PENBITS MODEL RAILWAYS

ASSEMBLY INSTRUCTIONS

PK005

SPRUNG BOGIE KIT BACHMANN/NRM PROTOTYPE DELTIC

PenBits Model Railways

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General Notes

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A Few Words ...

These advices, taken, several moons since, from John Lythgoe's instructions for his Formil Model Engineering Dyna-drive kits, have proved to be useful and enduring tenets:

- "Proceed with patience and due care at ALL stages and a free-running locomotive should result."
- "Allow sufficient time to spread the conversion over a number of modelling sessions."
- "Work in good light conditions. Use an anglepoise-type lamp if possible. A self-supported magnifier is a useful aid."

Safety

Our kits are intended to be assembled by adult modellers, with some workshop experience and awareness, who are able to exercise due care and attention when handling the materials and carrying out the various operations involved. Many of the metal components have sharp edges. Chemical products used in assembly can be injurious through contact with skin or eyes, ingestion or inhalation. Some processes involve high temperatures. The user should be aware of and follow the manufacturers' or suppliers' safety data and instructions for all tools, materials and products.

The Instructions

File Format

The instructions are available on line in both HTML and pdf formats. The HTML versions have one page for each major section, whilst the pdf versions have a single file for each kit.

Structure

We've divided up the instructions into "narrative" paragraphs, like this one, which indicate what is being accomplished by a particular stage,

"instruction" paragraphs, like this one, with the tick-box; "box-ticking" not our favourite activity perhaps but nonetheless can be useful, on a printed copy, for recording progress and making sure nothing is forgotten,

and "advisory" paragraphs, like this one, which pass on techniques that we found useful but aren't necessarily the best way, or the only way, of achieving a result.

Printing

We have introduced a "Check List" for some of the kits, which contains the texts of all the instruction paragraphs for the kit. This is a great deal more compact for printing than the full instructions, and perhaps more suitable for the workshop. The Check Lists are available only from the on-line copy of the instructions, from this Index Page.

We intend the Full Instructions to be viewed 'on-screen'. If you did need any of the diagrams or pictures in the workshop, you could download and print them individually (from the HTML instruction pages) to complement the Check List.

The pdf files can be printed in full or in parts to your own printer using your pdf viewer. Full printouts in booklet form can also be produced using third party services. For more information visit our Printing the pdf Files page.

If you wish to print out sections of the HTML instructions, they are formatted in standard HTML/CSS but, even so, the print function in some browsers does a better job of rendering them than others. We find that 'Print' function of the Google Chrome browser produces a good printed result: it also gives the option of 'Save as PDF', which is a convenient way of creating a single portable file, including all the illustrations, which you can view or print on any device.

If your printer can produce half-size A5 prints (two per A4 sheet) or, better still, double-sided A5 booklet printing, using those options can save a great deal of paper.

The Etches

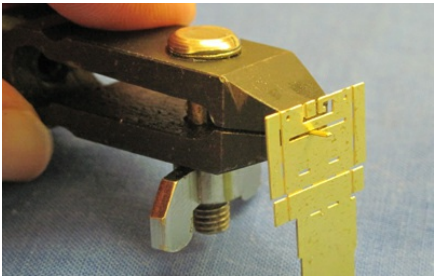
Tags

Components are attached to the fret by small half-etched tags. These can be cut through using a heavy craft knife with an old, stubby, blade (avoid the thin, pointed, 'scalpel' types, as they will break), against a hard surface. We keep a rigid Stanley knife expressly for this purpose, with an old carpet trimming blade ground to shape as shown.

Any remnants of the tag may be cleaned up using a flat file. We have tried to avoid putting tags on mating faces, but there are some instances where they need to be removed

thoroughly.

Slots



Some of the parts of our kits are designed to fit, perpendicularly, either into or through slots i n other parts. The slots are intended to provide a loose sliding fit for the other part. Because of variations in the degree of etching *(q.v., below)*, it is possible that the fit will be looser or tighter than ideal.

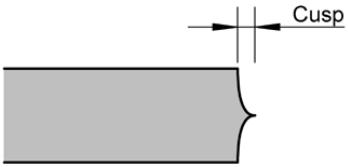
❑ Check the width of each slot with a piece of scrap etch before assembly, preferably before folding the slotted part. If the scrap will not pass through, hold it in pliers or a hand vice, as shown (though make sure the part is well supported), and work it through the slot until the loose sliding fit is achieved. In tight spots, it is possible to use a small drill held in a pin chuck as a file.

Degree of Etching

The etch is created for us by a third party industrial manufacturer using a process of chemical erosion. The 'Degree of Etching', i.e. how long the metal sheet is left in the chemical bath, is a variable which is set by the skill and judgement of the operator as each batch of sheets is produced. That dictates that the sizes of the etched parts on different sheets can vary, within a certain tolerance, around the nominally designed values. The variation is more significant with the relatively thick materials, that we use in the main structural parts of our kits, than it is with the thinner materials typically used for detail parts.

The ideal degree of etching is indicated by the slots (see above), as manufactured, being just slightly on the tight side of the easy sliding fit required. The range of degree of etching which we deem to be acceptable is from a 'lighter' etch, in which the scrap material has to be pushed through the slot quite firmly to achieve the clearance, to a 'heavier' etch, where the fit is a little loose. We have test built our kits from etches across this range to confirm that they may be assembled successfully.

Cusps

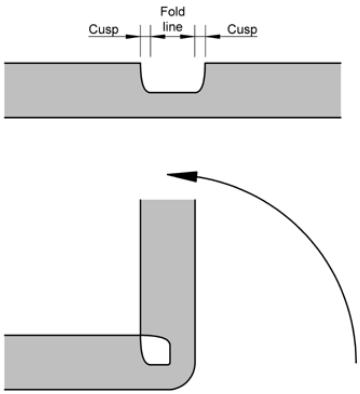


The chemical erosion process works equally from each side of the metal, resulting in the edges of the etch having shaped 'cusps' as in the diagram here. On edges which will be visible on the finished model, it is good practice to file the edges of the metal flat. Many of the edges on our kits are hidden from view.

Where edges form joints with other components, on a 'lighter' etch the edges may need to be filed to a flat surface to achieve a fit, whereas with a 'heavier' etch one might leave more of the cusps in place. In places which can't be reached by a file, e.g. in acute corners of the etch, the cusp may be pared away with a sharp knife.

Folds

Folds are indicated on the etches by half-etched lines. Unless stated otherwise, all folds are made at 90° with the half-etched line on the inside of the fold. Most folds may be made by holding the larger part of the workpiece in the fingers or, for smaller items, a hand vice or similar clamp, and then driving the fold from the smaller part either by using smooth-jawed pliers or by turning it over against a smooth, flat, hard block of material such as hardwood, metal or tufnol. For longer folds the workpiece may be clamped between two flat, straight edged pieces of similar material. Special folding tools or bending bars are not necessary, though of course you may find them useful if you have them.



Whichever way you make a fold, try not to force its location or direction, but let the brass bend at its weakest point as determined by the centre of the etched fold line. This should result in a correctly positioned and symmetric fold as shown in the diagram.

The act of making the fold will work-harden the metal along the line of the fold and may even, especially with a lighter etch, cause it to yield on the outer corner of the fold. Try, therefore, not to work a fold unnecessarily once made, as it will become increasingly brittle and prone to breakage. In general, folds are reinforced with a fillet of solder but this is explicitly dealt with in the instructions for each component.

Soldering

ⓘ We use Carrs 145° wire solder with either Carrs Green Label liquid flux or La-Co paste flux, except where stated otherwise. You will develop a technique that suits yourself and your iron, but the following notes might help as a starting point.

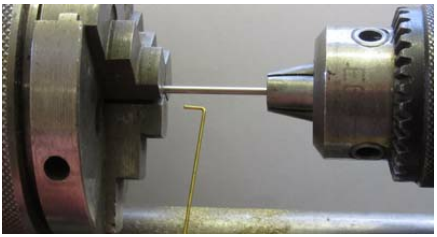
ⓘ Flux can be applied to the workpiece using a brush, a pointed cocktail stick or (for paste flux) a syringe. With liquid flux, reducing the surface tension of the flux, for example by adding a drop of washing up liquid or ox-gall, may help it wet the surface. The soldering iron bit is wiped on a damp sponge before each use. A small amount of solder can be picked up on the bit (it might need a little flux to help it) and the bit applied to the workpiece, holding it there until the solder 'flashes' off the bit into the joint; we are using relatively thick material so can afford to linger with the iron and get plenty of heat to the job. Alternatively a small length of solder wire can be cut off, placed next to the joint and the iron brought to it. The length can be anything down to the smallest sliver (and even that cut into smaller sections), giving precise control of the amount of solder applied.

ⓘ Flux residues should be neutralized and/or cleaned off after each working session. Green Label flux may be rinsed away with water; a little added citric acid will neutralize it. Liquid or paste fluxes can be washed away either with a proprietary flux cleaner or a 50/50 mix of methylated spirits and water.

Spring Winding

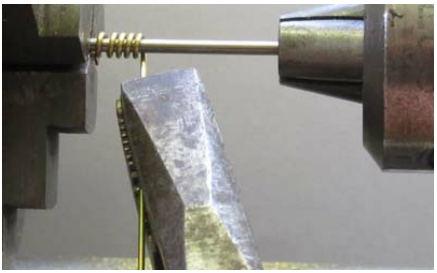
This section describes a method for producing coil springs, for cosmetic detailing, from wire. The example shown uses 0.6mm brass wire formed around the shank of a 1.4mm drill, other materials, e.g. steel or copper, can be used. Such springs will also work functionally, though note that steel of the correct scale diameter tends to be too stiff.

The drill, forming the armature around which the spring is to be wound, is clamped firmly into the lathe chuck with its shank protruding. The free end of the shank is supported by the chuck in the tailstock, lightly clamped.



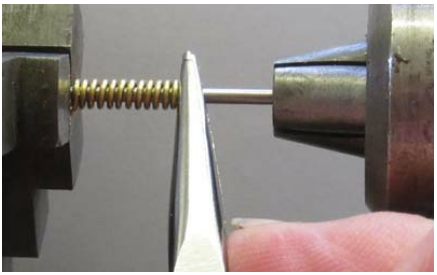
Start with a bend at the end of the wire to form an anchor. Catch it either between the jaws of the chuck (if they are far enough apart), or (for smaller wire and armature diameters) within the flutes of the drill.

Using a pair of pliers to apply tension, rotate the lathe chuck by hand to wind the wire around the armature. Pay heed to the direction of winding - a surprising number of diesel bogies were fitted with left-hand wound coil springs (sometimes with a duplex right-hand wound coil within).

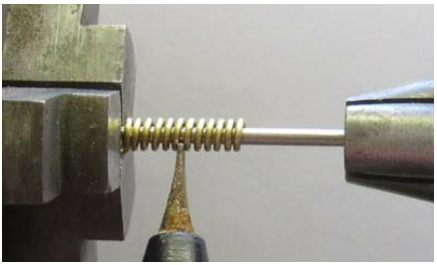


As you continue to rotate the chuck, vary the tension and angle on the wire to get as close as you can to the desired coil spacing (you can adjust this later, but it's best to get as close as possible to start with).

Keeping the coil on the armature, you can stretch or compress the spring axially to get the coil spacing you need.



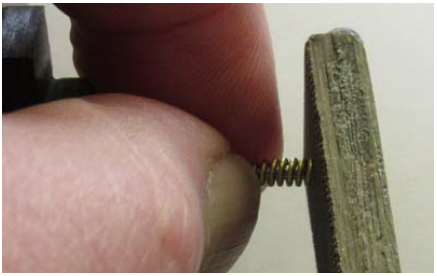
You can also use a tool such as a screwdriver or knife blade to get the spacing. If you have enough hands, you can do this as you wind the spring.



Slide back the tailstock and release the spring from the chuck.

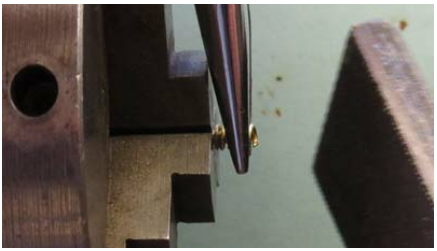
Trim off the waste at the ends of the spring.

File the ends of the spring flat, using the free end of the armature to support it.



Reset the armature in the chuck to the desired length of the spring.

Cut the spring slightly overlength and file the cut end flat using the armature as a support and length gauge.



Little beauties. Results improve with practice - all very therapeutic!

Warranties

The procedures described in our instructions require the proprietary locomotive to be dismantled and some of its components to be modified. The manufacturer's warranty will almost certainly be rendered void by carrying out the modifications. The user should ensure that the locomotive is free running and has no warranty issues before commencing work.

Please follow the manufacturer's instructions for the dismantling of the locomotive.

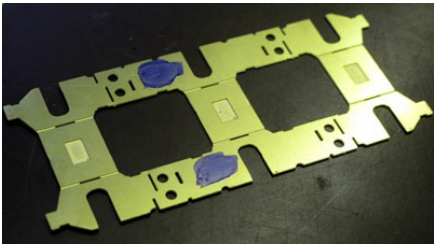
Our instructions guide you in making modifications to components of the locomotive and fitting the kit. The modifications, the kit and the instructions have been tested by the kit designer and others to confirm that they are practical, serviceable and, when used as intended, produce a working locomotive whose performance will bring much pleasure. However, as the fitting of the kit by the user is out of our direct control, we can make no warranty, expressed or implied, as to the performance and continued serviceability of the locomotive following modification.

Bearing Carriers

This stage of the assembly is fixing the subframe bearings into the bearing carriers and folding up the carriers around the bearings. The carriers are located on the fret in four frames, each of which folds up into a jig to help to fix the bearings in the correct place. The carriers are a little fiddly, but worth spending time to get right as they are one of the main functional parts of the suspension.

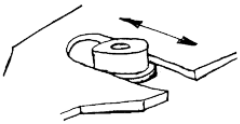
We find it useful to use two containers to store separately the components of each bogie; 1kg margarine tubs are suitable. Within them we have 35mm film cannisters, one for each axle, to keep the components for each wheelset together. We mark the containers and cannisters to match the id marks etched on to the subframes, bolsters and bearing carriers as explained below.

- Separate the two subframe etches from the fret. Remove any other components contained within each subframe etch and store them safely.



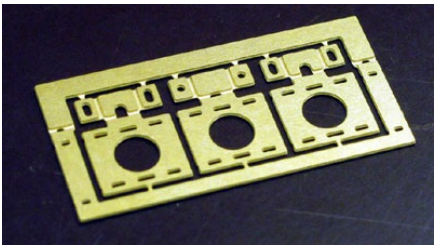
Note that one of the subframes is marked with a small triangular dimple. You will find that one of the bolsters, and one set of bearing carriers, are similarly marked. You can use the marks, through all subsequent work, to distinguish the components of each bogie.

- Take one of the twelve axle bearings and test it in one of the subframe axle slots. It should be a free sliding fit but if it's a bit loose don't worry. It will more likely be a little tight in which case gently file the vertical sides of the bearing slot - take off a little at a time equally from each side and try to keep the two sides vertical - until the free sliding fit is achieved for the entire depth of the slot. Now test fit the other 11 bearings in the same slot. You should find that they are all about the same size. If there is a variation, then you may wish to individually fit the bearings to the slots. You will then need to preserve the identity of each bearing through subsequent operations (there are marks etched on the bearing carriers and the subframes to assist with that - see below). But do bear in mind that, as we have no coupling rods, the accuracy of this fit is by no means as critical as it would be if we were building a steam locomotive. Whatever you choose to do, dress the remaining eleven bearing slots to get the free sliding fit for each of the bearings.

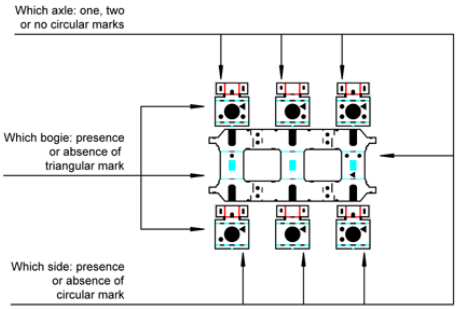


- Put the subframes in their containers safely to one side for now.
- Test fit the axle bearings on the 2mm replacement axles. They should be a free running fit. Remove any burrs or swarf from the front and rear faces of the bearings.

❑ Remove the bearing carrier frames from the main etch. DO NOT at this stage separate the bearing carriers from the frames.

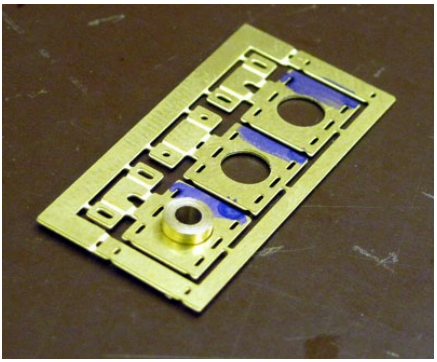


Note that the individual bearing carriers each have small half-etched identification marks. You can use these in conjunction with corresponding marks on the subframes to ensure that each carrier is always mated with the same subframe slot.

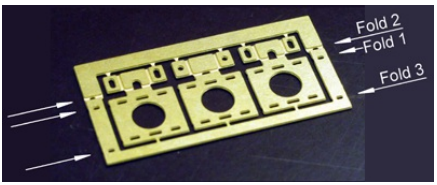


Note that the identification marks may be on the inside or the outside of the carriers, depending on whether the carriers face inwards or outwards in the subframes. The photos in this section show outward-facing carriers, used in all kits except for the Class 52.

❑ Test fit the bearings in the large central holes in the carriers. The body of the bearing (excluding the flange) should pass through the hole. If necessary, gently relieve the holes with a round needle file, working evenly around the edges, until the bearings pass through.

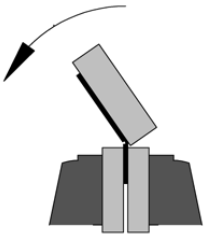


The folds in the bearing carrier frames are best made in bending bars, or between any two trued and parallel surfaces clamped together. Use a rigid piece of flat material to make each bend simultaneously along its whole length. This will help minimise any unwanted distortion in the fret.

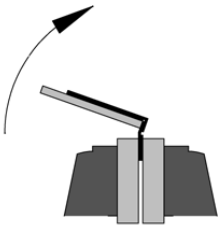


Note that Fold 3 is a jig fold, made along the tags at the base of the carriers.

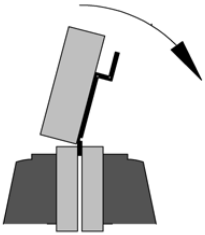
❑ Make Fold 1, check that all sections of it are at 90°, and reinforce it with solder. Be sparing with the solder; you don't really want to get any on the carrier faces to the inside of the fold. Apply a small amount of liquid flux to the slots on the outside of the fold, then get a small amount of solder on the iron and touch it against the central slot on the outside of the fold on each bearing carrier. You will see the solder flash along the joint to the other slots. Repeat for the two sections of fold on the carrier frame.



❑ Make Fold 2. You will need a thin, firm, flat piece of material to drive this fold; a robust steel rule (not a thin springy one!) works OK. If anything, overfold beyond 90° just slightly.

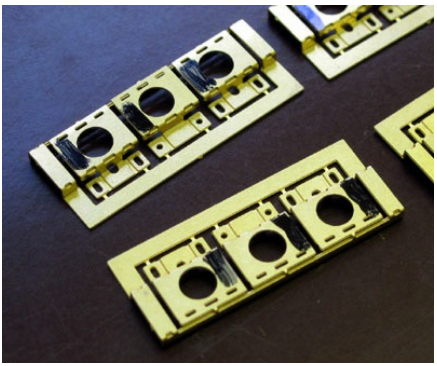


❑ Make Fold 3, to approximately 45°. Note that this fold is along the line of the tags at the base of each carrier, forming part of the frame assembly jig, and is not a part of the finished carriers.



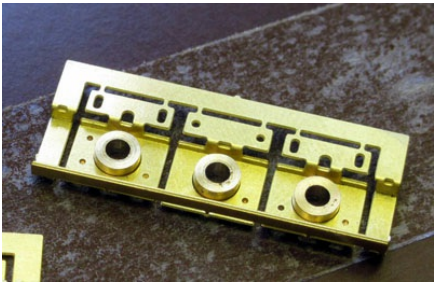
This is a view of the folded carrier frames. Fold 3 has been made to 90° in this case, but anything over about 45° will do.

The photo shows outside-facing carrier frames, used in most of our kits. For inside-facing frames (used on the Class 52), the half-etched id marks are on the faces visible in the photo.



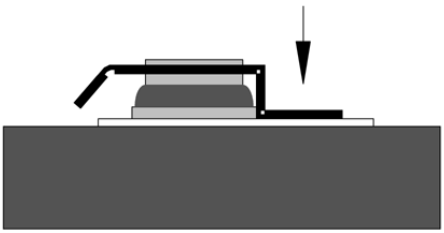
❑ Stick a length of double-sided tape, large enough to take one of the carrier frames, onto a clean, flat, heatproof working surface. Ensure the tape is firmly smoothed down

on the surface, with no air bubbles or foreign bodies trapped underneath.

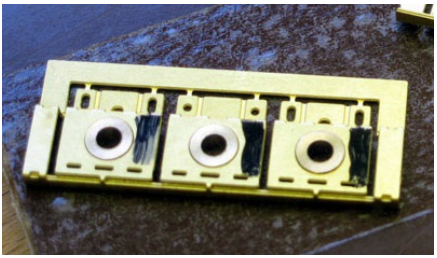


❑ Remove the backing paper from the tape, take it to one side and place on it three of the axle bearings, flanged face down. Place the carrier frame, inverted as shown, over the three bearings with the bearings passing through the three holes. Use the backing paper to carry the three bearings and frame on to the double sided tape, then slide the backing paper away, leaving the three bearings in contact with the tape and held in position by the carrier frame. Press the bearings firmly into place on the tape and remove the carrier frame. Repeat for the other three carrier frames.

❑ Using a cocktail stick, place a thin fillet of multipurpose grease around the flange root of each bearing. This will ensure that the area is kept free of solder when the bearings are fixed into the carriers. An alternative is to use a permanent marker: the ink should resist the flow of solder.



❑ Place the carrier frame, the correct way up, over the bearings and press down firmly the back of the frame and carriers, above Fold 2, on to the tape, as shown here. The unflanged end of each bearing should protrude from the face of its carrier by a very small amount (not quite as much as in the sketch), and the faces of the carriers should be parallel with the end faces of the bearings.



❑ Using a cocktail stick, apply a small amount of flux around the join between the protruding part of each bearing and the face of its carrier. Holding a bearing in place with a heat insulating instrument, to make sure it doesn't move, bring the iron with a small amount of solder to the join between bearing and carrier, and let the solder flash round the joint. Repeat for the other bearings. A small amount of solder may appear on the bearing outer surface under the inner face of the carrier but most of the bearing outer surface, in particular within about 0.5mm of the flange, should be free of solder.

❑ Remove any excess solder from the front faces of the bearings.

❑ Free the fret from the working surface.

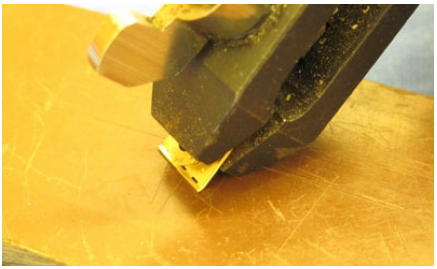
ⓘ Weaken the bond of the double sided tape with a soak in methylated spirits and slide a Stanley knife blade or a similar thin strip of metal under the fret and bearings to break the bond of the tape without causing too much distortion.

❑ Unfold Fold 3 and separate the individual bearing carrier assemblies from the frame. Take care, as the top parts of the carriers are quite fragile at this stage: it may be

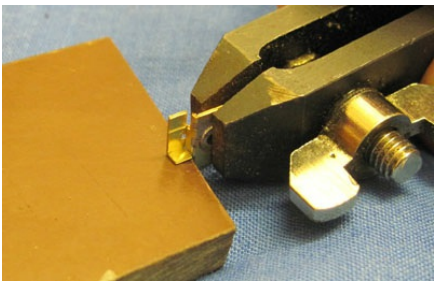
best to leave cleaning up the tags until after the folding and soldering stages below.

❑ Taking each carrier in turn, clamp it firmly into a vice (a hand-held vice is ideal for this) across the ends of the bearing with the bottom of the bearing carrier protruding. File away any remnants of the tag from the lower edge of the carrier.

❑ Working against a hard, flat surface, make the fold to form the bottom flange of the bearing carrier.

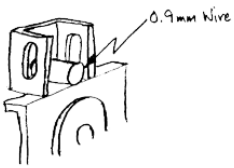


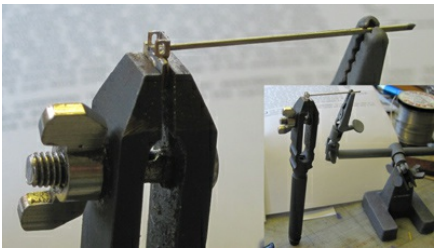
❑ Then, invert the carrier in the vice so that the carrier top is projecting. Fold in the ears at the top of the carrier. You may find that the ear catches against the top flange: do not apply brute force, but adjust Fold 2 and/or the direction of the applied force, and you will find that it folds easily. Folding against a block, as shown, gives a good, tight fold.



❑ On the inner carriers (the ones without a hole in their back face), apply a small amount of flux (cocktail stick!) to the folds and butt joints around the top of the carrier and flash in some solder to reinforce the folds and form a fillet between the lower edges of the ears and the top of the carrier body. Clean off any solder which adheres to the outer faces of the ears. Ensure the holes in the ears remain clear of solder.

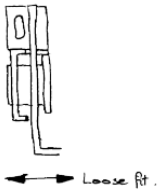
❑ On the outer carriers, pass a piece of the 0.9mm nickel-silver wire through the hole in the back of the carrier and across the top, parallel to the line of the axle. With a small amount of flux, solder the wire in place, at the same time reinforcing the folds and butt joints around the top of the carrier. Keep the bearing clamped in the vice while soldering; this will act as a heat sink and prevent melting of the joint between the bearing and carrier.



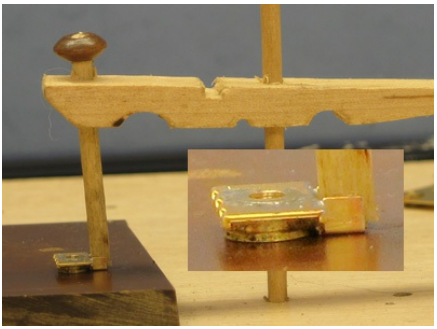


We hold the 0.9mm wire in the correct alignment with the bearing as shown here. Clamp the wire horizontally in the 'helping hands' at a distance above the bench that allows the hand vice, holding the bearing, also to rest on the bench. Using one hand to steady the vice, the other is free to wield the soldering iron. Snip off the wire, close to the bearing, when done, and it's ready for the next one.

- Trim the wire and finish it flush to the front and back of the bearing with a file. Clean off any solder which adheres to the outer faces of the ears. Ensure the holes in the ears remain clear of solder.



- Taking each subframe etch in turn, check that the carrier assemblies can slide freely in their respective subframe slots (see the next paragraph for a solution to bearing misalignment). It is as well at this point to associate each bearing assembly with a slot according to the markings on the bearing carriers and subframes, whether or not you have individually matched the bearings with slots. File away any burrs from the outer edges of the carrier tops. The fit along the line of the axle, i.e. of the subframe plate between the bearing flange on one side and the inner facing edges of the carrier on the other, should be quite loose to accommodate tilting of the axle. Check that all traces of the tag are removed from the edge of the bottom face of the carrier, as otherwise it can bind with the lower edge of the subframe slot.



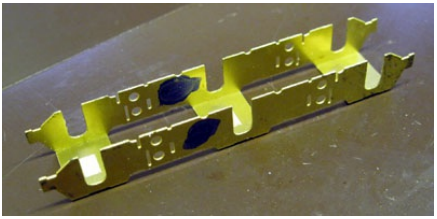
Although the aim is to have the bearing flange parallel with the front face of the carrier, a certain amount of misalignment can be tolerated. If, however, you find that the subframe side is 'pinched' between the two, then an individual carrier assembly can be corrected by clamping the back of the top of the carrier against a flat working surface. The soldering iron can then be applied to the bearing to melt the joint between bearing and carrier and allow the back of the bearing to be held down against the same surface. This should set the correct alignment.

- That completes the bearing carrier assemblies. To finish off, clean them up to remove any flux residues, and put the carriers and subframes safely away in their respective containers.

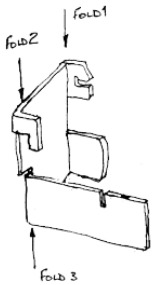
Subframes

- This section describes the construction of one of the two bogie subframes.

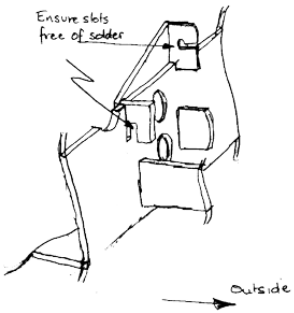
- Make the two main longitudinal folds, each of which is in three parts carried over the transom sections under each axle slot. Ensure they are at a true right angle and reinforce them with a fillet of solder. Take care to ensure that the region immediately around the subframe bearing slots, for at least about 1mm around the edges of the slots, is kept free of solder.



- Remove the four spring seats from the etch. There are two of each hand for each bogie. Make folds 1, 2 and 3 in each spring seat as shown.



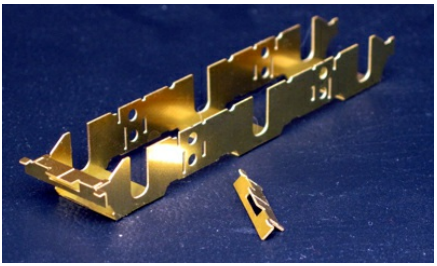
- From inside the subframes, fit each spring seat through the slots in the side of the subframe between the centre and outer axle slots. The back of the spring seat should come up flush to the inside face of the subframe side. Solder each spring seat in place, ensuring that the slots for the springs themselves remain free of solder. Make sure that the seats are as far down in the subframe slots as they will go. Check that they are all at the same height by inverting the subframes and resting the tops of the spring seats against a flat surface.



- Remove the two baseplates from the fret. Make the folds at each end of each baseplate, to about 80° rather than a full right-angle.

- Fit the baseplates into the subframes, noting that the lugs on the sides of the baseplates engage in the recesses in the lower edges of the subframe, and solder the joints between the two.

- Remove end stretchers from the fret and clean up. Fold the two outer lugs first then make the inner folds together. Fit the stretchers across the subframe ends and solder up.



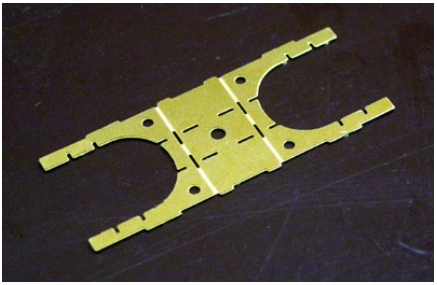
ⓘ When fixing the stretchers to the subframes, it is convenient to work with the subframes inverted and the stretchers supported on heatproof blocks.

- Fit the end plates across the subframe ends; support them against a block and solder in place from the inside.

Deltic Bogie Bolster

These instructions describe the assembly of one of the two bogie bolsters.

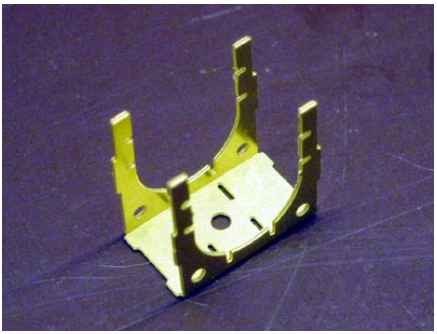
- Remove the bolster centre etch from the fret, taking care not to distort the 'legs' of the etch.



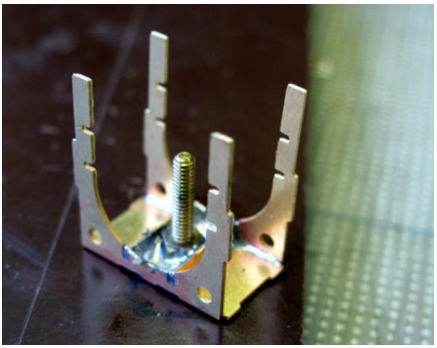
- The hole in the centre of the bolster is sized to take a 10BA screw. To use the 2mm pivot screw supplied in the kit, open out the hole to 2.0mm. Make sure the hole is clean and thoroughly deburred.

Open out the holes using tapered broaches to ensure that centres are preserved. Deburr the holes using a larger drill.

- Make the two folds in the etch

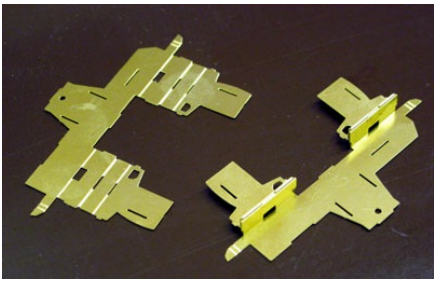


- Remove the two Upper Stiffener etches from the fret and fit them into place. Clean up the faces of one of the 2mm brass nuts to remove any machine oil and grease and prepare for soldering. Take one of the full-depth 2mm washers from the fret and thread it on to one of the 2mm screws. Apply some grease to the washer and the top few threads of the screw. From the outside, pass the screw through the central hole in the top of the bolster frame and thread on the nut. Screw the nut into place between the upper stiffeners and tighten up. Check that the nut is central between the stiffeners and flat to the face of the bolster top. Run generous fillets of solder around the nut and the Upper Stiffeners.

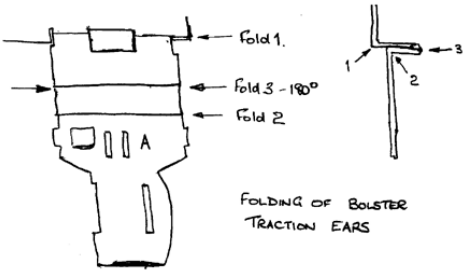


- ❑ Remove the screw from the nut (it should have been prevented from being soldered in place by the grease).

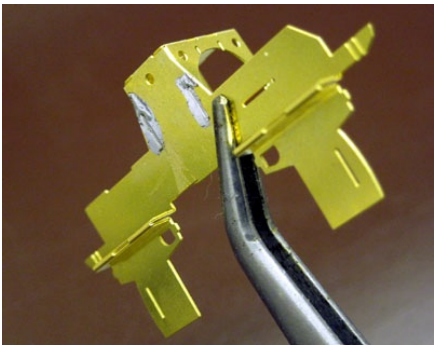
- ❑ Remove the two bolster side etches from the fret.

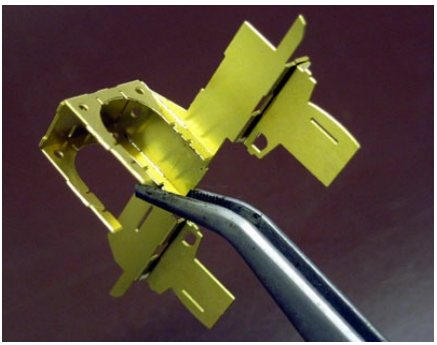


- ❑ Fold up the traction ears as shown. Note that Fold 3 is 180° with the etched slot on the outside of the fold. Make fold 1 first, then start fold 3. Finally, gripping surface A with pliers and supporting the main part of the fret on a hard, flat surface, make fold 2 and complete fold 3. Don't apply any solder to these folds just yet.

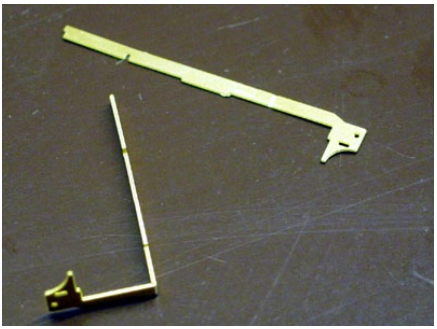


- ❑ Hold the bolster centre and bolster sides firmly together and tack solder them from the outsides of the slots in the bolster sides. Keep solder clear of the places where the inner and outer bolster frames will fit.



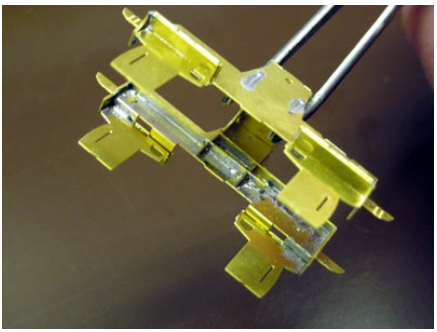


- Remove two Inner Bolster Frame etches from the fret and ensure that any tags are cleaned up from faces which mate with the inside face of the bolster sides. (The Inner Bolster Frames are the ones which engage in the uppermost slots in the legs of the bolster centre). Fold them up, fit and solder them in place along the bolster sides, noting that each has a slot which engages in a tab on the outside edge of the traction ears.

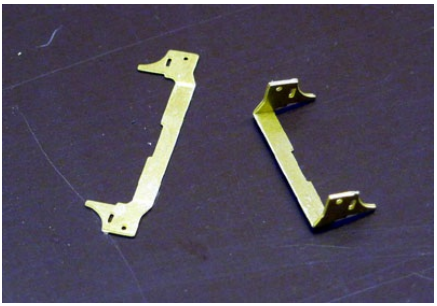


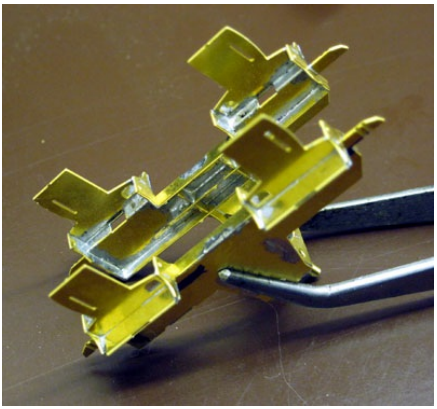
- For each traction ear, hold the two laminations of the traction ear firmly together and clamp the end of the Inner Bolster Frame against its outside edge, engaging the tab and slot. Ensuring that the other folds on the ear are at 90°, run a fillet of solder around the underneath of the ear on the inside where it mates up with the end of the Bolster Frame. Ensure that the spring holes in the Inner Bolster Frames are free of solder.

- Similarly fit the two Outer Bolster Frames.



- Fold up and fit the Central Stiffeners / Spring seats. The spring seats fit between the inner edges of the traction ears, engaging in similar slots to the Bolster Frames on the outside. You will find, if you start by sliding the 'noses' of the spring seats between the opposing edges of the traction ears, that the stiffeners can be sprung into place between the traction ears. Again holding the 180° folds of each traction ear firmly together, run a good fillet of solder under the traction ear where it engages with the Central Stiffener.

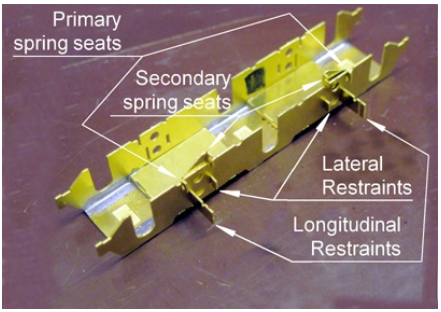




❑ Pair up the bolster with its subframe, as designated by the presence or absence of the tiny etched triangular marks. Note that the outer end of the bolster, as distinguished by the horizontal parts of the outer bolster frame being lower than those of the inner bolster frame, should be oriented towards the coupling end of the subframe.

❑ Check the bolster for dimensions and squareness:

- it should sit with the lower edges of all four traction ears in contact with a flat surface,
- the traction ears should just fit over the lateral restraints on the subframe sides, with a free sliding fit or just a slight resistance,
- the traction ears should just fit between the longitudinal restraints on the subframe sides, again with a free sliding fit.



A tight fit can be addressed in the first instance by light filing on the circular edges of the traction ears or lateral restraints to remove etching cusps. Other adjustments may be made by gentle tweaking of either the bolster assembly or the longitudinal restraints. If you do need to tweak the bolster, try to end up with the faces of the traction ears vertical; adjust the fit over the lateral ears by grasping firmly the central arch as well as by rotating the outriggers.

❑ Clean up the bolster assembly to remove all flux residues. If you wish to chemically blacken the bolsters and subframes, do it at this stage.

Deltic: Preparing the Locomotive

- ❑ Following the manufacturers' recommendations for running-in, ensure that the locomotive is performing smoothly and to your satisfaction generally. Deal with any issues now, especially those covered by warranty or your basic statutory rights as customer, before making any modifications.

- ❑ Separate the body moulding from the chassis block of the locomotive according to the manufacturer's instructions. Store the body retaining screws safely away.

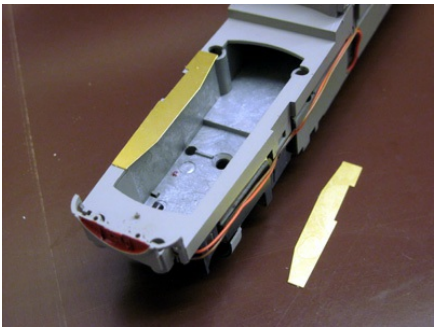
- ❑ Make a note of the identification of the terminals on the circuit board to which the two wires leading to each bogie are connected. Note also to which side of each bogie they go. Pop off the insulated sleeves from the terminals and disconnect the wires leading to the bogies. It might be necessary to desolder them but they may just be passed through holes in the terminals and retained by the sleeves.

- ❑ Select one of the bogies and undo the screw which retains the bogie pivot in the chassis block. Drop the bogie out from the bottom of the block. The cardan shaft joining the motor to the bogie will either come with the bogie or be retained at the motor end. Either way, remove it but note that the ears on each end of the cardan shaft are of subtly different shapes, so record which end is which.

- ❑ Assign the bogie to one or other of your sets of etched bogie parts, marking the bogie drive, drive shaft and chassis block accordingly.

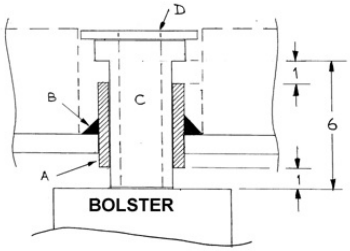
- ❑ Similarly remove the other bogie.

- ❑ Fix the four sole plates to the lower face of the chassis plastic moulding as shown, using an epoxy resin glue or double-sided tape.



Bogie pivot components are supplied in the kit to mate with the M2 nuts fitted to the tops of the bolsters:

- M2 x 10mm screws,
- M2 x 6mm nylon insulators,
- Brass tube 4mm OD x 3mm ID,
- and M2 retaining washers (on the fret).



A: BRASS TUBE 4mm OD x 3mm ID

B: FILLET OF EPOXY RESIN

C: M2 x 6mm INSULATOR

D: M2 x 5.5mm WASHER (from etch)

The diagram here shows the suggested pivot arrangement to which the following instructions apply. This arrangement is suitable for either conventional or 'American' pick ups (with which the bogie bolster is 'live'); the key attribute for the latter being that the outer brass tube, and therefore the loco chassis block, is electrically insulated from the bolster top. The arrangement also secures the bolster vertically, but allows some vertical movement to accommodate adjustments in ride height.

Other arrangements are possible; the epoxy glue can be omitted and all components can be shortened, for instance. If required, a thin insulating washer can then be placed on top of the bolster to prevent electrical shorting to the brass tube.

- ❑ Test the 4mm OD tube for a free sliding fit through the pivot holes in the loco's chassis block. Open out the holes if and as necessary. Note that the fit is for the tube passing perpendicularly through the hole; pitch and roll movements of the bogie are not accommodated at this pivot.

- ❑ Cut two sections of the 4mm OD tube about 4mm in length. Check that the nylon insulators supplied are a free fit through the tube, opening out the bore if necessary.

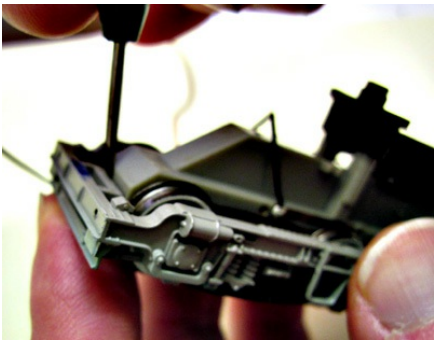
- ❑ Remove the M2 x 5.5mm diameter washers from the main fret.

- ❑ For each pivot, offer up one of the bolsters to the loco chassis, with the 'shoulders' at the tops of its traction ears resting on the sole plates, and tape it in place temporarily. Slide a piece of 40thou plastic card between the top of the bolster and the chassis, covering up the bolt hole. Put a ring of quick-set epoxy glue around one of the 4mm tubes and place the tube through the pivot hole in the chassis to rest on top of the plastic card, thereby positioning it about 1mm clear of the top of the bolster. To make sure it is aligned correctly, when the epoxy is half set, untape the bolster, pass the nylon insulator through the tube and secure it in place with the M2 screw and 5.5mm washer. Ensure that the bolster can rotate with the chassis sole plates resting on its shoulders, and allow the glue to set completely.

Modifying the Bogie Drive

This section describes the operations involved in modifying the drive train for one bogie. The illustrations are a mix of images from the Deltic and Class 47 models, which are identical in principle.

- Using a small screwdriver, gently unclip the bogie sideframe/undertray moulding from the ends of the bogie drive unit. If you wish to use the sideframes on your finished loco, take care not to damage the brake shoe and step detail. Put the moulding safely to one side for now.



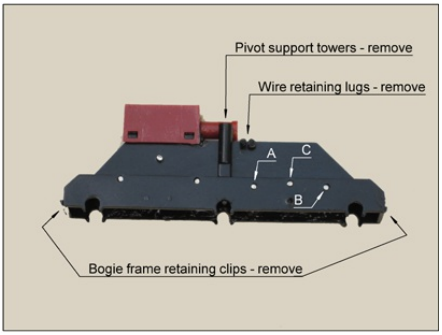
- Undo the two cross-headed screws retaining the bogie pivot to the tops of the two pivot towers and remove the pivot. These parts are not required for the converted bogie.

- Unclip the three wheelsets from the drive train moulding and put them to one side. Rotate the three free idler gears, between the middle and inner axles, to feel how free running they are, as you will need to reproduce this later when reassembling the drive train.

- Undo the cross-headed screws which retain the metal pickup strips on the side of the drive train moulding. Remove the strips and, with a sharp knife, the moulded pips which locate them. Put the pickup wires and strips to one side for reuse.

Gently press out the idler axles marked A and B. We found that the axles are a tight fit in one side of the moulding only so, once you have removed the first one and thereby determined which side that is, press them out from the tight side and, when the time comes, replace them from the loose side.

When removing the idler axles, support the moulding on a hard surface with some kind of slot or hole to receive the axle.



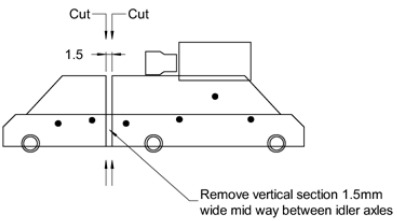
- Remove the gears that were retained by axles A and B and put them to one side for later.

- Now remove axle C and its gear. Again put it and the axles to one side until later but ensure that this gear is clearly distinguished from the other two in some way as its teeth are of the opposite hand. It is possible to tell them apart by close inspection but easier to keep them separate.

- The drive train moulding and your fingers will by now be thoroughly lagged in lubricating grease. Take a piece of kitchen paper towel and clean things up, then scrunch another clean piece of towel into the underside of the moulding to cover the remaining gears and protect them from the dust and swarf generated by the next operation.

- Referring to the illustration above, and using your favoured combination of razor saws and craft knives or burrs, cutting discs and grinders in a mini electric drill, remove the pivot support towers, wire retaining lugs and bogie frame retaining clips from the moulding. Take them right down flush to the surrounding faces of the moulding. Exercise some care as, in spite of being somewhat 'soft' and 'soapy', the plastic can crack in a brittle manner if overstressed. Take great care at all stages not to damage the retaining lugs for the main axle bearings.

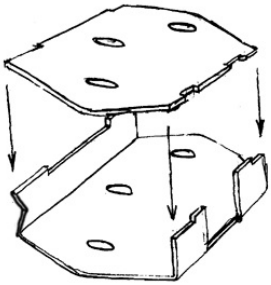
- The drive train needs to be split between the inner two axles, to allow the suspension to articulate, by making two cuts across the moulding as shown here.



A razor saw may be used to make these cuts. Take care that the moulding is adequately supported while cutting - it's helpful to have a solid block of material which just fits between the sides of the moulding.

The kit is designed to allow the model to be driven on all six axles, i.e. as a C-C, corresponding to the Co-Co arrangement of the prototype. It is, however, possible to avoid a certain amount of complication by using the 4-wheel parts of the drive as they are and assembling the loco as a B1-1B, in which configuration it will perform perfectly adequately and retain much of its hauling capacity. If you wish to take this option, you can skip the remaining steps in this section.

❑ Remove the power transmission plate etches from the fret. Check that the 1.5mm dia idler axles, that you removed earlier from the drive train, are a free fit through the holes in the plates (Note: one pair of holes is slightly larger than the others). Fold up the spacers on one of the plates and solder the plates together as shown, making sure that the larger holes are opposite each other. A chevron notch in the top spacer of the assembly indicates at which end the larger holes are. Check that the assembly is square.

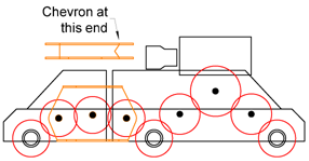


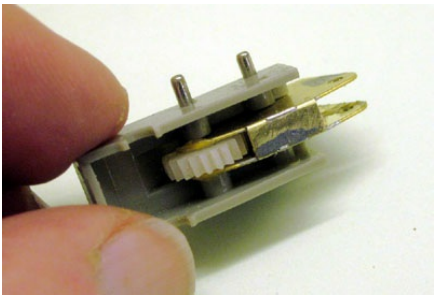
❑ Returning now to the three gears which you removed from the drivetrain, thin down their widths over bosses such that they are a free fit between the two power transmission plates, a dimension of about 2.9mm. There may be a small moulding pip on the side of the gear which should be removed. Ensure that the thinned gears each rotate freely on the idler axles.

ⓘ The bosses of the plastic gears can be thinned by filing them down. To hold the gear while working it, clamp one of the idler axles into a collet pin chuck with about 2.7mm projecting. The gear can then be placed over the axle and worked with the file while holding the pin chuck in the other hand.

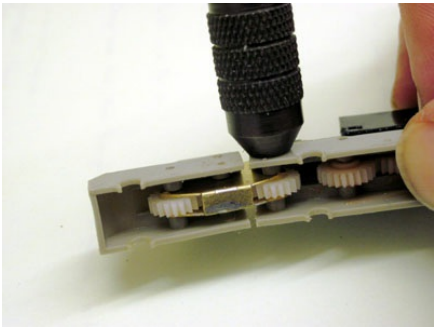
The filing operation will leave 'fuzzy clods' of deconstituted plastic around both the outside edges of the bosses and the axle holes. It is essential that this waste is removed, using a sharp scalpel blade, as the smallest amount will cause the gears to run tight on the axles or bind against the transmission plates. Use the scalpel to put the tiniest of bevels around the circumference of the axle holes and outer edge of the bosses. Finish cleaning with a wash of methylated spirits scrubbed by an old toothbrush. Do not be tempted to relieve the axle holes with a broach or reamer - any tightness will be down to dust or swarf.

We now re-assemble the drive train in its articulated form as per the diagram here.

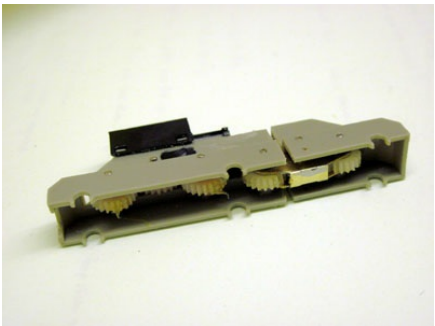




❑ Take the smaller part of the drive train moulding and insert the transmission plate assembly into it, with the chevron in the top spacer facing outwards, such that the two smaller holes line up with the idler axle holes in the moulding. Slide the unique one of the three idler gears into position between the plates, lining up with the axle hole in the middle of the plates. Press the idler axle into place to retain the gear. Similarly fit one of the other two gears and axles in the remaining idler axle position. Check that the gears rotate freely.



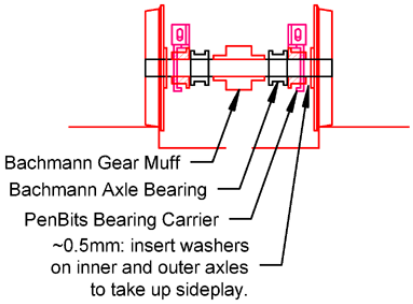
❑ Now slide the 'chevron' end of the transmission plate assembly into the cut end of the larger part of the drive train moulding. Slide the remaining idler gear between the plates, line it up with the holes in the plates, line up the holes in the plates with the holes in the moulding, and insert the idler axle to retain the axle and plates in position. Check for freedom of movement between the two parts of the drive train moulding: it should be sufficient for the inner axle to move up and down about 1mm with respect to an imaginary line joining the centres of the other two axles. It will probably be much more than this, but if there is a problem just file back the cut edges of the moulding where they come close.



❑ Check that the three idler gears rotate freely together as they did before disassembly. If any tightness is present, strip down the gears and ensure that they are clean and free from any kind of swarf or dust residues.

Fitting Wheelsets

The diagram shows the arrangement of the driving wheelsets. 2mm diameter axles match with the bearings supplied in the kits, and with the gears of driven axles. Unpowered axles can be of other diameters (requiring modification or substitution of the bearings supplied), e.g. the 3mm axles supplied in some conversion sets. For discussion on the possible choices of wheels and axles, see the Axle Bearings and Wheels and Axles sections of the Technical Description page on the website.



Pin-pointed ends should be removed from axles. If you are using ready-assembled wheelsets it will be necessary to remove at least one of the wheels from the axle.

- ❑ Dismantle the Bachmann driven wheelsets. Recover the final drive gears and the axle bearings. Discard the wheels and axles.

The Bachmann axle bearings need to be opened out to accommodate differential movements of the axles in the suspension whilst at the same time holding the drive gears in mesh and transmitting the tractive forces from the drive train to the axles.

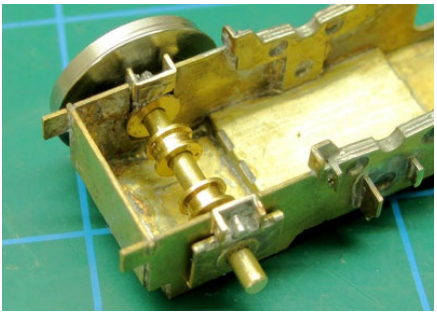
- ❑ Open out the internal diameters of each of the Bachmann axle bearings from 2.0 to about 2.1 to 2.2 mm.

ⓘ We found that the tapered end of a 2.3mm cutting broach was about 2.1mm diameter so used that to cut half way through the bearing from each side, finishing off with a smooth broach. Not a technique for the purist, perhaps, but adequate for our purpose. Alternatively, using a lathe, we have simply drilled through the bearings.

The following operations check the differential movement between the drive train and the bogie subframe. Repeat them for each bogie in turn.

- ❑ Find the brass bogie subframe and bearing carriers for the bogie.
- ❑ Taking the new axles one at a time, and with regard to the identification marks on the bearing carriers and subframes, slide on to each axle a bearing carrier, two Bachmann axle bearings and the second bearing carrier. Note that the ears at the tops of the bearing carriers face outwards towards the ends of the axle.

- Insert each axle into its slots in the Subframe, and check for free vertical sliding of the bearings in the slots, firstly with the axle horizontal, and again with the axle tilted such that one wheel is raised up to about 1mm above the other.

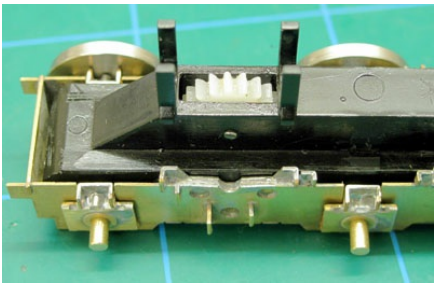


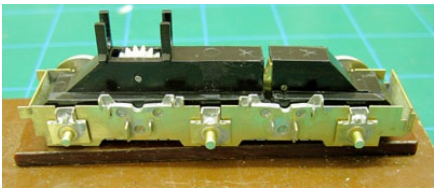
- Orientate the brass Subframe and the Drive Unit. The 'four-wheeled' part of the drive unit goes towards the outer (i.e. coupling) end of the bogie, driving the centre and outer axles, with the socket for the cardan shaft facing the inner end of the bogie.

- Test the fit of the drive unit within the envelope of the subframe, again both aligned with the subframe and also tilted slightly. Remove any remaining lumps or bumps from the drive moulding if these interfere with the movement.

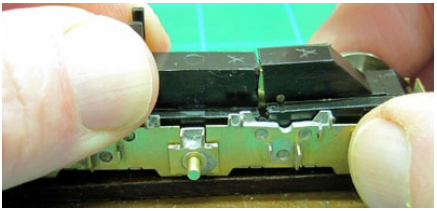
- Take the centre and outer axles and clip them in to the drive unit using the Bachmann bearings.

- Fit the drive unit into the subframe, engaging the four bearing carriers into the slots in the subframe. Holding the drive unit with one hand and the subframe with the other, check that the drive unit can move freely up and down relative to the subframe with the carriers sliding in their slots. At rest the tops of the carriers will be level with the tops of the subframes. The suspension is designed to deflect ±0.5mm, so the free movement needs to be maintained both when the base of the drive unit is parallel with the base of the subframe, and when one axle is raised up to 1mm with respect to the other. If there is any binding when the units are parallel, check the movement of individual carriers in their slots and correct as necessary. If there is binding when one axle is raised, open out the Bachmann axle bearings just a fraction more, up to a maximum of 2.3mm.

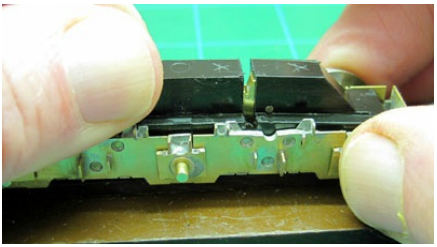




❑ If you are having three driven axles, remove the drive unit from the subframe and clip the third axle into place. Replace the drive unit in the subframe, now engaging all six of the bearing carriers into their slots.



❑ Holding the 'four-wheeled' part of the drive unit such that the tops of all four of its bearing carriers are level with the top of the subframe sides, check that the third axle has at least ±0.5mm of vertical travel.



❑ If this is not the case, check for free movement of the individual carriers in their slots and then, if required, open out the Bachmann bearings a little more, on this axle only, up to a maximum of 2.3mm.

❑ That concludes the test. Unclip the axles from the Drive Unit and store them in their respective containers.

We now use one of the inner or outer axles, still with its bearing carriers fitted, to check for lateral play. If you are using ready assembled wheelsets and have one wheel already fitted to each axle, you will need to vary the operations slightly to suit.

❑ Fit the wheels to the axle to the correct back-to-back measurement. Test fit the axle in the bogie subframe to determine the amount of lateral play. There should be just a little; enough to allow the wheelset to tilt such that the wheel on one side is raised about 1mm with respect to that on the other. If necessary, dismantle the wheelset and fit full- and half-width 2mm washers (supplied on the fret) between the bearing carriers and wheels, until this condition is met. If there is insufficient play, even with no washers fitted, reduce the inner width of the wheel bosses accordingly.

❑ Record the washer configuration you arrived at and dismantle the wheelset. If you had to reduce the inner wheel bosses, repeat the operation on the remaining wheels. Take off an extra 0.5mm on the wheels for the two centre axles, subject to not going beyond the line of the inner wheel rim.

Now we can fit the Bachmann gears to the new axles and assemble the wheelsets. Do the following for each axle.

❑ If you have one wheel already fitted to the axle, slide on the required number of washers adjacent to that wheel, then the bearing carrier (ears facing the wheel), then a Bachmann drive bearing.

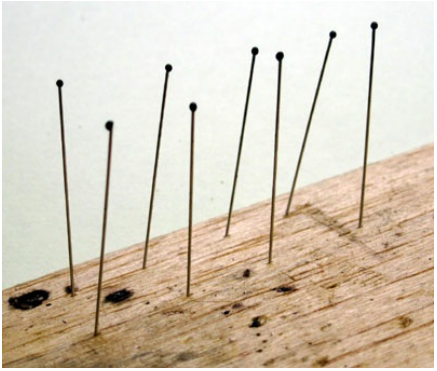
❑ If it is a driven axle, slide one of the Bachmann final drive gears into position centrally. The gear should be a tight fit on to the axle, sufficient to transmit drive forces without slipping.

- ❑ Slide the Bachmann bearings, then the bearing carriers, then any washers required, on to the axle.
- ❑ Fit the wheels to the axle to the correct back-to-back measurement. If you are using the 'American' pickup system make sure that the insulated wheel is adjacent to the carrier for the insulated side of the bogie.
- ❑ Test fit each inner and outer axle in its slot to confirm that the correct number of spacing washers has been fitted.
- ❑ Lubricate the bearings with a light machine oil and ensure that the oil is taken in to all the axle-bearing interfaces.

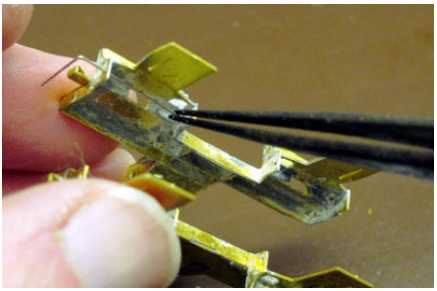
That completes the assembly of the wheelsets.

Springs, Bogie Assembly and Rolling Test

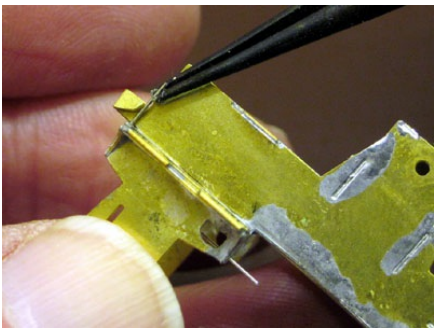
Spring wire sizes are listed on the card inserts that come with the kits.



- ❑ Cut eight lengths of the primary spring wire, each 32mm long.
- ❑ Degrease the wires and apply, to one end of each wire, a bead of fast setting epoxy resin about 1mm diameter, i.e. just large enough to prevent the springs being pulled through the holes in the ears of the central bearing carriers. Put the springs to one side while the resin sets.



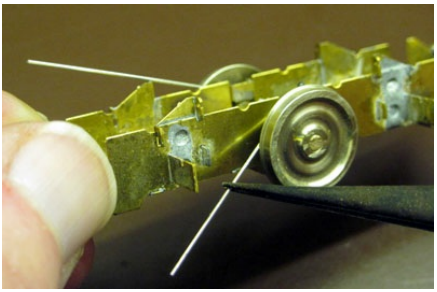
- ❑ Cut eight lengths of the secondary spring wire, each 24mm long. Make a bend in each wire, 8mm from one end, of just slightly less than 90°. Fold up the four spring retaining ears on the corners of each bolster. Pass the longer arms of the wires through the holes in the secondary spring seats...

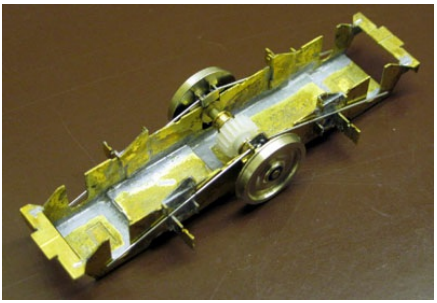


- ❑ ...and clip the shorter arms into the spring retaining ears. Put the bolsters safely to one side.

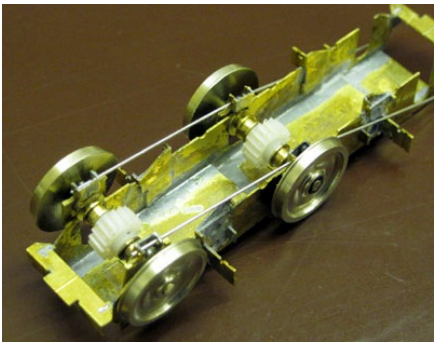
- ❑ Return to the primary suspension wires and check that the epoxy resin beads have set hard.

- Taking one bogie subframe, fit the middle wheelset. Take four of the primary springs and insert one through each of the four holes in the ears of the bearing carriers, feeding them through until retained by the epoxy beads.

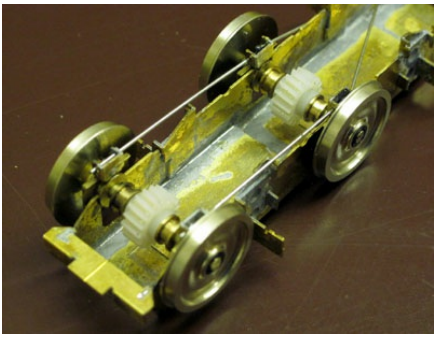




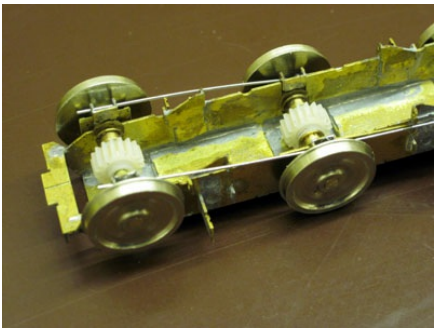
- Rest the springs on top of the secondary spring seats. Taking one of the outer wheelsets, thread the free ends of two of the springs through the slots in the ears of the bearing carriers...



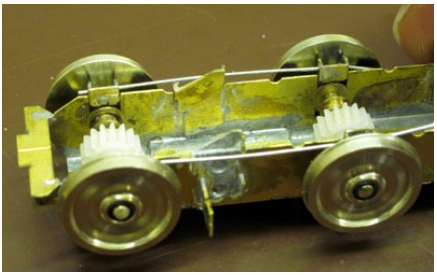
- ... and locate the bearings in the tops of their mainframe slots.



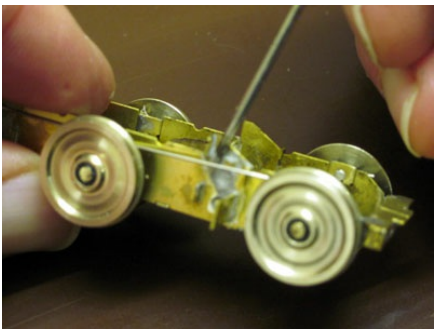
- Using a small screwdriver to manipulate the springs, bend them outwards to slide over the secondary spring seats...



- ... and then part way down the outsides of the primary spring seats.

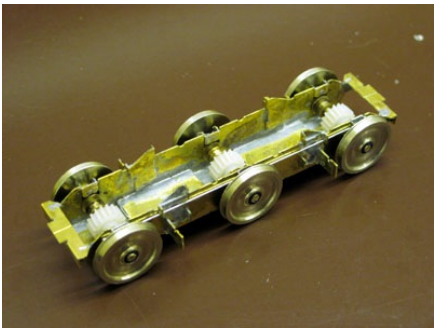


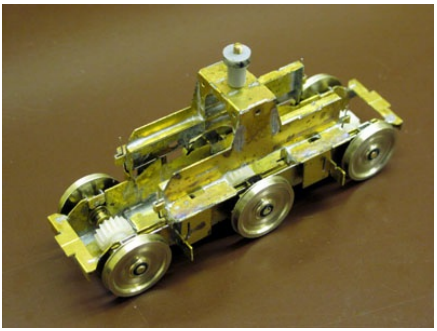
- Finally push each spring downwards until it snaps into its primary spring seat.



- Repeat this operation for the other outer wheelset.

- You now have a rolling bogie with fully functioning equalized primary suspension. Do a hand-powered rolling test to check for any tight bearings, wobbly wheels etc. It is easiest to correct such things at this stage.





- Now take the bolster, make sure it is the right way round, and slide it into place over the subframe. As you do so, push it to one side and you should find that the secondary springs on that side will snap in to place in their spring seats. On the other side, working through the slots in the tops of the traction ears with a small flat bladed screwdriver, push the secondary springs outwards and slide them down over their spring seats until they also snap into place.

NOTE: To remove the bolster, DO NOT attempt to reverse this method and flip the springs out of their seats, but remove each spring completely from the bolster, then lift it away from the subframe.

- Repeat the above operations for the other bogie so that you now have two rolling bogies.

- You can now fit the bogies into the chassis block of the loco and do a rolling test to check ride height, body clearances, ability to handle curves and suspension characteristics.

- Remove the bogies from the loco and dismantle them ready for the next stage.

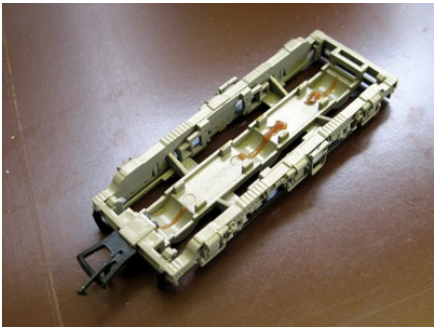
To remove the bolsters, remove the four secondary springs altogether rather than attempting to unclip them from their seats.

To remove the wheelsets from the subframe, use the screwdriver to press down the primary springs and pop them out to rest on the outsides of their spring seats, then slide the primary springs up over the outsides of the primary and secondary spring seats, at the same time removing the wheelsets from the subframe bearing slots. Remove the springs from the bearing carriers and return all components to their storage trays.

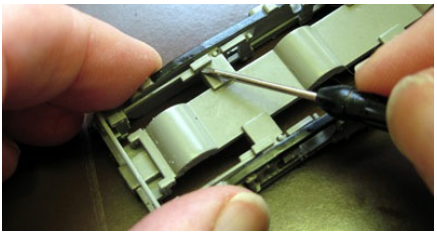
Deltic Sideframes

In this section we remove unwanted material from the Bachmann moulded bogie frame and attach the remaining cosmetic detail to the etched bogie subframe.

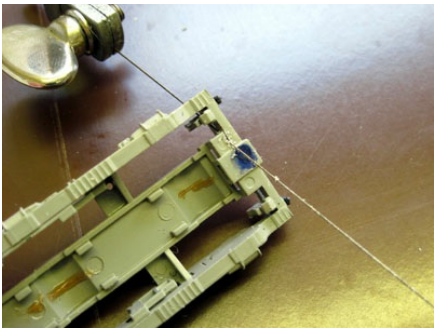
- Remove the coupling from the bogie frame.



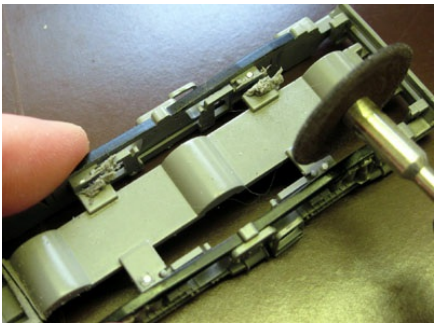
- Cut the brake pull rods at the shoe end using a sharp scalpel; support the shoe itself while you do this. Break the adhesive bond at the inner end of the pull rod and remove the rod.



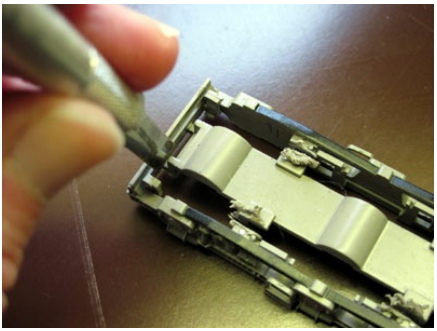
- Remove the undertray. Be careful not to overstress the moulded end stretchers. Start by cutting through the coupler moulding, as close to the line of the backs of the stretchers as you can...



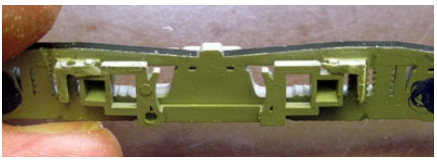
❑ ...then cut the intermediate stretchers flush with the back of the central brake/spring detail moulding...



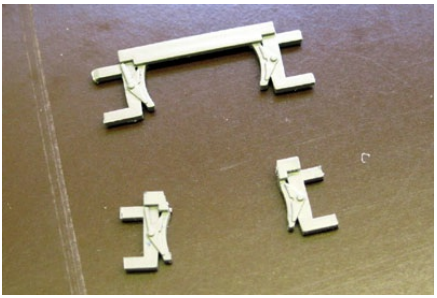
❑ ... and finally cut the inner end of the undertray from the backs of the inner stretchers. Clean up the cuts at the inner and coupler ends such that the backs of the stretchers present a single flat surface across the width of the bogie.



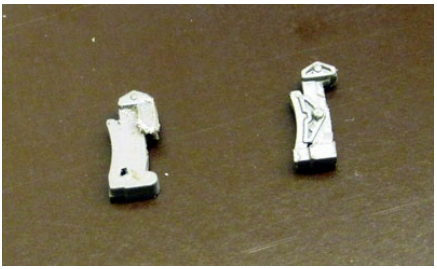
❑ Clean up the stubs of the intermediate stretchers, and file their vertical faces to fit between the outriggers of the etched subframe assembly.



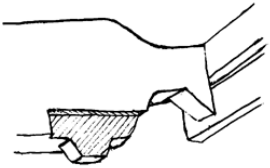
❑ Cut the central brake detail from the secondary spring mouldings as shown. Ensure the components are well supported when making the cuts. Cut about a further 1mm from the ribs which linked to the secondary springs. Remove the moulding which links the brake shoes, cutting as shown so that no part of the blocky moulding at the top of the shoe will interfere with installation of the central wheelset.



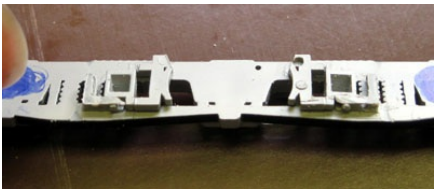
❑ Remove the end brake shoes from the bogie and remove material as shown so that they will sit a little further away from the outer axles.



❑ Cut a rebate on the inside of the moulding at the base of each outer axle detail as shown. This is to take the end of the pull rod detail and should be 0.4-0.5mm deep.

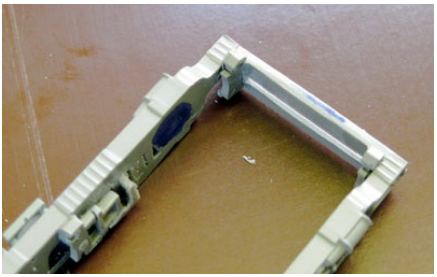


❑ Glue the central brake shoes in place as shown, spaced such that a wheelset can just drop in between them from the top.



ⓘ 'Plastic Weld' is a solvent adhesive which works well for re-attaching these components.

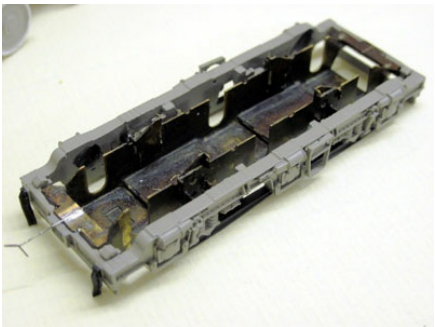
❑ Refit the outer brake shoes to the end stretchers, spacing them as far as they will go into the corners of the moulding, the top detail then dictating a small clearance between the shoe and the inside of the side moulding.



❑ Using a quick-set epoxy resin, glue the pull rod detail etches in place between the lower ends of the outer shoe details and the rebates in the inside of the sideframe moulding.

❑ If you wish to solder a coupling to the bogie subframe, it is as well to do it now before attaching the plastic outer frames. Note that if you are using 'American' style pickup it might be advisable instead to fit an insulating coupling mount.

- Again using quick-set epoxy, fix the moulded bogie frame to the end stretchers and outriggers of the etched bogie subframe. Note that the production version of the end stretchers is slightly different to that shown here.



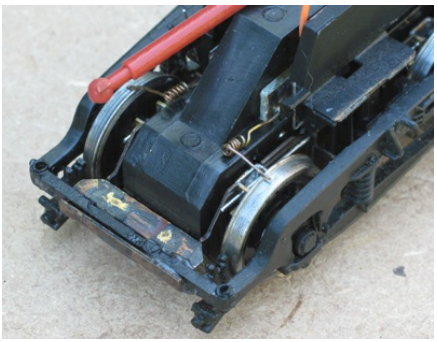
Pickups and Power

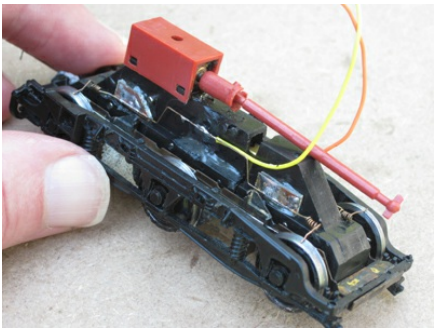
If you are using the 'American' system of pickup, with the wheels on one side of each bogie 'live' (i.e. with their wheelrims in electrical contact with the axles) then there is no need to provide separate wire pickups; the electrical connection can be made simply to the securing screw at the top of the bolster. If, however, you are using fully insulated wheelsets or, whilst using the 'American' system, still wish to add pickups to the 'insulated' side of the bogie, we offer some guidelines below.

We suggest that pickups are mounted in some way on the drive train moulding as there is very little movement between that and the wheelsets. The pickups will not then interfere with the suspension. Various arrangements are possible and you may already have your own preferences. Bear in mind the following:

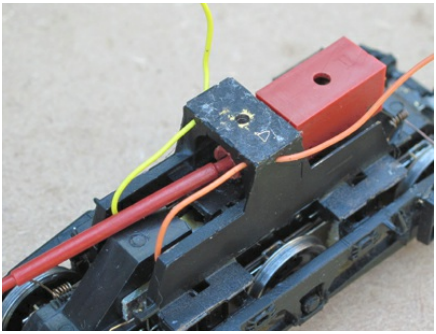
- If you fix any components to the sides of the drive unit moulding, make sure that they do not interfere with the free movement of the drive unit within the bolster and subframe. Limit their overall width to approximately that of the cover over the worm drive.
- If you run wires between the two articulated parts of the drive train, ensure that they do not restrict the articulated movement.
- Connecting wires should be sufficiently flexible, or routed in such a way, that they transmit no forces arising from differential movements between the drive unit and the bolster or loco chassis. If this condition is not met, there could be mechanical 'short circuiting' of the suspension, with wobbles and shocks being transmitted directly from the track to the loco body.
- Connecting wires should be routed clear of the rotating drive shafts.

We have used phosphor bronze wire pickups acting on the outer edges of the flanges at the tops of the wheels. They act on the outer wheelsets only, as there is limited space to fit pickups to the centre wheels.





- Small sections of pre-tinned copper-clad PCB material are glued to the sides of the drive unit. We use quick set epoxy, thoroughly degrease the mating surfaces on the drive unit and copper, and score the surface of the drive unit to provide a key for the adhesive. Pickups are bent up from 0.011" phosphor bronze wire as shown. The trapezoidal bends allow the wire to flex as the two parts of the drive unit articulate. The wire coils are formed of six turns around the shank of a 0.7mm drill, finished so that the pick ups themselves are preloaded below their operating position by about 1mm. The wires are tinned and then soldered to the copper-clad with a touch of the iron, with the feed wires tinned and soldered on in turn, resin-cored solder being used throughout.

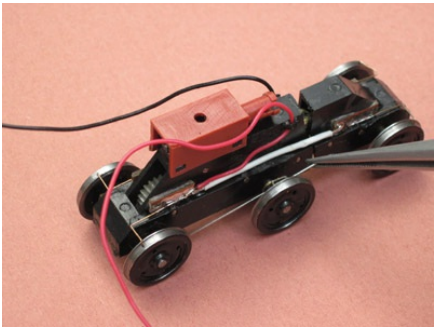


- The feed wires from the pickups back to the loco PCB are firmly anchored to the bogie bolsters; holes are provided near the top of each bolster to assist. This allows the route of the wires between the bolster and drive unit to be set and then to remain undisturbed when the wires are routed through the chassis block during the fitting of the bogie to the loco.

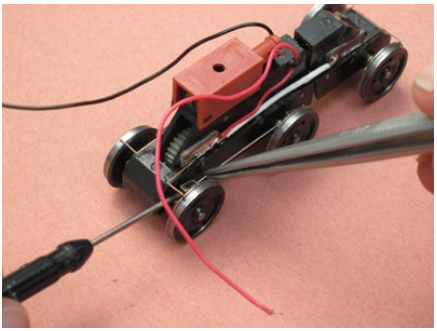
Final Assembly

- ❑ Take one of the drive trains and fit its wheelsets into position. If you are using a Heljan drive unit, replace the undertray.

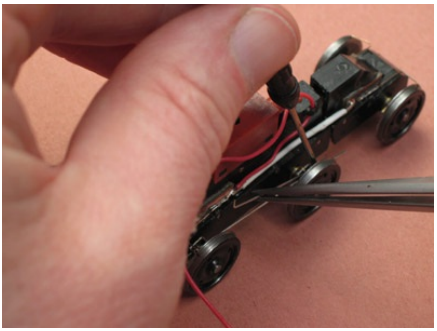
- ❑ Using a pair of tweezers to handle the springs, and a small screwdriver to manipulate the bearing carriers, thread one of the primary springs through one of the holes in the ears of the central bearing carrier.



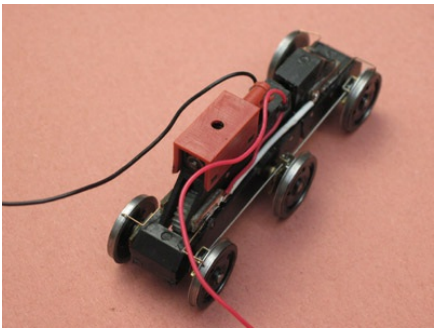
- ❑ Thread the spring through the slots in the ears of the bearing carrier of the outer axle.



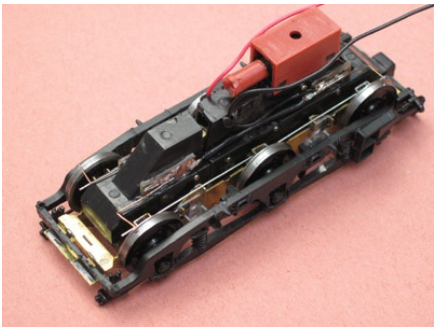
- ❑ Thread a second spring through the hole in the other ear of the central bearing carrier.



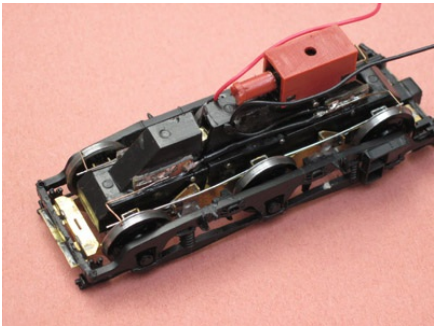
❑ Thread that spring through the slots in the ears of the bearing carrier of the other outer axle. Similarly fit the two springs on the other side of the bogie.



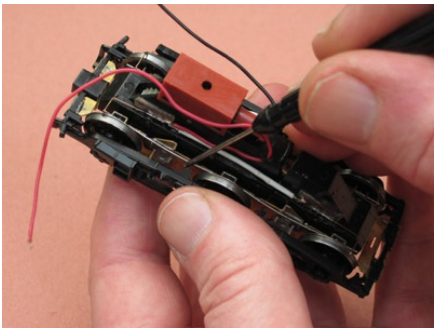
❑ Slot the drive train into the subframe with the four primary springs resting on the tops of the secondary spring seats. Ensure that all six bearing carriers are correctly engaged in the slots in the subframe, and that the drive train is the right way round (worm end towards the coupling end of the bogie).



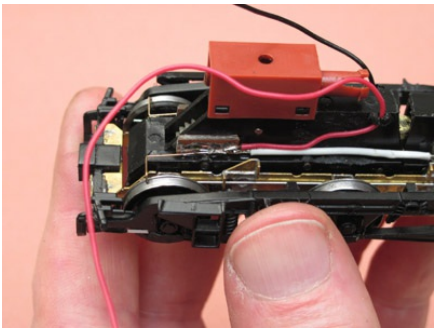
❑ Use a screwdriver to spring the springs outwards and downwards on to the outer faces of the secondary suspension seats.



❑ Push the springs downwards so that they slide over the secondary and then the primary suspension seats …



- ...until finally they clip into place under the primary suspension seats.



- Now take the bolster and slide it into place over the subframe. You should find that the secondary springs on one side will snap in to place in their spring seats. On the other side, working through the slots in the tops of the traction ears with a small flat bladed screwdriver, push the secondary springs outwards and slide them down over their spring seats until they also snap into place.

- Find the cardan shaft and clip the correct end into the drive socket of the bogie.

- Remove the retaining screw and sleeve from the top pivot of the bogie.

- Identify the correct end of the loco's chassis block. Route the pickup wires through the appropriate holes or slots in the block. Engage the free end of the cardan shaft into the loco's flywheel drive socket and line up the bogie top pivot with its pivot hole. Take up any slack in the pick up wires. Fit the bogie retaining screw, sleeve and washer.

- Repeat all of the above for the other bogie.

- Connect the pickup wires to the correct terminals of the loco's PCB.

- Place the locomotive on some track and give it a test run under power.

All being well, thats it! - the modifications are complete.

- Run the locomotive in gently at first. If the loco does not run freely or begins to bind up at any point, pay particular attention to lubrication of the axle bearings. You can feel for any binding by rotating the wheel rims with the fingers - there is enough slack in the drive train gears that you should be able to distinguish between a binding and a free wheelset.

- Finally, replace the body of the locomotive according to the manufacturers' instructions. On the Bachmann loco, you'll find that you'll need a slim-shafted cross headed screwdriver to replace the four screws adjacent to the bogies.

IMPORTANT NOTE: If you need to remove the body subsequently, please DO NOT at any stage attempt to pull the chassis from the loco by pulling on the bogies, as this may damage the secondary spring mountings.

