you're there.

\* Acrylic nail polish works well as shrink tubing. Use two coats.



Photo #2

Que tip: stick minus cotton is pointed. Poster putty goes a long way, has many uses. CLN = Clear Liquid Nails.

### GET THE LEAD OUT

While we are out shopping find a Wholesale Plumbing Supply store. Lead comes in three basic forms: as lead wool, birdshot and sheet lead. Needed: some sheet lead, as for shower pans. It usually comes in 48-inch widths and sells by the pound. We want 9-inches. Add a tin snips to the shopping list to cut the lead with and disposable rubber gloves to wear while working with it. Avoid smoking or eating while handling lead.

Cut the lead into 12" X 9" mini sheets. It is easier to handle. Place the sheet on a level and firm surface. Place a flat board on top of the sheet and pound the sheet flat. Turn the sheet over and repeat. Do not saw, sand or file lead. There will be small filings every where. Shave, or whittle, to fit. Big shavings beat small filings. Measure and cut five pieces 5/8" width, and 1-1/4" long. Use the rest to add weight to your rolling stock.

Stick-on weights, used to balance custom wheels, can be had at tire stores. Lead bird shot can be purchased at gun shows by the bag full. Some hobby shops carry sheet lead at a higher price.

### MEASURE THE INVISIBLE

You must be able to measure what can't be seen. At minimum you need to have and know how to use the following:

- \* Digital (easy to read) caliper for accurately measuring physical parts. You would be surprised at how much 0.003-inch difference can make, and you can't understand this until you have the means to *Measure* or *See* the physical difference.
- \* Multimeter that can measure voltage and current in various ranges. We need to *See* from 0 to 12 volts (the normal power) and 0 to 100 milliamps up to 2 amps. The current (or amperes) a chassis draws is a clear indicator of the amount of friction it has to overcome. I have two meters, one hooked up to measure voltage and one for current. Then I don't need to be constantly switching from one to the other.
- \* NMRA track gauge for your scale from your local Hobby Shop, Micro Mark Catalog or from the NMRA.
- \* Coupler height & trip pin gauge - Walters 380 — 205

Ask a modeling friend to demonstrate the use of your new tools — you will find them a practical *Must Have* addition to your troubleshooting skills. It helps if you can *see* what you are doing. Once you get familiar with using these four tools you'll never be without them again.

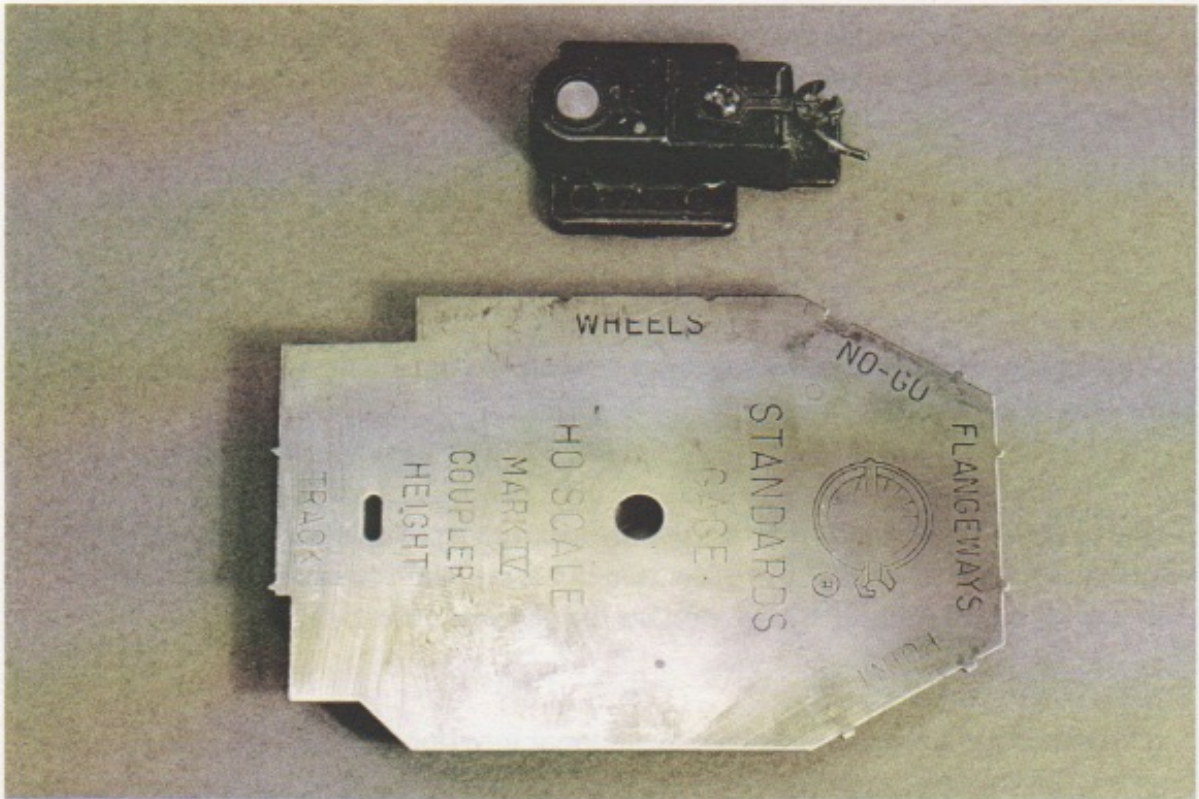


Photo #3

**Gauges - NMRA & Coupler. Standards are the key to quality.**

### ENOUGH GENERALITIES

Lets get started on the frame. We will be stripping the chassis and putting the parts removed into one of three small containers. When parts are cleaned up and ready to reinstall we ll need a second container labeled "Ready" to put them in. Also a container marked "BAD" for parts to be ordered. I'm partial to tuna fish cans, but any small containers will work. They don t need to be very big —most models aren t — and remember that the Climax is a small locomotive.

I keep small bottles of green and orange Acrylic paint handy on my work bench. Apply a small dot of orange with a toothpick if a part is bad. For the Jackshaft I apply it on the center of the Jackshaft between the worm gears.

Remove the body shell so you can see the mechanism and work on it without damaging the external details. Connect the Multimeter to your power supply. Record the voltage and current it takes to barely start the wheels turning. This is the Start Voltage/Current . Once started, often the throttle can be turned down until the wheels are still barely moving. This second reading is called the Crawl Voltage/Current . The goal is making the difference between the two as small as possible. Record all readings.

We are going to run two more preliminary tests before dismantling the chassis.

- First turn chassis up side down and apply 50% throttle power to the wheels of one truck. With chassis upside down check all four axles and wheels for wobble — looks like a bent bicycle wheel. Check both trucks. Slowly run power from zero to 50% and back while concentrating on one wheel assembly at a time. If one axle wobbles, identify for later.
- With power still applied to one truck, with your thumb apply *light* pressure to try stopping the wheels on the other truck. If you can stop any of the wheels on either truck you are going to probably need either new Jackshafts or the Jackshaft coupler is loose. This is a quick method of finding loose components. Later we will measure the worm gear diameter for a go/no go analysis

Here we have a potential problem. Right now replacement parts are not available from either the manufacturer or after-market. Bad Jackshafts run in pairs. If both of yours are bad you are probably out of options. I strongly advise reading the entire book before tackling any project. If you need parts that aren't available, and can't be obtained or custom built then you need to be aware. Now is the time to decide how far you want to go.

If you want your locomotive on your layout you can make it a Dummy. Leave out the bad Jackshafts, assembling the trucks without them. Use a wooden dowel or Q-tip for a Jackshaft instead, sticking the parts together with CLN. All that's needed is small dabs, just enough to hold things together. When installing the truck leave out the Universal Link. You now have a "Dummy" Climax.

An illustrated parts breakdown can be a very useful tool. It contains information not readily available elsewhere and will enhance a clearer communication. Complex mechanisms can be magnified for clarity. The parts named on the breakdown will be capitalized. If you see a strange word with a capital first letter, it is probably a parts name. 'Jackshaft' is an example. Looking it up on the exploded view can show how this part fits in. With Horizon Hobbys permission a reprint of the Parts Breakdown for the Climax is provided, plus two drawings, as attachments 2 and 3 in the back of this book.

## DRILL & MILL

With these two running tests complete, the results recorded and possible problems marked, strip the chassis. De-burr and round the edges where parts fit together, even if you think they aren't important. You can ignore the inside bottom of the chassis. Use a counter-sink or larger drill bit to knock off any burrs around the holes. General rule of thumb is to use a drill bit twice as large as the hole you're de-burring.

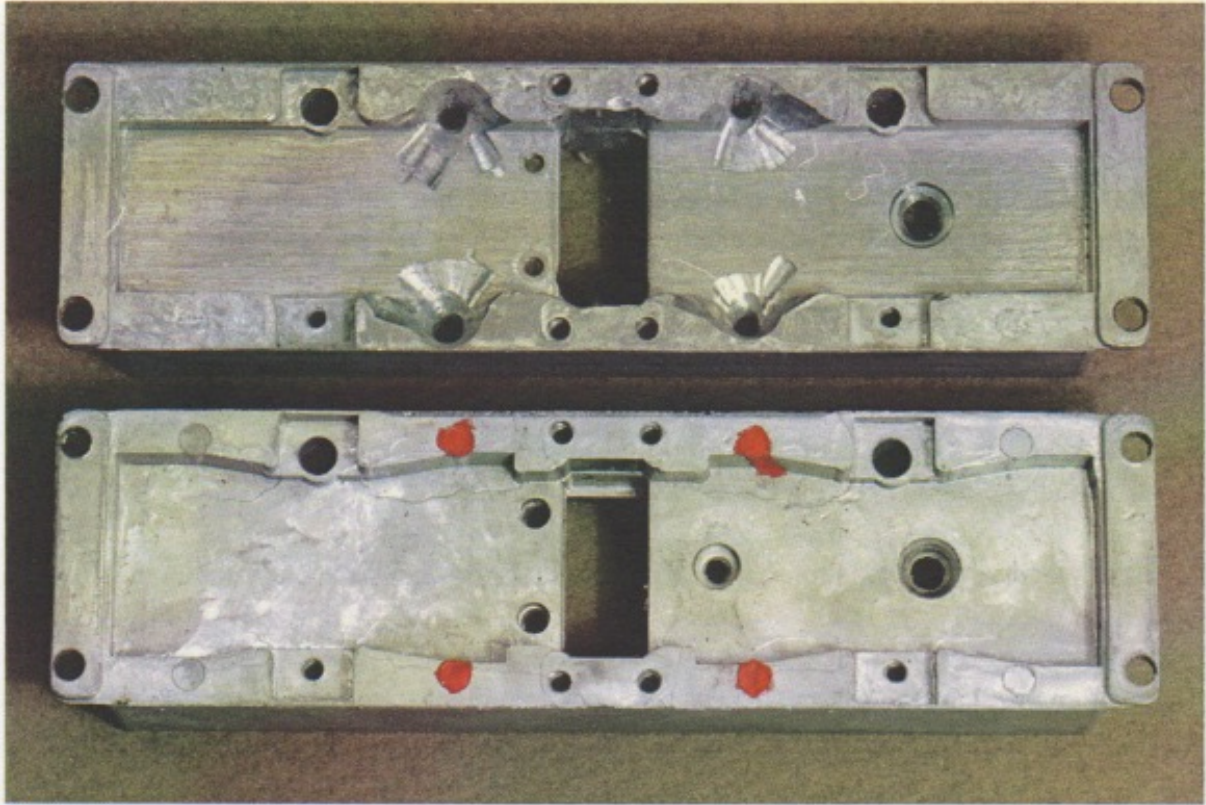


Photo #4

**Bottom frame with four orange casting dimples to show where to drill holes for 'Hard Wiring'. Top frame shows holes drilled with hole-wall machined out with #125 Dremel cutting tool. Note polished floors.**

Looking at the bottom of the chassis locate the eight casting dimples. Center punch the center four and drill a hole all the way through with a #43 drill. The drill size is not critical - just so a #29 gauge wire and insulation will pass through easily. Each mechanism is unique — basically the wire needs to transmit voltage from the wheels to the motor. Give this pathway some serious thought before proceeding. Assess where and how to leave some extra wire so taking the unit apart for maintenance won't be a nightmare.

Most frames are either of an engineering plastic or cast Zamac, a proprietary alloy of zinc and aluminum. Zamac is a soft metal — excessive heat can warp it with no clearly visible or easily measurable indications.

I always keep a container of soapy water handy to dip the frame in to prevent it from getting hot while drilling or milling. I mix up Super Wet Water using four to six tablespoons liquid soap per gallon of water. Keep a coffee can full where you're drilling. It's a great lubricant and cleans away the grit. Drill/mill 20-30 seconds, dip and swish, repeat. Applying maximum pressure while drilling only dulls the bits, generates high heat both in the frame and the motor tool and can cause distortion in the frame. Follow the same routine as drilling. Take your time - and don't forget your safety goggles or face

shield. When all four holes are drilled deburr the hole edges top and bottom. Wash, rinse and dry.

Using a Dremel #125 high-speed cutter at max RPM mill the metal from the four holes on the bottom. Round the hole opening out for a smooth transition for the wire to ride in. Do the front side of the hole also to increase truck swing.

If you have a Gear Housing with two enclosed gears test fit the Gearbox Housing (sans gears). Remove metal from both sides of the gearbox opening if needed, at a taper until the gearbox fits with a *very little* slop towards both sides. ***Be careful cutting around the gearbox mounting holes!*** When the gearbox fits remove and set aside.

If you have a single-gear Gear-Housing there is no fitting necessary.

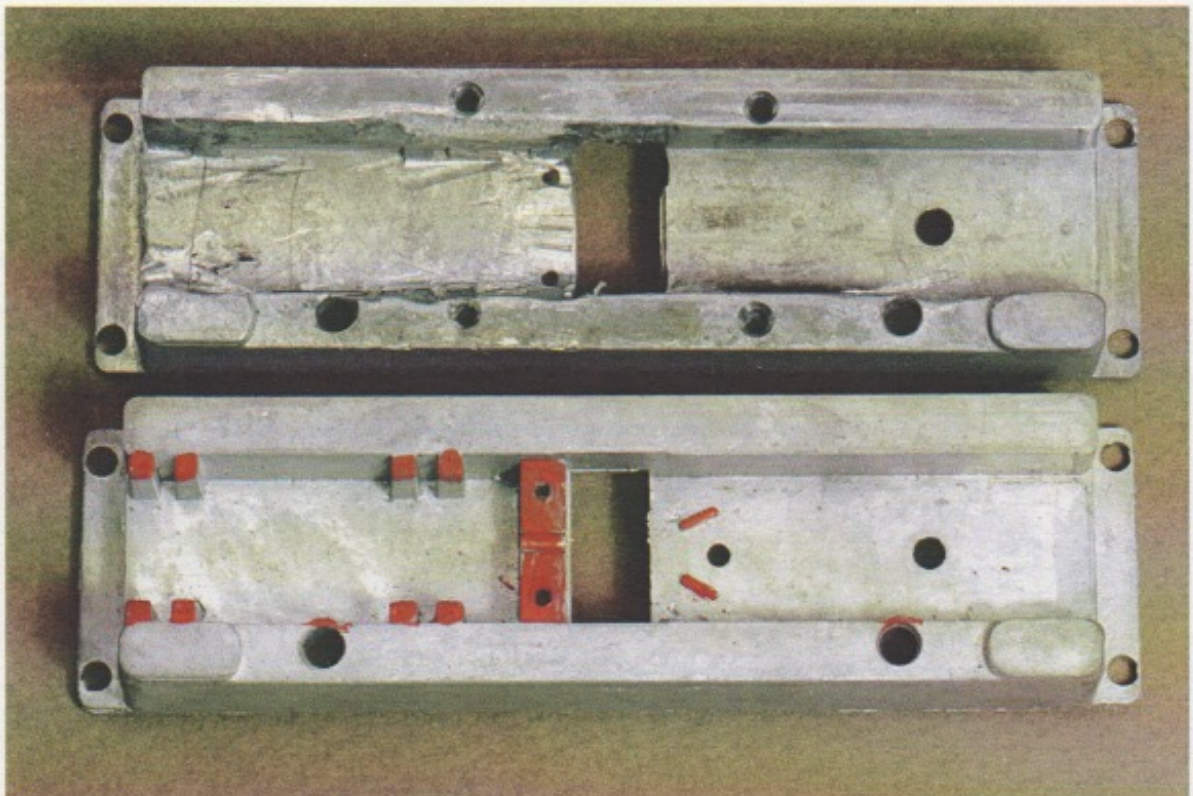


Photo #5

**TOP frame** —orange highlights show metal to be removed with #125 Dremel cutting bit. Looking down the top frame there should be no obstructions.

Turn the frame over and locate the two elongated v-shaped protrusions on the motor end and remove them. While we are at it remove the old gear-shaft post and flywheel guides also. We will want them out of the way when we add weight, a brass flywheel or DCC. Looking down the topside of the frame from end to end the only intrusions should be the small round walls of the two through screw holes. Mill these flat. If you're building a new kit most of the above is already done for you, except for the flywheel guides.

Back on the bottom side of the frame there are six screw holes — run a 2/56 tap down all six. If you don't have a tap you can use a 2/56 X1/4" screw. When tapping take your time — turn a half turn, back off a quarter. Clean tap frequently. Chasing screw threads is not the same as tapping. Run screw all the way down, then remove.

Self-tapping screws are usually short in length and are tapered. In my experience they tend to grab when tightening. Worse, if they won't tighten up they leave a loose part. This is what we are trying to correct. I use 2/56 X1/4" screws. The holes are plenty deep enough, already taped and they chase in without causing distortion and stress that can cause noise and friction. Let's build it to last.

One last step: the bottom of the frame floor where the truck retainer top rubs against the frame should be lightly polished. I start with a fine flexible file, coarse sanding stick, then fine. Using a side-cutter square off the rounded end of the sanding stick. Snap it loose with a twisting motion. When satisfied wash, rinse and dry. Put frame in 'READY' box.

#### TOP RETAINER & MOUNTING ARM

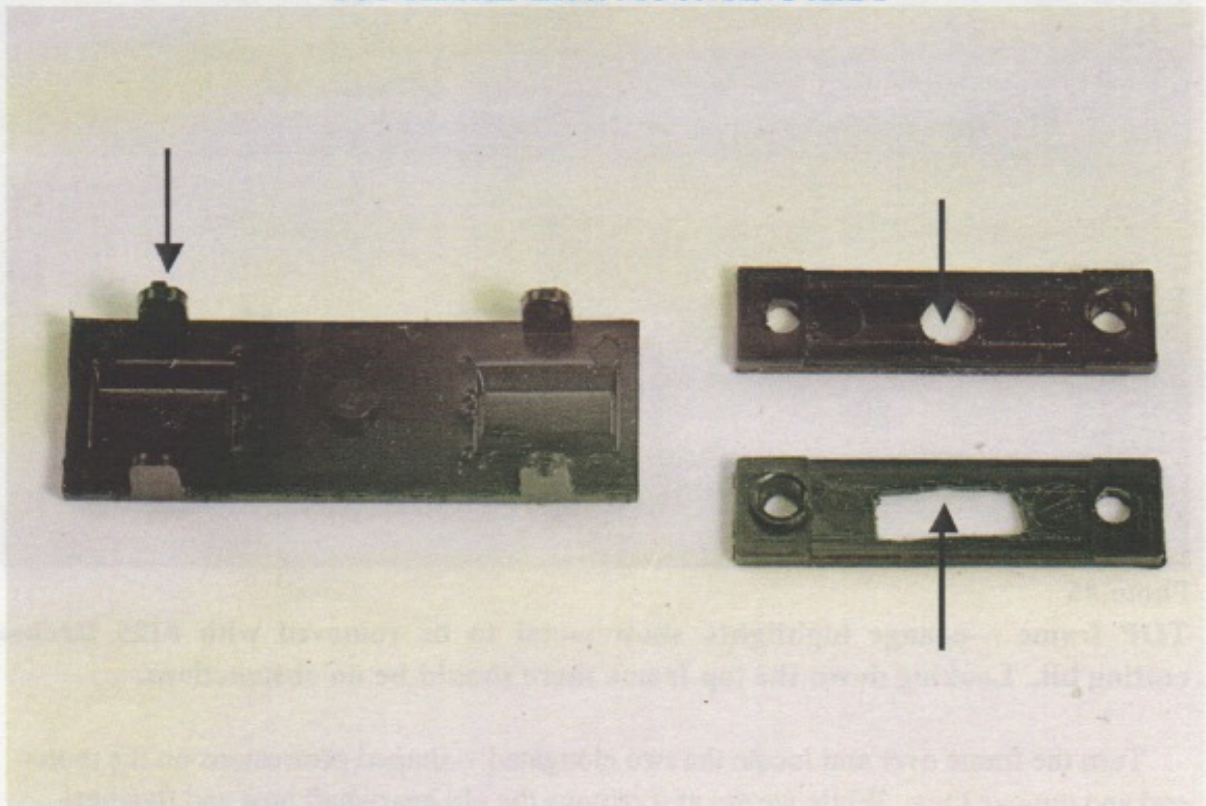


Photo #6

**A Top Retainer and two Mounting Arms. Round hole (top) = 15" min radius. Note lines top/bottom casting dimples to guide enlarging rectangular slot = 10" radius.**

Dig out the four plastic pieces that comprise the Top Retainer and Mounting Arm assemblies and thoroughly de-burr. All edges should be slightly rounded. Three key areas are the top flat side that rubs on the bottom of the frame, the outside edges of the fingers and the hole in the mounting piece. The top surface (no obstructions) *should not be sanded*. Just lightly de-burr the edges. The plastic contains a lubricant and we have already polished the frame floor. When we assemble the chassis we will give this surface a light coat of grease. Deburr the rest of the truck retainer.

The outside edges of the four fingers need to be as smooth as possible - they hold the truck assembly on, and just fit between the wheels and the side frames. Any burrs can cause friction and noise. *Do not sand/polish the balls on the inside end of the fingertips - they are all that hold the trucks on.*

The plastic mounting bar should be de-burred, edges rounded and the mounting holes lightly touched with a counter-sink. The center hole needs to be *slightly* enlarged with a small round Swiss file. What we want is some *small* amount of play of the truck side-to-side and front-to-rear. Improved tracking, better electrical contact of the wheels and noise reduction result — and the trucks are still firmly mounted to the frame. When you can wiggle it freely by finger without lubrication wash, rinse and dry. Put in 'READY' box.

### WHICH MOTOR GEAR

We need to find out what gearing is available that works. On the MDC Climax there are two styles of gearboxes. One style has only one gear, the Lower Gear. (AKA bull gear — so shall we call it). The other has two gears, the Bull and Idler gear. I sent a sample of both motor gears to NWSL. Experimenting, they came up with two possibilities, both stock components.

Which gear housing you have will determine which Motor Gear you need to order from NWSL. If you have a single-gear gearbox you should order NWSL part #77626-6. This is a brass 26-tooth large diameter brass gear. We have reverted to the Version #1 frame where the motor gear was the same diameter as the Bull Gear. This will work with 90 % of the units out there.

If you have the two gears style you should already have a good Motor Gear. Should your Motor Gear be damaged, or missing, order Part #78612 — 6. Both motor gears require adapter 10159-9.

Without the proper tools and experience to press-fit anything on a shaft will probably result in a failed motor. Everything must be near perfect to maintain concentricity. I send my motors to NWSL who, for a nominal fee, will mount the gears on the motor shaft for me. The wait and cost is worth it.

## NEW GEAR HOUSING - SAME OLD BULL

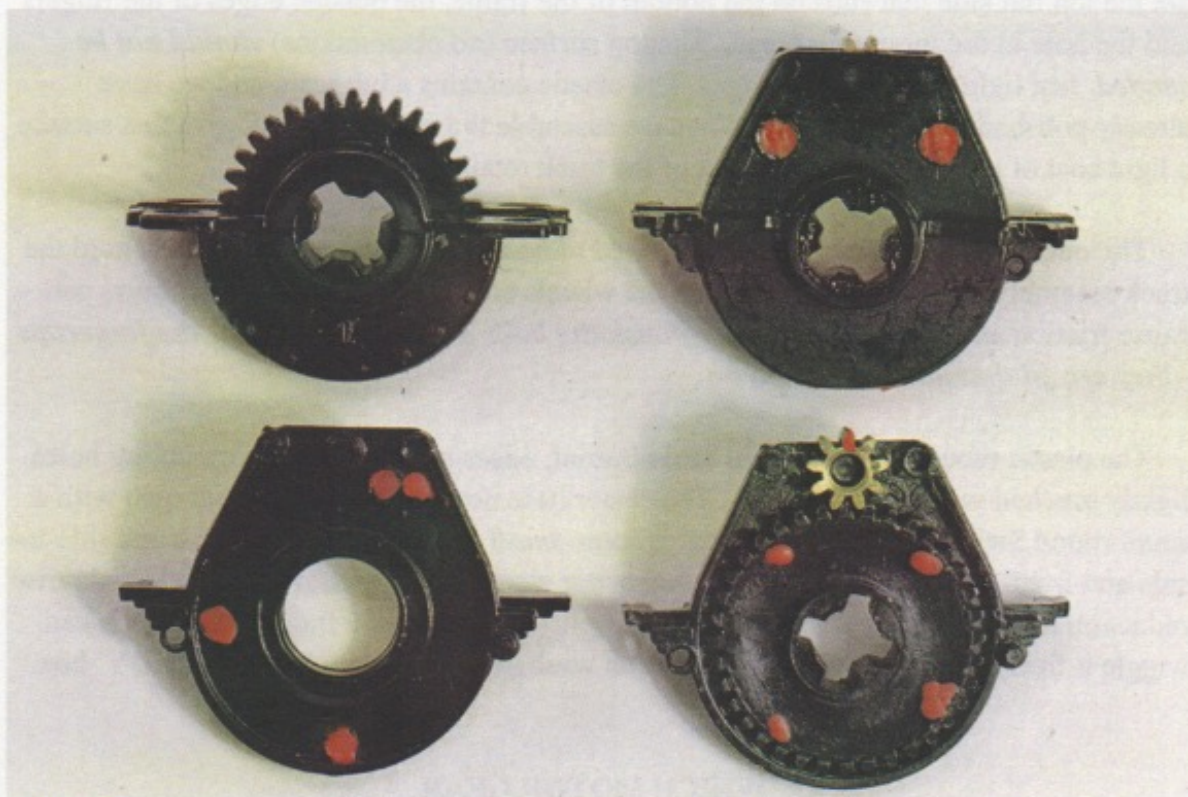


Photo #7

**Top Left: Old gear housing. Top Right: New gear housing, bottom of housing shaved for clearance. Remove two posts on one side only. Bottom Right: Dots on gears is for reference in polishing gear teeth. Bottom Left: dots indicate key area to deburr. Do both halves. Beveling the gears is not necessary.**

The old Gear Housing only covered half the bull gear. The new one completely encloses the Bull and Idler gear, a big design improvement. The same old Bullgear is still used in the new kits. There are four refinements to the Gear Housing that will enhance performance and lessen noise.

\* Leaving both gears out, snap the two gearbox halves together and hold up to a light. If the two mating sides don't completely touch, lightly sand the four posts down until no light can be seen. Small steps in sanding please. The two sides should fit snugly all around.

- Shaving the bottom of the two - Gear Housing allows passage over 321 uncoupling magnets, road crossings and etc. without high centering. Using your Dremel drum sander at low speed remove just a small portion of the bottom of the Gear Housing. Just enough to create a small flat spot. We don't want to eat through the housing. This is Preventative Maintenance — now when we go to run our finished loco, should

we need clearance, we'll have it. If we don't do this, and we did have a clearance problem, we would have to disassemble the engine to clean the sanding dust out of the mechanism.

The single-gear housing doesn't require shaving.

\* MDC recommends removing half the length of the upper half of each post on one (only) side of the gearbox housings. They recommend this as a way to remove the tension on the sides of the Gear Housing when snapped in the frame slot. I cut off both posts on one side with small side-cutters. Now we can make small adjustments, if needed, and completely eliminated the tension in the Gear Housing sides.

\* Looking at the inside of both gear box housing parts you will see three casting dimples @ 1, 6 and 9 o'clock. The dimple at 1 o'clock usually has the largest flashing, and can rub on both gears because of its position. With a sharp knife clean it up as best you can, then sand. Folding a piece of #400 paper in half 3 times will get the job done. ***Be careful of the idler gear post when doing this.*** The only thing to be done to this post is slightly rounding the top edge to remove burrs. Experience shows the rest of the interior should be clean and smooth, requiring no further attention - but check it closely anyway.

## GEARS

Cut some #400 grit to 1/2" X 1" strips. Put a reference mark on the top of an idler gear tooth. Fold the paper in half twice and polish all the gear teeth and valleys. Using a countersink or larger drill bit, de-burr the holes on both sides of the idler gear that rides on the post. Lightly does it. Polish the sides of the gear. I use small paint dots to reference my progress.

The 'Hot Phrase' these days is "polish and bevel the gears". On fixed gears like this I believe beveling is a waste of time. Beveling works where gears are sliding back and forth and meeting at an angle. I know I'll get mail on this one - but success is hard to argue with. Before you write look at the Bull gears' width versus the Idler gears' width - notice how narrow the Bull gear is - the sides of the Idler gear mesh with - nothing. Can you still believe beveling either of these gears would do any good?

On the Bull gear locate the side that has the three casting dimples. Clean up any flash around the dimples. Put four small acrylic paint dots 90 degrees apart on one side of the Bull gear towards the outer edge. These are for reference only while smoothing the gears. Change folds every 90-degrees. Smooth the gear teeth and valleys. Remove the paint dots. Wash, rinse and dry all four parts. Assemble the four parts dry - they should turn smoothly by finger with no binding or hesitation. (Two gears, plus two half Gear Housings.) Put in 'Ready' box. See pictures.

## DOUBLE THE PLEASURE

The trucks are the most complex assemblies, thus the most daunting. Yet they are simple if you take a moment to really look at them. Pick up one of the trucks and look at it carefully. Learn from my mistakes: follow these step by step instructions for disassembling the truck. The two Side Frame, Die Cast (AKA Metal Side Frames) are soft Zamac metal, so don't use excessive pressure. The Metal Side Frames have two posts that extend into the Sub Frame (AKA Plastic Sub Frames). Using a small flat screwdriver push it straight down between the bronze Pickup Arm and the Plastic Sub Frame. Gently pry outward, wiggling the blade back and forth, until the Metal Side Frame slides off. Repeat on the opposite side.

I normally try to keep the parts from each truck together. In most cases they are designed to be interchangeable, but I find that it generally works better not to mix them up unnecessarily. Mating parts may have run in together, especially if the locomotive has been run quite a lot before tuning, in which case they will run more smoothly if not mixed.

Turn the remaining assembly over so the wheels are on top, then tip wheels away from you. Look carefully to find where the Retainer, Bottom (AKA Bottom Cover) snaps onto the Plastic Sub Frame. Slide a small flat bladed screwdrivers tip under the bottom cover edge just above the two postholes in the Plastic Sub Frame and gently pry the Bottom Cover edge up and outward until the hooks release. The cover will pop off, the wheels will fall out, the Plastic Sub Frames will separate and the Jackshaft will fall out.

Remember our first check where we tested stopping the wheels with our thumbs? If both trucks passed you are probably in good shape. If not, I recommend that you check both worm gears on both Jackshafts. Normal readings should be between .305 to .310 inch. Failed measurements are normally .290 inch or less. There seems to be no in-between.

If you don't have a dial caliper you might have a mechanic or machinist friend check dimensions for you. If this resource is not available but both trucks passed the test I wouldn't worry about it, you're probably okay. But wouldn't you rather know for sure?

Why is the Jackshaft so critical? I was building four chassis at one time when I noticed that when one particular chassis was starting up a slight incline it would halt and just sit there with the motor turning but not the wheels. Investigating I could see nothing obviously wrong. I picked the chassis up from the track - the wheels turned. Put on level track it would run. Any incline, it would just sit there. When the trucks were replaced with known good trucks the chassis ran fine. Having known good trucks available, I started swapping individual parts until I had isolated it to the Jackshaft. I finally got

around to measuring and checking the other units I had on hand. Using my dial caliper I measured the worm gears that passed the thumb test - they all measured .305 to .310 inch consistently. The bad ones ranged from .285 to .295 inch. MDC standard is .305 minimum. *Just .010 smaller diameter made a big difference.* The worm gear engaged the upper tips of the axle-gear just enough to turn the wheels. But under load the tips of both axle gears slipped and that truck had no power transferred to the rails. *No noise, no symptoms, nothing.* I discovered this by accident, and have since resumed my old habit of measuring all critical components. If I had from the beginning this would not have occurred.

When I mentioned this problem to MDC, they replaced the under-tolerance shafts with good units at no charge. Years ago MDC had problems with the then vendor and changed to a different vendor. The ones I was working on were at least 20 to 25 years old, which fit into that time period.

### BACK TO TRUCKING - THE JACKSHAFT

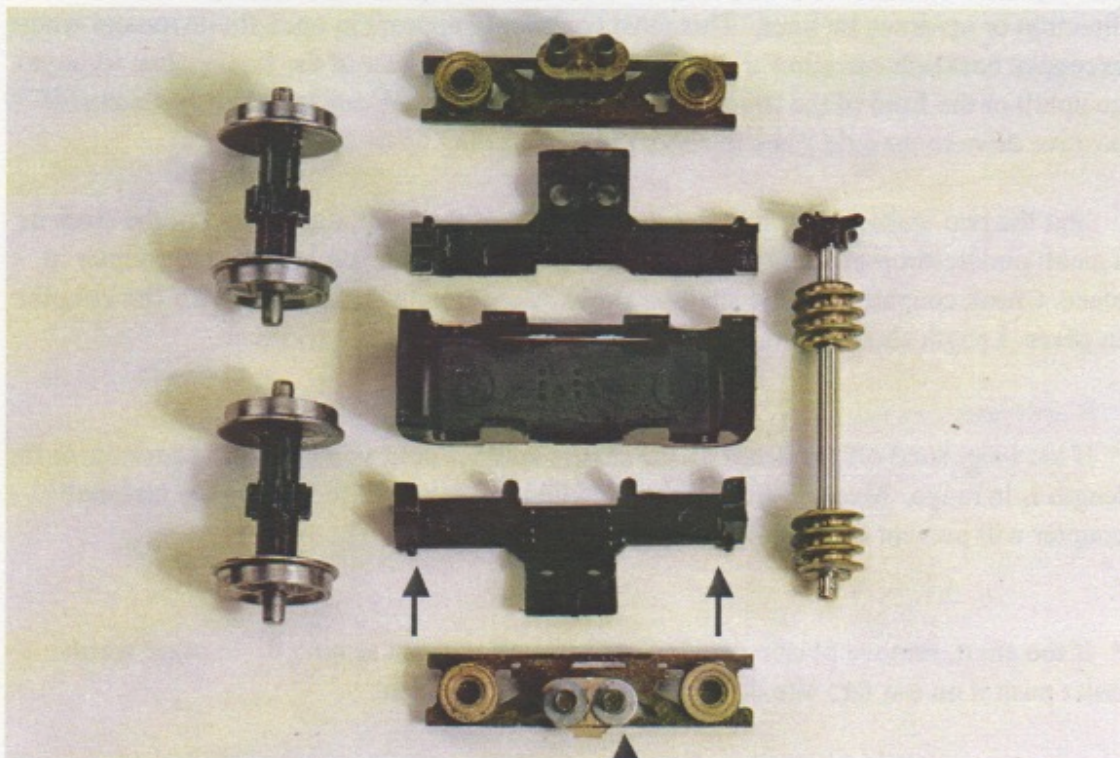


Photo #8

Disassembled truck. Looking at Plastic Side Frames as fat based T note protrusions at bottom ends of crossbar. Do not remove, as these line up the whole assembly. Spacer washers to shim side to side play.

We now have a truck disassembled. Pick up the Jackshaft, place the jaws of small needle nose pliers between the worm gear and the plastic coupler. Slowly pushing the

pliers handle down, remove the plastic coupler. Place a forefinger on the end of the shaft to keep the coupler from flying off. When separated remove the thrust washer from both ends and place them in the 'READY' container along with the coupler.

Check the worm gear diameters with your caliper. Test the shaft for run out by rolling across the workbench top. Feel the gears for burrs and remove if found. Check the worm gears to see if they are tight on the shaft. Mount the Jackshaft in one plastic side frame. The small end of the shaft should completely fill the half mounting. Place the other plastic side frame on the shaft. Holding the two plastic frames firmly push-pull the Jackshaft back and forth to calculate backlash. *We want to minimize the backlash but retain free movement.* Putting just one more washer on both ends restricts rotation. Check me out on this - try it your self. If you don't have extra washers, ok. Order part #103-4 washers from NWSL — see Parts List Attachment. We'll use them later.

An old rule of thumb is to always put the same amount of washers on both ends to center the shaft. *Better a shade too loose than a shade too tight.* Minimizing backlash in drive systems reduces noise and ensures we won't have problems running in either direction or up/down inclines. This most commonly appears in open frame motors where excessive backlash can allow a motor armature to rub the rear of the frame when trying to go uphill or the front of the frame when going downhill. On our Jackshaft it ensures positive drive to the axle gears in either direction, going up or down hill.

Put the two washers you have on the long end of the shaft, dip the end of the shaft in a small puddle-drop of ACC then install the plastic coupler. Lightly tap the coupler in place. Check coupler is on the shaft squarely. Measure the shaft length **with the coupler in place**. Length should be within 1.665 inch and no less than 1.655 inch.

\* If too long, sand off the detail on the plastic coupler until you have a flat surface, or the length is in range. Measure frequently. Sanding the detail off the end of the Jackshaft coupler will prevent driveshaft jamming.

\* If too short, remove plastic coupler and reinstall without seating it. In other words, don't push it on too far. We don't need to lengthen it much.

\* Wash, rinse and dry. Place it to one side for now.

## ENGINEERING PLASTIC PROBLEM

I receive at least six calls a year about this. The MDC engineering plastic was originally Devron, a black material that shrinks over 10-20 years. If it's a gear press-fitted on a shaft, over time the gear will usually split and then be off-center to the shaft, out of round and may slip. If a coupler is made of Devron there is less of a problem if it splits because the tolerances are very loose. In more recent years a more stable material has been used.

The Jackshaft Coupler being slightly off center is not a problem. The solution is to just remove the plastic coupler and reinstall it. Then it will be a loose fit on the shaft. If it's already cracked and loose even better. In either case just ACC it back on. Good for 20 years, or more.

## BOTTOM COVER

Next de-burr the Bottom, Retainer (AKA Bottom Cover) paying close attention to the outside and tops of the two ends - **do not sand/polish the top insides of the two ends.** Just remove obvious flash, the rest is not critical. Look at the four rectangular holes at the bottom. Find a Swiss file that will fit, and lightly polish the inside edges of the four holes. Remove flash on the side and top of the long side fingers where the wheels go. A burr here can hinder the wheel rotation. Clean up both outside sides. When finished, set to one side for now.

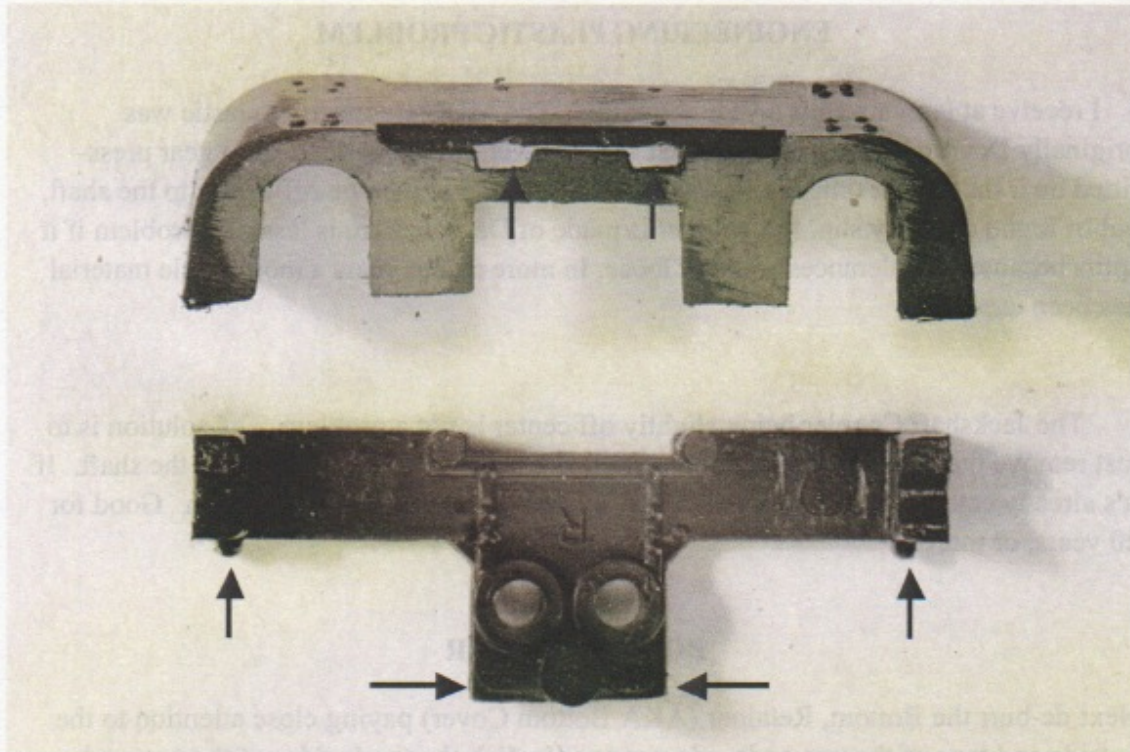


Photo #9

### PLASTIC SUB FRAMES

#### Bottom cover and Plastic side frame - arrows point out problem areas

Look at the Plastic Sub Frame so it appears as short, fat base T. At the bottom outside ends of the crossbars you will note a small protrusion pointing down. This is a critical item as it aligns the entire assembly and should sit squarely on the ends of the Bottom Cover. Any flashing on these tips can cause misalignment when attaching the bottom cover. If one is missing, or there is any misalignment, the entire truck can resonate and cause noise you wouldn't believe. *Leave any burrs on these small tips alone for now.*

De-burr the two Plastic Sub Frames, being careful with the above mentioned protrusions. The bottom of the fat T needs to be sanded with a fine sanding stick. The Bottom Cover snaps onto the Plastic Sub Frames at this junction. Run a small Swiss round file in the two holes that mount the Metal Side Frames. Again just pay attention to the obvious flash and what doesn't look right. There are three posts on one side of each frame - two small and one large - lightly de-burr the ends of all three. You may see an "L" or an "R" stamped on some frames - this is a mold ID mark and doesn't mean 'Left or Right'. Ignore the two letters if you see them. Place both Plastic Sub Frames with the Jackshaft and Bottom Cover on the side.

## TEST FIT

Gather the Jackshaft, Bottom Cover and the two Plastic Sub Frames together for a test fit. Lay the Plastic Sub Frames down so the centers are facing up. Insert the bare Jackshaft in the groves, place the two halves together and pick up the 3-part assembly with Jackshaft on top. Place into the Bottom Cover and snap the three parts together. The small tips should seat in the top outside surfaces firmly. If not try to locate the problem, saving deburring the small tips as a last resort. Look twice, and twice again, then sand once. Any burr inhibiting seating would be on the outside edge of the frames or on the inside surface of the cover. Use Caution here with a capital C. When you think you have a good fit try pulling the cover away from the frame ends. They should fit firmly. Look down at the Jackshaft — it should be firmly held in place down its length. Any thing less than a snug fit warrants new parts. If all is satisfactory wash, rinse and dry. Place in the appropriate container.

## METAL SIDE FRAMES

The Metal Side Frames are blackened soft Zamac. They are easily bent, and once bent impossible to straighten. I tried to seat the first ones I did with a pair of pliers - called MDC and ordered a new pair. When you look at them from the side, the journal boxes should be at the top of the side frame

Note the two brass bushings on each Metal Side Frame. Using a dull #22 Exacto blade try to remove each bushing by walking it out. First one side then the other. These are a press fit and you won't have much luck - until you find the one in a hundred that's loose. When and if you find one loose polish the sides and place it over the mounting hole. Start it square and tap it in gently with a hammer, gently but firmly. When properly seated apply super glue to the sides to anchor it. I found two loose, both from old frames. These were found while trouble-shooting noisy truck assemblies.

Place a metal straight edge across the face of the two bushings to measure alignment. Is the straight edge flush on both bushings? Parallel to the rest of the side frame? Yes, proceed. No, order replacement. (The odds of these being bad are exceedingly small). Check both side frames. Any bending or miss alignment means the bushings will not be square to the axle centerline. Noise and unwanted friction occur. The brass bushing interiors require no polishing. This should be a wear-in item.

Hold the Metal Side Frame until you are looking at the ends of the posts and bushings. With a small fine file with teeth on the edges, or folded sandpaper, remove the black from the end of the *large* post until you can see shiny metal. The end of the large post should be clean and shiny, especially between the posts. This is where we pick up track voltage from the axles. Some claim it's blackened, thus metal conductivity isn't affected. I

disagree. I like to see the metal shine, because it does make a difference! Chemical blackening is almost always an oxide — an insulator. You make the call here. Wash, rinse and dry. Put in 'READY' container.

### WHEEL/AXLE TRUENESS

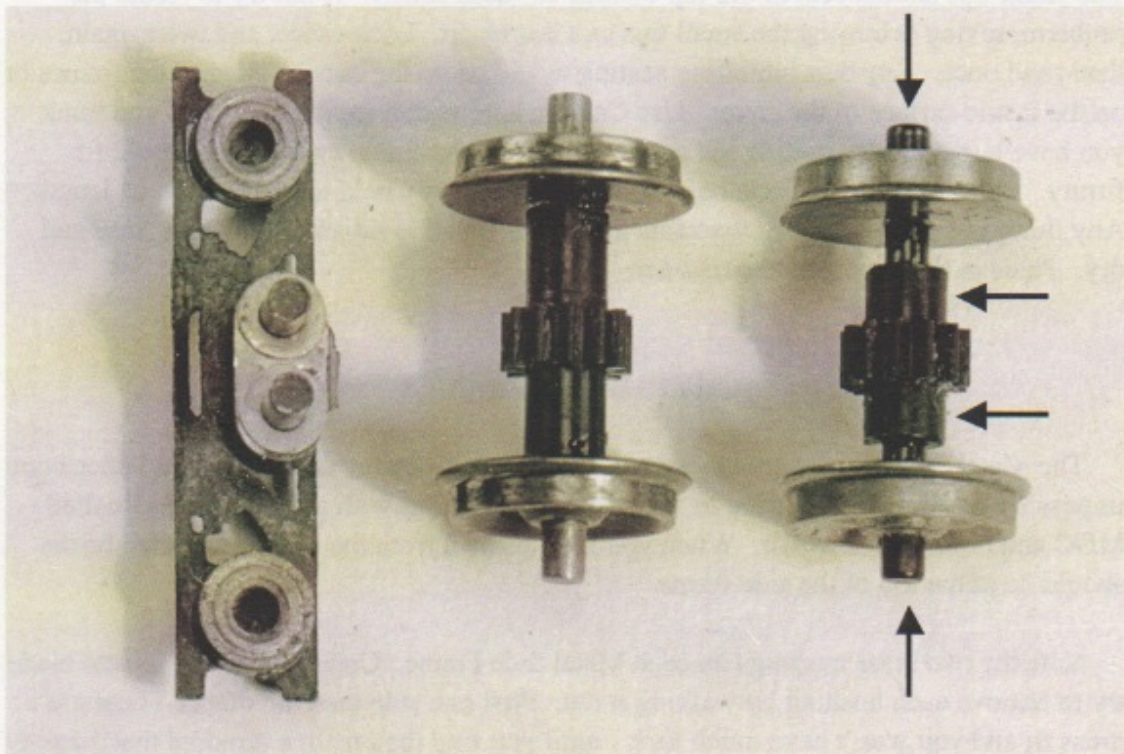


Photo #10

**Metal Side frames and wheel assemblies. Right hand wheel assembly is new style.**

Two years before closing the doors MDC switched to different vendors for their wheel assemblies. The new assembly is much shorter side-to-side. After running for a short period of time the outer wheel parts tend to walk in, and will eventually short out. If you have these types of wheel assembly be careful to gauge the wheels, then glue the three parts together.

Make a little ramp by placing a 12" section of track on the workbench facing away from you. Elevate the end closest to you with a pencil. Place an axle on the track and let it roll down. Does it wobble? Roll it again, only this time watch the left wheel flange. Is it straight? Repeat, watching the right flange. Is it straight? Do the same thing for the second axle. If all looks good, proceed. If not, order new parts. Yeah, we did a version of this test while the wheels were in the trucks. But this test usually gives more precise results. Finally verify that the wheels are properly gauged. I have found few with a gauge

problem but if they are too wide or too narrow they may look good and sound ok on the bench but give problems on the track, especially at turnouts.

Closely examine the axle gear on the axle center for bent, missing, or chipped gear teeth. If bad, replace. (Again, the odds are small). It's hard to polish these gears being buried between the wheels. I have pulled one wheel off to better accomplish this. I measured 80 gears; the diameter only varied .0005 inches. I have never found a bad axle gear and have given up on polishing them. Unless I can find something wrong visually I accept and use them as is. I generally polish all gears. In this instance I would make an exception. Should I have a problem, however, the axle gear is where I would start.

On some locomotives with power pick-ups on tenders there is some concern about insulated/non-insulated wheels with continuous metal axles. While not used on the Climax, tuners should be aware that the insulated wheel goes on the left side looking down from the top on the locomotive and the right side on the tender.

### WHEEL TREAD POLISHING

If you have a motor tool (Dremel for example) with a 5000 RPM or less range you can use it to polish your wheels. ***Please use eye protection goggles or full-face shield. Safety is #1 priority.*** Find a collet that will just fit on the axle end. Place a wheel in the collet and tighten. Using a sanding stick (#400 grit wet or dry — remember we made some up early on) polish the wheel tread and deburr the axle end. If the end is blackened, remove the black. Do both ends on all four axles. Use minimum side pressure; you will just push the axle assembly out of the collet. Recheck wheel-gauge and adjust as needed. We have just polished the wheel tread and increased electrical contact. Wash, rinse and dry. Put in 'READY' container.

When I gauge wheels, I like to glue the wheels to the axle shaft when through — if possible. The capillary action of ACC makes it ideal for doing this. I have no scientific basis for doing this. Nor do I have a database that confirms doing so has positive or negative results. But I do it any way. Suit your self. Just make sure the wheels are in gauge and clean before adding glue!

The first thing I check on any rolling stock I acquire is wheel gauge. Using a NMRA Standards Gauge I bring the wheels within tolerance. Flanges can be adjusted on metal axles by firmly gripping both wheels on a metal axle, twisting and either pushing or pulling depending on which direction you want to go.

Plastic axles must be done differently. Support them as closely to the wheel as possible and push against the support. Don't twist plastic axles. If you've never done this, you need to learn. Try it. If you don't have a gauge, get one and play with using it.

This tool can greatly enhance your modeling enjoyment when you learn how to use it. Everything runs more smoothly when the wheels are in gauge.

### VOLTAGE PICKUPS

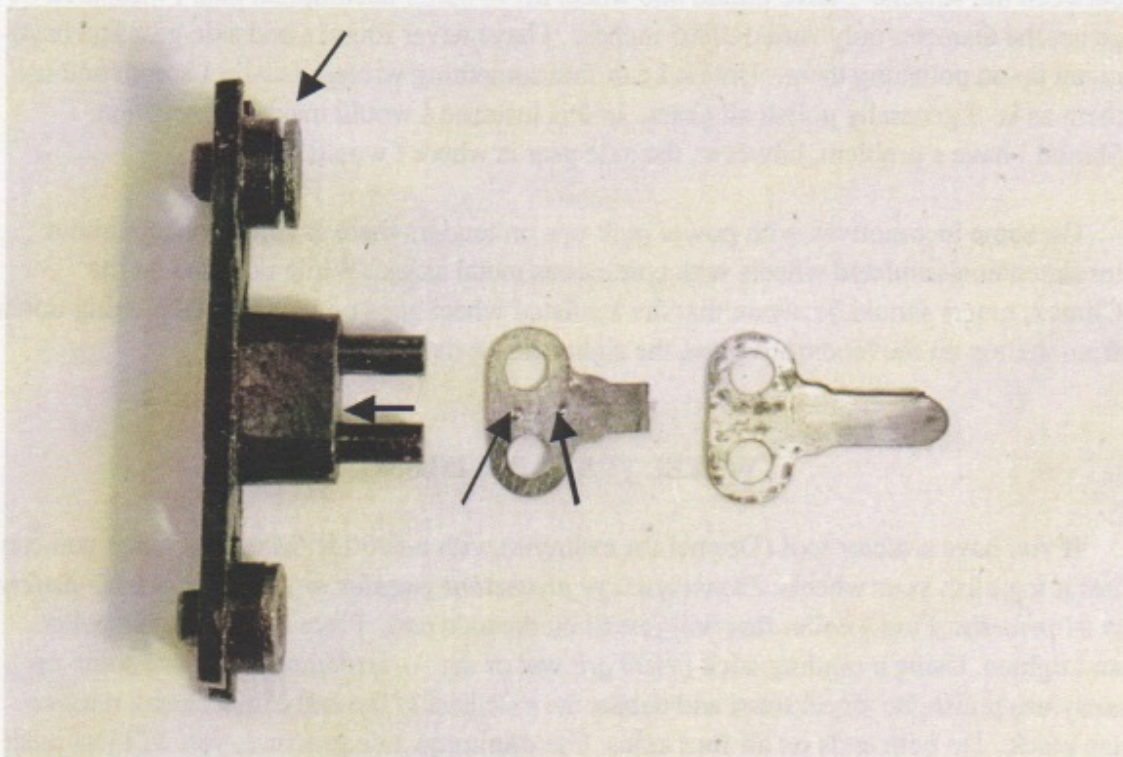


Photo #11

**MDC stock bronze pickups on right. Note the left one is 'dimpled' (hard to see). Voltage Pickup will be wire soldered to the pick up. Polish end of large post.**

This is where the difference between so-so and excellent running begins. Positive eight-wheel pickup can be had with your current pickups if they aren't broken off. And it's fast and easy. Here's how it's done.

Place pickups on workbench and get as flat as possible. Using #400 dry lightly sand until completely shiny. Do both sides. Imagine a line connecting the tops and bottoms of the two holes. Locate the middle of these lines. Lightly, lightly, center punch a small dimple between the two mounting holes top and bottom. We don't need much of a dimple and we sure don't need a third hole. Since we won't be using the tips you can practice first. Turn pickup over - you should just be able to feel the point of the projections.

Place a pickup with the dimple points towards the shiny large post over the two small posts on the Metal Side Frame. The narrow part of the pickup should be pointing up. With your thumbnail holding the bottom of the pickup against the inside of the Metal

Side Frame bend the pickup over towards the outside at a 90-degree angle with a fingertip. The projection points and pickup should now both point towards the outside. Remove the pickup from the posts, square the angle with a pair of long nose pliers, and reinstall. By eyeball, find the step-down, move out towards the outside end 1/16" and cut the pickup off. Put in "READY" box.

What we've done is establish a means to pick up the track power directly from the rail. And we have improved the connection between the pickup and the Metal Side Frame. We have eliminated the pickup rubbing against a screw head - to a nut - to an electrical connection via a bar of metal - to a wire - to the motor. No more hit or miss bending pickups for good connections. When we assemble and install the trucks just solder a wire from the bronze pickup directly to the motor terminals via the holes we drilled in the frame. It's called 'hard wiring' with 'eight wheel pickup'.

Since I build these chassis frequently I keep a spare chassis I know is quiet and a good performer just for testing. Only one truck is wired as above for power. Then I can pop truck assemblies in and out the other end for testing without worrying about soldering wires, etc. It runs through six turnouts with plastic frogs and a small radius double S curve without hesitation. Once in a blue moon I have to nudge it if the track or the wheels get dirty. With both trucks wired, I have had no problems.

#### END SILL AND STEPS

Round up the two End Sill/Steps and two End Sill Retainers. De-burr all four. On the Sill/Step pieces slightly round off the ends of the two mounting posts and trial fit on the frame. The two Sill/Step Retainers need all the holes lightly filed out and the hole edges de-burred with a counter sink. Do both sides. *Don't do the coupler mounting.* Note that the mounting holes are offset. The long side should face the frame so the coupler mounting is correct. Hold frame upside down and place firmly down on the edge of the workbench. Install retainer by lining up the holes over the posts. Seat with the tip of a small flat blade screwdriver. Remove both from the frame. Now de-burr the coupler cover. Wash, rinse and dry. Put in "READY" box.

I soak the two End Sill/Steps in white vinegar for an hour. Then with a toothbrush and dry scouring powder (I use Comet) I scrub them to slightly roughen the surfaces. A final scrub with soap and water, rinse and dry. Prime the outside only, then paint a dark red. Set them somewhere safe to dry for a couple of days, then put them in the ready box.

## UNIVERSAL LINKS

The last two plastic parts are the Universal Links. These complete the power train. Remove any flashing, de-burr and lightly smooth. Check to ensure the four rear fingers are all the same length. There is a 90-degree edge on the bottom of the cup that should be rounded slightly with a fine emery board, then lightly polished. Don't get carried away while rounding: there's not a lot of material here. All that's needed is to knock off the sharp edge. Wash, rinse and dry. Put in "READY" box.

## A FLYWHEEL EVOLUTION

The only assembly we haven't touched so far is the Flywheel, Die Cast (AKA Flywheel) assembly - although we did remove the four mounting guide posts on the frame. Let's look at why.

The flywheel on the climax is optional. I will wager that you will probably never notice the difference in performance, with or without one, if you tune the chassis. But just for grins let's look at installing the stock MDC flywheel. This is a simple looking assembly - a cast metal flywheel and two plastic mounting brackets to support it and a plastic tube to connect it to the motor shaft. Three plastic and one cast metal part. How easy it looks, how simple. What could go wrong here?

De-burr and smooth the two plastic pieces. On the flywheel shaft lightly polish with #400 wet the bearing surfaces just enough to remove any tarnish. On the flywheel body remove any large obvious burrs and sharp edges.

I grease the plastic bushings and push onto the flywheel. The offset bushing should be facing the flywheel. The small long flywheel shaft should point to the motor. Carefully observe that rear plastic mount (motor end) has one shoulder lower than the other three. Pick up the three pieces and set mounts in grooves. Seat plastic mounts in with flat blade screwdriver. Check top and side-view to ensure flywheel centerline is parallel and centered in frame. Test run chassis for a minute. Then install 5/8-inch plastic tubing to connect flywheel shaft with motor shaft, and re-run chassis.

The first few I built there were no problems. On the fourth one it sounded like a banshee caterwauling. Take out the flex tube - quiet reigned. Put in the flex tube, wailing and yowling. Memories stirred of long ago shop projects. I built a crude jig to test the balance of the rotating mass. Bingo! The flywheel was out of balance. I now had three choices: run without it, balance it or replace it. All three are valid choices. I spent several hours balancing the flywheel the best I could with my spur of the moment test jig until I

finally got it to run quietly. Two hundred is a small number to predict a trend - but five of them were out of balance. A couple of hours to balance each was not acceptable to me, nor was the mess. My customers wanted a flywheel - running without one was unacceptable. The choice left was to replace it with another flywheel.

I looked at the NWSL Brass flywheels in their catalog. #402-6 comes closest to fitting our needs. The size is right, and it's for a 2mm shaft. But it's a press fit; it can not be installed on a single-shaft motor without destroying the motor. Again, three solutions exist - drill out the flywheel our self, reduce the motor shaft to fit or find a flywheel that is a "slip-fit". The first two options can quickly lead to serious and expensive problems and should not be seriously considered by beginners, or old timers. I tried the first two methods, but the waste was cost prohibitive.

I called NWSL about a 2mm slip-fit flywheel. For a modest set-up charge they ran off 10 for me. My costs increased 33.3%, but my flywheel problems decreased 100%. Discussions with Fred Martin resulted in NWSL now stocking these as a standard item. The new part # assigned to the 2mm Slip-fit Brass flywheel is #432-6 @ \$3.95 each. We will discuss installing the 'slip-fit' flywheel later. When you receive it put in "READY" box.

#### BALANCING JIG

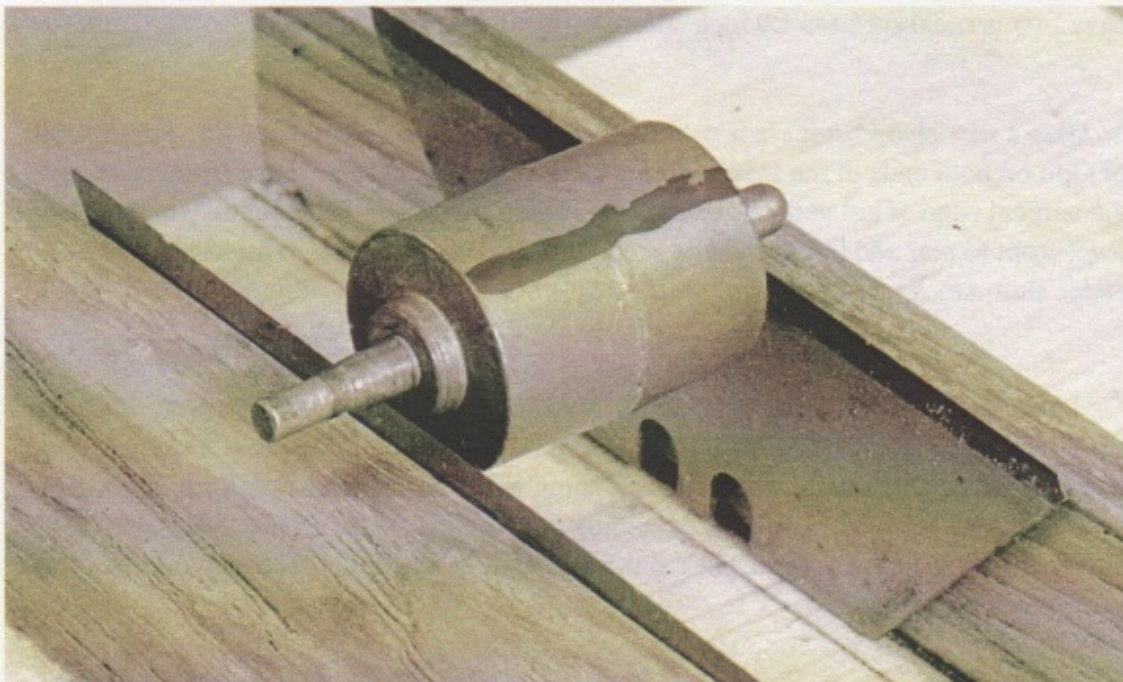


Photo #12

**Rotating mass balancing jig constructed from scrap lumber and Stanley knife blades. Used to balance stock MDC flywheel. Crude, but effective - it works.**

Since this article is about tuning methods, and written for the novice tuner, balancing a rotating mass should be included. It's becoming a lost art. The prime factor is supporting the object being balanced with a minimum amount of friction to the rolling surface. This is done by rolling it across two precisely parallel, and level, sharp edges. Even if you aren't going to use your flywheel you should build one of these jigs and check the balance. You can try adding a weight with poster putty to create a temporary unbalanced condition. Costs are zero — just your time. A good free experience is hard to come by.

Required to build a jig: the base, two adjacent flat square surfaces, white glue and two new razor blades from a Stanley knife. I used a 6-inch hunk of two by four and a couple of short 3-inch, 1/2-inch quarter-round moldings - all free scraps from the local lumberyard. The key point here is two adjacent square sides to mount the razor blades vertical and parallel, while the razor edges are both equally level.

Measure the center distance between the two bearing ends of the center shaft. The MDC flywheel is 1.0 inch between mid-bearing surfaces. Draw a pencil line across the Base using a square and draw a second line. Measure 1.0 inch from the first line and draw a second line. Measure between the two lines, at the outside edges, to check correct distance between lines. On left line glue one quarter-round molding against the line with the round surface facing left. Mirror image on the right side. The middle section should have two vertical surfaces 1.0 inch apart.

Glue a new sharp razor blade to the left vertical surface - sharp edge up. Smear a dab of Goo on both ends of the Stanley razor blade, then mount it in center (front/to/rear) on the vertical edge of left vertical surface. Repeat on right side. Place jig on workbench and level front to rear and left to right as accurately as possible. Keep in mind our stock of paper shim stock

Place the flywheel on the two razor blades and barely nudge the flywheel. It should slowly roll back and forth until the heavy side rolls to the bottom with a rocking motion. Repeat several times to make sure it's stopping at the same spot every time. Draw a thin line across the top of the flywheel extending over both sides for a reference point. I prefer a fine-point felt tip pen. I used orange paint in the photo. Just so you mark it for reference.

Using a coarse drum sander in a Dremel tool remove some metal from the **middle of the mass** opposite the line across the flywheel. Re-measure, grind; - re-measure, grind. Repeat measuring and grinding until nudging the flywheel results in it stopping at

different locations at random. The flywheel is now statically balanced. Take your time and be patient - balancing can be tedious. But it can pay off. Wash, rinse and dry. Install in Chassis, connect plastic tube, and run a final check. Everything should be quiet.

### LET'S PUT IT TOGETHER

We have taken the Climax chassis apart, ordered any new parts available, modified and/or smoothed the individual parts and then put them in our "READY" box. Now lets put it back together.

#### END SILL/STEPS & RETAINERS, END SILLS

- \* Retrieve the frame, the End Sill/Steps and Retainers.
- \* Using Elmer's Rubber Cement apply a coat to the frame extension, both top and bottom, at one end.
- \* Immediately install the steps on the extension top, turn over and install the retainer piece. The retainer mounting holes are offset towards the frame end.
- \* Holding the frame assembly upside down place it on the edge of the workbench. Line up the holes over the two posts and press on with a small screwdriver blade until everything snaps together snugly. Repeat on the opposite end. We will install the coupler later.

We have just accomplished five valuable and positive things:

- \* Rubber cement firmly anchors the two pieces to the frame --
- \* Eliminated coupler sag --
- \* Reduced vibration, which leads to noise. -
- \* Secured the parts with an adhesive that will allow us to easily disassemble them should we need, or want to.
- \* Installing them now will afford some protection to the delicate truck retainer fingers.

#### DECISION TIME - SEE PIC #6

It's time to make a decision about what our ultimate minimum radius will be. As built stock we should be able to pull 15" radius easily. If 10" radius is desired for branch line operation we need to articulate the trucks at this point. To do this, we will modify the truck retainer mounting bars so that the trucks can both swivel and move from side to side.

- \* Stock we will have rock-solid coupling/uncoupling.

- \* Modified we will have to sacrifice reliable coupling a little. Why? Because the articulated frame and chassis allows the frame-mounted couplers to be off-center with the track. Two ways to correct this:
  - \* Align the frame by finger
  - \* Arrange your coupling at the end of a sharp curve. Running through a tight curve self-aligns the couplers.

The modification is simple. Find the Truck Retainer Mounting bars. Using the drawing as a guide use a small square or round Swiss file to elongate the center hole towards both sides. Go slow and easy. Test fit while doing this. The retainer should be able to bump up against both frame sides and the elongated slot should be just wide enough to slide comfortably. Too large a slot and the Jackshaft coupler fingers won't stay in the Universal Link slots. Too small and nothing will work right. Slow and easy does it.

### INSTALLING THE TRUCK RETAINERS

- Locate the two Truck Retainers and two Truck Retainer Mountings.
- \* Snap in the two plastic bushings on the top of the frame sides.
- \* Brush a coat of grease on the Truck Retainer side opposite the fingers.
- \* Place Truck Retainer on the polished frame floor and position for mounting.
- \* Place small amount of grease on the guidepost of the Truck Retainer.
- \* Install mounting hardware barely snug. (One side will require the long screw with plastic bushing and nut).
- \* Discard the metal strip that ran between the two screws.

Assembly trick: A small pinch of poster putty applied to the screwdriver blade tip will hold a screw on the blade and makes starting the screw much easier. Run screw in half way, remove putty and finish seating the screw. Back off one turn.

Eyeball the alignment of the Plastic Mounting Arm that runs side to side. It should be approximately square to both sides. Tighten each screw snugly. Re-check Squareness using same eyeball.

Someone said that no lubrication is needed – all plastic components are internally self-lubricating within the material. Out of curiosity I assembled a chassis and ran it briefly with no lubrication. To say it was rough and noisy is an understatement. We will be lubing during construction, but only as directed. When all is done, one of the last steps will be a final lubrication before being released for service.

## COMPLETING THE TRUCKS

- \* Place one of the Plastic Sub Frames on the bench in front of you.
  - \* Turn it so the top of the T and the Frame interior is facing you.
  - \* Put a touch of grease with your small brush where the Jackshaft sits in the frame on both Sub frames. Just touch a tad to the end of the worm gear on non-coupler end.
  - \* Slip thrust washers on the shaft all the way. The grease will hold them on.
  - \* Now lay the Jackshaft in the Plastic Sub Frame, being sure to get the thrust washers inside the frame.
  - \* On the other Plastic Sub frame put just a LIGHT dab of CLN (Clear Liquid Nails) on the end of the large post. The only purpose of the CLN is to hold the two parts together while we handle things during re-assembly.
  - \* Place on top of the first side frame making sure everything lines up square. You can pick it up to check that every thing lines up.
  - \* Set aside and let the CLN setup for 30 minutes.
- 
- \* Place the Bottom Cover in front of you, fingers up. Place an axle assembly in the left and right openings after brush-greasing the gear tips only.
  - \* Carefully pick up Plastic Sub Frame assembly - with Jackshaft on top -set into Bottom Cover.
  - \* Carefully pick up, align all pieces and snap Bottom Cover to Plastic Sub Frames. The ends of the Plastic Side Frames should sit squarely *on* and *inside* the ends of the Bottom Cover at both ends.

Set wheels down on workbench top. Place bronze pickup on Metal Side Frame, with dimples facing in the PLASTIC Sub Frame, projections out towards the Metal Side Frames.. Gently push, on the middle only, the Metal Side Frames into Plastic Side Frame. Remember to keep the journal boxes up. You will have to align axle ends into the bushings before you can seat, on the middle only, Metal Side Frame in all the way. Repeat on other side.

## TRUCK QUALITY CHECKS.

- \* Turn the coupler end. There should be no binding or tightness in the shaft.
- \* Looking down at the top, front to rear, the two Plastic Sub Frames should be snug to the Jackshaft, Bottom Cover and all mating points. If the Jackshaft is loose and sloppy it will be noisy and never perform well.

**Do the following step by step.** This is critical, as well as tedious. Take your time. Wheel gauge being accurate dictates the shimming accuracy.

- \* Push/pull side-to-side each axle between the Metal Side Frames. There should be some small amount of side play. One, or both, metal side frames need to be shimmed out. If one or more axles are less than originally gauged, re-gauge. Any tiny shift in wheel gauge can totally throw off the effect of shimming the Metal Side Frames.
- \* Disassemble the truck and re-gauge the wheels, if necessary.
- \* Reassemble the truck.
- \* Dig out six of the Jackshaft .010 inch thick spacer shims we bought from NWSL and slip one over each small post on **just one** Metal Side Frame. The washers go on over the bronze pickups.
- \* Reinstall Metal Side Frame and check axle side play again. If still too tight remove the second Metal Side Frame and add another pair of washers (one per post).
- \* Check wheel gauge – reset if wrong.
- \* Now recheck side-to-side play again. If still too tight repeat installing a second layer of washers on the first Metal Side Frame. Four washers are the maximum amount of shimming (2 + 2) that can be done, but I doubt you will ever get that far. If you do, something major is wrong.

Wheel assemblies with axle ends that are blackened tend to drift inward while running which results in a short across the track. The loco will just stop. Re-gauging the wheels will remove the short. MDC changed to the new vendor source two years before selling out. When assembling the Trucks, I glue the center section with the gear on it to the two side axle and include the plastic insulated end. Apply glue only when the wheels are in gauge.

We're done! That wasn't so bad was it? The second truck will be easier, so let's do it. Just follow directions. When I can, I glue the wheels after putting them in gauge. This is called 'Preventative Maintenance'.

### INSTALLING THE TRUCKS

The Truck Retainer has four fingers sticking up, with balls on the inside finger tips. There are four corresponding dimples in the Plastic Sub Frames. We want all the fingers outside the Plastic Sub Frame and the fingertips in the dimples. This gets tricky here so don't be in a hurry. These are going to be in and out frequently so we might as well get familiar and comfortable with doing it. It's a lot easier with the Universal Link and the wires out of the way.

- Holding the frame in one hand and the truck in the other with the coupler fingers towards the center of the frame, ease the truck into the frame. Slightly rock the truck sideways and downward so the two fingers on one side are just pressing the Plastic Sub Frame.
- \* The other side-frame should just clear the tips of the fingers on

the other side.

- \* Rock the truck down and in while pushing against the opposite fingers until we have the second two fingers engaged outside the side-frame.
- \* Push down - the fingertips should snap into the dimples. Slightly slide truck forward and backward until they do.
- \* Check that all four fingers are on the outside of the truck frame and in the dimples.
- \* Remove and re-install truck several times until you feel comfortable with the process. Leave both trucks in the frame, and place the two Universal Links back in the Ready container.

### GEAR HOUSINGS

The following applies to both the one and two gear Housings.

- \* Take apart and apply grease directly to inside of both gearbox halves. Apply with a small brush. Coat the gear housing center ridges that support the bull gear.
- \* If your gear box is of the two gear design lightly grease inside and sides of small idler gear first before setting it on the post.
- \* With small brush apply a light coat of grease to both shoulders of the Bull gear - install in gear housing
- \* Turn the idler gear, or Bull gear, with your finger - it should turn freely. There will be some slight drag due to the grease but no rough spots or binding.
- \* Install the Gear Housing in the frame, again checking by eyeball to make sure it is square and centered in the hole.
- \* Tighten the four screws evenly until snug then give a final tweak. There should be no distortion to the fingers that hold the shell on, and the Gear Housing should be square and centered in the frame.
- The bottom of either gear housing will extend down below the Sil/Steps.

**With the trucks out of the frame, the chassis should be turned over on its side to prevent damage to the Gear Housing**

### MOUNTING THE MOTOR - GENERAL

This method of mounting the motor is simple, helps damp motor noise and absorbs vibration. If a mistake is made, the motor can be pried out, cleaned and re-installed. Best, the motor is electrically isolated from the frame, a prime requirement for DCC. This mounting method will work with **nearly** any motor installed in any chassis.

The motor selected for our Climax will not have much impact on how it is mounted. The Motor Gear, however, will impact *where* it is mounted. To isolate and mount the motor, mount it on electrical tape, with a small line of CLN to add and hold any shims.

The tape acts as an insulator and the CLN is a rubbery substance that also is an insulator. This should be ample insulation for our low voltage system. The use of gear spacing shims just adds more dampening.

### MOUNTING THE TWO GEAR MOTOR

- \* Retrieve the motor and motor gear. The white motor gear is the exception to the rule. The white plastic is a nylon-like material that will slide down the motor shaft with a little effort. It's in-between a loose press-fit and a tight slip-fit. You can do this yourself, with care.
- \* Try to push the center of the gear versus the outer edges. It is possible to warp the gear if too much force is applied to the outer edges.
- \* Since we have a slip-fit flywheel we can use it to push the gear down the shaft. If we didn't have a slip-fit flywheel we could make one. A small block of wood, or better yet a small wooden dowel, with a hole drilled in it slightly larger than the motor shaft, would fit the bill.
- \* Make a 0.080 inch thick spacer to position the gear where we want it to end up. (I used two pieces of .040 styrene glued back-to-back).
- \* Hold the spacer on the bronze bushing and push the gear down to the spacer.
- \* Place the motor assembly on the frame. The sides of both gears should be even.
- \* The end of the silver motor housing should be even with the edge of the slot in the floor.
- \* The bronze bushing should extend into the slot but clear the gearbox housing.
- \* Remove flywheel.
- \* Place the frame on the workbench with the motor end facing you.
- \* Cut a piece of 3/4" electrical tape 2 to 3 inches long.
- \* Line up and cut one end of the tape square to the edge of the gearbox slot and one side of the entire half frame floor with the tape.
- \* Using a sharp knife trim off any tape that extends above the floor.
- \* Press the tape to the floor with the flat side of a standard screw driver blade.
- \* Hold the motor by hand and check the gear mesh, so there is a small amount of backlash.
  - If too tight, insert one or more shims under the motor until it is correct.
  - If slightly loose, try tipping the rear of the motor up with shims until the gears engage. See Attachment #3.
- \* When happy with the gear mesh, glue the shim/shims to the tape with CLN. Just a thin strip down the middle of the tape is needed to keep the shim in place.
- \* Hold the motor firmly to the frame maintaining alignment and try turning the motor shaft gear with your fingertip – everything should move freely. If not, find the problem and cure it. There are only two gears to check, plus backlash between motor and idler gear.

- \* There is no practical way of adjusting gear teeth clearance inside the two-gear Gear Housing.
- \* Cut a 3" x 5" index card into 1" strips 1/2" wide to be used as motor spacers. We'll need eight, but a few extra won't hurt.
- \* Line up the front end of the motor housing with the gearbox slot edge. The sides of the gears should be even.
- \* The motor red dot terminal goes on top, black on the bottom. The bronze nose should be over the slot edge but clear the gearbox housing.
- \* Apply a generous bead of CLM down the center bottom (Black dot) of the motor housing.
- \* Position so motor housing is lined up with the gearbox slot as above and place on the electrical tape, or shims, firmly.
- \* Slip 3 cardstock positioning spacers between each side of the motor housing and the frame sides. (If one side has the rounded protrusion - mount positioning spacers in front of it.)
- \* Check to ensure the motor is sitting straight up and down.
- \* Now try to slip a forth shim between the motor housing and the other shims on one side.
- \* The motor should be snug and centered in the frame slot and the motor gear should be centered in the gear-housing top opening.
- \* From the side view the two gears should be lined up. Slip flywheel back on shaft to check clearance.
- \* Check one more time that the motor is upright. If motor is not mounted straight vertically the body shell won't fit. When satisfied that all is in proper alignment remove flywheel and put chassis aside to set up.

### MOUNTING THE ONE GEAR MOTOR

Basically everything is the same, except we'll mount the motor where the flywheel used to be. The NWSL large diameter motor gear lacks depth to engage the Bullgear. Remembering that the two floors are of different height I tried the motor on the flywheel half. An almost perfect fit! The flywheel floor is lower than the motor floor. So lay your tape and adjust for proper gear meshing with the Bullgear. Of the six I've done I had to shim the motor up at the back end to get proper gear mesh. This is a time-honored practice. Just follow instructions step by step from there.

Two exceptions:

- \* Mount motor with red dot down instead of up. The left hand wires will attach to the top (black) terminal.
- \* Place tape on the other half of the floor to cover holes where the motor mounting screw holes went. When we glue the sheet lead in we don't want any adhesive sticking up the truck retainer.

### FLYWHEEL INSTALL

While we've got every thing on hand we can install the flywheel. The two most commonly used adhesives for attaching slip-fit flywheels are ACC and epoxy. I've had good luck with CLN - and should I need to, it's a lot easier to remove the flywheel. The flywheel is just along for the ride and there is no mechanical drag on it. On gears and other drive components I would use epoxy. Both epoxy and CLN give you some working time. ACC usually gives you only one chance.

- \* The flywheel we are using has a hollow side and a flat side.
- \* Put a dab of your preferred adhesive on a toothpick and apply to the inside of the hole on both sides. Place just a touch on the end of the motor shaft.
- \* Slide flywheel flat side onto the motor shaft until the shaft end appears at the other end of the hole.
- \* The flat side should clear the gear housing slot and sit on the frame opening edge.
- \* Set aside for 60 minutes.
- \* When the CLN has set up, test gear smoothness with fingertip by turning the flywheel in *both* directions. Remember, it's a long way around the Bullgear. Binds can occur in one direction but not the other so check both directions. Should a bind occur it will, hopefully, show up before any damage can occur. All should be smooth - if not, recheck alignment, etc.

### COFFEE STICK WIREGUIDES

This is one of those freebies that cost you nothing. I collect coffee stirring sticks of all sizes for modeling in any scale. Any place that serves coffee is a prime source. The small dark brown sticks are best for HO scale. Cut into one-half inch length and apply where wanted with a small drop of super glue. When dry, apply a bead of CLN along down any handy side.

### FRONT WEIGHTS

While waiting for the CLN to set up in the flywheel we might as well install the front weights.

- \* Find the lead pieces we cut earlier and test fit them again. Stack them until the top is level with the side frames. Mark the floor where the lead will fit. Remove lead.
- \* Smear CLN over the frame floor, to be covered by the lead piece, with a toothpick.
- \* Install a layer of lead to the frame floor.
- \* Continue until we have a Dagwood lead sandwich.
- \* Line up the weight to clear the front of the chassis.

- \* Note: only use CLN. The big advantage: if we ever want to remove it just slide a small flat bladed screwdriver under the bottom piece and pry up.

### MOTOR REVISITED

- \* Enough time has elapsed by now that the motor should be fairly firm.
- \* Carefully pull the spacers out of one side.
- \* Gently, lightly wiggle the motor - it should be firm.
- \* If not replace the spacers.
- \* If steady, pull the remaining spacers and run a bead of CLN down between both sides of the motor and the frame sides. I use a round toothpick to apply small beads of CLN. This will hold the motor firmly when set.
- Put aside overnight. We have just custom made a rubber motor mount and electrically/mechanically isolated the motor from the frame.

### REMOVING THE MOTOR

- \* While we're waiting let's look at how to remove the motor should we ever have to. Here's how to do it:
- \* Assume the beads are well set.
- \* With a small flat knife blade cut the bead down both motor sides. Repeat down the top of both sides of the frame.
- \* Grab rubber with tweezers and literally peel it off.
- \* Using two small screwdrivers placed under the motor rear and front (if possible) gently rock up and down while prying motor up. Remember? It's only glued to a piece of electrical tape.
- \* When out, peel off the CLN and we're ready to start again.
- \* Back to twiddling our thumbs.

### THUMB-IN-EAR DIAGNOSTICS

Hearing a noise source is like measuring dimensions – it leads directly to locating possible problems. This is probably one of the oldest mechanical tests known.

- \* Clip the power supply leads to the motor terminals.
- \* Place a small amount of grease between the motor gear and idler gear, start motor at low rpm and let it circulate a minute, then shut down.
- \* Apply another small amount of grease and reverse motor, again at low RPM.
- \* Find a long semi-rigid hollow plastic tube such as a spray bottle pickup tube, or a long wooden dowel. A Windex tube works well.

- \* Hold it between the back half of your thumb pad and the first joint of your fore finger.
- \* Place end of your thumb firmly in your ear. The other end goes on the chassis anywhere it can't slip and cause damage.
- \* Crack the throttle slowly up to a quarter. When your thumb finds the right amount of pressure to apply in your ear you will hear the motor noise loudly and clearly.
- \* If all is still quiet, slowly increase throttle to 50% and listen to the noise transmitted up the tube.
- \* Test run in both directions. ***Shut down power immediately at any sudden increase in noise levels.***
- \* Use finger power to find the problem and fix it. Memorize this sound - it is the basic signature sound of your unloaded motor and chassis.

There are several methods of listening to noise; this one allows you to see the end of the tube while listening, giving better control thus increasing safety. Use what you are comfortable with.)

As mechanical assemblies (trucks) are added to the power train, they will add their own signature with different frequencies - but the basic signature sound should predominate. If there is any major jump in noise volume, the problem has to be in the newly installed component. Use this tool with every assembly added to the chassis. Fast, easy, simple and free. Square-cut gears and rigid trucks preclude us from totally eliminating all noise - and after all, it is a climax.

### GEAR BOX READING

An easier method is to hook up the Amp meter in series with the power supply. With both Trucks out, the only element left is the gearbox. Turn the throttle slowly to 50%. The meter should read approximately 50 - 70 milliamps. If it's still less than 100, but high, let it run for 15 minutes - the reading should slowly drop. If still high try loosening the four screws that hold the gearbox to the frame. Play with positioning and slowly tighten the screws. This will relieve any tension.

### INSTALL UNIVERSAL LINKS

- \* Remove both trucks from the chassis.
- \* Apply a dab of grease on the end of four-fingered coupler on one truck and coat the inside of the Bull gear.
- \* Place Universal Link cup on the end of the Jackshaft.
- \* Reinstall truck by holding the chassis up vertically with the missing truck on the bottom.

- \* Slide truck in at an angle to engage Universal Link fingers into the gearbox while mounting the truck into the retainer fingers - motions previously practiced.
  - \* Universal Link fingers can be lined up by rocking the truck or turning the flywheel. Don't get in a hurry - it takes some jiggling.
  - \* Check all fingers are properly located - push/pull to make sure fingers are seated.
  - \* Practice doing this a couple of times to get comfortable with doing it. You'll be glad you did when we start adding wires.
  - \* Hook up our "glasses" (Multimeter) in series with the power leads. At 50% throttle let's see how many milliamps the truck is pulling. Also listen with our 'ear' tube. From experience, the one truck should pull close to what the gearbox did and our 'ear' should detect no appreciable increase of noise. Let run for a minute.
  - \* Milliamps should still be close to the gearbox alone reading. When satisfied all is okay proceed.
  - \* When comfortable install second truck and repeat all tests.
- \* If at any time the current meter exceeds 100 milliamps there is a problem. Troubleshoot and isolate to identify problem. Most common is the Bottom Cover and the ends of the Plastic Sub Frames are out of alignment.

### FOREFINGER POWER

- \* Place chassis on workbench wheels down.
- \* With one fingertip only touching the chassis turn flywheel continuously in one direction. Chassis should walk across the bench with just your finger as the power source.
- \* Walk for 2-3 inches, then reverse fingertip direction and walk back. There should be no binding. If there is, trouble shoot and repair. This is how smooth a loco should be.

### BRUSHING WITH CREST

For years modelers who needed a mild abrasive that was cheap and readily available turned to toothpaste. Travelers frequently come home with a small tube of Crest that ends up being thrown out. Let's look at how it is used. Believe it or not, toothpaste is very abrasive. As an example, take our plastic gearbox. Suppose we had a small bind or tightness that can't be found.

- \* Remove gearbox from frame. Use a small, clean brush to apply toothpaste on/in all the gear teeth, the Idler Gear and the post it sits on as well as the Bullgear shoulders.
- \* Pack it in (it's free!)
- \* Set (just hold it in with your fingers) the gearbox back in the frame and apply a light coat on the motor gear.

- \* Turn on the power supply at lowest setting to get things turning.
- \* Run for 30 seconds, then reverse power and run for another 30 seconds. Do not exceed 30 seconds. Plastic is soft and 30 seconds is about the maximum time without risking having to replace parts. Wash twice, rinse and dry.

A second example: On the trucks the metal axle ends and the bronze bushings are a wear in item.

- \* With a truck mounted in the frame with the Universal links installed remove the Metal Side Frames.
- \* With our small brush again apply Crest to the bronze bushings and the **metal** axle ends. Reinstall the Metal Side Frames to the trucks. Apply power at the lowest setting and time the polishing to two minutes.
- Reverse direction and run another two minutes.

In both examples above the items polished need to be thoroughly and completely cleaned. In the first not only the gearbox gears and housing but the motor gear needs to be completely cleaned. Keep water away from the motor.

Try to maintain the relative position of the parts so they can be put back as close to the way they came out. On the Metal Side Frames the trucks will have to be removed and disassembled in order to clean the outside of the wheels. Remember – the times above are somewhat critical. Any longer and the risk factor increases quickly.

The downfall to all this is what do you do when plastic and metal co-exist in an assembly you wish to 'brush'? Like the Jackshaft in the truck? Or a brass gear in the middle of a string of plastic gears? And you can't separate the two? Remember, metal eats plastic faster than plastic wears on metal.

In this case, I've learned to leave well enough alone. If I should have some all-metal assemblies I wish to do I mix a little light oil with some toothpaste. Toothpaste dries out very quickly when exposed to air. Thinning with oil keeps the paste flexible for a considerable time.

### 10% POWER TEST

Using a fine tip black magic marker, draw 4 lines 90-degrees apart from the front of the flywheel to the back. Hook power alligator leads to the motor. Place chassis wheels down on the workbench. Watch the flywheel while slowly increasing power. When it just starts to rotate note the throttle setting. You should be around 10%. Rotation should be smooth with no loping, stuttering or surging and you should be able to count the lines on the flywheel as it turns. If it passes this test proceed to full power test.

## HALF-SPLIT TROUBLE SHOOTING

The Half-Split method is dividing a chassis into component parts in order to pinpoint the problem to a sub component. If there's a problem, shut off power and:

- \* Remove one truck and Universal Link - retest.
- \* If problem still exists reinstall first truck and then remove the second truck. Retest.
- We removed half of the possible problem in order to isolate the problem.
- \* If one or both trucks fails this test, trouble shoot. **Recheck all steps were followed.** (Disassembly, parts preparation, cleaning, re-assembly and lubrication) There is a bind somewhere. Walk through these instructions again to ensure that everything was done properly. Take the time to completely go over the problem assembly from start to finish. Maybe you forgot something. When you think you have found and fixed the problem, go back through the testing procedure. To save you some time looking through these instructions we've summarized the power test and alignment procedures already covered in detail below.

## FULL POWER TEST

When satisfied all is okay hook alligator power leads to the motor. Now get the 'Ears' and 'Eyes' out.

- \* With tube pressed against the frame and thumb in ear listen closely while slowly increasing to quarter power. If it sounds and looks okay (less than 100 milliamps with no big swings), turn down power and reverse.
- \* Slowly apply quarter power and listen carefully for any noise that indicates a problem. If all sounds and looks okay, slowly increase to full power.— there should not be any loud noises or dramatic changes in power.
- \* For comparison, place tube on truck bottom cover and see if it sounds different than the frame.
- \* Turn down power - reverse and run slowly back up to full power. When satisfied everything is correct, shut down power.

## CHECK TRUCK ALIGNMENT

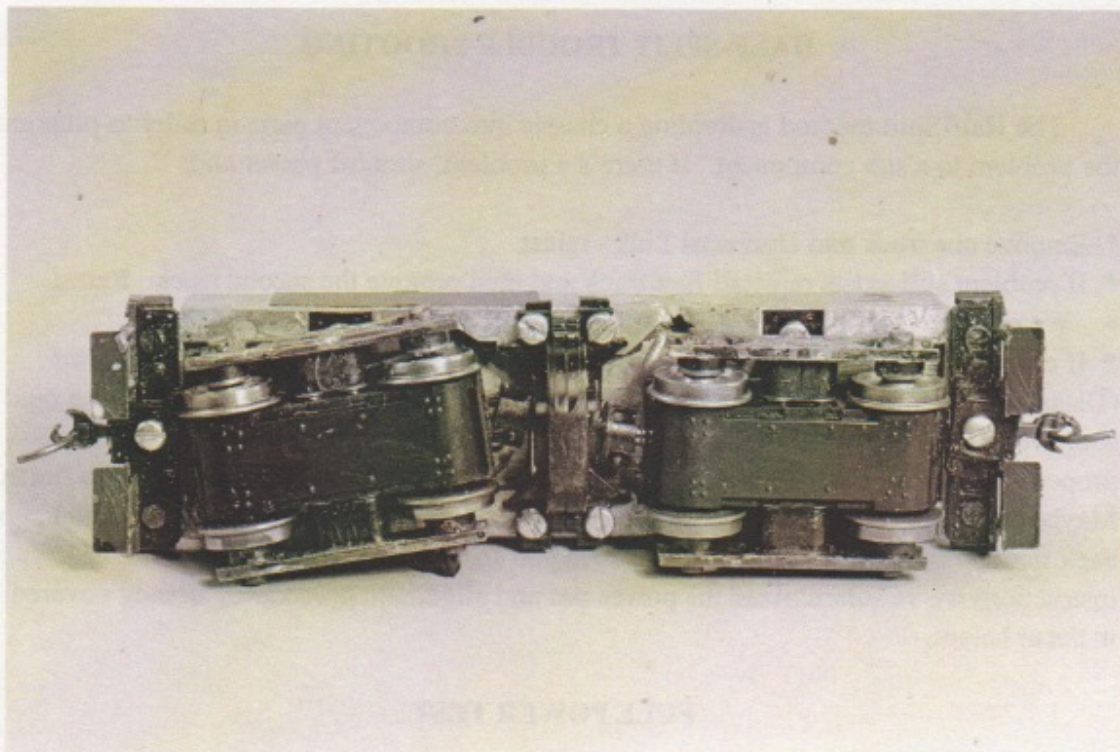


Photo #13A

**Truck alignment with 50% throttle applied to motor check bottom of chassis. Trucks should be aligned with side of frame. If only one truck is out of alignment, adjust that trucks Mounting Arm cross piece.**

Turn frame up-side-down so you are looking at the bottom covers. Slowly increase power to half and closely observe both trucks while they are running. Are the:

- \* Centerlines of the trucks and power train in a straight-line?
- \* Truck frames in alignment and parallel with frame sides?
- \* With fingertip push/pull end of one truck out of alignment - it should spring back.
- \* Test other truck.
- \* If everything passes we can proceed. If not, trouble shoot. We don't want the trucks trying to go down the track crab-wise. This generates noise and has other bad effects.
- \* If only one truck is out of alignment recheck retainer fingers. One finger may be inside the Plastic Side Frame.
- \* If not, the Truck Retainer Mounting is probably out of alignment. Remove bad truck and loosen the two screws that hold Truck Retainer Mounting in. A small change in Mounting Arm positioning is reflected in a large change in truck alignment.
- Tweak alignment, tighten screws and re-install truck. Test run - repeat until truck lines up correctly. This is the famous Trial & Error method.

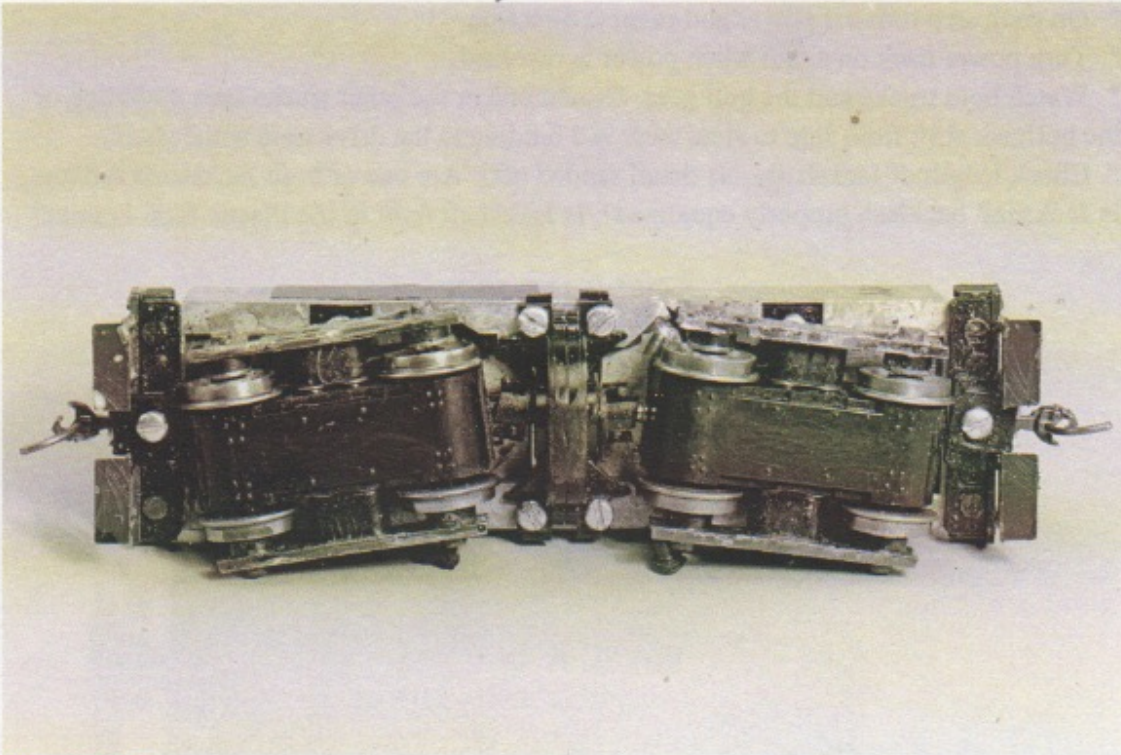


Photo #13B

**If both trucks are miss-aligned (top frame) adjust gearbox. Spacing between gearbox housing and end of universal links should be equal. Adjust by positioning gearbox.**

- \* If both trucks are out of alignment the gearbox is out of alignment. At reduced 20% throttle and meter hooked up, loosen four mounting screws, tweak gearbox and re-tighten mounting screws.
- \* Watch the meter for a minimum current draw when reseating the gearbox. This is called The Sweet Spot for it denotes the maximum accuracy in alignment is achieved.

Observe the bottom of the chassis - does everything appear to be in alignment? Check:

- \* Spacing between the Universal Link couplers and the gear box. They should be approximately equidistant from the gearbox. If not, loosen gearbox and adjust - then recheck truck alignment.
- \* The Jackshaft coupler fingers should not be bottomed out in the groves of the links. There should be some small amount of play on both sides.
- \* Check while running in both directions.

Perform the next diagnostic test.

- \* Disconnect meter and lay chassis on its side.
- \* From zero to 50% throttle slowly increase power in 5% steps.
- \* On each step turn off power and reverse direction.
- \* Turn power back on again when power is reversed.
- \* Watch both trucks and the bull gear. Should one or the other trucks start wobbling or the bull gear shift from side to side, there is a binding in the drive train somewhere.
- \* Check length of Jackshafts - Is detail sanded off? Are one or both Jackshafts too long? Is Jackshaft backlash properly equalized? Is Jackshaft tight in the Plastic Side Frames?

### WIRE AND RUN

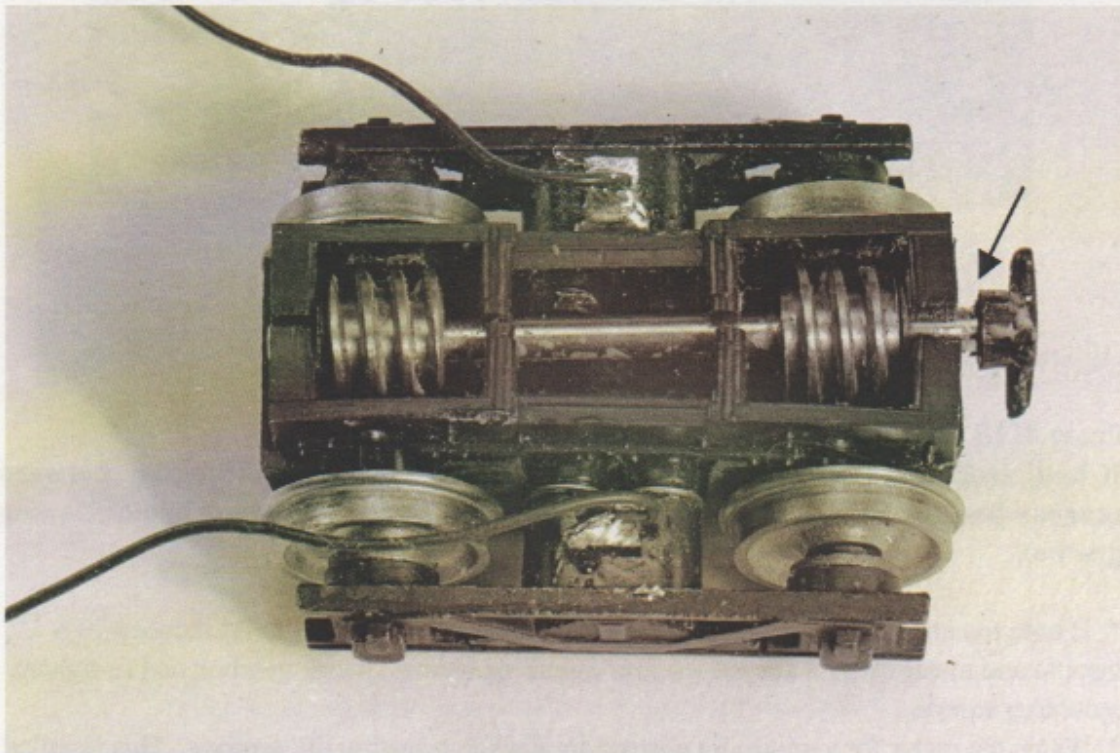


Photo #14

**Assembled truck with wire soldered in. Wires should lead towards coupler end. Wires lead in wrong direction. Dimples on other side of Plastic Side Frames mate with the ball inside of truck retainer fingers. One protrusion not inside bottom cover**

Use NWSL #10007-9 black wire. Black is most commonly used for engine wiring because it is less visible when seen in a cab. This is 51-strand extra flexible 29-gauge wire that comes in two-foot lengths. Yes, three of us counted one rainy day. It is rated at 1.0 amp, which is enough for our can motor chassis.

- \* Cut four six-inch lengths of wire.

- \* Strip 1/8-inch off all four wires and tin these ends.
  - \* Remove front truck from chassis and tin both pickups.
  - \* Next solder six-inch wire to pickups on each side. Wire should lead away from pickup toward coupler end.
  - \* Repeat on rear truck, again with wire leading away from pickups towards coupler end.
- Caution: excessive or prolonged heat can melt plastic side frames. I keep a damp (not wet) sponge handy to press frame to. Better safe than sorry.

- \* Lay chassis up/side/down and position front truck with 6-inch wire as if installing it back in frame.
- \* Poke left wire down through left side hole in frame and right wire down through right side hole in right side. Keep pulling wires through hole until snug while installing truck back into chassis.
- \* Make sure all wires are clear of the universal links.
- \* When truck is close to install position, pick up chassis so that truck being installed is pointing up. This will help keep universal link from falling off. Truck and chassis can be held with one hand while wires are pulled snug.
- \* Be careful not to get wire caught between retainer fingers and side-frame. Slow and careful does it.
- \* When the truck is snapped in, correctly, check to make sure wires will move freely.
- \* Using a small flat bladed screwdriver press wire to lay down against inside of frame.
- \* Pivot truck side to side to make sure wire moves freely.
- \* Press two wires on left side down towards the rear motor terminals.
- \* Trim two wires to same maximum length. Strip   -inch of insulation off both wires and twist together. Tin wires, then tack solder to red terminal. Right side goes to black terminal.
- \* Remember that no matter how you look at the assembled chassis, that 'left' and 'right' are the same for both trucks.
- \* Repeat all above with other truck.

Place chassis on track and run. It should be smooth and relatively quiet all the way to top speed. Check chassis is running in the correct direction, both forward and in reverse. When polarity is verified, clean motor terminals and properly solder connections.

#### POLARITY CHECK

- \* Hook up a DC power source to a straight section of track.
- \* Connect the Multimeter voltage leads to the track, place Direction switch to the right and apply voltage.

- \* When the meter indicates a Positive Voltage with the red meter lead on the track away from you, the black meter lead closest to you reduce power to 0%.
- \* Place loco on track facing right and turn power up just enough to get loco running. It should run to the right. If it runs left swap motor leads and retest.
- \* Use another loco you know is right just to double check yourself.

### OIL! THE OIL!

As a final step before putting the chassis on the layout we need to lube it. Use LaBelle #108 plastic compatible oil except for the axle ends, which take metal-to-metal LaBelle #107. I am often asked to drill a hole in the bottom cover to make oiling the axle gear easier, but I don't think it's a good idea. You need to see how much you're putting where. Too often the oil doesn't get where it's needed. I also think if one component needs lubing the whole chassis probably needs lubing.

I use three small 000 brushes to lube – one for grease, one for 108 oil and one for 107 oil. Dip the brush tip in the oil, blot on a paper towel and apply precisely where wanted. I identify the brushes with the word oil/grease in small print from my computer then cover with scotch tape.

- \* Let's get started by removing the black tape holding the wires to the motor.
- \* Stretch out the wires so trucks can be set to one side of frame. All we are concerned with is readily handy.
- \* Remove both trucks and tuck the Universal Link away so we don't lose them.

#### Top of the frame:

- \* We can ignore the motor - it is lubed for life and there are no carbon brushes to worry about. Instead gold/silver "wipes" are used.
- \* Lightly oil-brush the teeth on the motor and idler gear, put a small touch on side of idler gear and the gear housing.

#### Bottom of frame:

- \* With brush apply oil on face of both gear housing ridges.
- \* On left side push the bull gear to the right - brush oil into shoulder ridge. Repeat on right side.
- \* Don't forget the center inside the Bullgear and coupling pocket ridges.
- \* Put a small drop of oil in both Truck Retainer guidepost holes, wiggle retainers.

Trucks:

- \* Oil-brush both worm gears, touch between worm gears and plastic ends and turn Jackshaft to spread oil.
  - \* Lightly brush coupler fingers. Do both trucks, then install both back onto chassis.
  - \* Don't forget Universal Links. Axle gears will be lubed from worm gears.
  - \* Hold chassis upside down.
  - \* With small screwdriver blade pry metal side frame outward until you can just see the axle ends.
  - \* Brush a small amount of #107 on both ends and push metal frame back into the plastic frames.
  - \* Do other three metal frame assemblies.
- 
- \* Apply 25% power to motor with alligator leads. Run for several minutes, then reverse direction for several minutes.
  - \* Apply 50% power and Open bottle of alcohol, pour some into cap then clean all eight wheels with Q-tips.
  - \* When clean polish all eight wheel treads with #400 dry. Remember our pop-cycle sticks?
  - \* Wipe up excess oil and clean everything off. I use nose tissues for this.
  - \* Disconnect power.
- 
- \* Fold excess wire back along the motor in an S curve.
  - \* Hold wire against the motor with electrical tape applied so that one side is even with the front of the motor.
  - \* Run tape from bottom left side of the frame to the right side.
  - \* Apply a second piece slightly over lapping the first to completely cover the motor.
  - \* Trim both sides just barely above the bottom of the frame.

The black tape will hide the motor when the frame is installed in the Shell. When removing trucks for maintenance the extra wire will be appreciated. Should you decide to add DCC at a later date, and need an extra inch of motor lead, just reverse the trucks end for end. Not bad, huh!

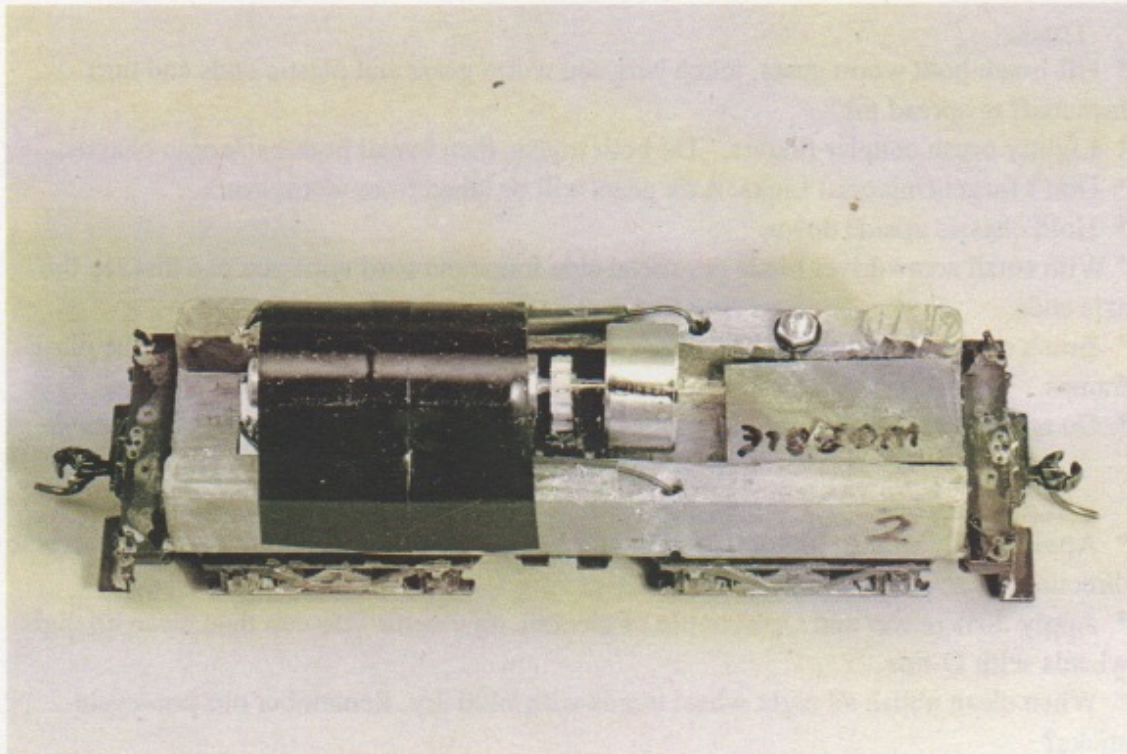


Photo #15

**Completed chassis. Black tape holds excess wire in S curves against motor, hides motor when shell is installed. When removing trucks from chassis first remove tape for extra wire length. Chassis will run by turning flywheel with fingertip.**

### THE SHELL

I include the shell as a step in the tuning process. I have tuned locomotives only to put the shell on and immediately have problems. All the time tuning the mechanism can be quickly wiped out.

Check the shell over carefully. De-burr and check for loose parts; windows, handrails and roof. The roof is the most common item that resonates on the Climax. Held on by two protrusions that snap in, they're usually the only spots that are glued. If you lift the four corners with a fingernail they will probably be loose. Using Plastic Glue, bond all roof contact points around the four sides. Shells vary widely — but parts that are not secured can cause many problems.

Install the Climax shell on the chassis. Are the gear-housing fingers that hold the shell on warped? Out of line? Are the grooved slots the fingers mount in too small? Alignment should be adjusted until the fingers fit completely and firmly in the two grooves. The shell should fit against the frame sides snug and firm. Adding window glass of thick clear plastic will stiffen up the shell sides, if needed. Mount the shell; does the chassis run quietly with the shell on? If yes, you are almost done.

### WEATHERING: QUICK & DIRTY

Weathering is optional – but can sure leave the impression of a loco in the real world. This method is quick and dirty. Try it on an old plastic freight car to check appearance.

Needed: any brand India Ink from an office supply store and a pint of alcohol. Place an inch of alcohol in a small glass jar, then add one drop of India ink. Stir with a flat 0.25 inch wide X 0.5 inch or longer soft brush. Apply to newspaper white borders to see depth of color. Slowly, slowly add ink drop by drop until painting some mixture leaves a stain on the white paper. Do not get in a hurry here or you'll quickly end up with a pint bottle full of ink, and still be too dark.

When the stain is to your satisfaction, with brush apply liberal amounts to the entire shell. I do mean wet all surfaces you desire to weather. Place somewhere to dry.

I strongly advise novice modelers to get a gallon of flat latex earth color for their layout. One they like. Then when weathering rolling stock it will match the color of the dirt through which consists travel.

Wet water is water to which a surfactant has been added. I use one tablespoon liquid soap to a gallon of water.

Repeat as for the India ink. To an inch of wet water, add a teaspoon of latex earth color. Stir with a flat 0.25 inch wide X 0.5 or longer soft brush. Apply to newspaper white borders to see depth of color. Slowly, slowly add paint until painting some mixture leaves a stain on the white paper. I do mean wet all surfaces you desire to weather. Set aside to dry.

The India ink will highlight the details while removing the shiny new look. A light paint stain can be applied several times, which becomes dirtier with each application. A big plus to this method of weathering is – if you don't like it you can wash the shell with warm soapy water and be back to where you started.

No, I don't seal the weathering with anything. When dry, the paint is hard enough to take quite a bit of handling. Both solutions stored in sealed container will last for years. I call this the Lazy Modeler Weathering Method.

### ADDING BALANCED WEIGHT

A frequently asked question about the Climax is "How, and where, can I add weight?" There doesn't seem to be anywhere to add weight. A gambling friend bet me \$20.00 I

couldn't add any significant amount of weight. Significant was defined as 0.5-ounce. Here is how I won that bet.

"Less is More" is an old engineering (and con mans) adage. We'll start by removing weight: Remove the 0.77-ounce stock flywheel from the chassis (Less). At first I used four 1/4-ounce stick-on weights (More), and didn't remove the mounting guides from the frame. This added 1.0-ounce. But I had to notch the weight to fit and we lost a little weight. Tiny particles were everywhere.

I now remove the four guideposts and use sheet lead to weight my chassis. I cut 5 pieces to just fit in the space the stock flywheel occupied 5/8-inch wide and 1-1/4-inch long. Four pieces came up even with the frame sides and weigh in at 1.69-ounces. We just gained 0.92-ounce (More). By removing the heaviest item on the chassis we gained a significant weight increase.

An added benefit is we now have a platform 5/8-inch X 1-1/4-inch to mount a DCC decoder and possibly a sound card. The NWSL flywheel will sit in the middle of the frame – and adds another 0.5-ounce. Sticking a 1/4-ounce wheel weight on the back wall of the shell up against the wood fuel load brings us up to a 1.67-ounces. And the weight is balanced over both trucks. Less is indeed More.

### ANOTHER \$20 BET

My gambler friend stopped by while I was finishing up. The completed stock shell was sitting on the bench ready to be installed. He bet me \$20.00 there was no way to add significant weight to the shell. Significant defined as 0.5 ounce - and that the added weight had to look natural. The stock shell weighed .75 ounce with the 0.25 oz stick-in weight we'd applied earlier.

### ADDING DETAILS

The appearance of the model changes dramatically for the better with small details. Better, their addition enabled me to win the bet about weight. Here's what I did.

- \* Added a MDC Shay toolbox primed and painted red. Glued it on with CLN.
- \* From the kit details I added a generator - removed the mounting post, sanded the bottom and glued it with plastic cement to the roof.
- \* The plastic rear light is from my junk box.
- \* On the front boiler shelves remove the post tips that stick up above the shelves with a sharp knife.

\* Add crates and barrels. JL Innovative Design produces a wide variety of metal and wood barrels as well as crates. All are cast metal. A package has five barrels all in one color. Their crates are four to a package. All are painted and decaled. I now spray them with Dullcote before use - the first ones I didn't and the decals slipped off during weathering. Order four packages - two colors of metal barrels, one of wood barrels and one of crates. They are less than four dollars a package and what you don't use on the climax will look good next to the cookhouse or engine shop. Apply them by spreading CLN on the bottom and position them where you want.

\* Add Cal Scale brass water pump and hose reel. I wrap solder on the reel for the extra weight, leave solder a light gray and stick both parts on with CLN. My eye sight no longer allows me to do piping, so there is no piping.

\* The Climax kit comes with the air tank and compressor. I mount both on the rear. A touch of gold paint on the top of the air compressor adds interest.

\* Paint the handrails around the headlight base, the whistle (rear dome) and detail top of air pump (front left) and don't forget the bell.

\* Clover House blackened brass chain is draped over the front dome and allowed to hang down both sides. Don't let them hang down below the steps. I tack them on the dome with a small drop of ACC. Where the chains hang over the edge I use ACC.

\* Wood load is wooden Q-tip sticks stained and cut - CLN holds the logs to the painted plastic well.

The shell now weighs in at 1.5 ounces - a .75 ounce gain. {All together we've added 2.15 ounces, or a 25% increase - and it's balanced weight.} My new winnings paid for all the detail parts. I shared what detail parts were left with my friend.

See the trend? Many small changes = large total effect.

### MINOR DETAILS

There are always minor details. Example: couplers. I don't remember if we de-burred and smoothed the coupler box covers. Locate them, and the 2-56 X 1/8" screws. Mount the coupler of your choice. I use the new #58 to-scale Kaydee units.

Balanced weight - I mount a standard yellow pencil to a piece of 2" x 4" board slightly longer than the engine I'm balancing with white glue. The pencil has a small flat area that makes balancing less touchy, but just as accurate. Turning the engine on its side, place it on the pencil and find the balance point. It should be within the middle third of the engine. Add or subtract weight as is practical until engine balance is as close to center as you can get. A larger locomotive will need a wider flat area for balancing.

### PERFORMANCE TEST

- \*START VOLTAGE - The voltage required to get an engine to run.
- \*START CURRENT - The current required to get an engine to run.
- \*CRAWL VOLTAGE - The lowest voltage an engine will run consistently and smoothly.
- \*CRAWL CURRENT - The lowest current an engine will run consistently and smoothly.
- \*CRAWL SPEED - the lowest speed an engine will run consistently and smoothly

All five terms are used to measure some aspect of electrical/mechanical performance. Very few modelers use the terms, fewer yet understand how or why to measure performance. The numbers allow a practical and *repeatable* unit of comparison.

The first four are useful as a comparison tool to measure Power (in terms of voltage and amperage) required to perform a specific task. All too often when power is applied the engine will jerk into motion, and then the throttle has to be turned back down so it will crawl. A finely tuned engine requires less power to start and less power to run. It will run slower, and faster, than an identical unit that is not tuned. I can see the perplexed look on some of your faces - slower, yea - but faster? Less friction to overcome results in higher efficiency. It's like pushing a car with the emergency brake half on.

If one could tune a loco chassis well enough that the Start and Crawl volt/amp were the same we would be reaching perfection. The ratio of the two is an indicator of efficiency between power and friction.

### SCALE MILES PER HOUR

My article "S.M.P.H. at a glance" on page 81 in the September 2003 Model Railroad Craftsman is reprinted with permission from Carstens Publications. It appears as Attachment 4 in the back of this book.

The best test of a tuned loco is 'How slow will it go?' This is the least understood, and yet simplest measurement. Determining the Time/Distance ratio gives us Scale Miles Per Hour. How do we measure it? The formula for measuring Scale Miles-Per-Hour in HO scale is:

S.M.P.H. = .6818 X Scale Factor X Distance (In decimal feet) / by Time in seconds.

S.M.P.H. = .6818 X 87.1 X Distance (6" = .5') gives a constant of 29.69239

Accurately measuring a 6-inch (0.5 feet) distance we have a constant of 29.692 divided by seconds = SMPH.

Testing the tuned chassis we just built for this article it fired off at 0.75 volts, 25 milliamps, and took 4 minutes (240 SEC) + 8.71 seconds to cover the six inches. This is  $29.692 / 248.71$  or **0.119 SMPH**

I raised one end of my four foot test board six inches for a 12.5% incline and run the same test again. This time it fired off at 0.75 volts, 50 milliamps, and took 4 minutes - 23.43 seconds or **0.113 SMPH**. Test your favorite engine as above for comparison.

\*I draw four black lines on the flywheel 90-degrees apart. Without the lines it's hard to tell if it's running. Running, you should be able to count the lines as the flywheel turns.

\*Using a four-foot test track I clean the wheels and the track with alcohol. The digital Voltmeter is attached to the tracks and a 0-500 milliamp meter hooked in line. Wheels and track are cleaned to minimize errors due to poor pickup.

\*Measurements are made with the chassis on the track.

\*An MRC 1300 DC throttle (no pulse) is used. (Note: a tuned engine will run much better without the Pulse feature).

\*I measured an accurate six inches and marked both points on the test layout. I use a digital sports stopwatch for timing.

Testing the stock MDC climax chassis before we tuned it, it took over 4 volts and 380 milliamps to start running. At top speed it was 14.5 volts and close to 1000 milliamp (1 amp). After tuning, our readings were 0.75 volts and 30 milliamps for both Crawl and Start specs - and top speed at 15.0 volts only drew 70 milliamp. Start and crawl on stock chassis hard to accurately measure due to poor pickups. Crawl speed was impossible to read. But you can see the difference immediately.

### THE FOUR DIRECTION TEST

Put your completed locomotive on the layout and run it for a couple of hours at various speeds. Avoid running at max throttle. That's all it will take to wear-fit everything in. If you have a test loop of track (your minimum radius) you might first give your loco the '*Four Direction*' test. **The smaller the minimum radius, the more critical this test is.**

- \* LF-F = Left Facing, Forward.
- \* LF-R = Left Facing, Reverse
- \* RF-F = Right Facing, Forward
- \* RF-R = Right Facing, Reverse

Place loco facing left on the test loop and run a couple of hours forward, then reverse throttle and run a couple hours in reverse. Turn loco facing right and run a couple of hours forward, then a couple of hours in reverse.

We have checked that the engine drive-train alignment allows tracking through your minimum radius curves from all directions possible. If there is any significant misalignment it will show itself by the front axle on the lead truck jumping off the track in *only one* of the four directions. It would best be found here rather than spending hours trying to fix a 'track' problem. Of course your friends or visitors will be standing right there when it happens.

You can see the finished Climax on the front and rear covers.

### PARTY TIME

Invite your friends over and amaze them with the little engine that could - - and can - - run off finger power! Then listen to the Silenced Critics!

**ATTACHMENT #1**

AT THIS TIME THERE ARE NO PARTS AVAILABLE FOR THESE LOCOMOTIVES.

THE FOLLOWING ARE AFTER MARKET SOURCES OF MOTORS AND DETAIL PARTS.

**NORTH WEST SHORT LINE**

10007-9 = #29 GA BLACK WIRE EXTRA FLEXABLE - 2 FOOT	\$1.95
432 - 6 = 2.0 MM SLIP-FIT FLYWHEEL	\$3.95
77626-6 = LARGE BRASS GEAR FOR SINGLE GEAR CASE FOR MOTOR SHAFT	\$6.00
78612-6 = SMALL BLACK PLASTIC GEAR FOR TWO GEAR CASE FOR MTR SHAFT.	\$6.00
103-4 = SHIM WASHER PACK OF 10	\$0.99
10159-9 = ADAPTER, 2 EACH PER PACKAGE	\$1.95

**NWSL PHONE ORDERS: 206/932-1087**

**DISCOUNT MODEL TRAINS - DALLAS  
VARIOUS DETAIL PARTS FOR SHELL:**

JL INNOVATIONS METAL BARRELS - 2 COLORS	\$6.36
JL INNOVATIONS WOOD BARRELS - 1 PKG	\$3.18
JL INNOVATIONS CRATES - 1 PKG	\$3.03
CAMPBELL CHAIN 12"	\$4.20

CAL SCALE WATER PUMP KIT AND HOSE REEL WP-287:	6.80
CAL SCALE BELL:	3.85
CAL SCALE WHISTLE:	2.10

**DMT NATION WIDE PHONE ORDERS  
1-800/387-2460 OR 972/931-8136 DALLAS**

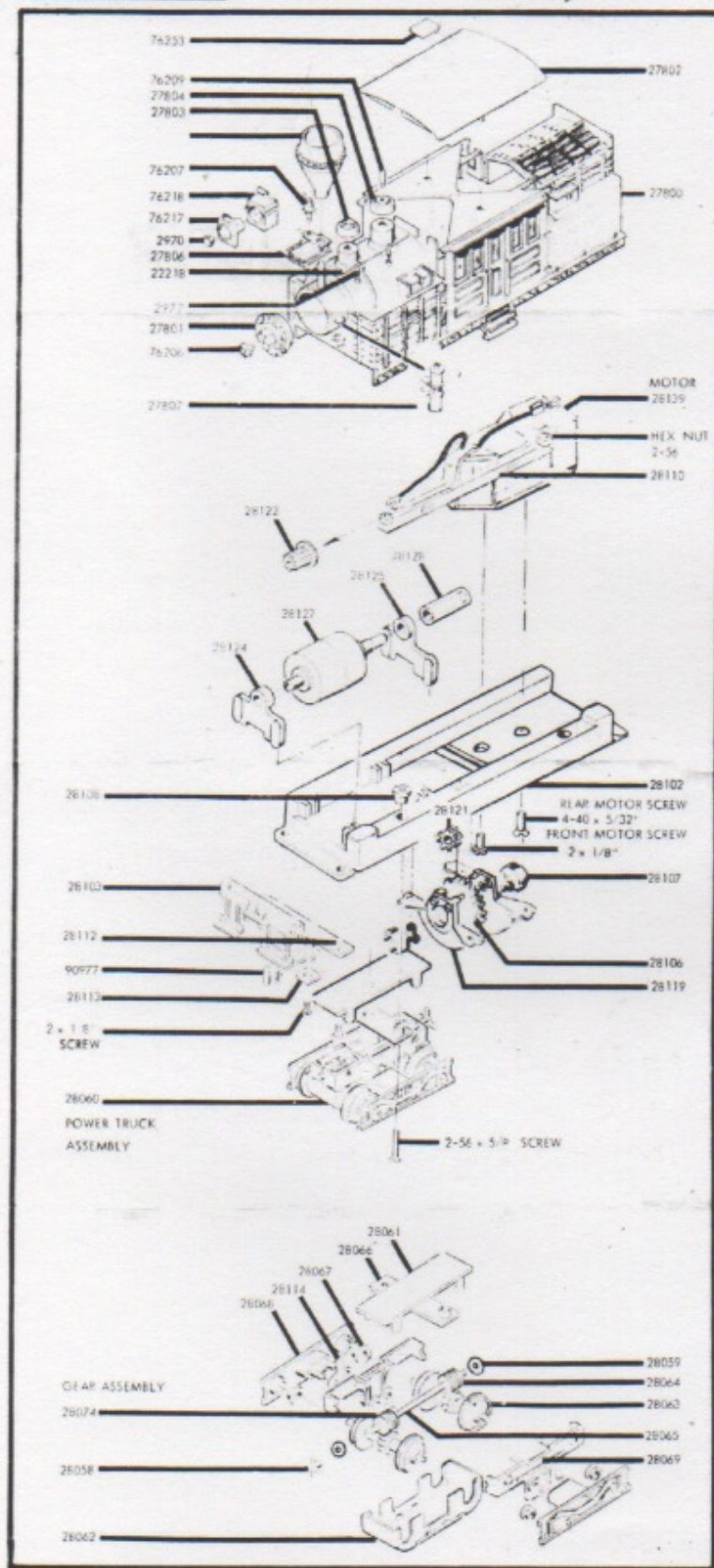
**MOTOR**

HO CAN MOTOR FF-180PH - WITH 2 MM SHAFT X 0.5-INCH LONG \$8.00  
TONY MUSCO 352/688-8637 Eastern

## ATTACHMENT # 2



## CLIMAX Locomotive



AT THIS TIME THERE ARE NO PARTS AVAILABLE FOR THESE LOCOMOTIVES.

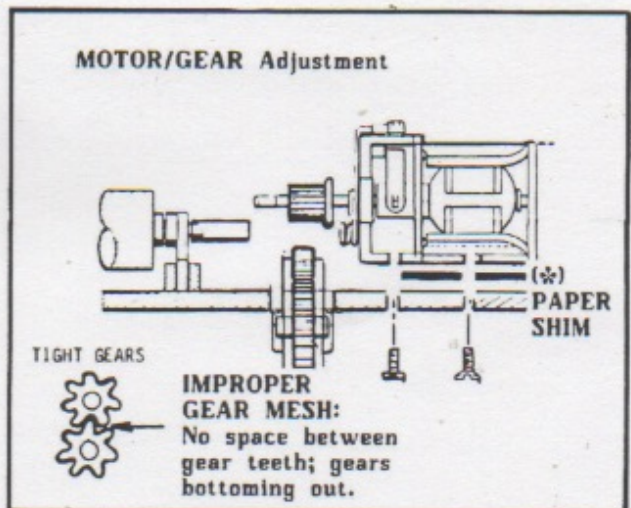
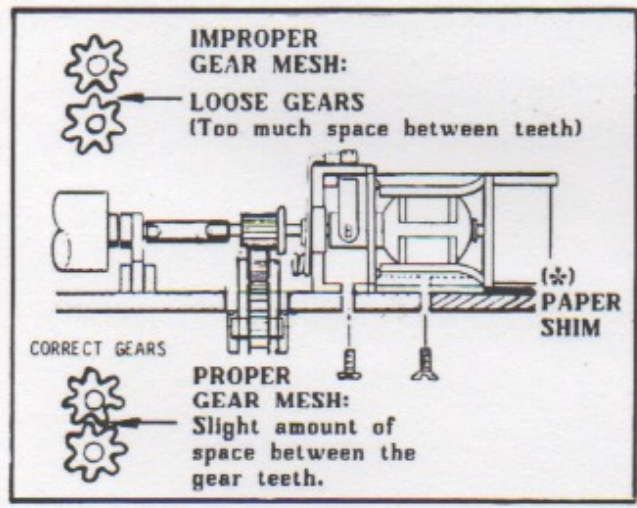
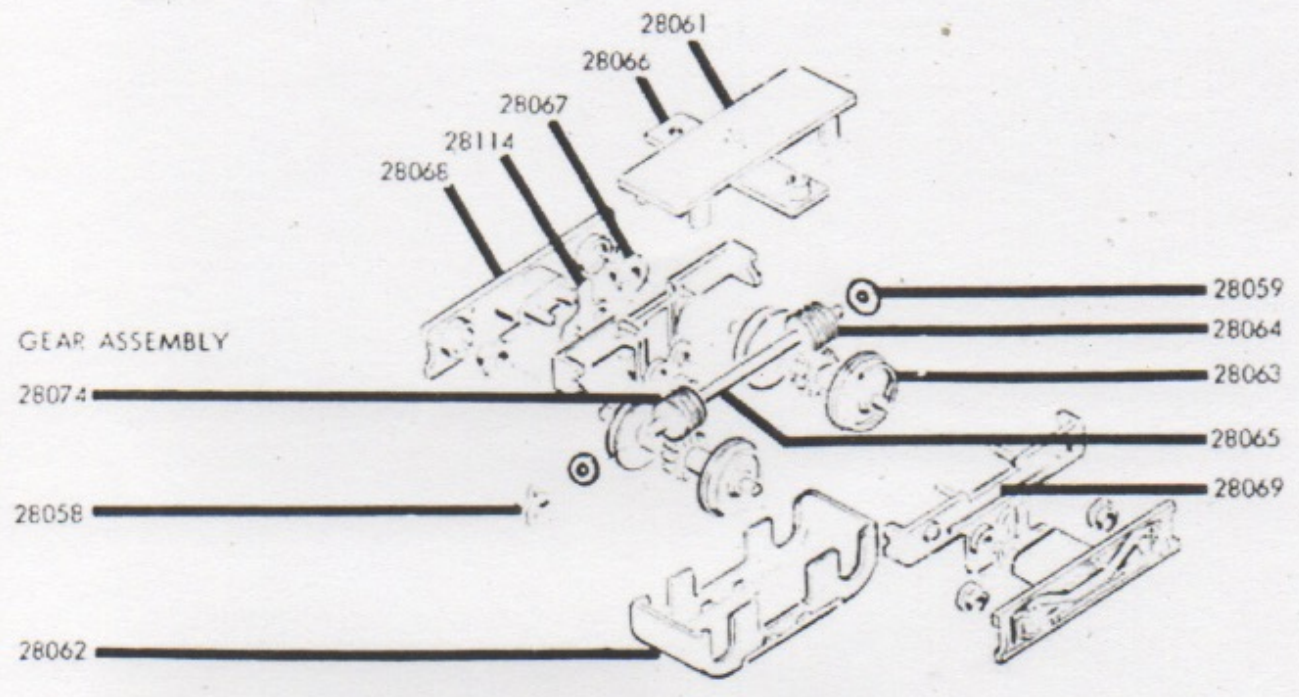
27800	Climax Body .....
2977	Handrail Post (Brass) .....
22218	Handrail Wire, 6" .....
2970	Headlight Jewel, 3/16" .....
27805	Climax Detail Molding Set (includes 27801-27807) .....
27801	Smoke Box, Front .....
27802	Cab Roof .....
27803	Sand Dome, Top (front) .....
27804	Steam Dome, Top (rear) .....
27806	Headlight Bracket .....
27807	Air Pump .....
2980	Baldwin Loco Detail Molding (includes 76206-76253) .....
76206	Number Board Round .....
76207	Bell .....
76208	Number Board, Rectangular .....
76209	Whistle .....
76210	Pop Valve (2) .....
76217	Headlight (Front) .....
76218	Headlight (Rear) .....
76241	Smoke Stack (Straight) .....
76242	Smoke Stack (Capped) .....
76243	Smoke Stack (Caldron) .....
76244	Stack (Small Diamond, Bottom) .....
76245	Stack (Small, Diamond Top) .....
76248	Stack (Large Diamond, Bottom) .....
76249	Stack (Large Diamond, Top) .....
76253	Loco Cab Hatch .....

## MECHANISM PARTS

2798	Mechanism Powered .....
28058	Universal Driver .....
28059	Washer .....
28060	Powered Truck Assembly .....
28061	Retainer, Top .....
28062	Retainer, Bottom .....
28063	Wheel Assembly .....
28064	Worm Gear Brass .....
28065	Jack Shaft .....
28066	Mounting Arm .....
28067	Axle Bearing, 4-Pieces .....
28068	Side Frame, Die Cast .....
28069	Sub Frame, Plastic .....
28074	Jack Shaft & Gear Assy .....
28102	Underframe, Die Cast .....
28103	End Sill & Steps .....
28119	Gear Housing .....
28106	Gear Lower .....
28107	Universal Link .....
28108	Insulated Pushing .....
28110	Jumper Bar, Metal .....
28112	End Sill, Retainer .....
28113	Draft Gear Lid .....
28114	Pick-Up Arm .....
28122	Drive Gear .....
28121	Idler Gear .....
28124	Retainer, Front .....
28125	Retainer, Rear .....
28127	Flywheel, Die Cast .....
28128	Coupling Plastic .....
28139	Motor with Gear .....
90977	Coupler .....
90006	Screw, #2 x 1/8" .....
90007	Screw, #2 x 3/16" .....
90020	Hex Nut #2-56 .....
90027	Screw, #2-56 x 5/8" .....
90041	Screw, #4-40 x 5/32" .....

### ATTACHMENT # 3

THIS IS A DISCONTINUED MODEL. AT THIS TIME THERE ARE NO PARTS AVAILABLE FOR THESE LOCOMOTIVES.



MOTOR - SHIM\* Use a match book cover and cut out a flat, small piece approximately the width of the motor and place at the end which needs elevation.

MOTOR/GEAR Adjustment -

**TIGHT GEARS. Solution -** Raise motor using paper shim; place shim under front & rear of the motor.

**LOOSE GEARS. Solution -** Raise rear of motor using paper shim; place shim under rear of the motor

## ATTACHMENT # 4

# Scale miles-per-hour at a glance

Calculating speed is easy/Ron LaFever

When modelers talk about how slow an engine will run, too often it's in "how many ties per minute." The number of ties per foot varies widely between track manufacturers and the scale, and it is like comparing persimmons to pomegranates. There is an accurate and simple method of measuring scale miles per hour that seems to have been forgotten over the last 25 years.

In his article "Calculating scale speed" in RMC, July 1977, Don Fiehmann derived the formula for accurately calculating scale miles-per-hour:

$$\text{S.M.P.H.} = .6818 \times \text{Scale Factor} \times \frac{\text{Distance (in decimal feet)}}{\text{Time}}$$

where **SF** equals the scale factor (taken from Table 1); **DIS** is the distance in feet expressed as a decimal (6" = .5 foot, 9" = .75 foot); and **Time** is in seconds.

Here's an N scale example:

$.6818 \times (160 \text{ SF}) \times (2.0 \text{ feet Dis}) = 218.176/\text{Seconds}$ . If the time in seconds to travel two feet is 4.32 seconds, then:  $218.176 / 4.32 = 50.5 \text{ s.m.p.h.}$

On most N and HO scale layouts there is usually room for a straight two feet of track that's convenient and can be used to measure s.m.p.h. On my N scale layout, I established a method of quickly measuring scale speed. I placed a small spot of burnt umber on the end of a railroad tie, then measured an accurate two feet and made another burnt umber dot. The second dot does not have to be on the end of a tie. Time has revealed that frequent visitors seldom see these dots until they are pointed out. With a stop watch I can now measure the time in seconds and accurately determine true scale speed by using a calculator.

Carrying both a stop watch and calculator soon got to be cumbersome. Being lazy, I transposed the basic formula by using algebra to:

$$218.176 / \text{s.m.p.h.} = \text{Seconds.}$$

$$218.176 / 5 \text{ s.m.p.h.} = 43.64$$

Using this transposition of the basic

formula, I built a table in 5 s.m.p.h. steps (see Table 2). On the bottom of the table, I added the prototypical speeds of various consists:

#### Average speed of the prototype:

Yards = 5 to 15 m.p.h.

Long freights = 20 to 35 m.p.h.

Express freights = 35 to 55 m.p.h.

Passenger trains = 50 to 70 m.p.h.

I then posted a copy on the fascia board next to my control panel. When measuring the speed in seconds, I glance at the chart to obtain a quick approximation of the train's speed. Unless I needed a precise and accurate

calculation I forget the calculator.

When a visitor comes, I frequently hand them the throttle and stopwatch, and ask them to regulate the train speed to the correct prototypical speed. This is a quick way to get a visitor involved in my scale world.

Next I tackled my HO scale switching layout, whose maximum allowed top-speed is 20 s.m.p.h. I quickly discovered that two feet was too long a distance for practical use and limited the places I could utilize. Trying various distances, I found one foot to work well. This gave shorter time periods of measurement at slow speeds, maintained reasonable and consistent accuracy at high speeds and increased the number of locations I could use. Plugging these new numbers in the basic formula I got:

$$1'-0" \times 87.1 \text{ scale feet} \times 0.6818 = 59.385/\text{Seconds} = \text{s.m.p.h.}$$

Transposing:  $59.385/\text{s.m.p.h.} = \text{Seconds}$ , I built a new table (Table 3).

I discovered two general rules of thumb exist. One, the slower the speed being measured, the shorter the distance traveled should be. When waiting 15 minutes to get a measurement, one can get distracted. Two, the higher the speed being measured, the longer the distance traveled should be. Accuracy under 3 seconds borders on being suspect. For a wide speed range there has to be a compromise. From around 60 seconds slow speed to three to five seconds high speed seems to be livable and practical.

Usually a stretch of straight track is available to establish an accurate distance. If you have to use a curve in your measurement, mark a piece of string with your dimensions, then hold the string to the centerline of the track. Place dots accordingly. By plugging in the distance in feet and the correct scale factor in the basic formula, one can accurately measure the true s.m.p.h.

By transposing the formula, make your own custom table for your particular layout. When finished and posted, you too can quickly estimate the approximate "Scale Miles-Per-Hour at a glance."

Table 1: Scale factors

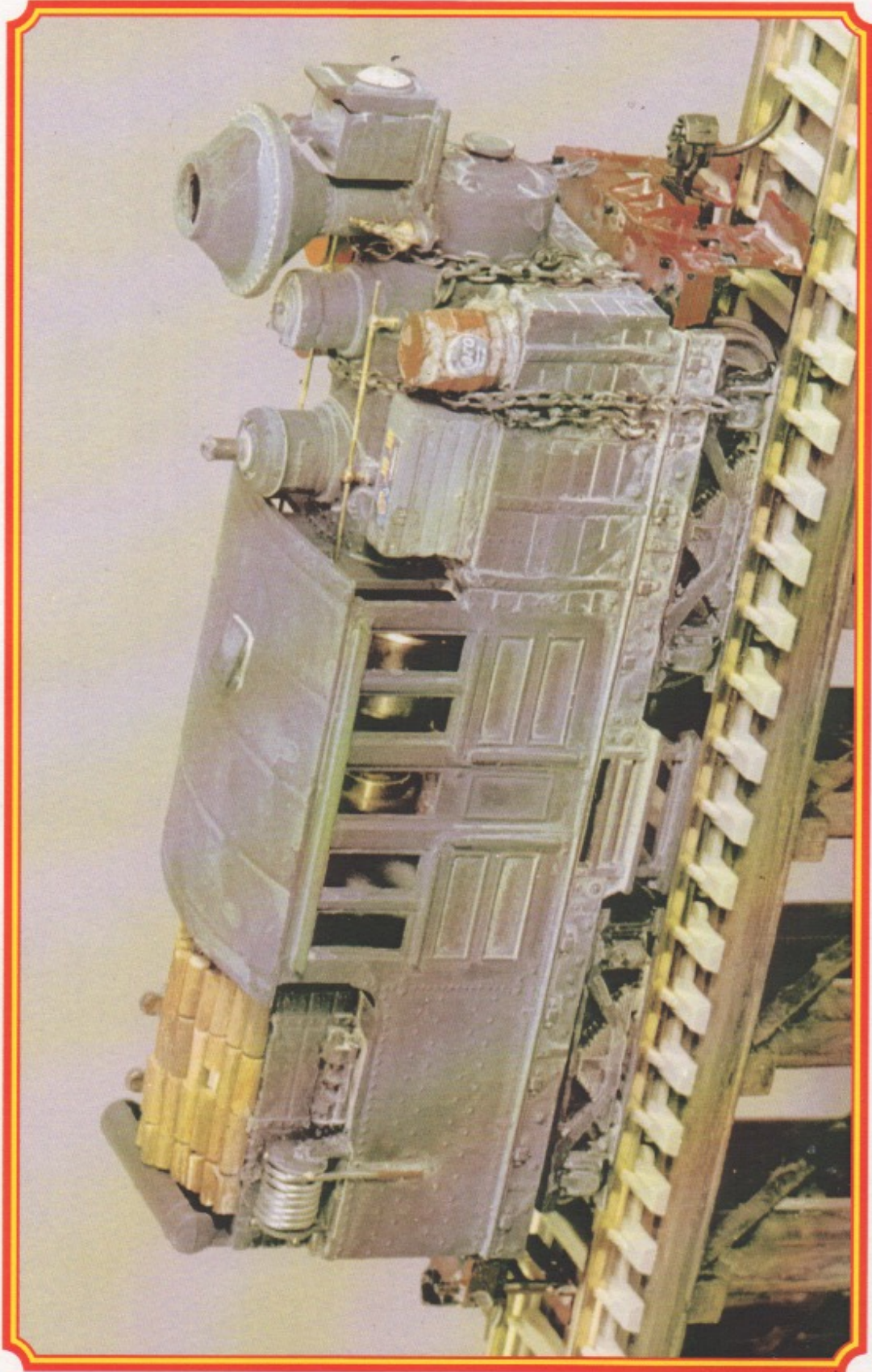
O = 48, S = 64, HO = 87.1, TT = 120,  
N = 160, Z = 220

Table 2: N s.m.p.h per 2 feet

Seconds	s.m.p.h.
43.64	5
21.82	10
14.55	15
10.91	20
8.73	25
6.23	30
5.45	35
4.85	40
4.36	45
3.97	50
3.64	60
3.36	65
3.12	70

Table 3: HO s.m.p.h per 1 foot

Seconds	s.m.p.h.
59.39	1
11.88	5
5.94	10
3.96	15
2.97	20
2.38	25



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