Brassmasters Scale Models

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Chassis Kit for

Bachmann LMS Ivatt 2MT 2-6-0

Locomotive and Tender

For EM and P4 Gauges only

Instructions

1) Introduction

a. This chassis kit uses the same basic techniques for the loco and tender springing as our EasiChas kits, which are based on the original concept devised by John Brighton, having been specifically designed to allow easy conversion to a fully sprung locomotive in EM or P4.

b. IMPORTANT, PLEASE READ - This chassis kit is a little more difficult than our EasiChas as the Bachmann brake gear cannot be re-used on the loco or tender. The replacement needs to be soldered which means an ability to solder is required. For those who want a more detailed model, the kit also includes full replacement cylinders and valve gear, and for those that want a complete replacement set of frames and not re-use the Bachmann chassis block, there is a full set of frame spacers to enable this.

c. The Ivatt 2MT has three 5' 0" 15 spoke driving wheels and one 3' 0" 9-spoke leading wheel, the tender has three 3' 6" 10-spoke wheels. Wheels are available from Alan Gibson (EM and P4), Markits (EM) and Ultrascale (EM and P4). Our test build has been built using Alan Gibson wheels on 1/8" axles as follows: part numbers 4860 (4S60 for P4), 4836ST (4S36ST for P4) and 4842ST (4S42ST for P4). Also needed are crankpins, short crankpin bushes (6), and long crankpin bushes (2).

d. Unfortunately, it is not possible to re-use the Bachmann locomotive pick-ups on this EasiChas. A suggested method for making pick-ups for the loco has been given, which has worked very successfully on the test build, although there are many other methods which the builder may prefer to use

2) General Notes

a. There are two etches for the chassis containing parts for both locomotive and tender. There are also four smaller etches, one each for the pony truck, the fall plates, the cab doors and supplementary parts, the latter for items missed off, or replacements for parts, on other etches. Numbers shown in square brackets [ ] in the instructions refer to the etch. The part number appears on the etch diagram at the end of these instructions. Certain parts, e.g. bolts, wire, springs, are not numbered.

b. Some of the parts are small and easily damaged, so do please take care. Parts should be removed from the sheets as and when needed by use of a small scalpel etc., and the tabs and etch cusp removed with a small fine-cut file.

c. Some parts (e.g. the brakes and crossheads) are designed to be held as a group by part of the surrounding etch for assembly, take care where this is noted in the instructions as removing the individual parts from the etch before assembly can make assembly more difficult.

d. All folds and bends are made with the half-etched line on the inside unless otherwise stated.

3) Before you start

a. Tools Required

A selection of cross head and flat blade miniature screwdrivers
Small pliers
Small plastic bags and labels to identify parts and screws when dismantling
Small files
Soldering iron
A steel rule or set of bending bars to help with the long bends
Back to Back wheel gauge
For wheels without automatic quartering, e.g. Alan Gibson, the use of a GW wheel press and quartering tool is recommended.
A set of taper broaches to enlarge any etched holes as required
A variety of drill bits and a pin vice
Plastic solvent, superglue and epoxy resin (24 hour and 5 minute)

b. In all cases, bag and label all small parts and source of screws as soon as removed (they are all different) -trust us on this one!

4) Ivatt 2MT Prototype Notes and the Bachmann models

The later engines built at Darlington and Swindon had a number of noticeable differences from the earlier batches built at Crewe. Bachmann have modelled some of the variants but close examination of a photograph of the chosen prototype is needed to check the details described below, particularly the pony truck and tender footsteps and ladders.

A full description of the class is in the Irwell Press Book of the Ivatt Class 2-6-0s. Go to www.Rail-Online.co.uk for over 350 photographs of the class.

Nos.	Built at	Region
6400-6409	Crewe	LMS
6410-6419	Crewe	LMS
46420-46434	Crewe	LMR
46435-46449	Crewe	LMR
46450-46459	Crewe	LMR
46460-46464	Crewe	ScR
46465-46482	Darlington	ER/NER
46483-46502	Darlington	NER
46503-46527	Swindon	WR

Boiler and smokebox

Apart from a stovepipe chimney on 46424 for a short time, three chimney styles were eventually used on the class. The second type was taller and thinner than the original type on 6400-46464 and was used on the first 25 Darlington built engines from new, 46465 to 46490. The third chimney was basically a taller version of the original and was fitted, at building, to all those from 46491 onwards and as a modification on those up to 46464; this last variant also appeared later, on some of the engines built with tall thin chimneys.

46503-46527, had ejectors with GWR pattern control valves fitted to the tops of the ejector bodies and an additional short exhaust pipe to the smokebox.

Cab

Draught screens were fitted between the two windows from 46420 onwards, but they were not retro-fitted to 46400-19. The injectors on the first twenty engines were horizontally mounted under the cab but from 46420 onwards they were positioned vertically; 46400-46419 were not modified.

Guard irons

6400-46464 had prominent guard irons attached to the front frames. On 46465 onwards, smaller guard irons were instead fixed to the pony truck. Some of the early engines were modified to this pattern during overhaul at Darlington; those confirmed are 46400, 46409, 46413, 46438, 46450, 46451, 46453, 46460, 46461 and 46463.

Lamp brackets

46503-46527 had GWR pattern lamp brackets instead of the LMS type on the earlier engines. The angle iron over which the lamp dropped was turned at 90° compared with the LMS version. Also, from late-1963 the upper lamp bracket was, for safety reasons when working under overhead live wires, moved down to the right of the central door fastening. The central lamp bracket above the bufferbeam was also moved to the right to remain directly underneath it. This only applied to a few engines.

ATC and AWS

46503-46527, were built with GWR pattern ATC – the only visible external evidence of this was the rectangular battery box below the left-hand platform immediately in front of the cab. The BR version was fitted to at least 17 North Eastern Region engines at Darlington in early 1961; another eight were dealt with at Crewe for LMR based engines, but not until 1963. The receiver was mounted between the pony truck frames and therefore did not a protection guard attached to the buffer beam. The cylindrical vacuum and timing reservoirs were on the left-hand platform immediately in front of the cab and the rectangular battery box was in the corresponding position on the left-hand side.

Tenders

Over the course of the various batches there were a number of minor variations. The tender cab floor mounting was changed, probably for safety reasons, from a vertical edge inset above the top footstep on the first twenty tenders, built with 6400-6419, to a 'waisted-in' shape on all subsequent engines.

The tenders built at Crewe for 6400-46464 had a long ladder on the rear of the tank which reached to the bottom of the frames, and no vertical grab rail. The ladders were shortened to platform level on the Darlington and Swindon built tenders paired with engines 46465-46527 and a vertical handrail was added to the rear end of the tank sides with footsteps on the frame below it.

Tender Nos.		Date		Built	Engine Nos.		Cab floorplate	Ladder	Rear steps and vertical handrail
7000	7019	Dec-46	Mar-47	Crewe	6400	6419	Rectangular foothold	Long	No
7020	7064	Nov-48	Jun-50	Crewe	46420	46464	Curved foothold		
7065	7102	Jun-51	Mar-52	Darlington	46465	46502		Short	Yes
7103	7127	Nov-52	Mar-53	Swindon	46503	46527			

The step at the front end of the frames was a rather lightweight fabricated construction. The LMR replaced these with a more substantial wider and deeper type but this was not done on the tenders operated by other Regions.

5) **EasiChas Options**

The EasiChas can be assembled in various ways to suit the builder.

- Simplest conversion re-using Bachmann motor, gear tower, cylinders and valve gear.
- Etched cylinders and valve gear are provided for those that wish to improve on the Bachmann originals.
- A set of frame spacers is included for those that wish to build the chassis without re-using the Bachmann chassis block. This allows the replacement of the Bachmann motor and gear tower with motor and 'Roadrunner' gearbox from High Level Kits. It also allows the builder to fill in the front of the Belpaire firebox and reduce the backhead intrusion into the cab.

6) Dismantling the Locomotive

a. Unplug the plastic plugs connecting the cables from the locomotive to the tender. This cabling will be used in future so be careful not to deform it.

b. Unscrew the bolt on the locomotive which holds the locomotive to the tender drawbar, this is a special bolt which is wasted so be extra careful not to lose this one. The body is retained onto the chassis by two screws, one central at the front and the other at the rear just in front of the drawbar screw (this is partially hidden by wiring and the brake gear pull crank).

c. Before removing the keeper plate, it is best to disconnect the valve gear from the centre axle. The hexagonal bolt on the return crank should be unscrewed which will disconnect the return crank and allow the connecting rod to be removed from the crankpin.

d. Unscrew the front and 2 middle Philips screws in the plastic keeper plate.

e. Pull the chassis block down from the front (there is a tab at the rear which holds it in place).

f. The Bachmann valve gear and cylinders can be removed in one piece from the top of the chassis block (they clip into the reverser 'lifting' cranks). Keep everything safe even if you intend to make up the replacement etch valve gear as they can be a useful reference.

g. The keeper plate should come away from the main chassis block. While the wheels and coupling rods are not required the final drive gear is needed. Remove the wire which represents the sanding gear.

h. Pull the wheels off the axle with centre gear and place in a vice such that the gear wheel is supported on the vice sides but the axle is loose, tap the axle with a small hammer or similar and the gear wheel will slide off the axle. If you do not have a vice use a pair of pliers on one side of the gear wheel, gently slide the plastic gear

down and off the axle by holding the axle vertical and pressing down. It is very important not to damage this gear.

i. Remove the Bachmann motor and gearbox from the chassis block. To do this gentle pry the motor from its mounts and the front and rear then remove the two Philips screws which hold the plastic mount to the block. Push the motor back into its mounts once removed.

j. You will now have a box of bits and an invalid Bachmann guarantee!

7) Modifications to the Bachmann chassis block

If it is the intention to retain the Bachmann motor and gear tower, then a little modification is required to the Bachmann chassis block.

a. There are two options for the lifting arms that are part of the chassis block. The lifting arms stick out each side of the chassis block and can be left on the block but will require a slot to be cut in the EasiChas frames etch to give the necessary clearance. However, etched replacements are included as part of the valve gear and can be added later (see section 42). If this option is chosen then the supports for the reversing lifting arm will need to be removed.

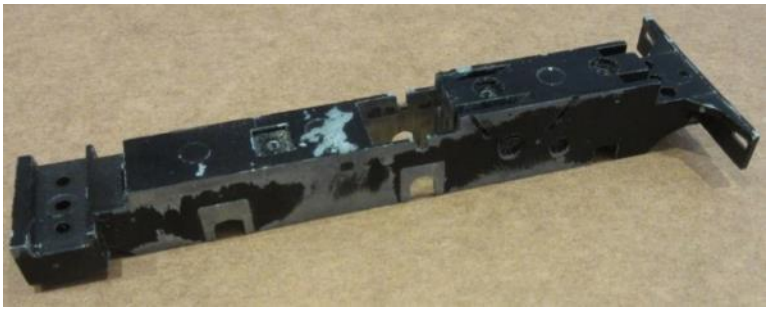
b. The four triangular supports for the footplate need to be removed. There are replacement parts on the etch to replace them later. These parts should pull out relatively easily by pulling with a pair of pliers.

c. The cast injector just in front of the rear buffer beam needs to be removed.

d. The chassis block has three slots which the original 3mm driving axles run in. The central slot was a little deeper to give some limited movement. As these slots will not have any purpose in aligning the axles in the EasiChas it is recommended to widen them slightly with a file so that they will not interfere with the axles once they are assembled.

e. The gear tower slot in the centre of the block needs to be enlarged slightly to allow for the additional thickness of the etch. This can be done by removing the various ribs from the sides and making the sides smooth.

f. The photograph shows what to remove.



8) Preparing the wheels

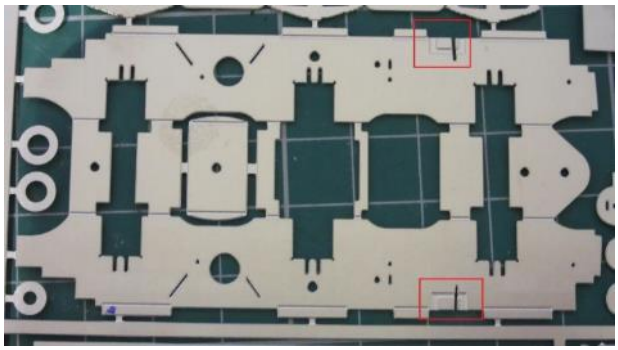
a. The Alan Gibson 5'0” wheels appear to be some of those which come with the crank pin hole pre-drilled. However, you may find that the crankpin hole needs to be drilled out using a 0.65mm drill. The hole must be perpendicular to the wheel. The Gibson wheels have quite a large boss on the rear which fouls the head of the crank pin bolt, ensure that you cut away a section of this boss around the crankpin hole otherwise the countersink of the crankpin will tend to twist it 'off true' when it hits the boss.

b. The following will prevent problems with loose crankpins. Countersink the rear of the crankpin screw holes using a 3mm drill and half screw the 12BA screws home. Using 24-hour epoxy smear the remaining thread and screw the 12BA screws home. Smear a little epoxy over the head for additional security but there should not be a big blob that will catch on wheel rotation. Leave in a warm place for 24 hours to set. This will retain the screws and stop them from rotating.

9) Basic Locomotive conversion

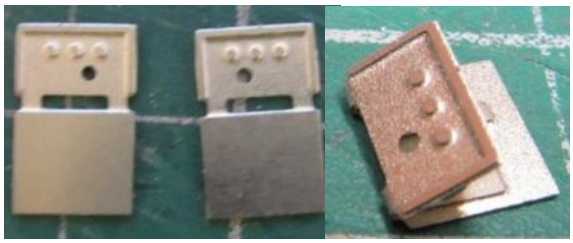
a. Remove the main frame [L1] from the etch. Clean up the residual tabs with a small file. Remove the pony truck rubbing plate [P7] from the centre of the part and put away safely for use later.

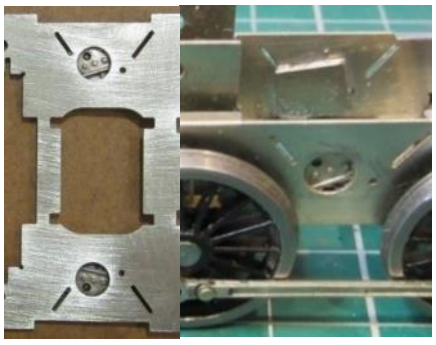
b. If you are retaining the Bachmann cylinders and valve gear then the area marked by the half-etched line needs to be



removed from either side (see photo).

c. Locate and remove the ashpan details [L2] from the etch. Fold these back on themselves and attach on the inside of the frames, using solder or glue, ensuring that the angle of the ash-pan slopes down towards the front of the locomotive (see photos).





d. Fold up the main frames using bending bars or a pair of steel rules to produce a 'U'-shape, all the half etched lines are on the inside of the bend. Strengthen the bend with a bead of solder.

e. Fold the tops of the frames inwards by 90 degrees to provide a spacer between the new frames and the Bachmann chassis block.

f. Enlarge the holes for the mounting screws slightly with a broach until the Bachmann screws are a comfortable fit. The finished component should look like this.

g. Check the fit of the brass bearings into the slots in the mainframes. If tight, using a smooth sharp file lightly file away the cusp equally on both of the edges of the slots until the bearing slides up and down with no binding. It is very important that too much metal is not removed resulting in a sloppy fit – no side play whatsoever is the aim, just a smooth sliding fit.

10) Bachmann motor and gearbox conversion

a. If you are building the chassis without using the Bachmann chassis block and motor then now is the time to install the additional frame spacers in between the frames. See Section 50

b. If you are using the original Bachmann motor and gear tower remove the gear tower [L3] from the etch. Test fit a pair of 1/8" top hat bearings to the large bottom holes, enlarging the hole slightly with a broach or file to fit. Fold the etch into a square 'U'-shape. Solder the top hat bearings in place with the top of the top hat on the inside ensuring that a 1/8th" axle runs smoothly through them, ideally use a 1/8" reamer to ensure the bearings are smooth. File the excess bearing flush with the outside of the gear tower. The etch cusp on the new gearbox will also need removing.
The etch should fit around the Bachmann gear tower and the top two pairs of holes align with the rods which form the axles for the two intermediate gears.

c. The axle which supports the top-most gear should be replaced with a length of 1.4mm nickel silver rod 9mm long. This axle then fits into the holes in the etch and ties the etch to the original gear tower ensuring that the gear on the locomotive axle is held in mesh. The original axle for the centre idler is re-used and does not extend into the etched gearbox. Ensure that the gear tower, surrounded by the etched part will slide easily through the hole in the centre of the Bachmann chassis block – remember that it needs to move completely freely as the sprung hornblocks move up and down (and twist slightly over track bumps).

11) Chassis keeper plate

a. Remove the Chassis keeper plate [L4] from the etch. Clean up the residual tabs with a small file.

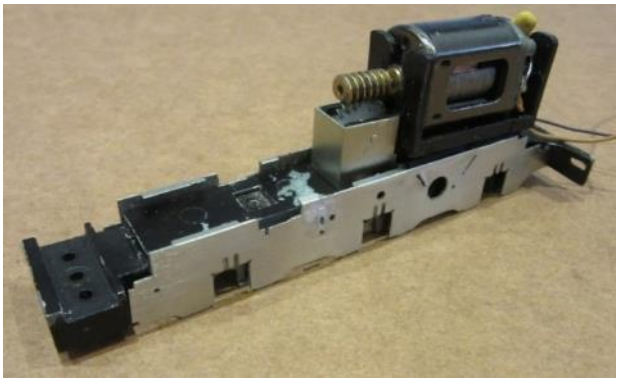
b. Fold down the cosmetic springs and strengthen the bend with a bead of solder.

c. Test fit the keeper plate into the bottom of the main frames. You may need to file away some of the solder bead to get a good fit. Note that the keeper plate is not symmetrical, ensure that you aren't trying to force it in the wrong way around.

12) Chassis assembly

IMPORTANT - Carefully examine the bearings as they are not symmetrical - the flange on one side of the slot is wider than the other side. For EM gauge, the bearings need to be mounted in the frames with the thicker flange towards the centre of the frames. For P4 gauge, the bearings need to be mounted with the thinner flange towards the centre of the frames. Increased side-play on the middle wheels can be obtained by having the thin side of the bearings on the outside or rubbing off the circular beading round the axle hole. For EM gauge, it will be necessary to file off the raised rim on the inside face of the bearings to ensure the bearings move up and down freely.

a. If you are using the Bachmann motor and chassis block now is the time to test fit the mainframes to Bachmann chassis, place the bearings in the slots and check for easy movement.
Check your axles are a smooth fit in the bearings, if tight ream them out to 1/8" using a reamer or, if you do not have one, a small round file, a precision drill or a broach). Then place each axle through the axleboxes and through the “slots” in the Bachmann chassis block. If the axles catch the side of the chassis block, file away the offending part of the block.



b. The recovered gear wheel from the Bachmann chassis needs drilling or reaming out from 3mm to 1/8” (it needs to be tight but not over-tight on the 1/8” axle. Open it out be using a slightly larger drill each time until the required size is reached (if too tight it will split in a couple of years’ time!).

c. If you are using Alan Gibson wheels you may find the axles are slightly over length for P4. They need to be approximately 22.6 mm long. Take the axles and file the sharp edges off the end to a rounded profile. Use a drill bit of around 5mm diameter to chamfer the rear of each wheel axle hole. These two actions help the axle to ‘centre’ in the wheel when they are pressed on.

d. To assemble the driving axle is quite involved. First assemble one wheel on the axle, making sure it is on square, then add a bearing ensuring it is the correct way round. The axle then needs to go through one side of the gear tower, through the plastic gear wheel, through the other side of the gear tower. Ensure the axle is central in the gear tower and the gear wheel is offset to match the Bachmann gear train (it may be advisable to lightly roughen the surface of the axle where the gear will sit to give a little extra friction to stop the gear revolving on the axle). Then add the second bearing again ensuring it is the correct way round, before finally adding the second wheel loosely.

e. The gearing meshing is quite course and there is a fair amount of allowance in the mesh.

f. Mount one wheel on the remaining two axles then add the bearings on all axles the correct way round, adding any spacing washers required (there will be about 0.6mm lateral movement on an axle with no washers in 18.83

gauge –so not many washers are required). For both EM and P4 we suggest one full washer on each side of the leading and trailing wheels. Finally, add the second wheel loosely to each axle.

g. For final assembly and quartering use of a GW wheel press/quartering tool is highly recommended if you are using Gibson or other wheels which require manual quartering.
Note - When quartering the centre axle DO NOT FORGET to ensure your gearbox/gear tower and gear on the axle and get it the correct way round (open end at rear)!

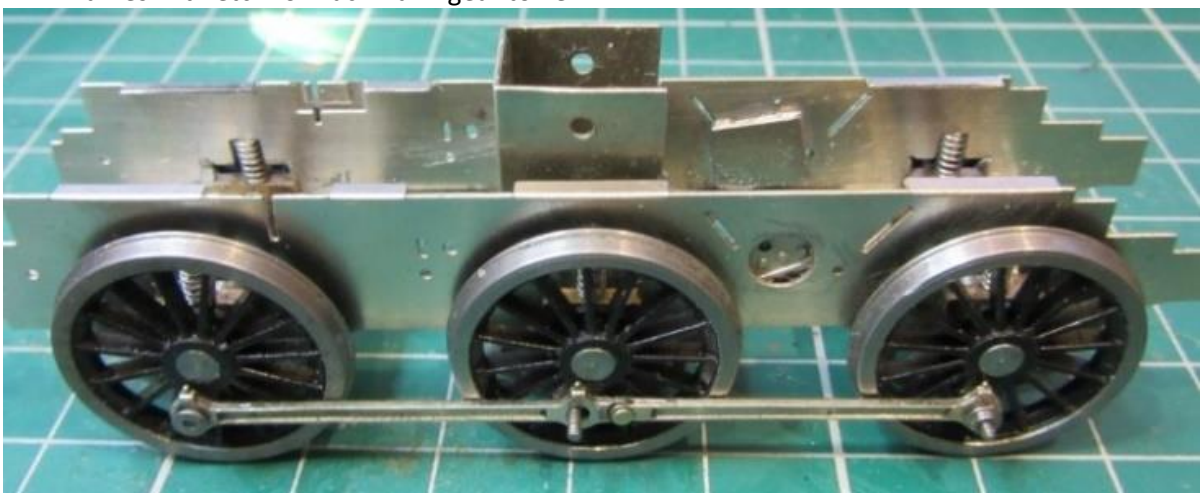
h. Press the wheels home with a back-to-back gauge between the wheels. This gauge should be an interference fit between the wheel backs with no 'slop'. Ensure this is so by turning each wheel through 90 degrees to check for wobble, and, if present, twist the wheel. Quarter the wheels with the right hand wheel leading the left hand wheel by 90 degrees when travelling forwards. For those without a quartering tool, we do this by setting the driven axle first so a wheel spoke is horizontal on one side and vertical at the other, then each other wheelset fitted is lined up with the horizontal spoke, the chassis turned over very carefully, and the spoke on the other side lined up by eye against those on the driven axle.

i. Place the bearing springs over the tongues on the frames (a small dab of grease on the spring will keep it in place). Fit the wheelsets into the main frames and attach the keep plate. Check that the motor turns the centre wheelset with no sign of any binding by gently rotating the motor. You can try applying power to the motor by temporarily connecting the cable to the tender and feeding power from the tender wheels. Check the wheels spring freely with no binding and test fit to the locomotive body. Remove the etched frames from the Bachmann chassis block when happy as it is easier to fit the rods and check the quartering the frames disconnected from the motor drive. The Bachmann gear tower can be split from the motor by pushing through the top gear axle and gently prising out the plastic motor/gear train assembly.

13) Coupling rods

a. If the original Bachmann coupling rods are to be re-used, then press a coupling rod bush into each of the holes. If they are loose, then a touch of solder or glue will hold them in place

Frames with etch for Bachmann gear tower b.



c. Once happy that the chassis rolls smoothly, the Bachmann chassis block can be reinstalled and fastened using the front and rear bolts. At this point the motor and Bachmann gear tower can be added back into the etched gear tower. If you plug the unconverted tender into the locomotive using the original Bachmann cabling you can power the chassis from the tender to test, though obviously the tender will still be OO so you might need to be creative with the track/rolling road.

14) Footplate and boiler modifications

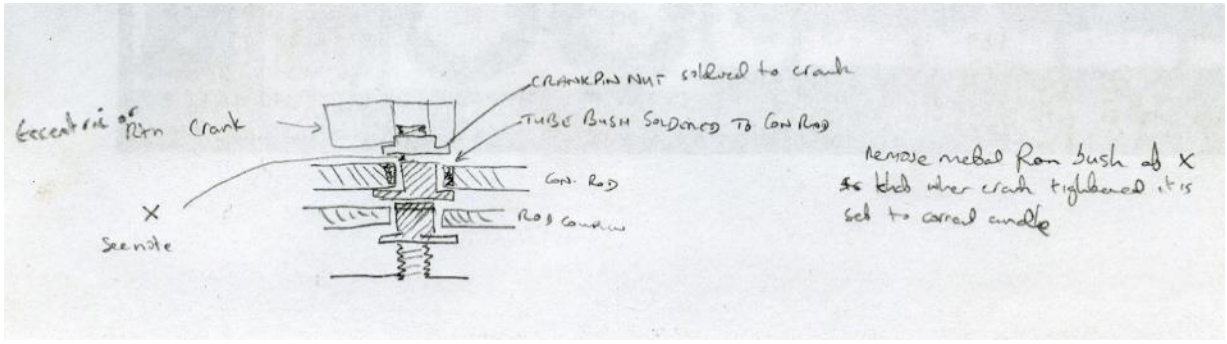
a. If using the Bachmann gear tower the slot in the footplate and the bottom of the boiler will need to be slightly widened to accommodate the additional width of the etched sides. This can be done simply with a small file. Remember that for the driven axle central springing to work effectively the gearbox/motor needs to move

freely in the Mazak chassis and loco body (the Bachmann motor is designed to be a tight plug-in fit). Therefore, the plastic motor cradle needs thinning by at least 0.5mm on both the sides and ends (it is wider that the motor itself). This is best done with the motor removed using a course file. We also removed the screw lugs on the bottom of the motor cradle.

15) **Re-using the original Bachmann valve gear and cylinders.**

a. If you are re-using the original Bachmann cylinders and valve gear then a slot needs to be cut in the EasiChas frames to accommodate the motion bracket. (see section 9b). There is a half-etched outline on the inside of the frames. It is not critical to get an exact fit because the motion bracket is held securely onto the Bachmann chassis block.

b. Fit a coupling rod bush into the large hole at the end of the Bachmann connecting rod. The Bachmann eccentric crank (also called return crank) has small pips inside it – remove these with a round file and solder in place from the rear onto a Gibson crankpin nut. This now can be screwed onto the Gibson 14BA crankpin. The relative angle is controlled by the amount of bush length is available on the crankpin See drawing below.



c. Re-assembling the Bachmann valve gear is fiddly and a time-consuming exercise but must be done with care to ensure a free running chassis. We use standard short length Gibson crankpin bushes on the front, middle and rear wheels for the rods, plus a long one additionally on the centre crankpin for the connecting rod and return crank, shortening as necessary, a little at a time, until the correct angle is achieved when the return crank is tightened fully 'home'. It is essential that the coupling rod and connecting rod are not pinched 'tight' during this process and are free to rotate.

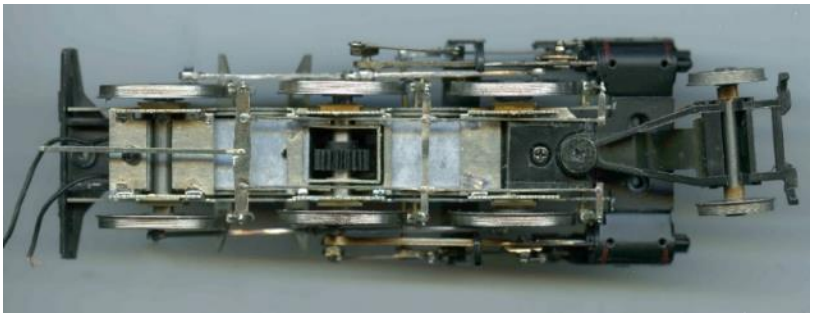
d. The front crankpin nut has to have sufficient clearance behind the crosshead, but there is sufficient space if a nut recessed into the front overlay of the rods is used.

e. On the prototype the front of the Return Crank has a plate with four bolts, this can be represented by filing down and using the etched part [L38]. Build and fit the Lifting arm as per section 26 because the Bachmann one cannot be re-used.

16) **Re-using the original Bachmann pony truck**

a. It is possible to re-use the Bachmann pony truck and springing arrangement, or a new Brassmasters pony truck can be fitted (see section 26). If re-using the Bachmann one, then cut the plastic keeper plate as in the picture (shown with the spring fitted). This can then be attached to the chassis with the appropriate screw retaining both the etched keeper plate and the plastic one. The pony truck can then be attached with its original Bachmann special screw.

b. Note - when the brake gear is fitted it will be necessary to cut the front brake cross rod as shown in the photo to clear the pony truck.



17) **Footplate bracket**

The footplate brackets fit into the diagonal slots between the middle and rear axles. There are two different heights, the slightly taller ones [L5] fit in the rear slot, the shorter ones [L6] fit in the front slot.

18) **Brakes**

a. It is not possible to use the original Bachmann brake gear so new brake blocks, hangers and linkage are provided on the etch. The brake components are mounted together and should be removed from the fret as a single unit. This makes folding and locating the parts together easier.

b. Locate and remove the locomotive brake hanger assemblies [L7 and L8] from the etch, there are eight of these, you need six, two are spares available as offerings to the carpet monster. The brake assemblies are 'handed', four are available for each side of the locomotive. Ensure that you can get a piece of 0.6mm wire through the central holes of the brake block and hanger and a 0.8mm piece of wire through the top hole, doing this while the component is still flat. It is easiest to do this using either a drill or small broach.

c. For each set, bend the etch in a 'Z'-shape using the half etch lines on the frame on the outside of the bend. Then flatten between the jaws of a small pair of pliers (use a set with smooth not serrated jaws as these could mark the metal). This will align the three components over each other for soldering. You can tweak the position if necessary.

d. Thread a length of 0.6mm brass wire through the hole in the brake block, this will align the components together and form the bolt detail on the brake block. Cut this roughly off so it doesn't get in the way while soldering.

e. Apply some flux and solder from the curved face of the brake block, this will run in between the components and join them securely.

f. Remove the assembled brake from the surrounding etch with a sharp scalpel. Don't worry if the diagonal tabs on the rear brake don't come off too cleanly, they are totally hidden when on the locomotive or a small file will remove them.

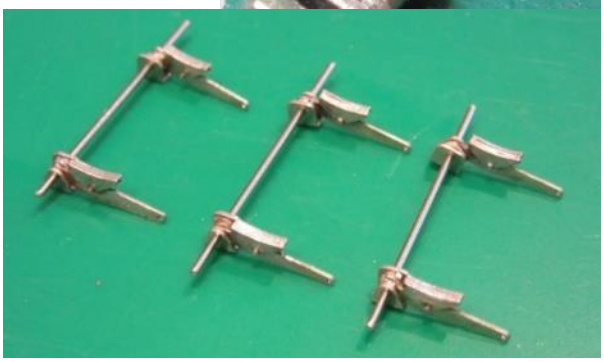
g. Lightly run a small file around the hanger to remove the cusp and use a half-round file smooth the surface of the brake block where the three thicknesses of brass are laminated. If you slightly slant the file back from the front of the brake block you can give slightly more clearance between the rear of the block and the wheel tread which will help prevent any short circuits once the brakes are mounted on the chassis.

h. Locate the brake hanger brackets [L9] on the etch. Whilst the components are still on the main etch, open out the holes to 0.8mm using either a drill or small broach.

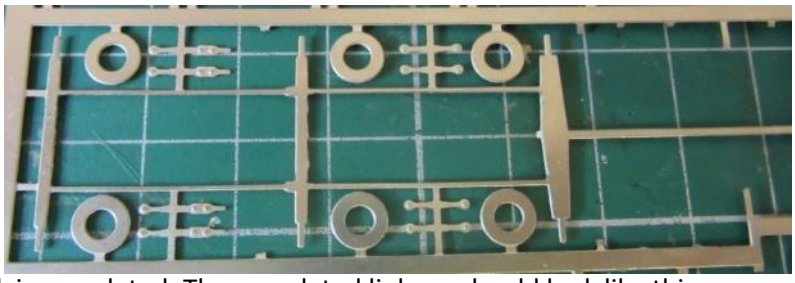
i. Fold the larger end into a ‘U’-shape, ensuring that the sides are parallel and perpendicular to the end. The U needs to fit the thickness of an etch so you can fold the part around a piece of scrap etch. Bend the smaller end into a ‘U’ shape along the bend lines.. Once folded back on itself the completed part should look like this. Fit a length of 0.8mm wire through the holes to ensure all is aligned.

j. Remove the wire, apply a small quantity of solder to the part and then clean out the hole again to fit the 0.8mm wire. Feed a length of wire through the part and use this to hold it while you remove the cusps and any rough spots where the etch tabs joined.

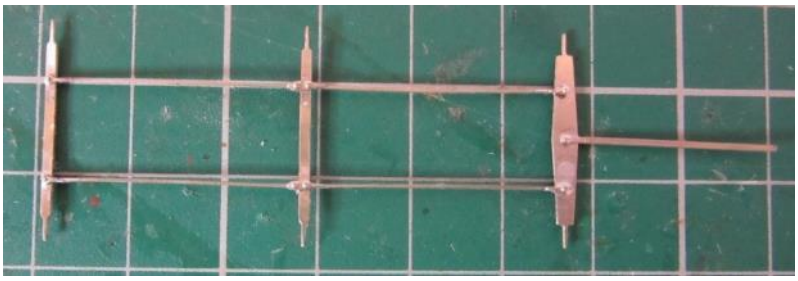
k. Repeat this process six times until you have a complete set of brake blocks and hangers which can slide onto a length of 0.8mm wire. Ensure that you have three of each hand brake block. Do not solder to the rod.



l. The brake pull linkage [L10] comes with matching half-etched linkage details [L11, L12, L13, L14] which need to be applied to the top and bottom of the main etch. It is easiest to tin the parts BEFORE removing from the main etch and to leave the pull rod itself attached to the main etch while this work is completed. The completed linkage should look like this photograph.



m. The ends of the brake cross members are over-long at this stage and need to be filed down and rounded so that they can poke through the holes in the bottom of the brake assemblies. The holes in the brake hangers can also be enlarged slightly with a broach if necessary.



n. The brake gear is made up in a single unit with the tops of the brake rods springing into holes in the chassis.

o. With the Bachmann chassis block removed from the frames temporarily bolt the keeper plate to the chassis. Thread a 30mm length of 0.8mm wire through the hole in the frames. Thread a brake hanger and brake assembly onto each end and then thread the ends of the brake pull linkage into the lower end of the brake assembly. The completed assembly should be able to be positioned so that the brake blocks are just clear of the wheel rims. Small pieces of wire insulation can be useful to stop these parts falling off prior to soldering.

p. Solder the brake hanger brackets and brake hangers to the 0.8mm wire. Do not allow the solder to join the brake hanger brackets to the side frames as we want these to be removable.

q. Solder the bottom of the brake hangers to brake cross members. Avoid getting flux splashes on to the tyres of the wheels with a small strip of paper. Once happy with the position cut the central section of the 0.8mm wire away between the frames with a saw for the first cut, leaving about 0.5mm to protrude through the frame. This will allow the whole unit to be sprung off the chassis so that the wheels can be removed.

r. Fold up the bracket which forms the rear linkage to the brake pull rod [L15]. Fold the part up and then thread the two linkage pieces [L16] in to the centre using a short length of 0.45mm Nickel-Silver wire.

s. The completed assembly can be located with the chassis mounting bolt and soldered to the rear chassis spacer.

t. Test fit the chassis on the footplate. The end of the brake pull rod can just be located between the pull linkage so that it stays in place but can be removed should you need to remove the brake pull rods and wheels. The brake hangers will be hard up against the footplate, file and adjust as necessary.

19) **Balance weights**

a. There are two sizes of balance weights. The larger two [L17] go on the centre wheels, and the smaller ones [L18] go on the leading and trailing wheels. Referring to photos of the loco determine where the balance weights are attached relative to the crank pins. Remember the position on the wheels is a mirror image of the other side. Attach the balance weights to the wheels using epoxy resin or super glue.

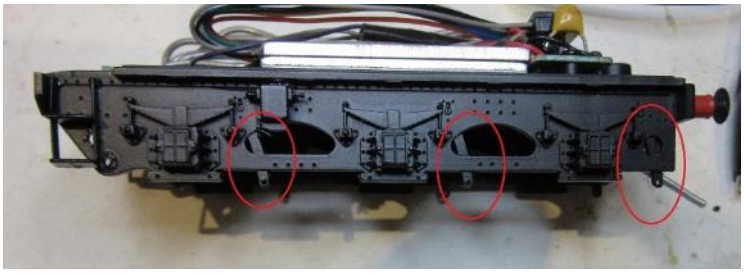
20) **Pick-Ups**

Fitting pickups on the locomotive is optional as you can get adequate pickup from the tender wheels only. However, it is relatively straight-forward to add them to the rear two axles. The recommended method is to stick a short length of copper clad paxolin (PCB) to the bottom of the etched keeper plate. Short lengths of phosphor-bronze wire can then be soldered on and bend to contact the wheels. The power can be fed into the original chassis by either soldering to or springing a wire against the original Hornby power connection plate.

21) Modifications to the Bachmann tender chassis

a. Remove the tension lock coupling and remove the screws that hold the rear tension lock coupling block in place, remove the fixing block. This reveals the body retaining screw (in a recessed hole). The front of the tender body is retained on two clips protruding through the tender floor – releasing these with a fine screwdriver allows the body to be removed. The wheels can be taken out by springing apart the plastic side frames.

b. On the main plastic chassis remove the water scoop and the four lugs for the securing screws. The bottom of the tender should be totally flat except for the front lug for the coupling pin (This can be achieved using a burr in a mini-drill).

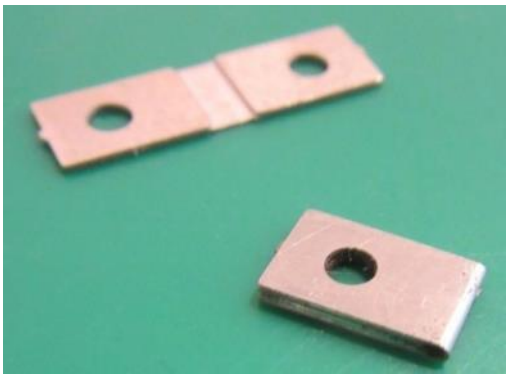


c. Remove the cosmetic representation of the tender brakes and brake hangers with a scalpel.

22) **Main tender chassis etch**

a. Locate the main chassis etch [T1]. Bend the etch into a U shape along the bend lines closest to the middle. Then, with the fold lines to the outside of the bend, fold the sides back on each other to the inside of the completed frames. Fold out, to 90 degrees, the eight small supports with the holes on the sides for the CSB springing, as shown in the photograph. Solder the side frames together for added strength.

b. Gently file the sides of the horn-guides slots to remove the cusp on the etch so that a 2mm axle can run smoothly up and down the guide. In the photo the front of the tender frame is to the right.



c. Locate the bearing etches [T2]. There are seven of these so there is one spare available. Open out the holes to clear a 2mm axle. Fold the bearings over with the half etch side on the inside of the bend. Start the fold using a piece of spare etch so that the bend is centred in the middle of the half etched section. When the bend is nearly complete, insert an axle through the holes to make sure they align.

d. Once folded, squeeze them together at the open end with a pair of parallel pliers or in a vice, then run some solder into the joint from the non-folded end. Just use a little solder and ensure that the folded slot at the top of the bearing remains clear of solder as the spring wire passed through this fold.

e. Fit the wheels through the bearings, setting the back-to-back

f. Thread the 12 thou spring wire through the lower hole of the supports on the chassis and through the bearings. The higher hole might be useful if you are fitting a particularly heavy loudspeaker in the tender.

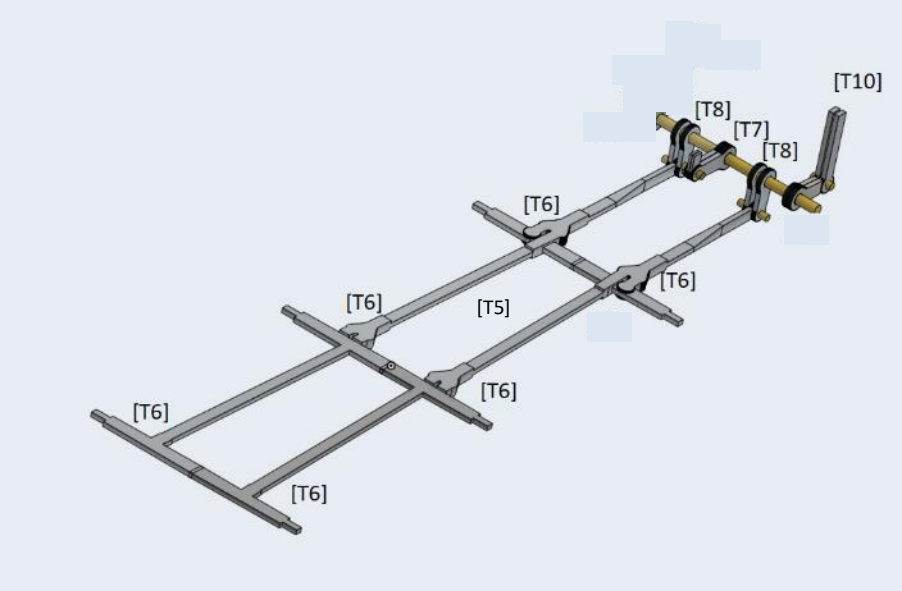
g. Locate the tender brake hanger assemblies [T3 and T4]. These should be folded and soldered in exactly the same way as the locomotive brakes (see section 18). Once again there are a couple of spares on the etch.

h. Feed a length of 0.8mm wire through the brake hanger holes in the tender chassis. DO NOT SOLDER IN PLACE. The brake hangers need to be spaced off the sides of the tender frames by 2.5mm for P4 or 2mm for EM and this best done by inserting a short length of 1.0mm brass tube over the wire. Cut the tube to length by marking 2.0 or 2.5mm and then rolling with a heavy Stanley knife until it cuts.

i. Locate the tender brake pull rod etch [T5]. The half-etch detail parts [T6] need to be soldered on the top and bottom of the etch, as shown in the diagram, and it is much easier to complete this while the etch is still on the fret. Tin the parts first, then attach the detail parts in the same way as the locomotive brake gear.

j. Once the brake pull rods are complete, remove from the fret and slightly round the corners of the ends of the cross beams so that the ends will fit into the holes in the bottom of the brake hangers.

k. Twist the long ends of the brake pull-rods through 90 degrees.



l. Fit the rods into the brake hangers. As with the locomotive brakes, fitting with temporary pieces of wire insulation will help this process. The completed assembly should be able to be positioned so that the brake blocks are just clear of the wheel rims. Solder the brake hanger to the wire at the top and the brake beam at the bottom.

m. Cut an 40mm length of 1.0mm wire to form the brake shaft and check that it fits through the lower holes at the front of the plastic tender frames.

n. Solder together the two parts of the vacuum brake lever [T7], and make sure they fit on the brake shaft. Also make sure that all four brake pull rod levers [T8] fit on the brake shaft.

o. Solder together the two parts of the hand brake linkage [T10], make sure they fit on the brake shaft then add a piece of 0.6mm wire through the lower end.

p. With the tender chassis mounted in the plastic tender body, assemble all the brake levers on the brake shaft as per the diagram. Then mount the brake shaft in the plastic tender frames.

q. Using 0.6mm wire, place a short length of wire through the bottom of the brake pull rod lever and the ends of the brake pull rods. Solder together.

r. Position all the levers on the brake shaft, and very carefully solder them to the brake shaft. Do not let the heat build up such that it melts the plastic frames.

s. Remove the central section of the 0.8mm wire between the frames, making the first cut with a saw. This will allow the brake assembly to spring off the chassis to remove the wheels.

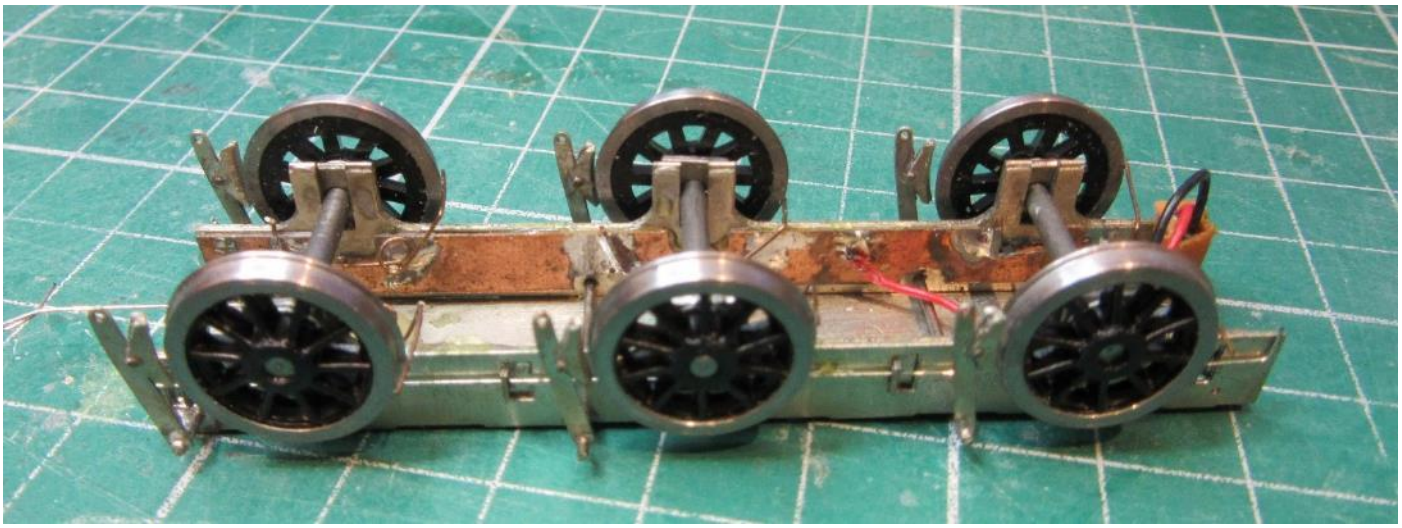
t. Locate the tender frames into the Bachmann tender and secure with the two self tapping screws.

23) Tender guard irons

Take the two tender guard irons [T12] and bend to shape so that when they are stuck to the inside of the plastic outer frames of the tender moulding the rounded ends are just above rail level.

24) Tender pickups

Pickups can be arranged to spring on the rear or sides of the wheels. With care the original Bachmann pickup strips can be re-used by gluing length of copper clad paxolin (sleeper strip or similar) to the outside of the chassis to solder the pickup strip to.



a. Alternatively the copper clad strip can be stuck to the inside of the chassis and spring wire bend up to rub on the wheel flange. The photograph shows how these fit.
b. If the locomotive is not providing pickup the wiring from the tender pickup can be connect to the locomotive wiring connector. Alternatively the wires from the pickups can be connected into the original wiring where it runs from the tender-loco connector to the DCC socket.

Final detailing

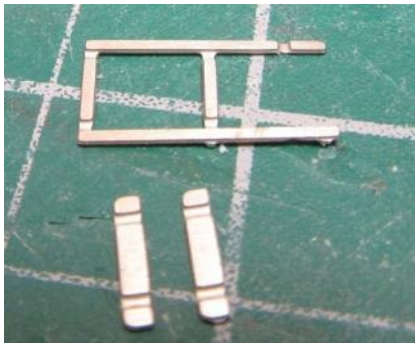
The detail on the Bachmann model is generally good. but we have included a few additional etches - frame mounted guard irons, replacement footsteps, cab doors and fall plates.

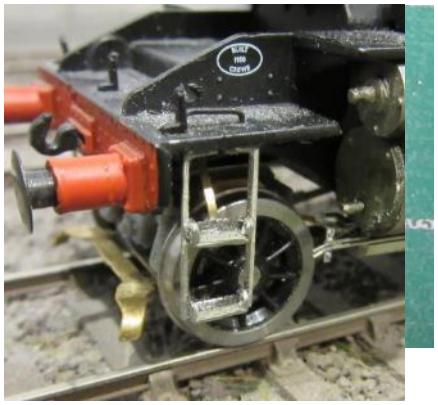
25) Frame mounted guard irons

a. Some locomotives had guard irons mounted on the frames rather than on the bogie. If your chosen loco is one of these take the guard irons [D1] and curve them in an 'S' so that, when fitted inside the front frames, the ends are over the rails. Don't forget to make them opposite hands.
b. Atach to the inside of the front frames with the straight edge towards the front using super glue or epoxy.

26) Loco and tender footsteps

a. The plastic footsteps provided for the locomotive are quite fine but if you want the additional robustness of a metal part alternatives are supplied as loco footstep frames [D2] and tender footstep frames [D3, D4] with common footstep treads [D5]. The only difference between the locomotive and tender footsteps is that the tops of the loco footstep frames bend inwards towards each other whilst the tops of the tender footstep frames both bend in the same direction (see photo of tender steps below).





b. Bend up the ends of the step treads [D5] and then fold the sides of the loco or tender step frames around them. Solder the treads in place in place and then tidy up by filing the cusps back to thin down the thickness. Make sure there is a left hand and right hand set of steps for the tender.

c. A strengthening brace, made from a narrow piece of fret, should be soldered to the middle of the back of the loco top step and the tender bottom step. The braces on both types of steps need then to be bent diagonally upwards and cut to length so they reach the loco frame or tender frame with a small bend at the end.
d. Mount the assemblies under the front footplate or tender footplate using super glue or epoxy.

27) Cab doors

a. Take the cab doors [D6 and D7]. Fold up two small 'U' shaped parts from 0.3mm wire, the width of the 'U' shape being equal to the width of the strapping on the cab doors. Fold back the strapping trapping the 'U' shaped wire. The ends of the wire should point away from the cab doors.
b. Fix the ends of the wire to the cab door fixing plate [D8] forming a hinge, aligning the top of the door with the top of the strip. Repeat for the other side. Make sure the doors move.
c. Attach the door fixing plates to the insides of the cab using super glue or epoxy, again making sure the doors move.

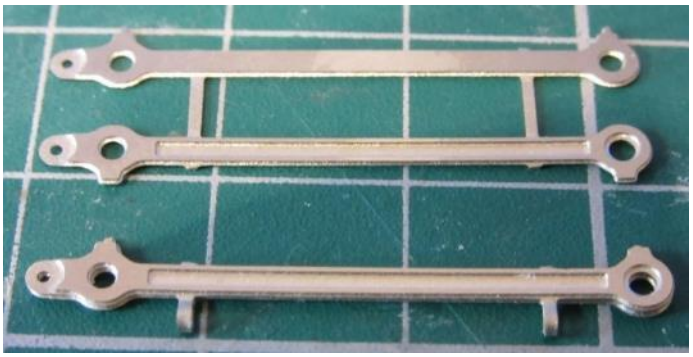
28) Cab fall plates

a. There are two ways to attach the fall plates, either fixed or hinged.
b. For the fixed version, take the two fall plates [D9, D10], bend down the fingers at the front, trim as necessary, and attach to the vertical back of the cab floor with epoxy resin or super glue level with the floor, leaving a small gap between the two plates.
c. Bend the fall plates so that they just miss the tender platform.
d. For the hinged version, cut off the fingers at the front of the fall plates.
e. Solder an 8mm length of 1.0mm tube central to the underside of the front edge of the fall plates.
f. Take 12mm length of 0.45mm wire, put it through the tube on each of the fall plates. With the wire central, bend the ends at right angles to the tube.
g. Drill 4 x 0.5mm holes line the rear edge of the cab mazak and 0.5mm down from the top edge (not the easiest job in the world). (see photo for all dimensions).
h. Check the fit of the wires in the holes, trimming the wire if necessary.
i. With a very small drop of epoxy or super glue on the ends of the wire, push the wire into the holes. Make sure the fall plates are free to move up and down.

Additional/Alternative Items

29) Replacement coupling rods

a. The replacement rods [L19-L22] are designed to be jointed in the prototypical manner, the 'tongue' and 'forks' for the joint being formed by half-etching.
One hint to aid construction is to remove the two main parts of each rod from the fret but leave the tabs in place. The rods can then be folded back on each other which means that the alignment can be set and held in place while the parts are soldered together.



b. Each rod has half-etched overlays [L23-L25] which can be fitted to the ends to make a thicker crank boss. Do not add the additional half-etch layers to the front of the leading coupling rod as it would prevent adequate clearance. It is easiest to align these parts if the rods are assembled with a suitable rod (e.g. 1.5 drill bit) is threaded through the crankpin hole. Take care not to get solder into the slotted part of the joint as it will make the pivot stiff. If you do get solder into the slot, then de-soldering wick is the ideal way to remove it! Pivot the joint with either some 0.9mm Nickel Silver wire or a small rivet.

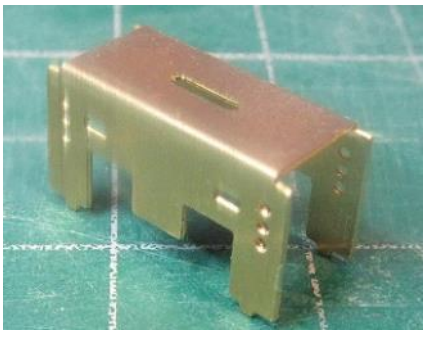
c. The front coupling rod has a larger hole etched on the outer side (the one with the fluting on it). This is designed to accommodate the smaller diameter part of an Alan Gibson crankpin nut (this front crankpin nut is reversed with the smaller diameter part on the inside to give greater clearance behind the crossheads). Check each of the crankpin holes in the rod is a good fit over your crankpin bushes. You will need to open the holes out slightly to get a good close fit. At this stage it is better to err on the 'too tight' side rather than 'too loose'.

d. Fit the crank pin bushes, rods and crankpin nuts (reversed on front axle) to the wheels. At this stage you could also use a small piece of electrical wire sleeve (this does not come unscrewed unlike a proper 14BA nut!). If your wheel quartering is correct, then you should be able to roll the resulting chassis along the bench without it binding. If it is binding check the quartering and check each crankpin in turn to see which one is stuck. If required, then slightly open up the crankpin hole in that rod. Do this carefully and a bit at a time, you can easily remove material -putting it back is a lot harder.

30) **Replacement Pony truck**

a. Remove the pony truck bottom [P1] from the etch being careful to include the two little 'arms' which form the diagonal bracing. Clean up the cusps and ensure that a 2mm axle slide feely in the slots for the axle. Bend up the sides to 90 degrees.

b. Remove and bend up the pony truck top [P2]. Then fit over the bottom part, ensuring that you have the rear (with the slots) facing the correct way.



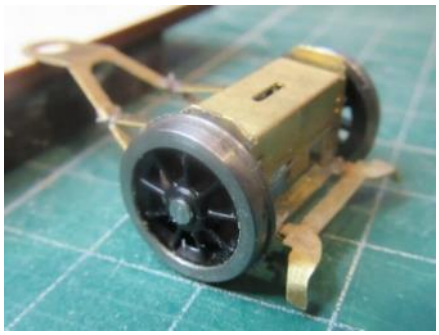
c. Fold the diagonal bracing on the bottom etch back on itself and then position so that they are aligned with the slots in the rear of the top part. Then bend the rear of the truck into place so that the part with the pivot hole ends up the same height as the top of the central rubbing plate. Solder up the sides and joints.

d. The etched horn block ‘bearings’ for the pony truck [P3] are similar to those on the tender and which fold over with the half etch on the inside of the curve. The half-etch results in a slot through the top of the hornblock forming a hole for the spring wire. Solder the two sides

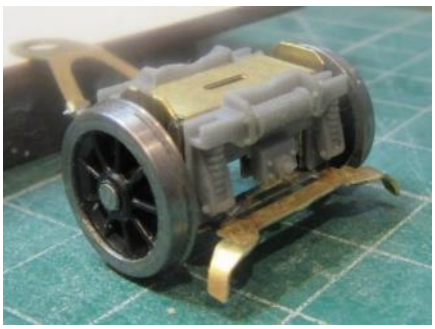
together, ensuring not to flood the gap for the wire with solder. Once soldered drill/ream out the axle hole to 2mm.

e. Feed the horn blocks into the pony truck from the rear, positioning them with a pair of tweezers. Then feed axle through one pony truck side, the horn blocks and then the other pony truck side.

f. Bend a 40mm length of 8 thou spring steel wire into a square-U shape with the width to match the distance between the holes in the pony truck (12.5mm). Then wrangle the wire through the holes in the front of the pony truck, through the slots in hornblocks and out of the holes in the rear of the pony truck. The pony truck has three pairs of holes, the lowest of which give around 3/4mm of vertical movement to the axle. Attach the pony truck wheels to the axles ensuring that you have the correct back-to-back gauge. Limit the side play using the various etched washers supplied on the etch.

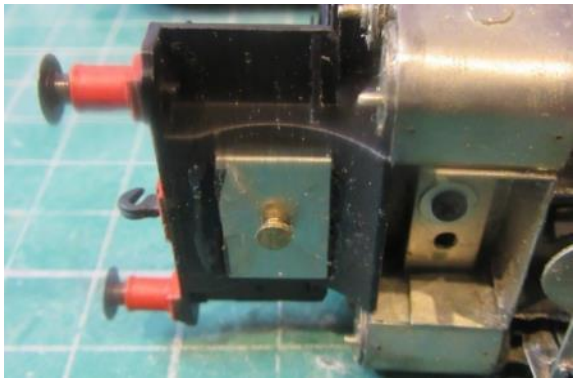


g. Depending on your prototype the guard-irons may be fitted to either the pony truck or the frames. If your prototype has them mounted on the pony truck then attach the pony truck guard irons [P4] to the two prongs on the front of the pony truck base and bend so that the ends protect, but do not touch, the wheels.

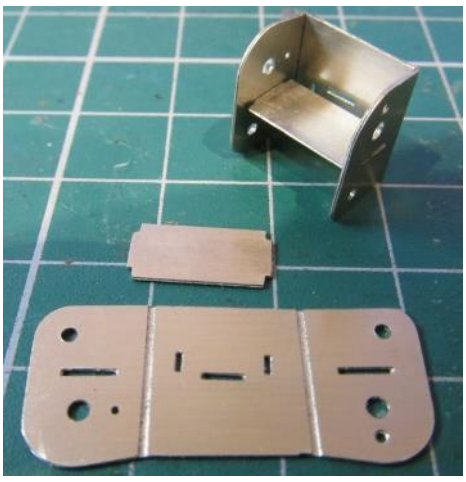


h. Two 3D printed parts are supplied for the front detail [P5] and rear detail [P6] of the pony truck. The front one has a slot in the back to fit the central section of sprung wire while the rear has holes for the ends of the wires. These should be glued in place using superglue or epoxy.

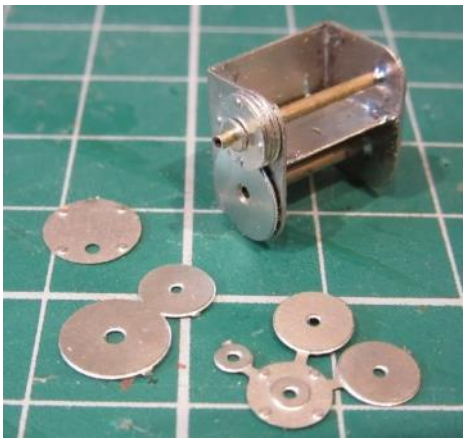
i. Fold up the pony-truck rubbing plate [P7] (which was removed from the main frames). Solder a 10 BA nut on the top and glue the plate into the curve of the Bachman footplate ensuring that it is parallel to the top of the footplate. Screw in a 10 BA bolt which then rubs onto the top of the pony truck. The bolt should be shortened to the appropriate length to support the pony truck, the thread of the bolt allowing just a little adjustment in the final height.



31) **Replacement cylinders**



a. The cylinder frames [L26, L27] and the cylinder spacers [L28] should be removed from the etch. The larger holes for the piston rods should be opened up with a broach to be a close fit on the 1.5mm tube supplied. The smaller hole for the valve rod should be opened out to be a close fit on the 1.2mm rod supplied for the valve tube. Also drill out the hole adjacent to the rear piston rod to accept a 0.5mm wire, this is use later to help align the slide bars. The frame should be folded up into a 'U' shape with the spacer inserted in the slots to hold the ends square. Don't solder at this stage as it is easier to fit the piston and cylinder tubes and then solder the lot together.



b. The piston tube is a length of 1.5mm O/D 1.0mm I/D brass tube 14mm in length. It should protrude from the rear of cylinder frame by 2mm.

c. The valve tube is 3/64” O/D 1/32” I/D brass tube, this is cut longer at 17.5mm. The valve tube should stick out of the front of the cylinder etch by 3.5mm.

d. The front of each cylinder is detailed using the cylinder and valve front [L29], the two valve front spacers [L30], the valve front overlay[L31] and the Valve Gland [L32]. These should be soldered over the protruding valve and piston rods and the visible sides filed smooth. Finally attach the cylinder front overlay [L33], and again the visible sides filed smooth.

e. A short length of 0.8mm wire should be soldered into the front of the valve tube to seal the end. this should only go into the tube by 1mm so as not to foul the valve rod later. At the bottom of the cylinder another length of 0.8mm wire should be soldered in to form the pressure relief valve.

f. The top of the valve detail should be filed flat level with the main cylinder etch in order to clear the footplate. Once completed the fronts of the cylinders should look like this.

g. The rear of the cylinder is detailed using three valve rear spacers [L34] and the valve rear overlay [L35]. The two slots in the valve rear overlay should be vertical as these align the valve rod support.

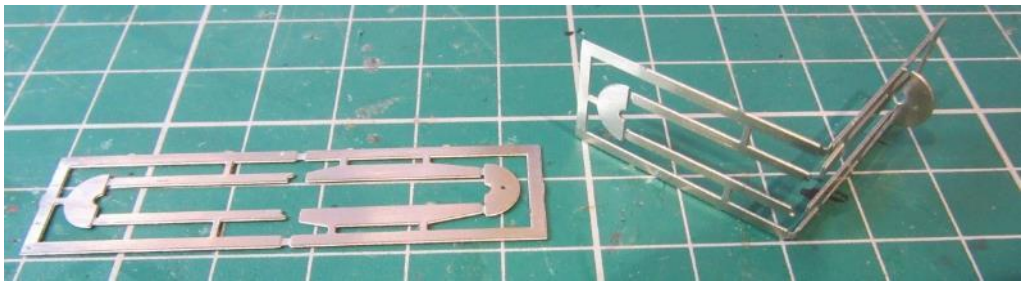
h. The valve rod support

Take the valve rod supports [L36] and bend the long 'tails' to the guide rods should folded back on themselves and soldered to form additional layer on the front of the component.

Once soldered, the part should be rolled around a rod or drill approximately 2mm in diameter to give the correct shape. The completed valve rod support should then be soldered to the rear of the piston valve. This is best aligned by wrapping some tape around a length of 0.8mm rod until the tape is a snug fit through the part, then place the rod into the valve tube and this should hold the valve rod support in place while soldering. Apply a little oil to the rod to stop it soldering into the tube. It is important that the slot in the valve rod support is in line with the valve rod itself.

32) **Slide bars**

a. The slide bars [L37] are etched in a frame to aid alignment. The frame should be removed from the etch. There is an alignment hole in the semi-circular end which does not have a tab which needs to be drilled out to 0.5mm. This end should be folded up to the frame through 90°.



b. The sides of the slide bars which are going to be folded in on each other can be tinned at this point as this will aid the next steps.

c. Fold the entire frame back on itself 180° ensuring that the two parts of the slidebars align correctly. This can be aided by pressing on the outside of the frame. Note the fold in the frame is done with the half-etched section on the outside of the bend.

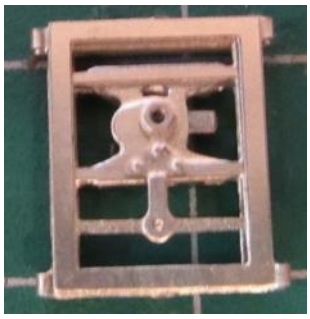
d. Solder the two thickness of etch together along the length of the slidebar.

e. Do not remove the slide bars from the etched frames at this point as the frames give additional strength to the slidebars while fitting the crossheads.

33) **Crossheads**

a. The crossheads [L38 and L39] are also etched within a frame, this one folds in a concertina to form a part with five layers of etch. Tin the surfaces of the mating pieces first and fold with the half etches in the frame on the outside of the bend.

b. Once the frame is folded together it can be manipulated with a pair of tweezers until the entire frame is square. A drill bit can also be used to ensure that the parts are aligned correctly by passing through the connecting rod bearing hole in the centre.



c. Heat the entire assembly with a soldering iron until all the solder which you applied previously melts and the unit is solid.

d. The piston rod itself is an 18mm length of 1mm nickel-silver rod. This rod is joined to the crosshead assembly by means of a 2mm length of the same 3/64" tube which formed the piston tube in the cylinders. The short length of tube can be positioned over the extend stub in the middle of the cross head and the wire fed in through the frame of the assembly. This should aid soldering the parts together. Once connected the complete crosshead can be removed from the frame with a piecing saw and the ends of the crosshead slides filed to the correct length.

e. The pivot hole for the union link in the crossheads should be opened up to 0.6mm.

34) **Fitting the crossheads to the slide bars**

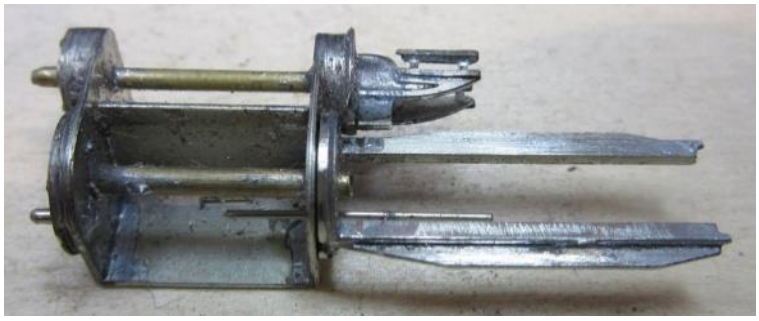
a. The next step is to ensure that the crossheads slide smoothly in the slide bars. This will require the slots in the cross heads to be clear of solder and smooth and the slide bars to be filed smooth and at the correct distance apart. Keeping the slidebars together in their frame makes this unit much stronger and easier to file.

b. Start by clearing any excess material in the crosshead slides caused by the cusp of the etch or by too much solder. A small file or even a gentle action with a piecing saw will do this. Then file the slidebar surfaces down until the crosshead is a sliding fit all the way along. This work can be done with the crosshead reversed (i.e the rod pointing away from the semi-circular ends) as a smooth fit should be accomplished in either direction.

c. Once you have achieved a smooth sliding fit the frames of the slide bars can be removed from their frame and the remaining semi-circular front can be turned through 90°.

d. The cylinder rears [L40] can be fitted to the slide bars. Ensure that the small alignment holes line up as a wire needs to pass through this later. Depending on the depth of etch and the fold position on the semi-circular parts of the slidebar may overlap the cylinder rear. They can be filed back to match the cylinder rear.

The slidebar assemblies are fitted to the rear of the cylinders. The hole in the, now round, front should fit over the tube extending from the rear of the cylinder. You will probably need to file away some of the etch from the piston valve rear detail in order to get it fit. A length of 0.5mm wire should be fed through the alignment hole in the cylinder and slidebar front, this is used to ensure that the slidebar is aligned vertically with the cylinder block. This is important because the slidebars must be vertical to avoid fouling the front coupling rod. Solder in place.

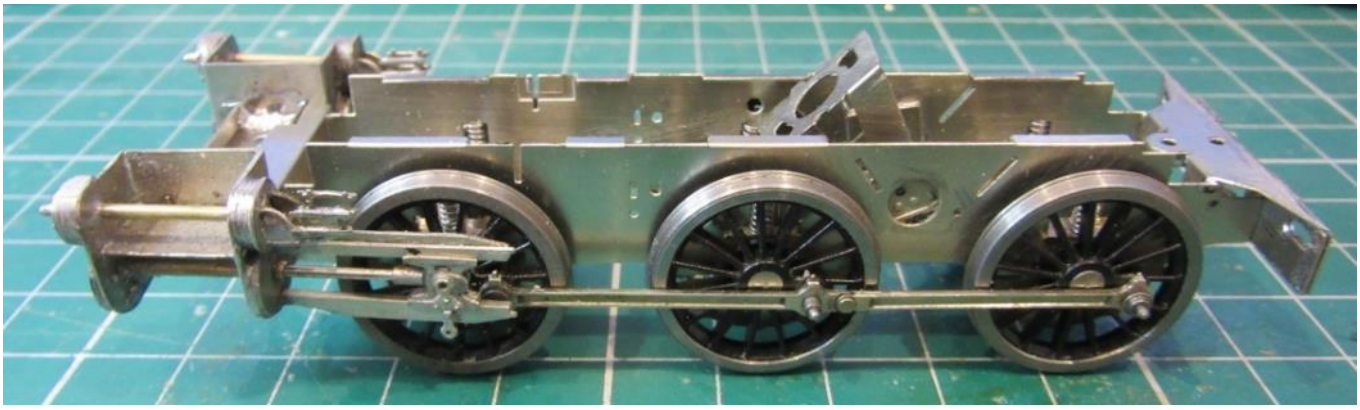


e. The cylinder wrappers are fitted later (see section 46).

f. The two cylinder assemblies are soldered to the cylinder spacer [L41]. This should be removed from the etch, the cusps removed, folded up into a 'U' shape and the bends strengthened with solder. The side with the lower section is towards the rear of the locomotive. This part should be a tight fit in the Bachmann chassis block.

g. Regardless of whether you are not going to use it further, it is easiest to use the Bachmann chassis block as a jig when soldering the two cylinders and the spacer together. The block will hold the parts parallel as they are soldered together.

h. The resulting assembly should be a tight fit into the slot in the Bachmann chassis block, but it should be removable.



i. The piston rod and the crossheads should be slid into the slide bars and the clearance checked between the rear of the crossheads and the front axle crankpin nut. It is a tight clearance, but it should be possible to rotate the front axle without the crankpin hitting the cross head. You will need to reduce the length of the crankpin bush to about 0.5mm. Ensure that the crank pin nut is reversed to the normal practice (i.e. the small diameter is facing the wheel) and that it the smaller diameter section sits into the hole in the front coupling rod.

j. At this point you should have a rolling chassis with cylinders and crossheads in place.

35) **Connecting rods**

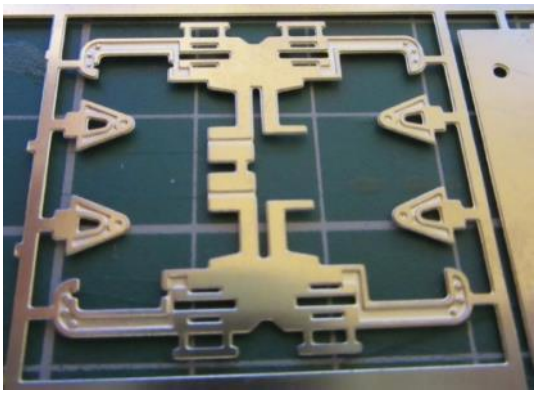
a. The connecting rods [L42 and L43] should be assembled, again removing from the etch with the tabs connecting them will make alignment easier. Once soldered together the big end holes should be enlarged to 1.6mm to match the Alan Gibson crank pin bushes and the little end to 0.8mm to take a length of 0.8mm nickel-silver wire as a pivot in the centre of the cross head.

b. Test the connecting rod as a fit into the crosshead, it should be able to pivot up and down once a length of 0.8mm nickel-silver wire has been inserted through the crosshead. It may be necessary to remove some metal from the top of the rod around the bump which represents the oil filler to get adequate rotation. The rod must be able to rotate up and down between top-dead-centre and bottom-dead-centre of the centre axle. Once you are happy that you have enough movement in the joint, the big end should be fitted over the centre axle crankpin.

c. Cut a length of 0.8mm nickel-silver wire to form the pivot between the cross head and the connecting rod. Fixing the pivot in place is best achieved by filing down the ends of the rod once in place, the action of filing will tend to flare the ends of the rod making it stay in place. If required it is possible to apply a tiny bit of solder to the rod, apply some oil to the inside of the crosshead to prevent it from soldering solid.

d. Once you have the connecting rods in place give the chassis a good run by rolling it along the track. However, as there is no support on the rear of the slidebars they may have a tendency to bend in and reduce the clearance between the back of the crosshead and the front crankpin. This is resolved once the motion bracket is in place.

36) **Motion bracket**

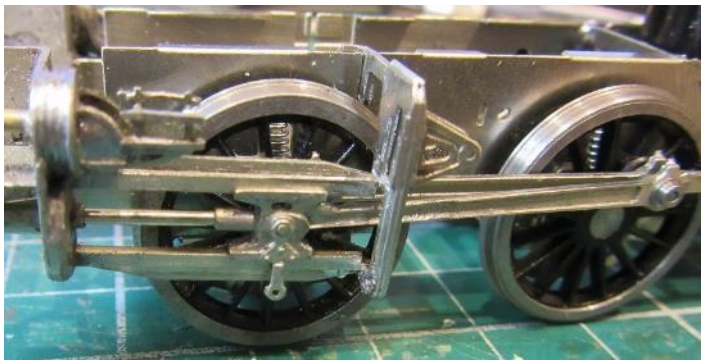


a. The motion brackets [L44 and L45] and the associated triangular brackets [L46] can be removed from the fret. The etch folds back on itself so that the etched detail is on the outside. The little 'wings' with two bolt head details fold back on either side to form part of the bracket which supports the expansion link. When folding these over ensure that you keep the slot in which the triangular brackets fit is kept clear. Solder together.

b. Drill out the holes in the triangular brackets to 0.8mm to take the wire for the pivot. Also ensure the slot between brackets is wide enough to fit two thicknesses of etch (0.8mm) so that the radius rod can be fitted through after assembly.

c. The motion bracket also has a tab which is folded back at right angles to sit along the inside of the main chassis frame. It is a good idea to reinforce the corner of this tab with solder.

d. Solder the triangular brackets into the motion bracket (ensure that you fit them into the right side of the motion bracket!).



e. The motion brackets have half-etched recesses to take the ends of the slide bars which are on the front of the bracket, the triangular brackets for the expansion link fit from the back and point to the rear of the locomotive.
Mount the motion brackets in the slots in the frames and slide the crossheads to the front limit of their travel . Solder the slidebar ends into the recesses. Check again that the front axle crankpin still clears the rear of the crosshead as the wheel rotates.

37) **Radius rod**

a. It is necessary to decide where the radius rod is going to fit in the expansion link before assembling. On the prototype the radius rod is free to slide up and down through the expansion link controlled by the lifting arm. When the radius rod is at the bottom of the expansion link, the loco is in forward gear, when it is at the top, it is backward gear and if it is in the middle it is effectively coasting or stationary. If the model is to be in forward or backward gear then the radius rod needs a pivot wire added and then assembled with the expansion link.

b. This can be achieved on the model by pivoting the expansion link on tiny stubs of 0.8mm rod which are fitted into either side of the expansion link. This will require the lifting arm to pivot to lift the radius rod between forward gear and backward gear. There are a couple of alternatives though each is a compromise. If you don't mind the radius rod set in mid-gear then you can just feed the pivot rod straight through the motion bracket, the expansion link and the radius rod all in one go, or if you want to put the locomotive into forward gear you can push the radius rod down to clear the pivot and just feed the pivot rod through the motion bracket and the expansion link. If it is to be in mid gear, then the radius rod is assembled into the expansion link when the expansion link is pivoted in the motion bracket.

c. Remove the radius rods [L47 and L48] from the main etch. Leave the part of the front fork connected and fold it over to form the connection to the valve rod.

d. If the radius rod is to be in forward or backward gear in the expansion link, the next step is to solder a length of 0.8mm wire through the hole in the radius rod adjacent to the long slot. This rod forms the pivot for the radius rod as it sits in the expansion link. The pivot will sit in the curved half-etched slot on the inside of the expansion

link so only needs to be a half etch thickness proud of the surface of the radius rod i.e. about 0.25mm. Make sure that a piece of 0.6mm wire can slide along the length of the slot at the end of the radius rod.

e. If the radius rod is to be in mid gear (or if pivoting the rod in the sliding track of the expansion link sounds too hard), then simply open up the hole adjacent to the long slot to clear 0.8mm wire fitted later.

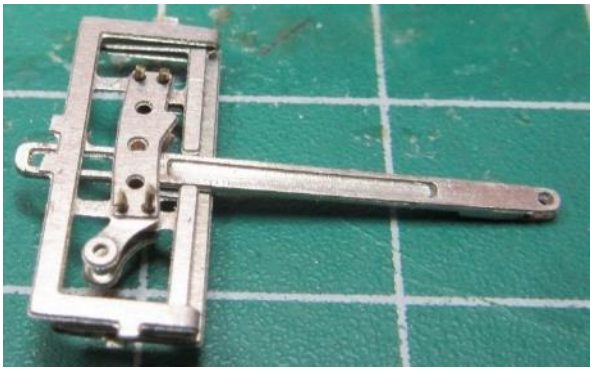
f. Note - the bump on the end of the radius rod above the slot represents the oil point on the rod and should be pointing upwards when assembled. It is easy to get the rods muddled as they are handed.

38) **Expansion link**

a. The expansion links [L49 and L50] are a three piece fold-up construction. Open out the holes - the four small holes in the ends of the links need to fit a piece of 0.33mm brass wire, the central hole takes a 0.8mm wire as a pivot and the lower hole for the return crank rod pivot is 0.6mm. The half-etched section down the centre of the expansion link forms a slot into which the pivot on the radius rod can slide.

b. The expansion link folds together so that the curved half-etched slots face each other.

c. If the radius rod is to be in forward or backward gear (and going to oscillate with the expansion link) then it should be inserted into the expansion link assembly as it is folded ensuring that the radius rod is handed correctly. The long end of the rod is pointing away from the outer curve on the expansion link. Also check that the oil filler stub on the radius rod is pointing upwards and the fluting is facing outwards. It is probably worth assembling the two expansion links as a pair in a dry run to ensure the correct orientation.



d. Once folded in place insert four short lengths of 0.33mm wire into the holes in the expansion link. When happy that everything is aligned slide the radius rod to one end of the internal slot and apply solder to the other end of the link,. Slide the radius rod to the other end of the slot and solder the second end. Finally, the expansion link can be cut out of the alignment frame.

e. If the radius rod is to be in mid gear it is not necessary to include the radius rod in the assembly. Simple insert four short lengths of 0.33mm wire into the holes in the expansion link and solder each end together.

39) **Valve rod**

a. The valve rod is made from a length of 0.8mm approximately 22mm long. On one end of this the rod a fork is formed from the valve rod end [L51] (there is a spare of this part because it is tiny).

b. File two flats approximately 1mm long on two opposing sides of the end of the valve rod.

c. Fold part the valve rod end around the rod so that these flats sit inside the half-etch recesses. Solder together ensuring that the resulting fork is clear of solder. The pivot hole needs to be opened up to 0.6mm so that it can pivot on the combination link.

d. Test fit the valve rod into the cylinder block and check that it slides freely.

40) **Combination lever**

The combination levers [L52 and L53] have three pivot holes all of which need opening out to 0.6mm. The lever is also cranked slightly just below the middle pivot so that it clears the slidebars. Check that the pivots for the valve rod and the radius rod can be assembled with 0.6mm wire. It is probably best to just to test fit the rods at this stage and not solder or fix any pivots until all the valve gear has been completed.

41) **Union link**

a. This links the bottom of the cross head to the bottom of combination lever. The two union links [L54] should be folded on itself to create the two forked ends. Solder together ensuring that the forks and pivot holes remain clear of solder.

b. The pivot holes should be opened to 0.6mm and the link test fitted between the bottom pivot on the cross head (also called the drop link) and the bottom of the combination lever.

42) **Eccentric rod**

a. The small end of the eccentric rod (return crank rod) [L55 and L56] fits between the two sides of the bottom of the expansion link. It should pivot freely on a piece of 0.6mm wire.

b. The large end of the return cranks need to pivot on the return cranks. This requires a 0.8mm hole to fit the 0.8mm rivet.

43) **Return crank**

a. The return crank is made by folding the two parts of the etch [L57] together and soldering. The hole needs to be drilled 0.8mm to fit the 0.8mm rivet. The easiest method of fixing on the crank pin is to solder an Alan Gibson crankpin nut on to the reverse side. The resulting part can then be threaded onto the crank pin. The crankpin length then needs to be reduced so that the return crank is a tight fit against the end of the crankpin when it is correctly angled (it leans forward by 20° when the crank is at the bottom).

44) **Completing the valve gear assembly**

a. Now we have all the individual parts of the valve gear made and test fitted it is time to assemble them.

b. The joints are made of 0.6mm nickel-silver wire. Feed a length of wire through the joint and apply a touch of oil to the centre avoiding getting any oil on the front face of the rod. Apply some flux to the rod and front face and then apply a touch of solder in a quick 'in and out'. It is possible to get a secure joint between the pivot rod and the front face of the rod while still leaving the central part free to move. If you solder the whole thing solid don't panic, just clean it off and try again.

c. Start with the pivot between the lifting arm (which may already be fastened in the radius rod if you fitted it that way) and the combination lever (top hole). The slot in the motion bracket should have been opened up to be wide enough to allow this joint and the rods to slide through so this can be done away from the rest of the chassis.

d. Next make the joint between the bottom hole of the combination lever and the union link, again this can be done away from the chassis.

e. Slide the piston rod into place and then slide the currently assembled run of union link, combination lever and radius rod through the motion bracket. Fasten the rear of the piston rod to the remaining hole in the combination lever.

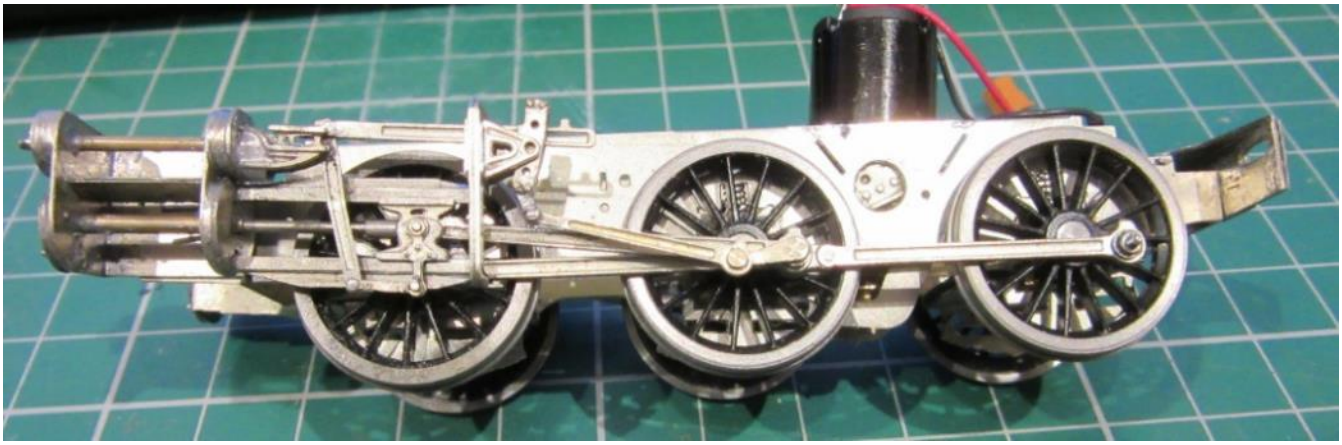
f. Fasten the free end of the union link onto the bottom of the cross head.

g. The pivot for expansion link can now be fitted. If you have chosen to model the valve gear in mid gear then this is just a length of 0.8mm rod fed through the motion bracket, the expansion link and the radius rod. If you want to model the valve gear in a forward gear then the radius rod should be dropped below the central pivot in the expansion link and the pivot rod just goes through the motion bracket and expansion link. If you want to be able to adjust the motion position then you will need to fasten a short length of rod from both the front and back of the motion bracket, leaving the radius rod clear to slide up and down in the internal slot in the expansion link. This can be done but is much trickier than just fixing the gear in neutral or forward gear.

h. Join the return crank and the return rod together with a 0.8mm rivet. Insert the rivet from the front. Ensure this joint is free to rotate smoothly.

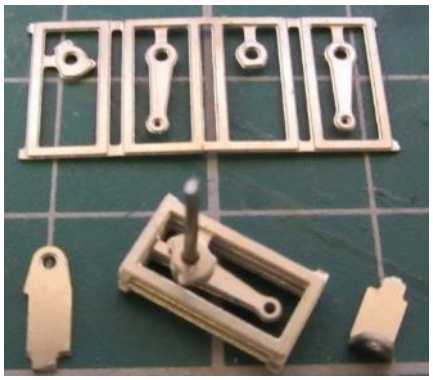
i. Fasten the return crank onto the centre wheel crankpin and adjust into position.

j. Fasten the 'little end' of the eccentric rod to the bottom of the expansion link with a 0.6mm wire pivot.

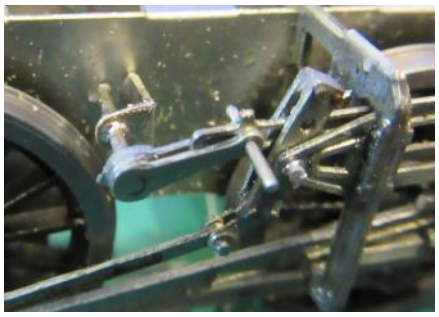


45) **Lifting arm**

a. The lifting arms [L58 and L59] come in a frame to make folding up easier. The larger holes need to be drilled out 0.8mm, the smaller ones 0.6mm. Apply solder to the faces of the parts whilst the frame is still flat, then fold up with the half etch line on the outside. Solder the part together with a 11mm length of 0.8mm wire through it. The small boss goes at the back and the rod needs to project out from this side.



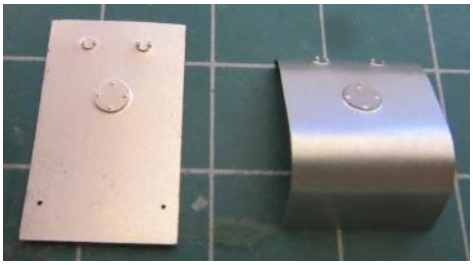
b. The small brackets [L60 and L61] are bent to 90° and slot into the rectangular slots in the mainframe. Note that these brackets are handed and that the shorter side is the lower one in order to clear the top of the brake hanger which will sit below it. Solder the brackets to the mainframe.



c. Put the lifting arm in place through the bracket and align the lifting arm with the slot in the radius rod. Insert a piece of 0.6mm rod through the arm and radius rod and carefully solder it in place. Trim back flush with each side of the arm.

46) **Cylinder wrappers**

a. The cylinder wrappers [L62] have several half-etched points which need to be pressed out from the rear to form the rivet/bolt detail on the raised detail.



b. The cylinder wrappers then need to be rolled to shape to shape using appropriate sizes of rod.

c. Solder the wrappers in place on the cylinder frames starting from the top of the cylinder. When complete, run a bead of solder down the sides.

47) **Cylinder drains and operating mechanism**

a. Find the cylinder drain-cock etches [L63 and L64] prviously removed from the middle of the tender chassis.

b. Take the left hand etch [L63] and fold where the half etched part meets the full-etch of the pivot rods. (see photo).

c. Add the pipe work using 0.45mm Nickel-Silver wire. Bend the wire to give a right-angled short length to align between the two full etched 'bolt heads'.

d. The top ends of these wires fit into the holes on the bottom of the cylinder wrapper.

e. The front end of these wires should now be soldered to the support bracket between the two full etched 'bolt heads'.

f. Repeat for the right hand etch [L64].

g. These ‘pipes’ may need to be bent outwards slightly to give clearance for the pony truck to swing dependant on the radius of curves you need to negotiate.

48) **Frame mounted guard irons**

If your prototype is a version with frame mountred guard-irons (as opposed to those mounted on the pony truck) use the parts [D1]. Stick these behind the front buffer beam bending to position the end above the rail.

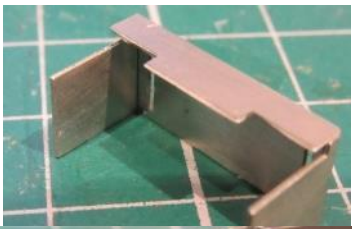
49) **Sanding gear**

a. Fabricate the sandpipes from 0.6mm wire, adding the steam pipes out of fuse wire if desired. Refer to prototype photographs as the sandpipes are rather ‘curly’.

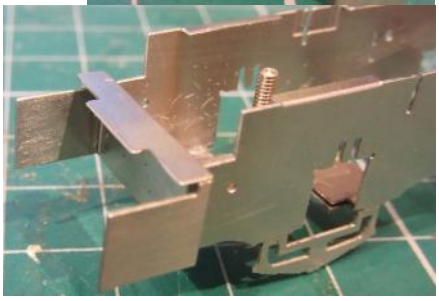
NEW FRAME SPACERS

50) **Frame Spacers**

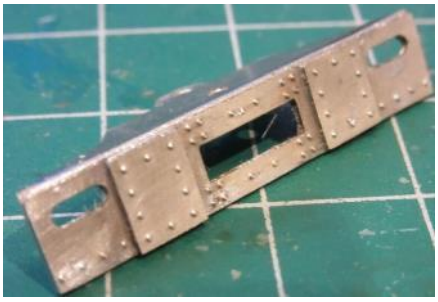
These spacers are used when the frames are being assembled for use without the Bachmann chassis.



a. A 10BA nut should be soldered over each of the holes in the central section of the spacer part of the main frames. These then allow the keeper plate and pony truck to be bolted into them. The recommended method of soldering these on is to clean both the frame and the nut completely, apply some oil to a bolt and use it to clamp the bolt tightly down to the frame, then apply some flux around the nut and apply solder. The tight fit and the oil should prevent the bolt from soldering to the nut.The front spacer [S1] bends up and fits over the horns on the front of the frames to support the cylinders, the flat horizontal plate on the upper side of the chassis.



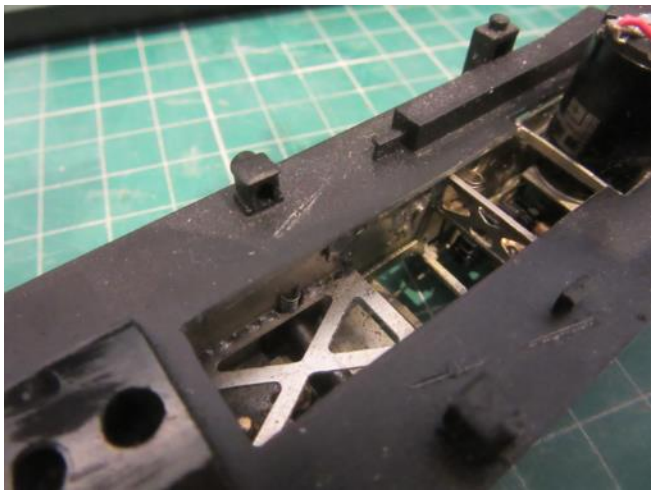
b. Before soldering to the frames, it is a good idea to fold up and test fit the cylinder connector [L41] to ensure this will fit as intended.



c. Fold up the rear drag beam [S2] and solder the two detailing plates [S3] on the rear.
d. Solder the assembly to the rear of the frames

51) Optional cosmetic frame spacers

Not using the Bachmann chassis block means the frames can be given some internal detail by using the two etched cosmetic frame spaces. However, this detail will only be visible if you remove the central section of the Bachmann footplate. This can be sawn out with a piecing saw to give a slot 11mm wide from 2mm behind the smokebox saddle to the existing hole for the motor tower (see photo).



a. Take the middle spacer [S4], fold up the etched detail and then solder horizontally between the frames noting the missing section to clear the EasiChas spring for the front axle (see photo). The middle spacer can then be fitted between the front two axles, solder it midway up the frames and ensure it remains clear of the bearing slots.
b. The rear spacer [S5] folds back on itself to give a thicker flange to the edge of the part. This is then soldered between the frames vertically, aligned with the top of the frames and 6mm in front of the middle axle.
c. If you are replacing the Bachmann motor with a High-Level Roadrunner and motor then this is the time to assemble them following their instructions. The motor should be fastened using the two holes within the fold of the gearbox, rather than the external 'wings', as the wings will need to be removed to clear the ashpan detail inside the frames.

Etched parts list

No.	Description	Quantity	Notes
L1	Locomotive main frames	1	
L2	Ashpan side detail	2	LHS and RHS
L3	Bachmann gear tower	1	Note 1
L4	Keeper plate	1	
L5	Footplate bracket – rear	2	
L6	Footplate bracket - front	2	
L7	Locomotive brake hanger assembly - left	3	3 elements in the frame
L8	Locomotive brake hanger assembly - right	3	3 elements in the frame
L9	Brake hanger brackets	6	
L10	Brake linkage	1	
L11	Brake linkage detail – front	4	
L12	Brake linkage detail - middle	4	
L13	Brake linkage detail – rear side	4	
L14	Brake linkage detail – rear middle	2	
L15	Brake linkage bracket	1	
L16	Vacuum cylinder linkage	2	
L17	Balance weight – large	2	
L18	Balance weight – small	4	
L19	Coupling Rod - Front Left	1	Fold together
L20	Coupling Rod - Rear Left	1	Fold together
L21	Coupling Rod - Front Right	1	Fold together
L22	Coupling Rod - Rear Right	1	Fold together
L23	Coupling rod leading boss	4	Omit front bosses for P4 clearance
L24	Coupling rod centre boss	4	
L25	Coupling rod trailing boss	4	
L26	Cylinder frame – left hand	1	
L27	Cylinder frame - right hand	1	
L28	Cylinder spacers	2	
L29	Cylinder and valve front	2	On supplemental etch
L30	Valve front spacers	4	
L31	Valve front overlay	2	
L32	Valve gland	2	
L33	Cylinder front overlay	2	LHS and RHS
L34	Valve rear spacers	6	
L35	Valve rear overlay	2	
L36	Valve rod support	2	2 spares
L37	Slide bars	2	Fold together
L38	Crosshead frame - left	1	5 elements in the frame
L39	Crosshead frame - right	1	5 elements in the frame
L40	Cylinder rear	2	
L41	Cylinder spacer	1	
L42	Connecting rod - left	1	Fold together
L43	Connecting rod - right	1	Fold together
L44	Motion bracket - left	1	
L45	Motion bracket - right	1	
L46	Motion bracket triangular brackets	4	
L47	Radius rod – left	1	Fold together
L48	Radius rod – right	1	Fold together
L49	Expansion link - left	1	Fold together
L50	Expansion link - right	1	Fold together
L51	Valve rod end	2	Plus a spare

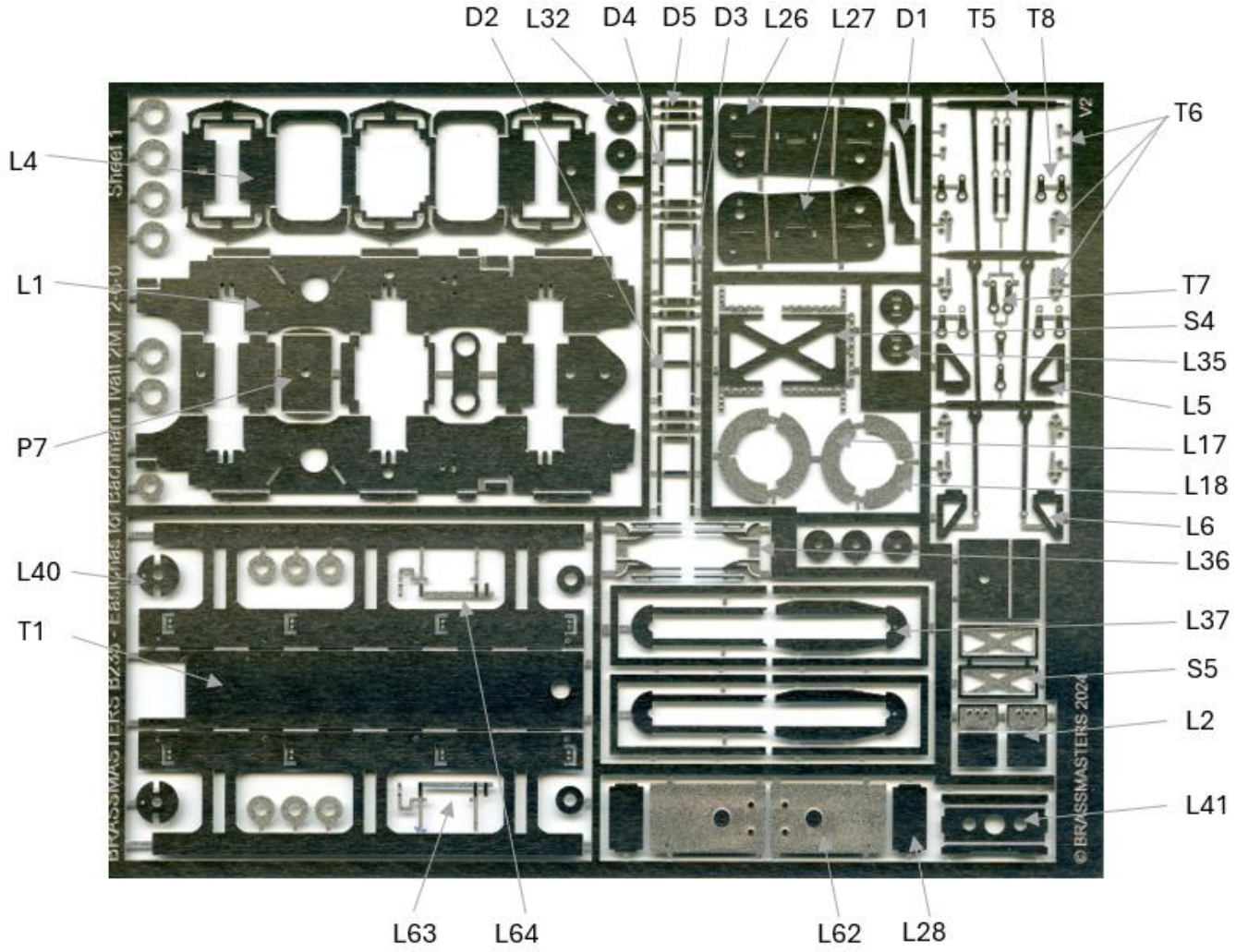
L52	Combination lever – left	1	
L53	Combination lever – right	1	On supplemental etch
L54	Union link	2	Fold together
L55	Eccentric rod - left	1	
L56	Eccentric rod - right	1	
L57	Return crank	2	Fold together
L58	Lifting arm - left	1	4 elements in the frame
L59	Lifting arm - right	1	4 elements in the frame
L60	Lifting arm bracket - left	1	
L61	Lifting arm bracket - right	1	
L62	Cylinder wrapper	2	LHS and RHS
L63	Cylinder drain mechanism – left	1	
L64	Cylinder drain mechanism – right	1	
S1	Cylinder support spacer	1	Note 2
S2	Locomotive drag beam	1	Note 2
S3	Draw beam detail	2	Note 2
S4	Chassis spacer (middle)	1	Note 2
S5	Chassis spacer (rear)	1	Note 2
T1	Tender main chassis	1	
T2	Tender axle bearing	7	One spare
T3	Tender brake hanger assembly - left	3	Plus a spare
T4	Tender brake assembly hanger - right	3	Plus a spare
T5	Tender brake pull rod	1	
T6	Tender brake pull rod detail	12	
T7	Tender brake-cylinder linkage	2	
T8	Brake pull rod levers	4	
T9	Spare		
T10	Tender hand brake linkage)	2	On supplemental etch
T11	Spare		
T12	Tender guard irons	2	On supplemental etch
T13	Tender foot step frames left	1	
T14	Tender footstep frames right	1	
T15	Tender footstep treads	4	
T16	Footstep braces	2	
D1	Loco frame mounted guard irons	2	LHS and RHS
D2	Loco footstep frames	2	LHS and RHS
D3	Tender footstep frames left	1	
D4	Tender footstep frames right	1	
D5	Locomotive and tender footstep treads	8	
D6	Cab doors left	1	On cab door etch
D7	Cab doors right	1	On cab door etch
D8	Cab door fixing plate	2	On supplemental etch
D9	Cab fall plate left	1	On fall plate etch
D10	Cab fall plate right	1	On fall plate etch
P1	Pony truck bottom	1	On pony truck etch
P2	Pony truck top	1	On pony truck etch
P3	Pony truck bearings	2	On pony truck etch
P4	Pony truck guard irons	1	On pony truck etch
P5	Pony truck front detail	1	3D print
P6	Pony truck rear detail	1	3Dprint

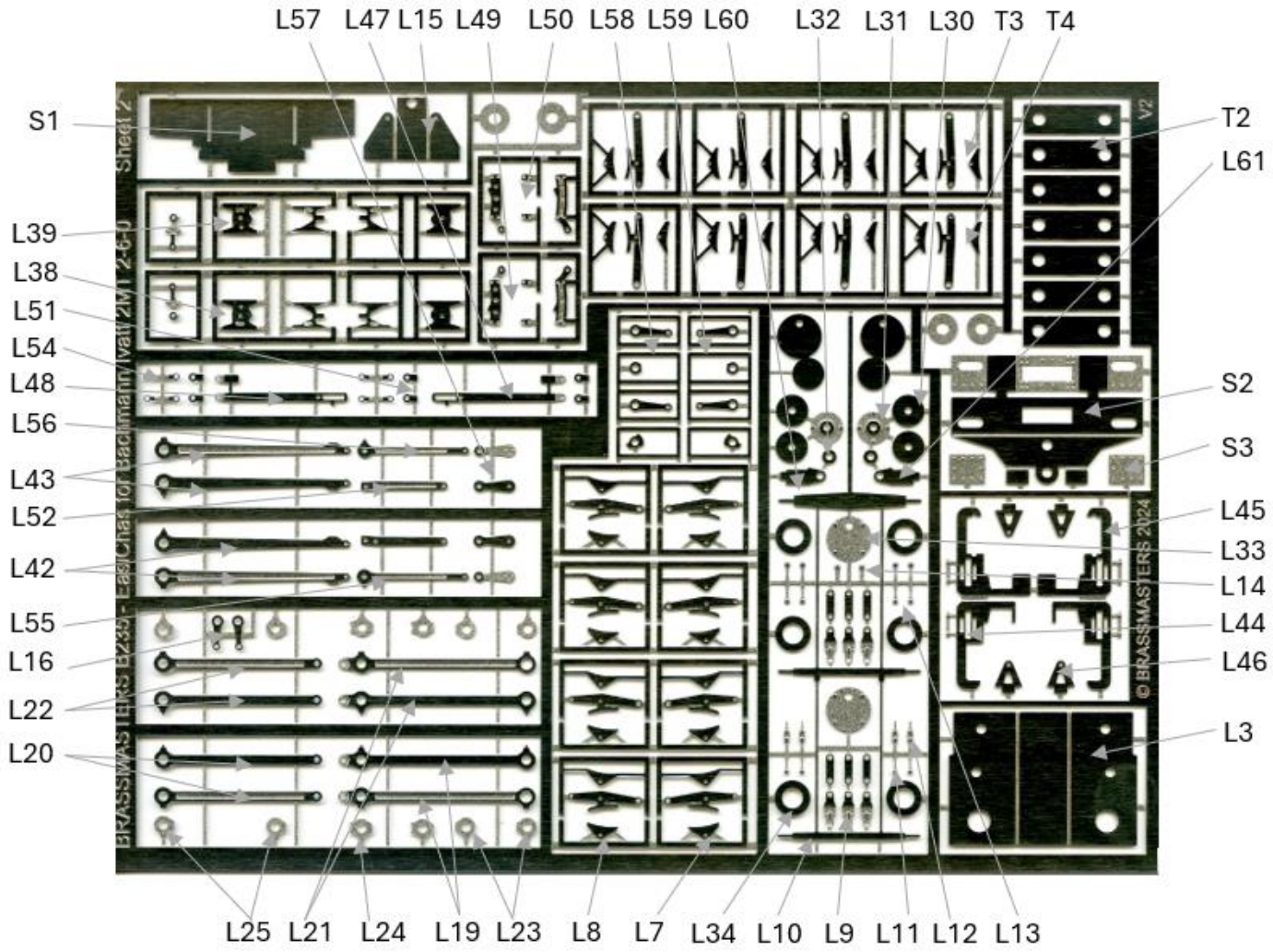
P7	Pony truck rubbing plate	1	On pony truck etch
Notes 1. part only required if re-using Bachmann motor and gearbox 2. part only required if replacing Bachmann motor and chassis block			

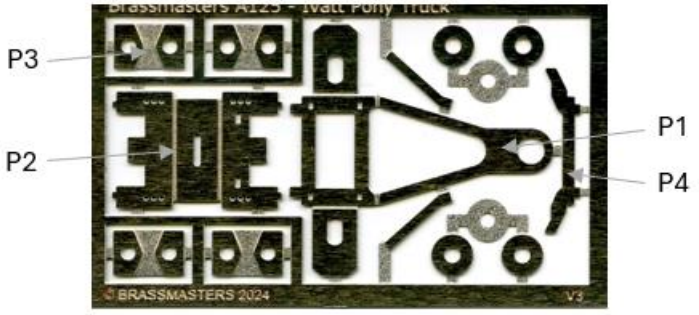
Other components

Countersink head screw	2
Coupling rod bushes	8
Hornblock	6
Hornblock springs	6
1/8” brass bush	2
Small rivet	2
8 thou steel spring wire	
12 thou steel spring wire	
3/64” brass tube	
1.0mm brass tube	
1.5mm brass tube	

0.31mm brass wire
0.45mm brass wire
0.5mm brass wire
0.6mm brass wire
0.8mm brass wire
1.0mm brass wire
0.33mm NS wire
0.45mm NS wire
0.6mm NS wire
0.8mm NS wire
0.9mm NS wire
1.0mm NS wire




L57 L47 L15 L49 L50 L58 L59 L60 L32 L31 L30 T3 T4
S1
T2
L61
L39
L38
L51
L54
L48
L56
L43
L52
L42
L55
L16
L22
L20
S2
S3
L45
L33
L14
L44
L46
L3
L25 L21 L24 L19 L23 L8 L7 L34 L10 L9 L11 L12 L13


P3
P2
P1
P4
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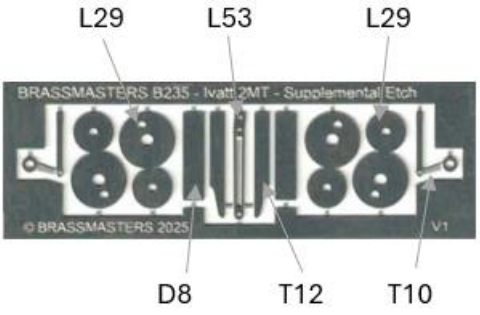
L29 L53 L29
BRASSMASTERS B235 - Ivatt 2MT - Supplemental Etch
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D8 T12 T10