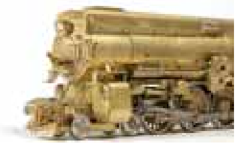


Rebuilding Brass Steam Locomotives

By Mark Schutzer

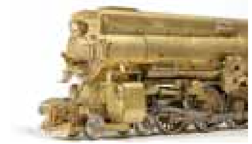
PCR Regional Convention, Fresno, CA

May 2008

Copies of this presentation can be found at

http://www.markschutzer.com

Clinic Overviews

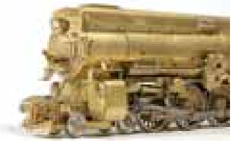


Part 1 – Troubleshooting and Repairing

- Brass steam locomotives have a reputation for running poorly. This clinic will discuss the common problems and show you how to fix them. A step by step example of a locomotive repair will be illustrated. This clinic is tailored to the beginner who wants learn how to improve the running of those cranky steam locomotives.

Part 2 – Rebuilding Steam Locomotives

- This clinic will show you how to turn those “noisy growlers” into prize runners that will silently creep down the track. Re-motoring and re-gearing will be discussed and illustrated in detail. Topics include motor and gearbox selection, motor mount construction, and the use of universal joint couplings.



The tale of three KTM Mountains…

A quick little demonstration

Mountain 4355

- Original condition, as obtained

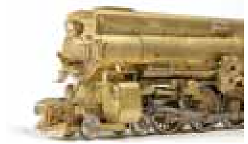
Mountain 4347

- After completion of clinic’s 1 and 2
  - Re-motored
  - Re-geared
  - Universal coupling
  - Decoder equipped

Mountain 4357

- After decoder clinic
  - Re-motored
  - Re-geared
  - With sound decoder installed

Problem Areas

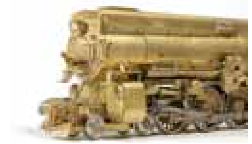


Motors

Gearboxes

Rigid motor to gearbox couplings

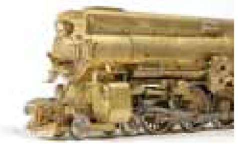
Motor Issues



Motor Issues

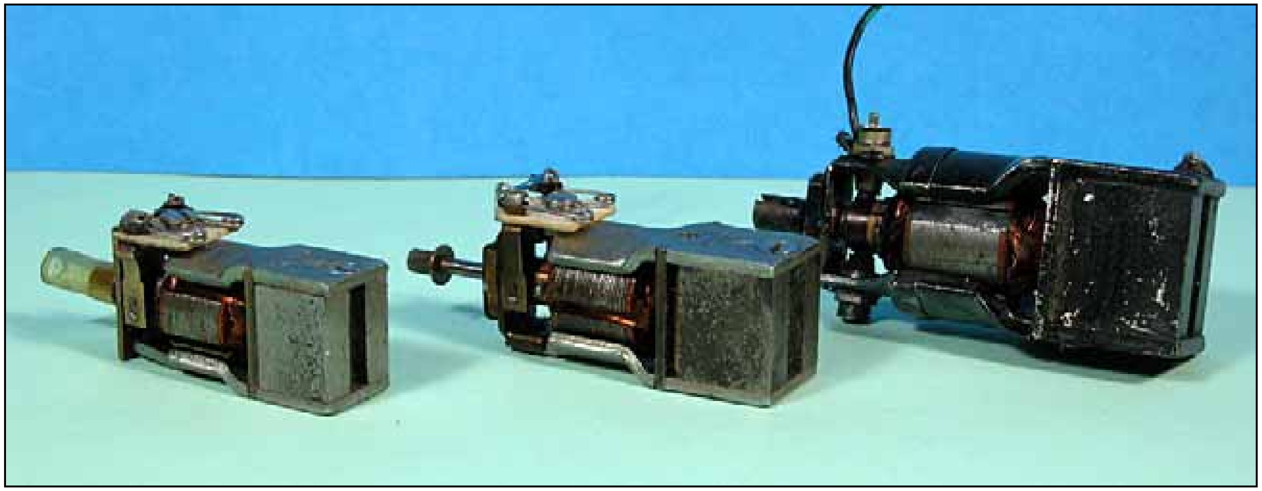
- Most early (1950’s through mid 1970’s) brass locomotives are equipped with open frame motors.
- Most of these motors have very poor starting torque resulting in a higher starting voltage.
- As a result it is almost impossible to get slow prototypical starting of a locomotive. The increased starting voltage causes the locomotive to lurch to a unrealistic start. Once running the voltage can be reduced to slow the locomotive down, but it won’t run well due to the poor slow speed torque of the motor.
- These motors are very inefficient by today’s standards and consumed lots of current. Typical stall currents for these motors are in the range of two amps or more. These high stall currents are not compatible with HO scale DCC decoders.
- As a result of the higher running speed of these motors large gearbox reduction ratio’s (37:1 or greater) are typically used. At higher locomotive speeds this results in noisy operation in part due to the high operating speed of motor and gearbox.

Original Motors

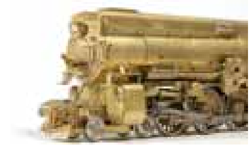


Some typical open frame motor numbers

Motor Type Open Frame KTM	Free Running Current (Amps) 12 volts	Typical loaded Current (Amps) 12 volts	Stall Current (Amps) 12 volts
Small	0.6	1.0 or more	2.0
Medium	0.6	1.2 or more	2.9 – 3.0
Large	0.7	1.5 or more	> 3.5



Gearbox Issues

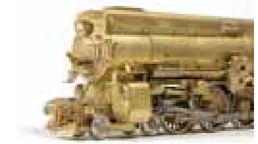


Gearbox issues

- Most early gearboxes run noisy due to large space tolerances between the gears. The early square cut worms are inherently noisy. A lot of the early gearboxes used both steel worms and steel worm gears, and the steel on steel also resulted in noisier operation.
- Many original gearboxes have high reduction ratios to make up for poor motor performance. The higher operating speeds also cause noisy operation.
- A lot of the earlier models use open gearboxes, or open gears which are both noisy and messy as the lubrication ended up all over.
- A lot of early gearboxes are poorly made and just don’t work well.

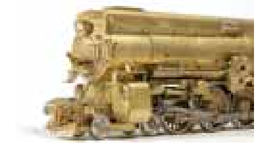
- A modern precision made gearbox should run nearly silent, even at high locomotive speeds

Coupling Issues



Rigid motor to gearbox couplings

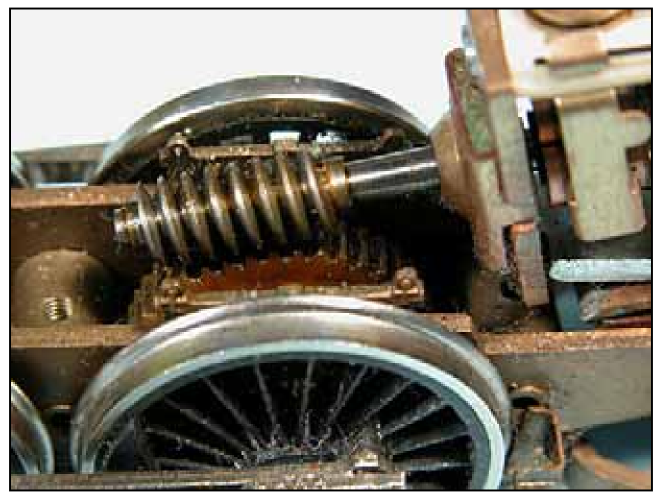
- Most early brass locomotives make use of a piece of plastic or rubber tubing to couple the motor to the gearbox.
- This tubing forms a rigid coupling between the motor and the gearbox.
- The basic issue is gearbox motion
  – Up and down motion due to sprung axles.
  – Side to side motion due to axle shifting on curves.
  – Motion due to residual wobble.
- The rigid coupling restricts the free motion of the gearbox causing noise and binding.



Coupling Issues

Open worm on motor shaft

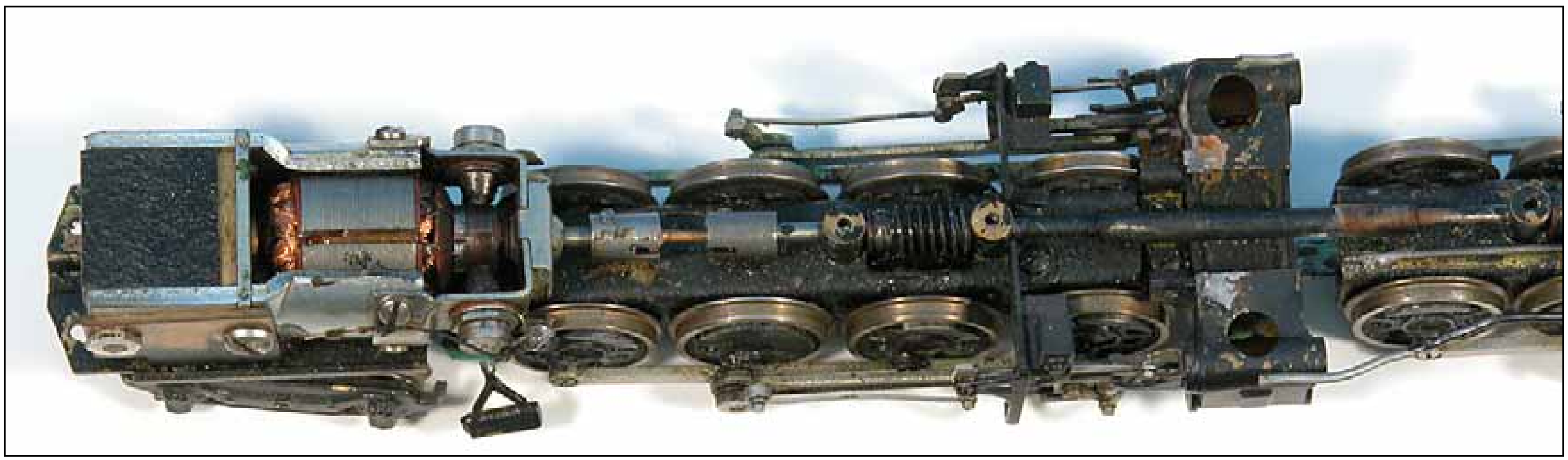
- Another common technique used on early locomotives had the worm soldered directly on the motor shaft. An open worm gear was used on the driven axle. The motor was mounted such that the open worm was suspended above and in contact with the worm gear.
- Common with un-sprung drivers.
- There are a few problems with this scheme, first it is difficult to maintain proper worm to gear mesh, the open gears are noisy, and you can't properly lubricate the gears without oil, and or grease flying all over the place.

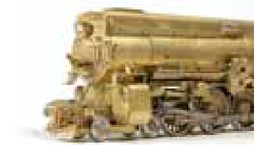


Coupling Issues

Metal Universals

- Many of the larger old articulated locomotives used metal universal joints in portions of their drivelines.
- These old metal parts ran noisy, and sometimes only a single ball and cup joint would be used, requiring critical alignment to work without binding.

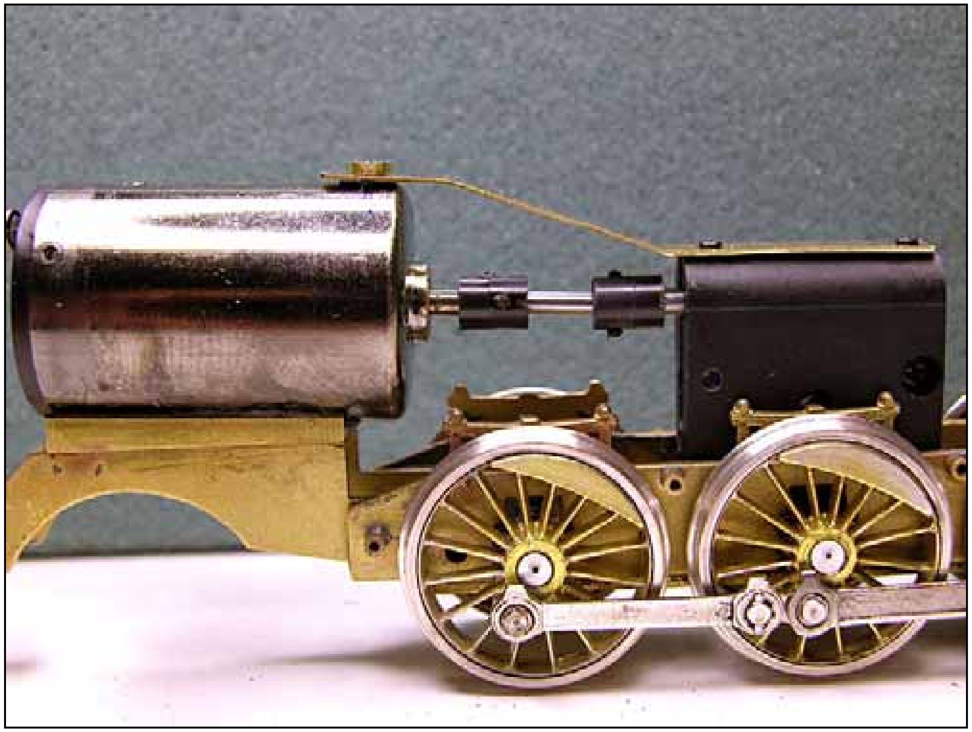




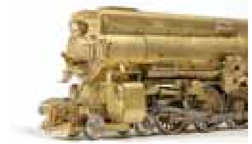
Rebuilding

Rebuilding Overview

- Motors
- Motor Mounts
- Gearboxes
- Drivers and Gears
- Coupling Methods
- Torque Arms
- Flywheels
- Balancing



Motors



Can motor advantages

- More efficient, much lower current draw
- Most are skew wound for very good slow speed performance
- Slower starting speeds and excellent slow speed torque
- Better slow speed performance allows lower gearbox ratios to be used reducing the top end noise.
- DCC friendly; isolated terminals, and most HO sized motors have stall currents under or about 1 amp.

Choose the largest size motor that will fit in the locomotive.

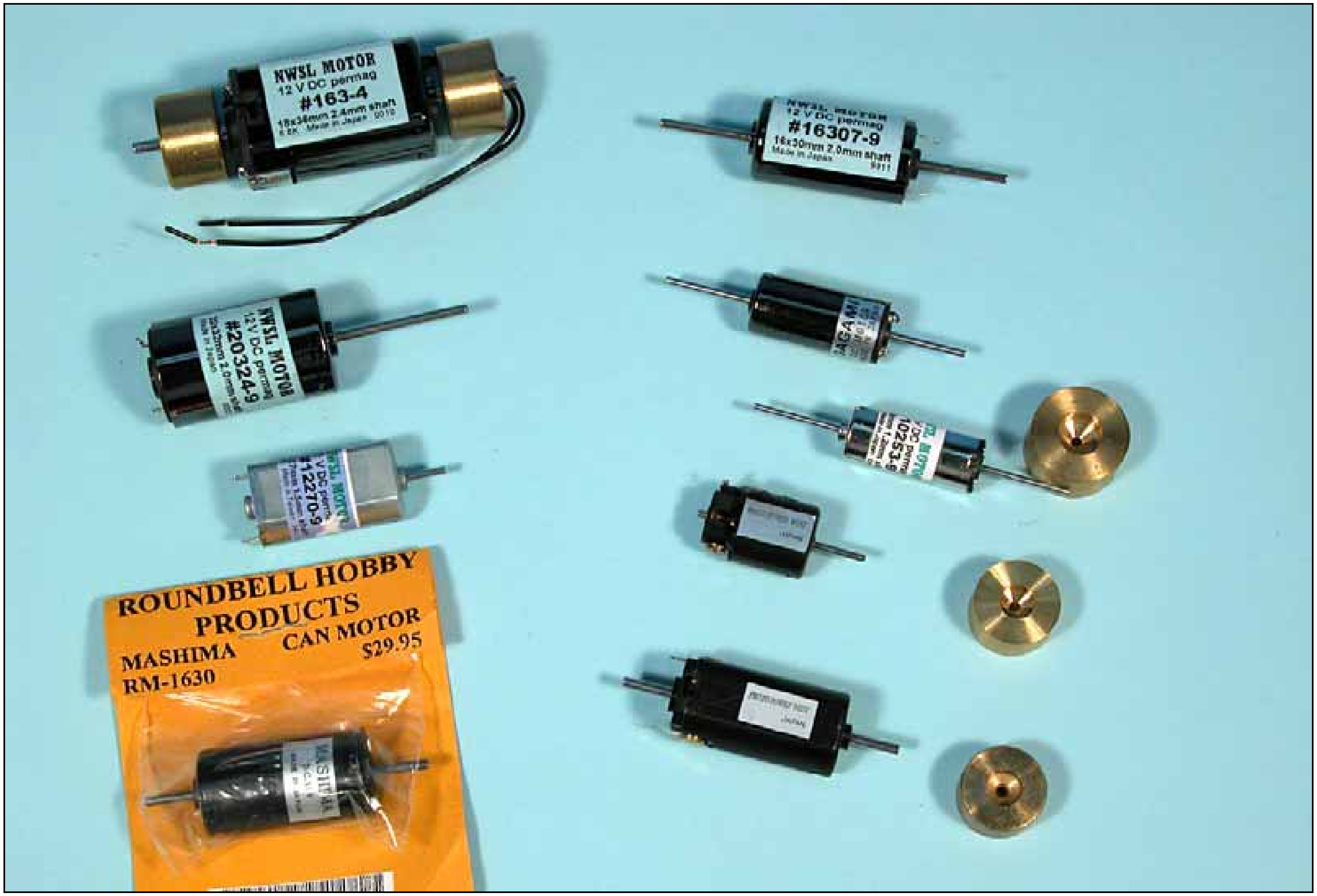
Use flat can types when your firebox area is narrow.

Many motors to choose from…

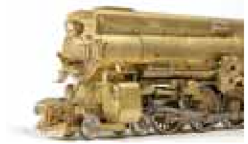
- NWSL – Sagami
- Mashima
- A line – Proto Power West
- Cannon

Motors

Can motor selection



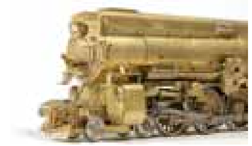
Can Motors



Some typical can motor numbers

Motor Type NWSL	Free Running Current (Amps) 12 volts	Max. Continuous Current (Amps) 12 volts	Stall Current (Amps) 12 volts	Stall Torque (Oz.-in.)
12270-9	0.08	0.25	0.54	0.61
16307-9	0.05	0.34	0.95	0.79
18367-9	0.19	0.40	1.20	2.50
20324-9	0.05	0.36	0.90	1.40

Motor Mounts

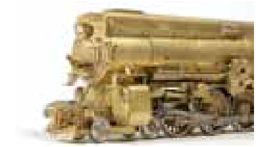


Motor Mounting

- The new motor needs to be installed and secured to the locomotive's frame.
- Motor needs to be removable for servicing.
- Mount should allow for minor adjustments in the motor position.
- Mount should provide for some isolation of the motor's vibration.

Solution

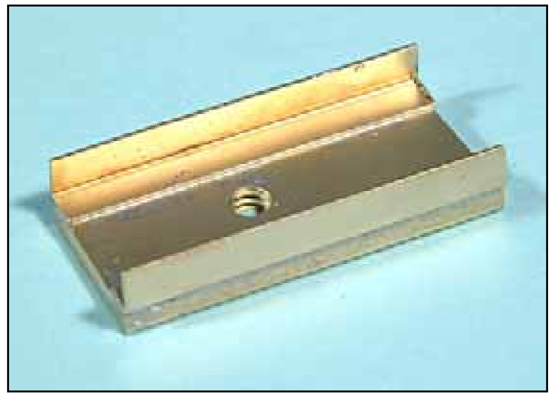
- Universal motor cradle fabricated from brass.
- Motor attached to cradle with Silicon Rubber sealant.
- Motor cradle attached to frame with the original motor mounting screw.



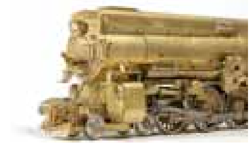
Motor Cradles

Motor Cradle fabrication

- Base made from .062” x .5” brass bar stock.
- Sides made from .125” x .125” angle stock.
- Solder together.
- Drill and tap hole in the base to line up with hole in frame.
- Milled version as alternative



Gearboxes



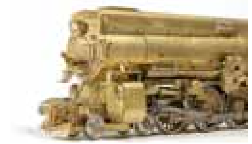
Replacement Gearboxes

- A large selection of precision gearboxes available from NWSL.
- Standard gear ratios of 28:1 and 36:1
- Most common HO sizes; 0.3 mod for small locomotives, 0.4 mod for medium to large locomotives
- Non idler, Idler, Double Idler, and High/Low types available
- All precision machined gears for silent operation

Tips

- Read the instructions carefully the first time.
- Sand gearbox bottom to eliminate excess axle play.
- Run a tap through all the holes to make it easier to install the screws.
- Make sure that worm shaft bearings are snug in gearbox. You may have to sand a little bit of a taper on one of the gearbox halves to assure snug worm shaft bearings for some gearbox models.
- See assembly tutorial write-up on my website

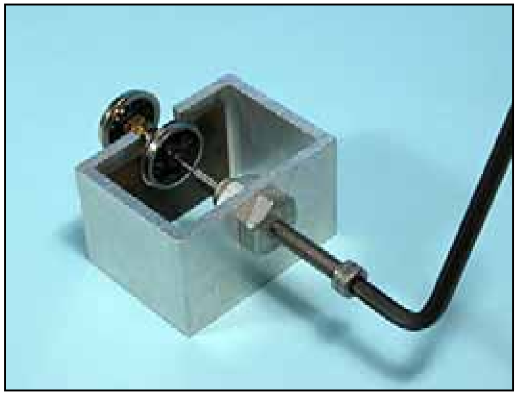
Gearboxes



New Gearbox Choices

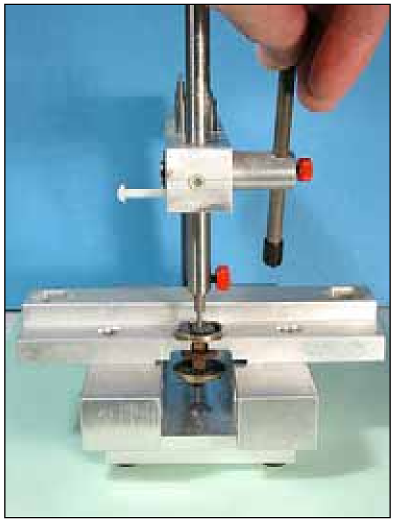
Pulling Drivers and Gears

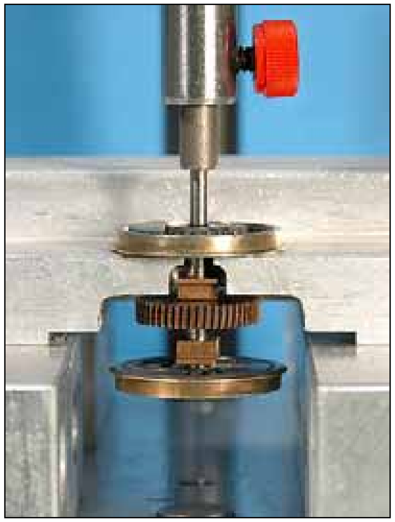
NWSL Puller



Arbor Press

- NWSL Sensipress
- PanaVise press





Pressing Gears

Arbor Press

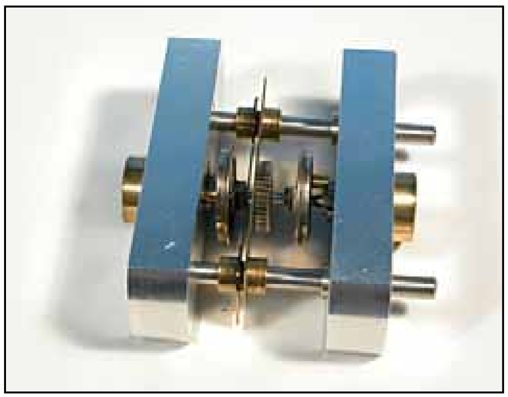
- NWSL Sensipress
- PanaVise press

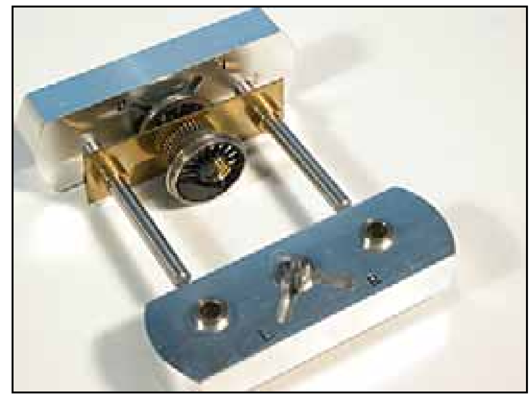
NWSL Gear Aligners

Quartering Tools

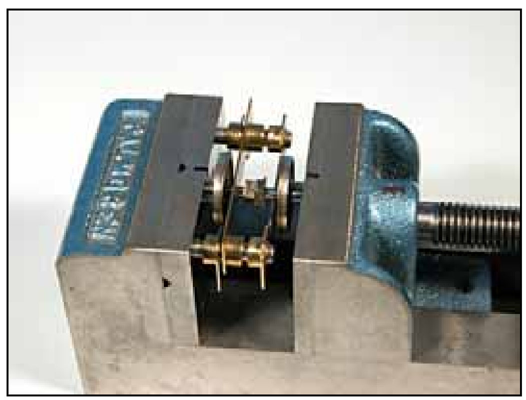
NWSL Quarterer

NWSL Quarterer 2



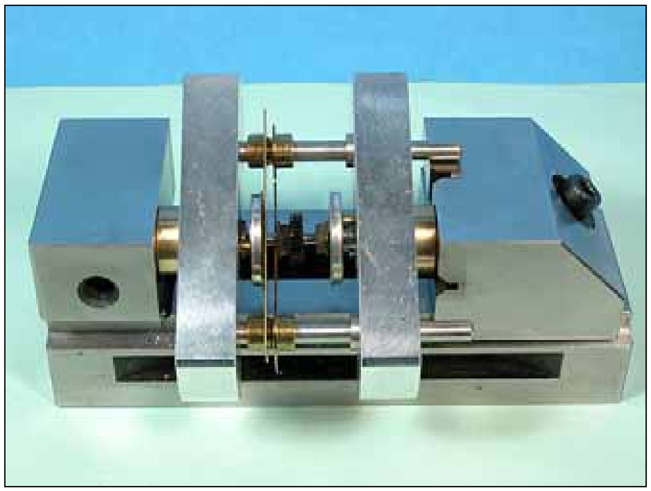


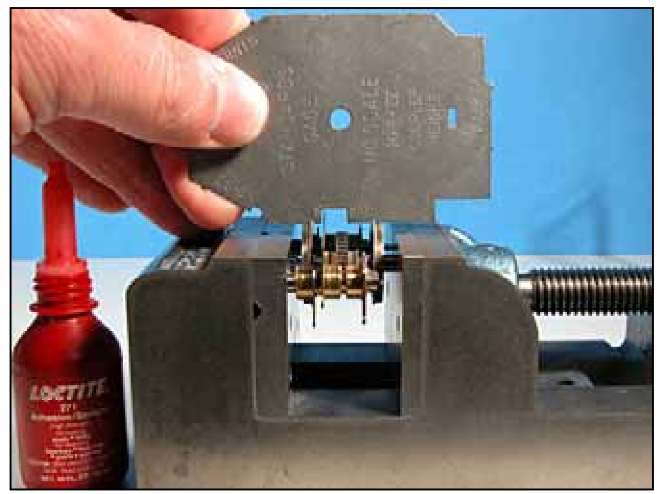
Quartering vise



Pressing Drivers

Quartering

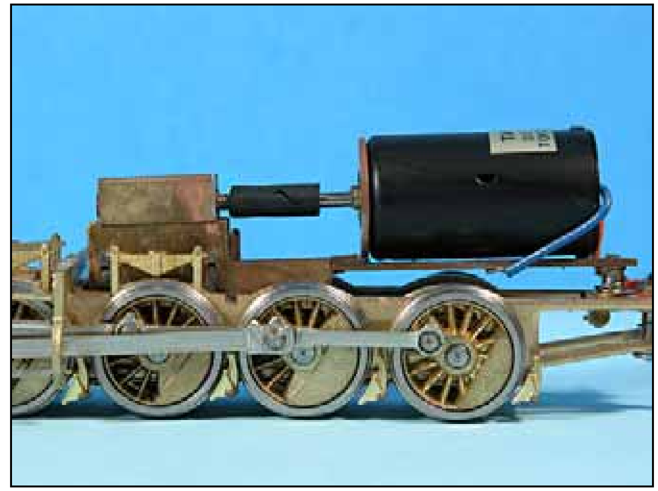




Coupling Methods

Rubber Couplings

- Can successfully be used in some rigid torque arm applications, but motor to gear box alignment critical.
- Universal joints recommended instead.

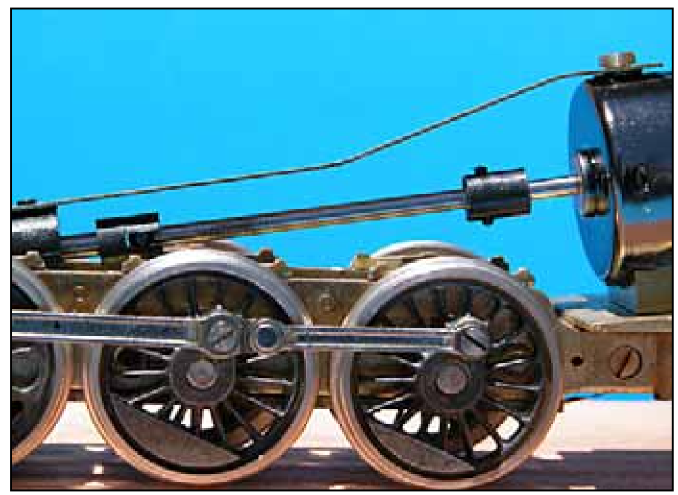


Motor shaft direct through gearbox

- Can be used in some applications.
- Eliminates alignment issues.
- Not practical for non idler gearboxes.
- Space issues, large motor close to gearbox.

Universal joints

- Preferred method, but requires torque arm.
- Non rigid connection between motor and gearbox.
- Works well even with some misalignments, keep angles to under 15 degrees per joint.
- Runs very quiet.
- Isolates gearbox from motor.

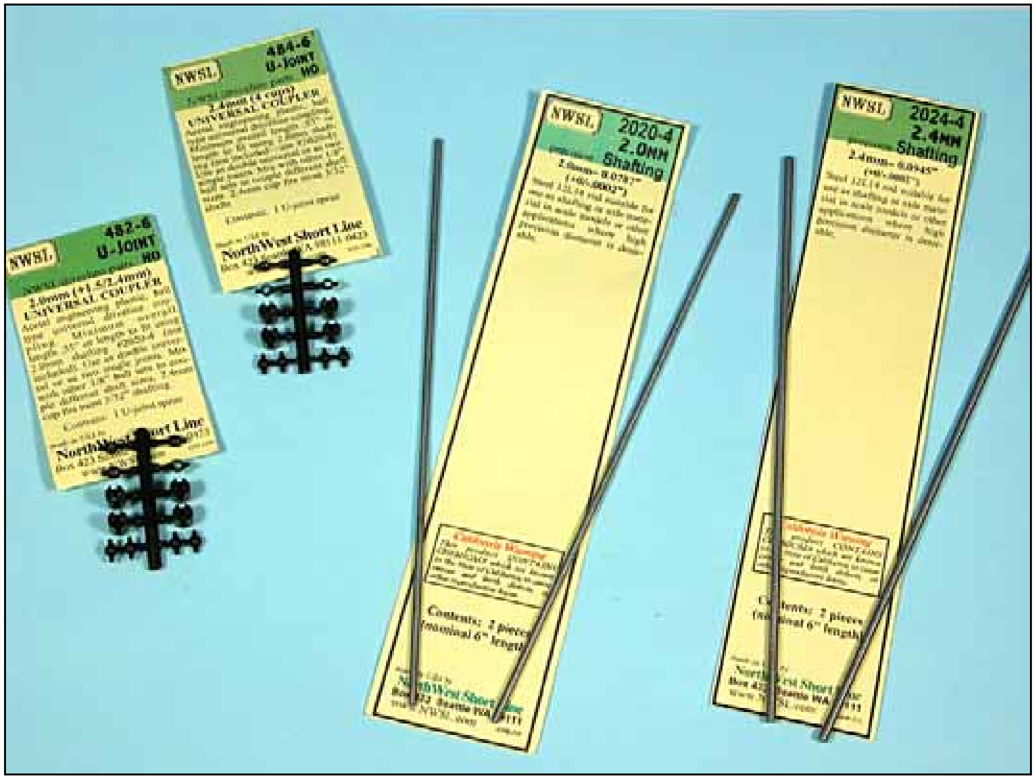


Universal Joints

Wide variety of choices available from NWSL.

Different sizes to support all the common shaft sizes; 1.5 mm, 2.0 mm, and 2.4 mm.

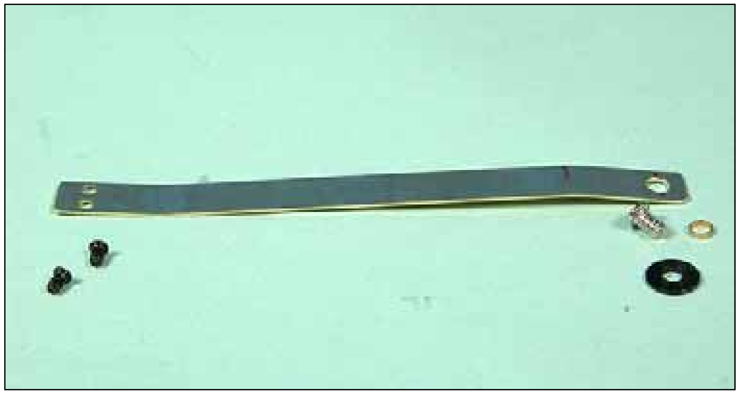
Precision shafting material also available from NWSL.



Torque Arms

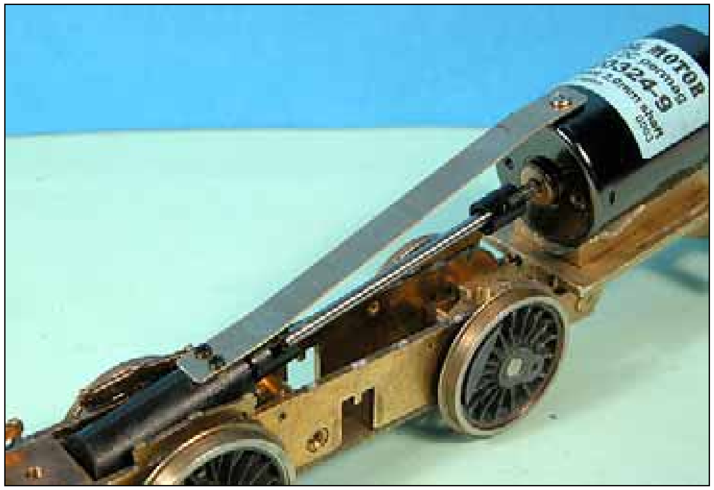
A torque arm is needed to keep the gearbox from rotating when using universal joint couplings.

I prefer an overhead torque arm with a pivot point at the motor attachment.



Construction

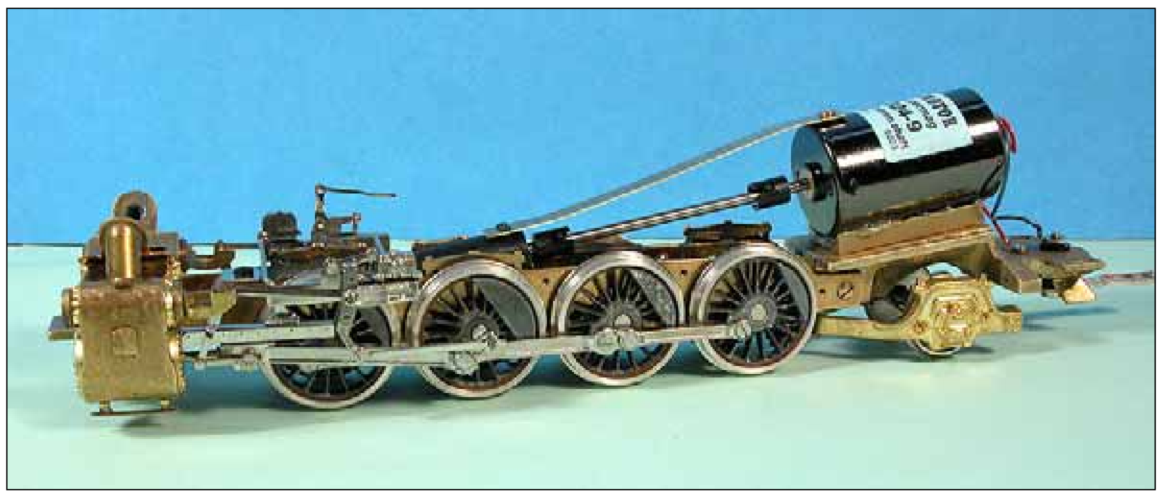
- Make from .016” brass sheet stock
- About .2” wide
- Bend as needed to fit application
- Drill two holes on gearbox end, drill and tap holes in gearbox to match (1.4 mm screws).
- Drill clearance hole on motor end to line up with the front motor mounting hole (2 mm screw).
- Use 2mm screw on motor end with a clearance spacer washer or a shouldered screw.
- Put plastic or fiber washer between motor and torque arm to prevent metal on metal noise when motor vibrates.



Torque Arms

Advantages of this design

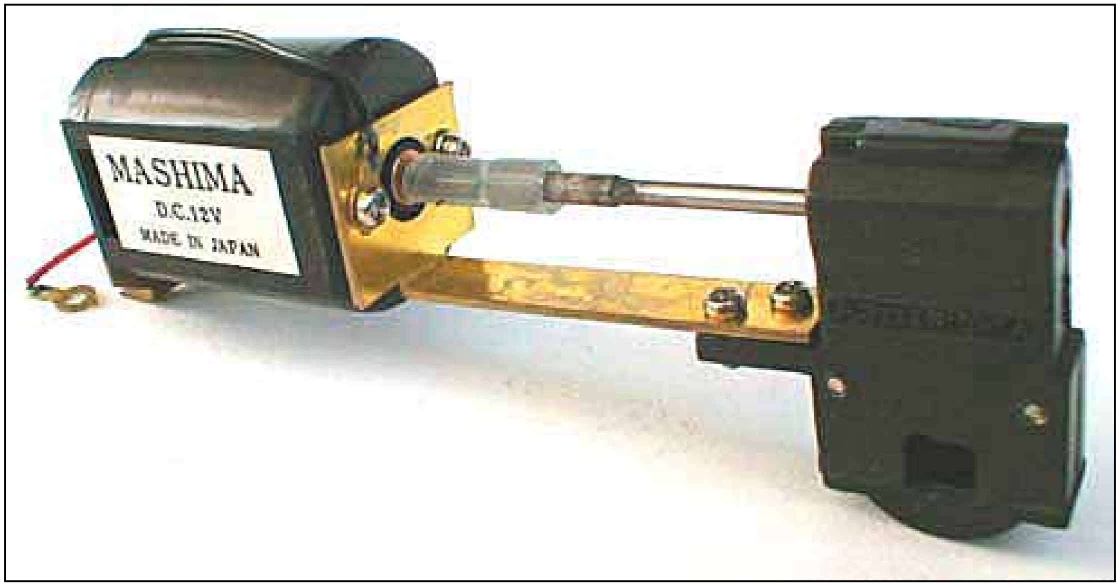
- Keeps gearbox from rotating.
- Gearbox is allowed to freely move up and down due to long thin torque arm.
- Gearbox is free to move side to side due to the torque arm pivot point on the motor.
- Gearbox moves freely to follow axle motion.
- Simple and fairly easy to construct.
- Works very well!



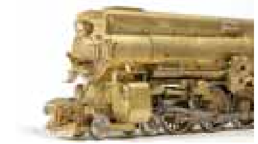
Torque Arms

Off the shelf alternative

- Motor / Torque arm combination available from Greenway Products

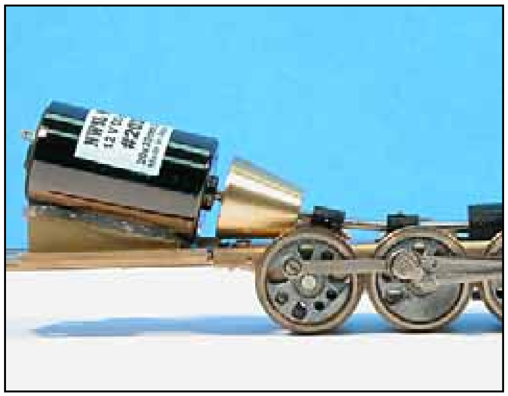


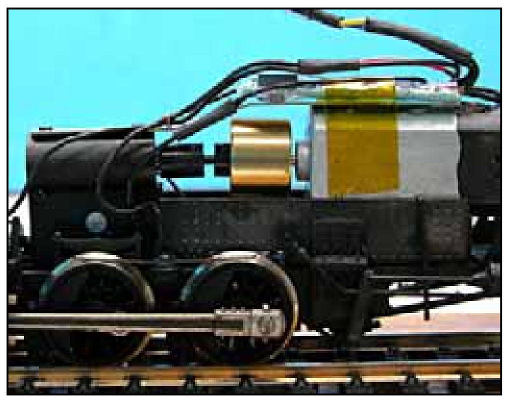
Flywheels



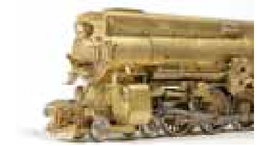
Consider adding a flywheel if space allows

- Improves performance, allows locomotive to coast over bad contact areas
- Can help slow speed performance as motor has larger rotating mass
- Consider it as optional when space allows
- Flywheels don’t have to be constant size, can be made to fit space.





Balancing



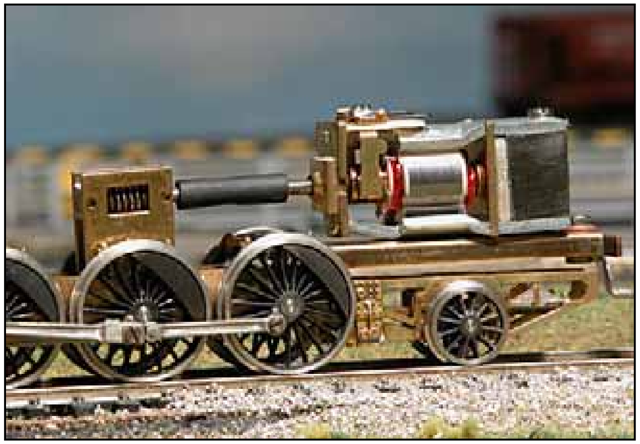
Balancing

- For the best overall performance the locomotive should be roughly balanced over the center point of the drivers.
- Somewhat controversial as to whether it improves pulling ability, claims both ways.
- Balance is often different after motor replacement.
- May need to add some weight in the locomotive rear to balance.
- Proper balance helps the locomotive to run smoothly as the non driven wheels will roll along the track while they are also being driven by the crank rods. Due to increased tolerances in models a un-weighted driver may cause loping in one direction even if quartered correctly.
- Most driver springs are too stiff and do not properly compress to equalize the load.
- Replace original springs with NWSL replacements, available in three strengths, medium, light, and wimpy. Use a spring that allows driver compression under the boiler weight.

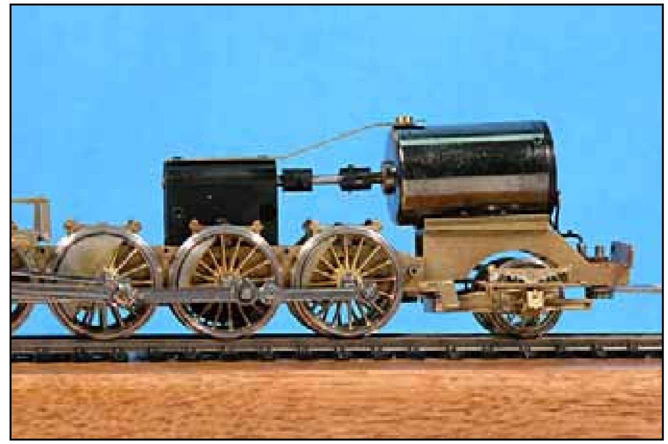
Examples

Examples

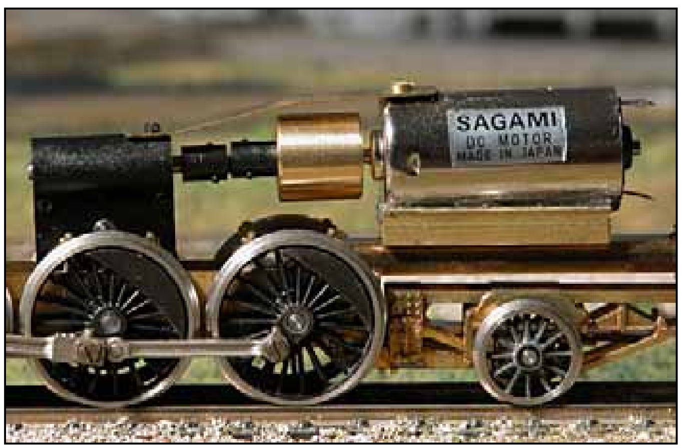
Westside P-1, before



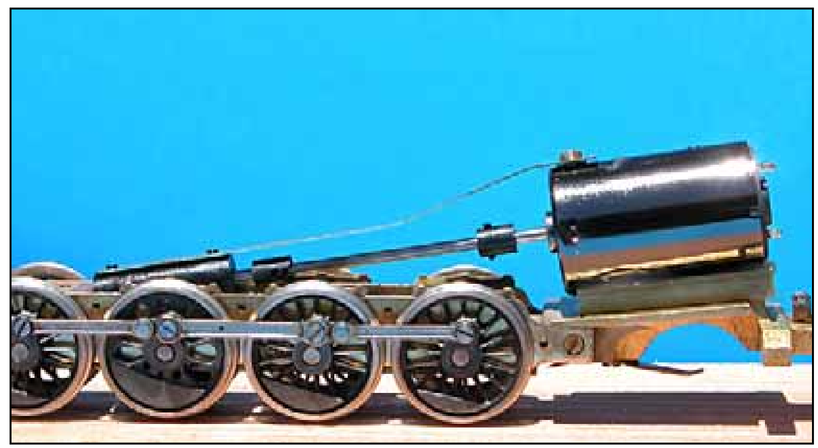
- Alco MT-2, after



Westside P-1, after



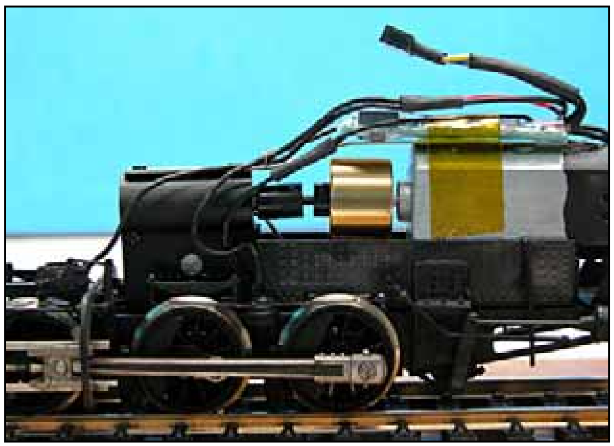
- Balboa MT-4, after



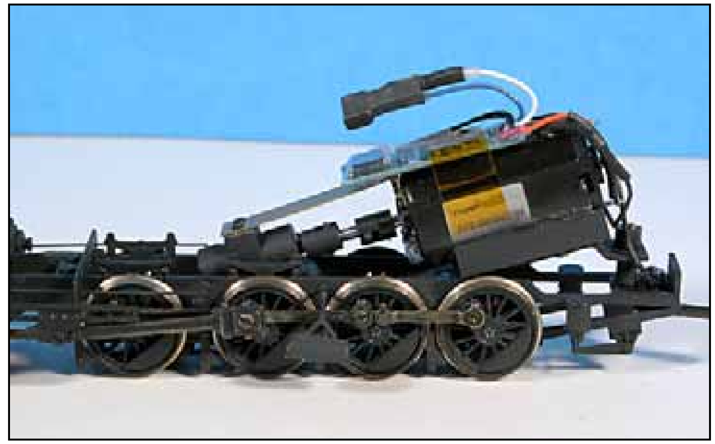
Examples

Westside 0-6-0T, before

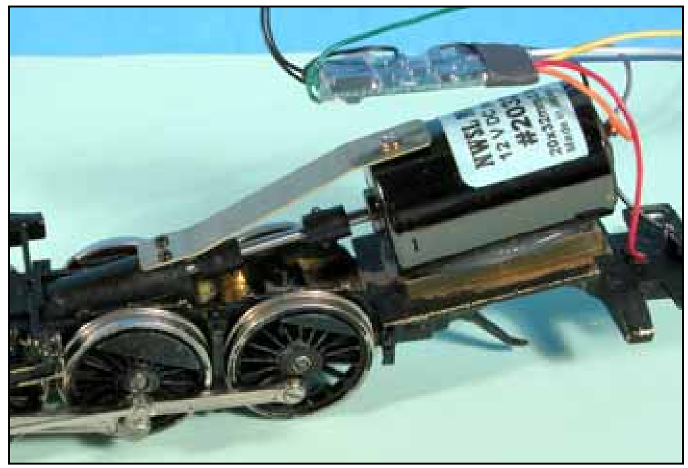
Westside 0-6-0T, after



- Max Grey TW-8, after

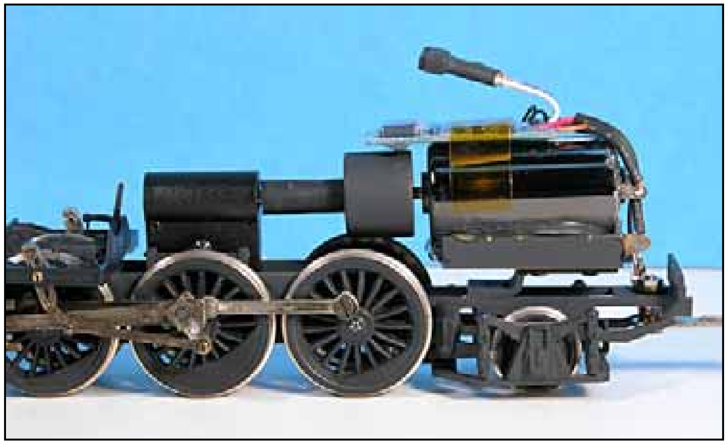


- Balboa P-8 #2467, after

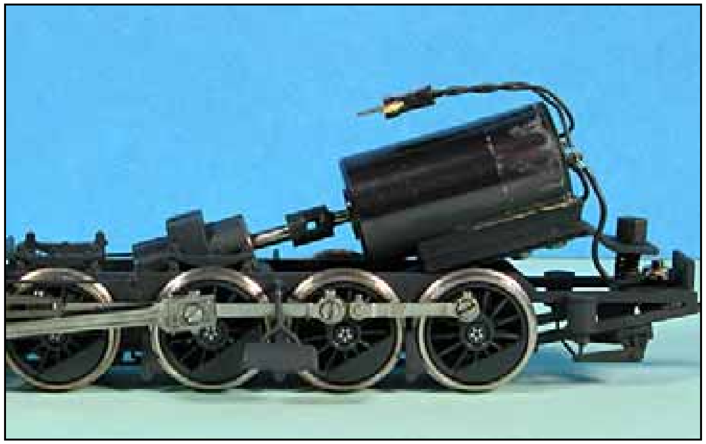


Examples

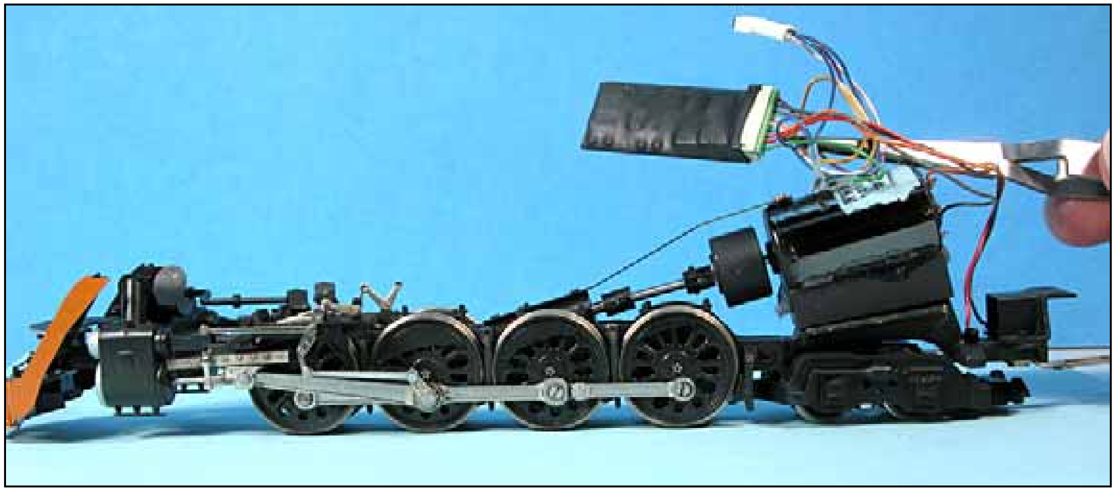
Tenshodo P-5, after



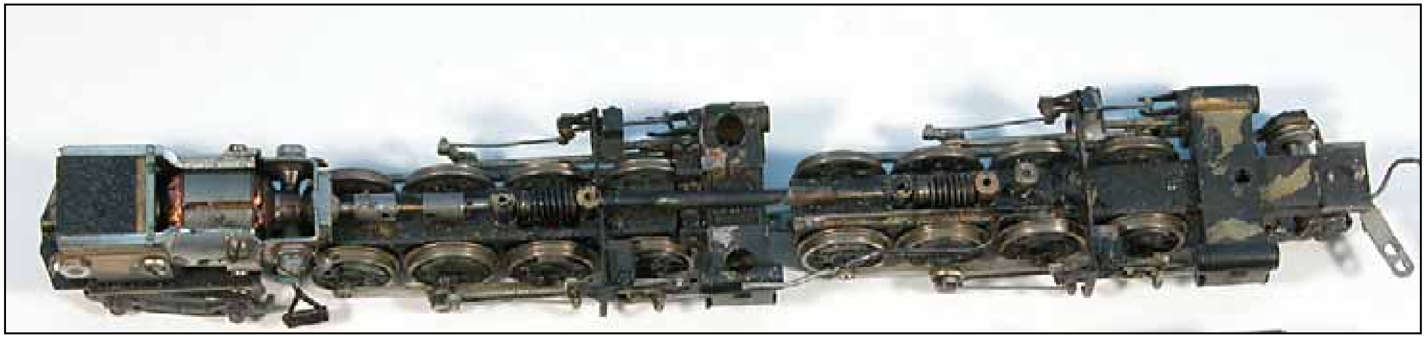
- Max Grey TW-8, after

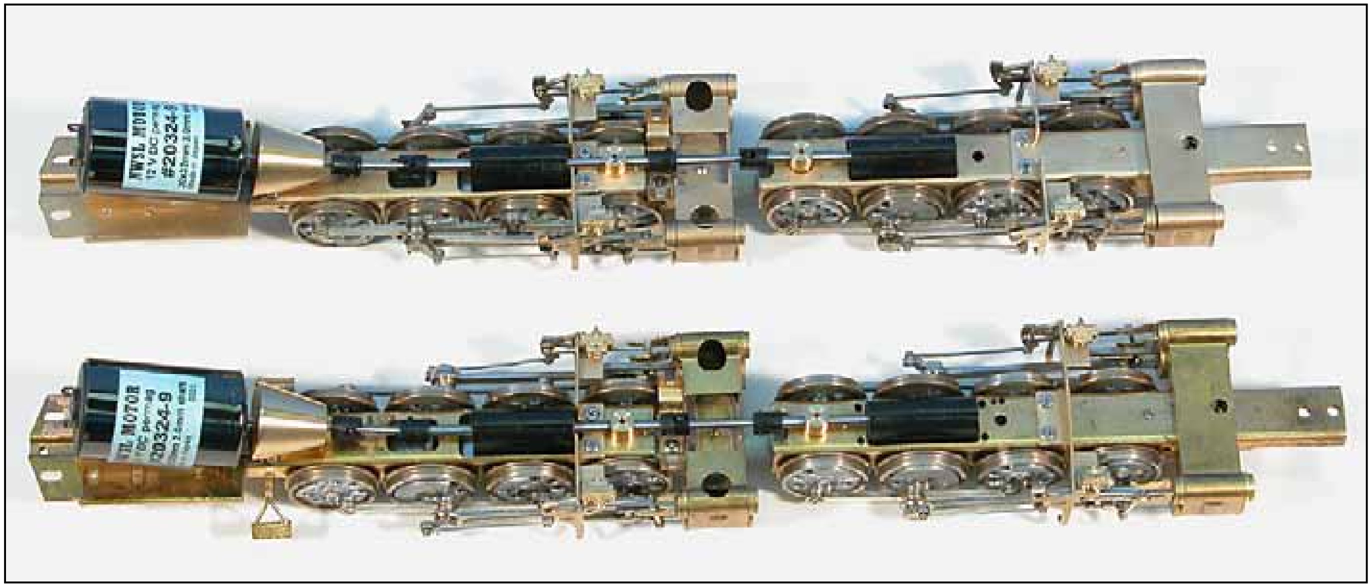


Balboa GS-4, after



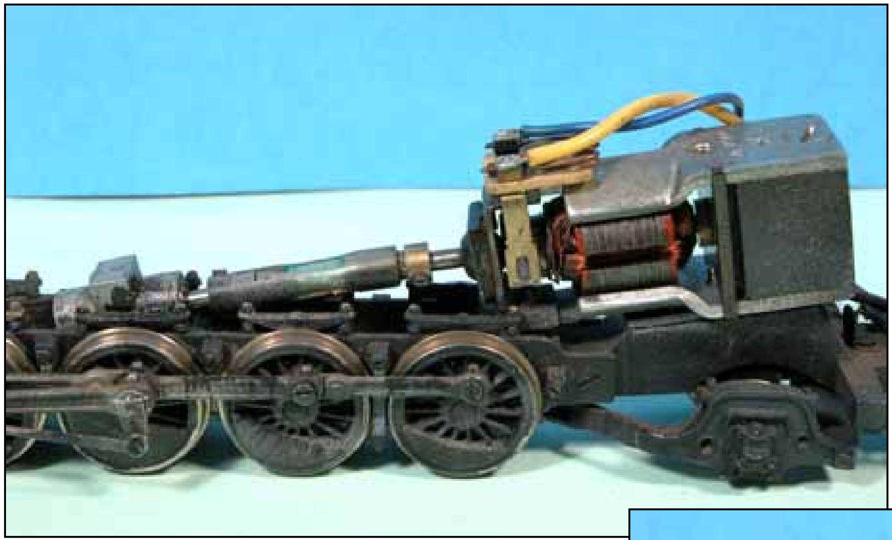
Akane AC-11's, before and after

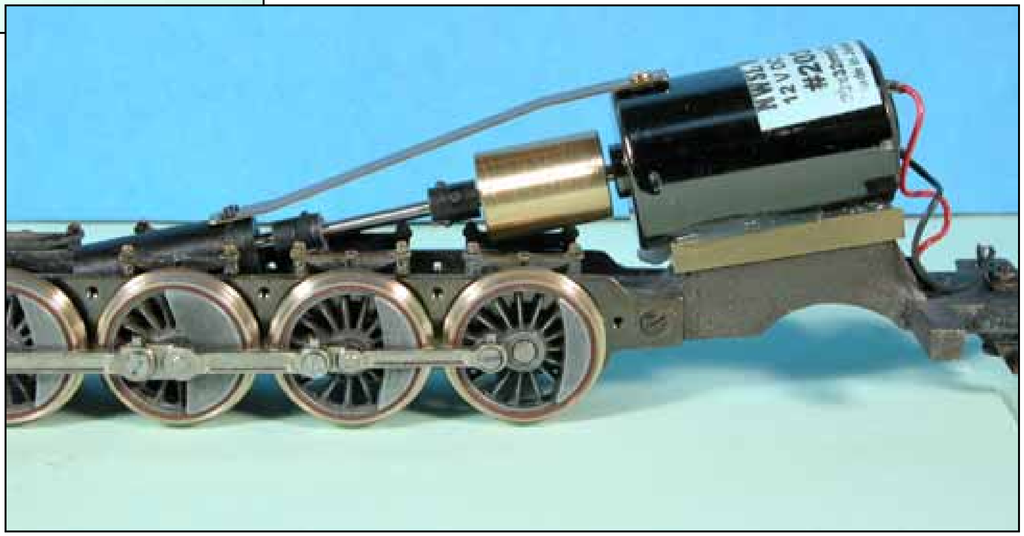


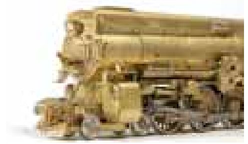


Examples

Max Gray SP-1, before and after

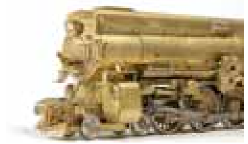






Tools and Sources

Tools and Other Stuff



Tools

- Jeweler's screwdriver set, Radio Shack
- Tweezers
- Needle file set
- 4 mm deep socket or deep nut driver

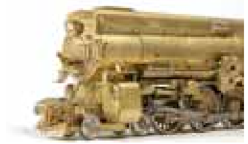
North West Short Line tools

- Quarterer, Quarterer 2
- Puller, Puller 2, SensiPress
- Aligner
- Metric taps and drills

Lubricants

- Labelle #102 gear oil
- Labelle #108 light oil
- Labelle #106 Teflon grease

Tools and Other Stuff



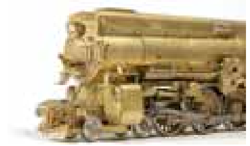
Thread locking

- Loctite 271 (red) high strength

Other Stuff

- NMRA track and wheel gauge
- .020” diameter Phosphor bronze wire (for drawbar tensioner)
- .062” x .5” x 12” brass bar stock, K&S metals or others
- .125” x .125” x 12” brass angle stock, K&S metals or others
- .016” brass sheet stock (for torque arm construction)
- .016” x .25” x 12” brass bar stock (alternate, for torque arm)
- .062” ID x .094” OD brass tubing, K&S metals, drill out ID to .081” and use to make clearance washers for torque arm pivot point.
- RTV Clear Silicon Rubber sealant

Sources



North West Short Line

- Motors
- Flywheels
- Gears and Gearboxes
- Universal Couplings
- Shafting Material
- Metric Hardware
- Wheel Springs
- And virtually everything else

Proto Power West – A-Line

- Motors

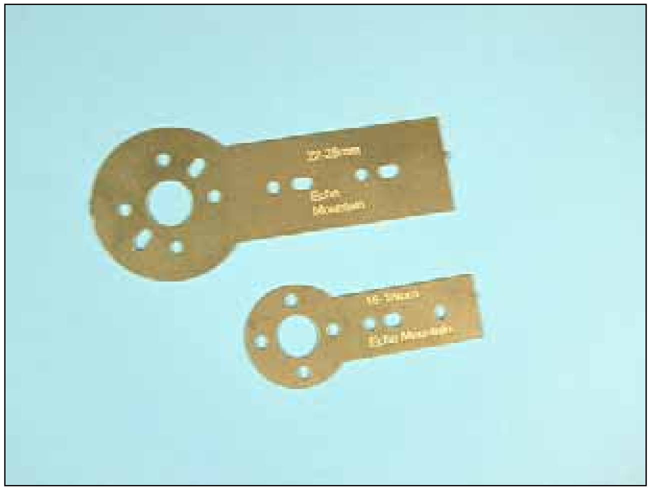
Roundbell Hobby Products

- Motors, Mashima
- Flywheels

Sources

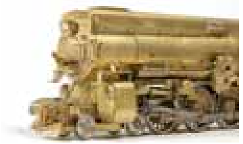
Echo Mountain Models

- Etched brass motor mounts for Sagami (NWSL) motors.



Greenway Products

- Drivers
- Crank screws and crank pins
- Motor / gearbox / torque arm combination



Questions?