



**CONNOISSEUR MODELS 0 GAUGE  
LMS FOWLER 4F FREIGHT ENGINE**



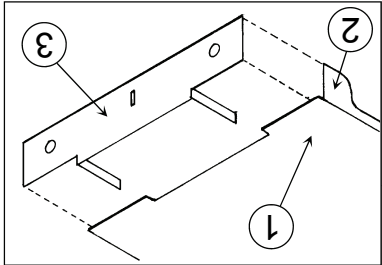
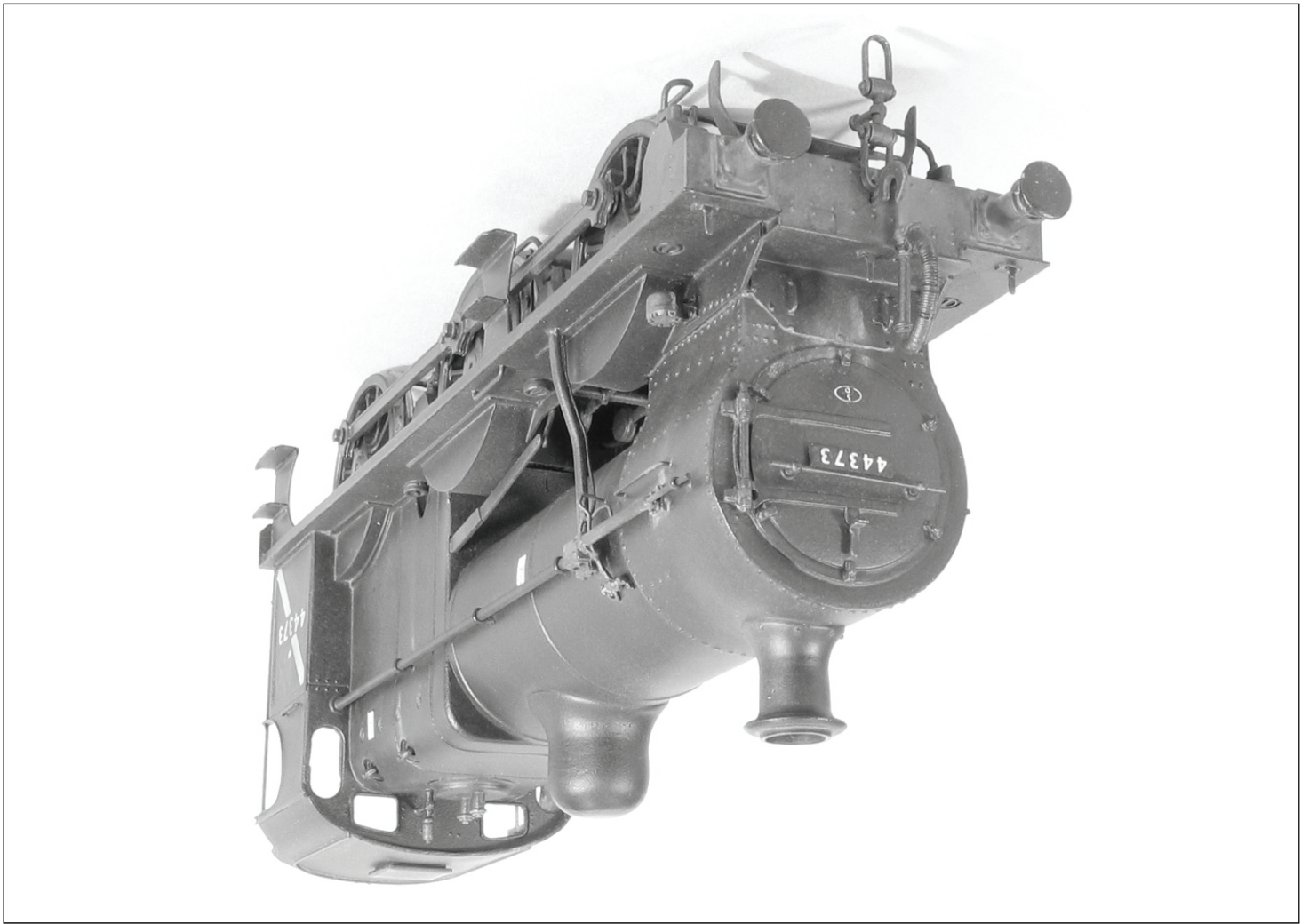
**Parts Required To Complete**

3 Sets 5' 3", 16 Spoke Driving Wheel (Slater's No 7863)  
3 Sets 4' 3", 12 Spoke Tender Wheels (Slater's No 7851)  
Plunger Pickups if desired (Slater's No 7157)

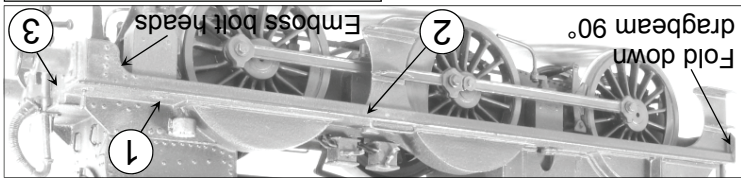
Available From Slater's, Temple Road, Matlock Bath,  
Matlock, Derbyshire, DE4 3PG, Tel 01629 583993.  
Mashima 1833 Motor and 40/1 Gear Set (Connoisseur)

**Connoisseur Models, 33 Grampian Rd, Penfields, Stourbridge, DY8 4UE, Tel 01384 371418**





Emboss bolt heads on buffer beam (part 3) and fold side strips through 90°. Then solder hard against the valve ends. I would now recommend soldering on the chassis fixing nuts.



1. Take the footplate (part 1) determine the top side and then fold the rear drag beam downwards through 90°. Take the valances (part 2) emboss the bolt heads at the front end and then solder into the half etched grooves on the underside of the footplate.

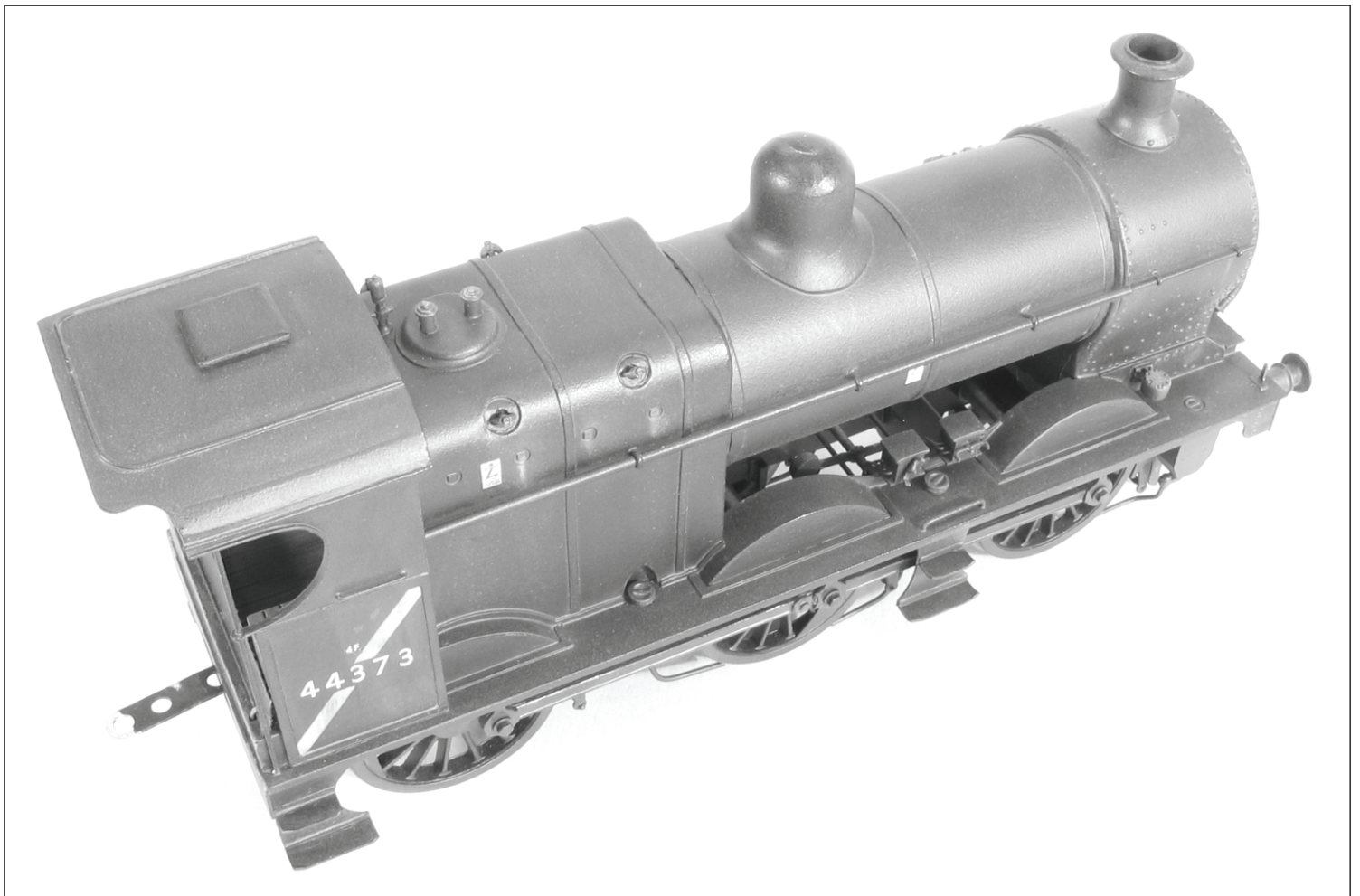
Parts are numbered in a logical assembly order. The slots and tabs don't give accurate location, they are only there to help position parts. Tack solder a part into place then adjust the next part to match. Solder solid only when happy with the assembly. I have tried to mark the etchings and provide location slots so that the positioning of parts is obvious without the need to constantly refer to complex exploded drawings. If you are a little uncertain about the positioning of a component from reading through the instructions don't worry as this should become obvious as construction progresses and most parts fit offered up to the assembly will only fit into the correct place.

**BODY ASSEMBLY**

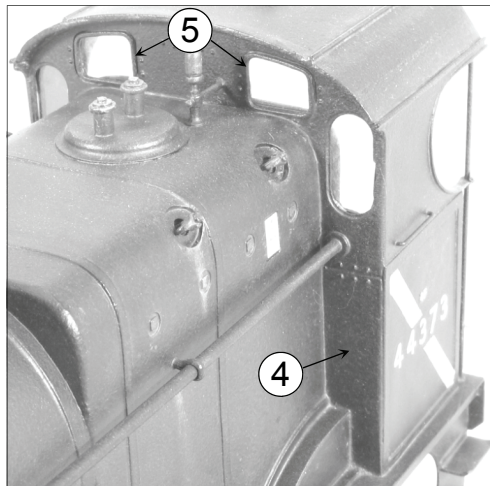
I originally designed the etchings for this kit for ACME models back in the days when money was scarce and I had to supplement my income by doing occasional kit designs for other people. When ACME no longer wanted to continue producing the 4F I purchased the tooling from them and added it to my range. As I was working to their specification a few areas of the kit design are slightly different from my normal practice, for example I would normally separate the chassis and rods onto a nickel silver sheet. These slight differences in design will probably only be apparent to modellers who have built a number of my kits as this kit builds into a very sound and detailed model.

The LMS 4F class numbered 772 examples. The first were right hand drive engines built by the Midland Railway the LMS continued construction but soon converted to building left hand drive engines as a group standard. This kit is intended to represent a typical left hand drive locomotive constructed in the main batch between 1924 and 1928. As with any locomotive class built in such large numbers there was a great deal of detail variations between individual locomotives. If a model of a particular engine is required it is expected that the modeller will carry out prototype research to provide photographs and determine exact details. A few detail alternatives are included in the kit but the kit is not intended to comprehensively cover all variations of the class. However the kit should provide a very satisfactory base on which to carry out modifications.

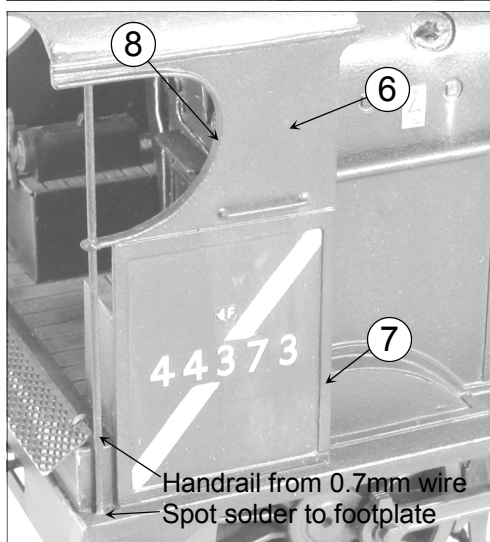
**LMS FOWLER 4F KIT**



2. Take the cab front (part 4) and emboss bolt heads. Take the cab window beading for the centre two windows (parts 5) and solder into half etched rebates. On the prototype loco only the centre windows had raised beading, the outer two oval windows had a recessed beading and the half etch represents this well. Now solder the cab front to the footplate ensuring that it is positioned centrally (line up etched centre line marks) and that it is upright. If you fold up the back splasher sides these will also help to provide a positive location for the cab front.

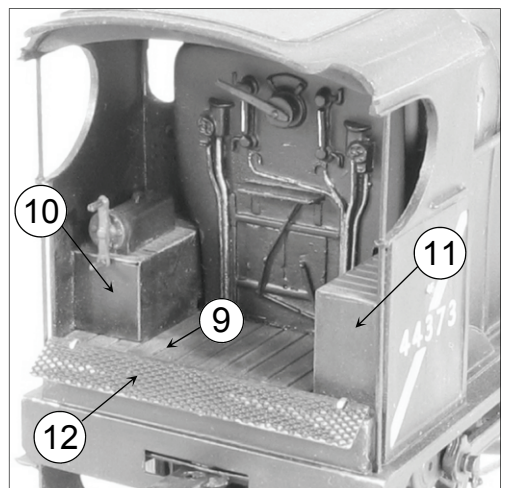


Take the cab sides (parts 6) and fold the top reinforcing strip through 180° and solder on the inside face. Solder the cab side beading (parts 7) to the cab side using the etched grooves to aid location. Take the cab opening beading (parts 8) roughly form to shape and solder into place with the etched groove on the beading locating into the cab opening. You may also wish to fit the cab side grab handrails at this point. Now solder the cab sides to the footplate and cab front. There is an etched rebate on the inside front edge of the cab side to help locate against the cab front and give a crisp square corner.

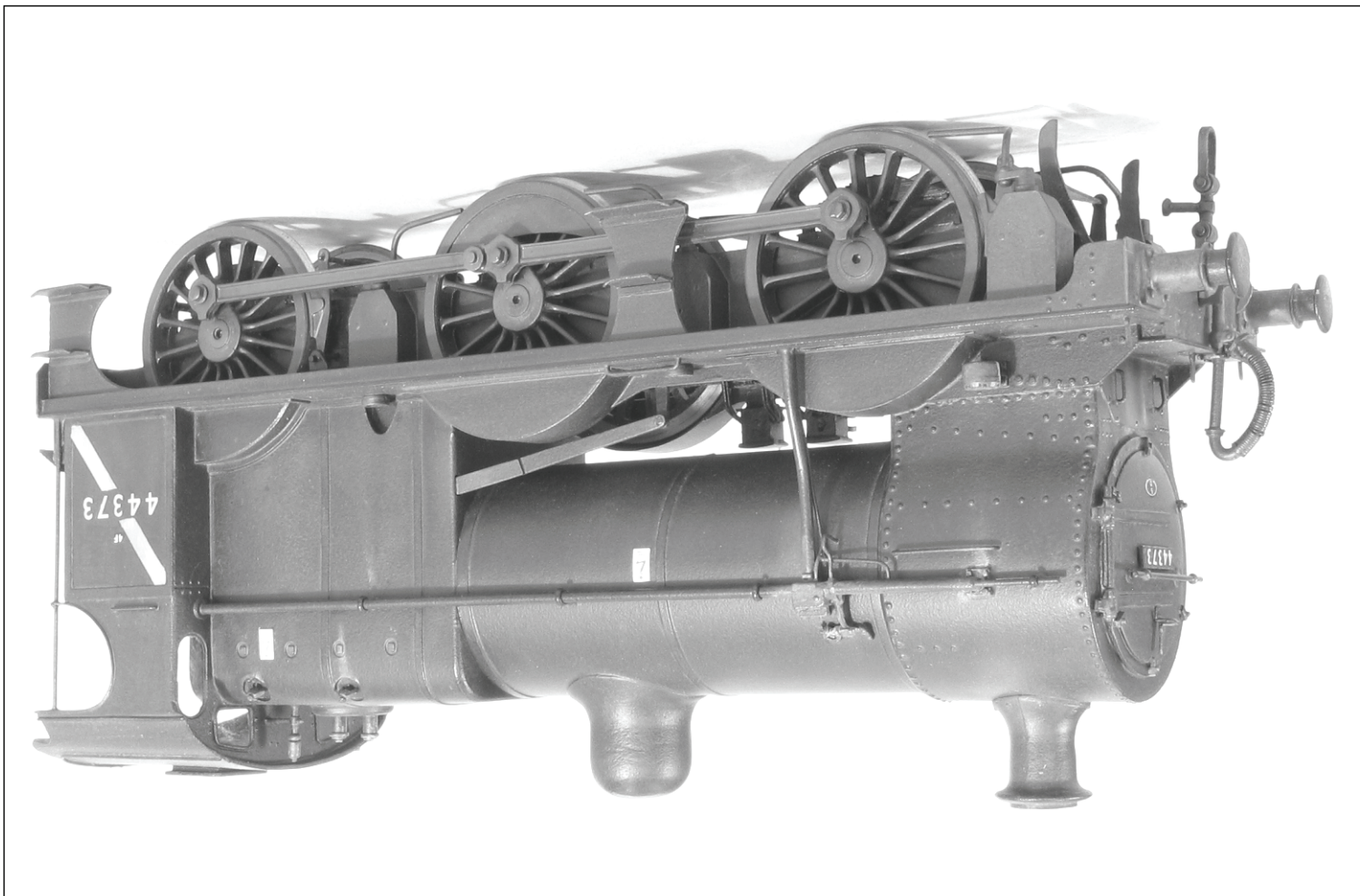


3. Take the cab floor (part 9) and fold the back edge. Fit into place between the cab sides locating the tabs at the front edge into the slots in the cab front. Fold up the left hand cab box (part 10) and solder into the left hand side of the cab hard against the cab side and front. Fold up the right hand cab box (part 11) and solder into place again hard against the cab side and front.

Fit the rear cab handrails made from 0.7mm brass wire. The wire is threaded through the hole in the end of the cab opening beading and the wire trimmed to length so that it's a snug fit underneath the top of the cab cut out. Spot solder at top and footplate.







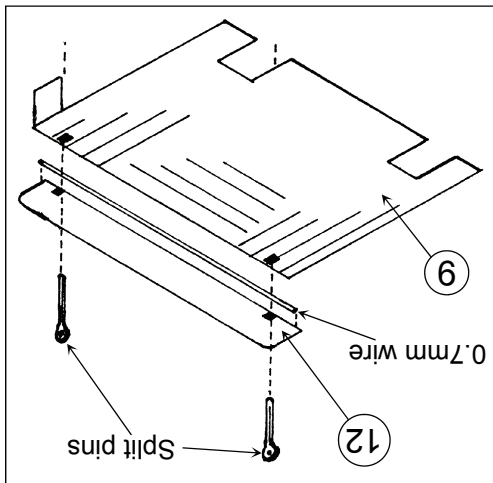
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Solder the fire box (cladding bands) boiler bands (parts 17) around the wrapper locating the full metal section of the band into the etched grooves to aid positioning the bands parallel. Start 1mm from bottom edge and work around over the fire box top to the other side. Fold up the two sand box cut out backing pieces (parts 18) and solder into place behind the fire box wrapper. The firebox can now be soldered to the footplate and cab front. Ensure that the assembly is fitted as square and central as possible. You may find that passing a length of tube through the holes in the cab front and firebox is helpful in lining everything up.

Take the smoke box front (part 19) and emboss bolt heads. Then roughly pre form the smoke box wrapper (part 20) to match the profile of the front and fix the front face down onto a flat surface. Solder the wrapper around the front, positioning the wrapper centre to the half etched line on the front and working from the centre solder in sections around each side. Solder the spacers (parts 21) into the slots on smoke box front making sure that they sit square. Solder the smoke box rear (part 22) into place inside the wrapper and locating onto the spacers. When happy with the assembly file a slight radius around the front and back edges. Pre form the rivet detail wrapper (part 23) and solder around the assembly by lining up the chimney holes and working around each side.

Take a boiler end former (parts 24) and fix to a flat surface so that the etched ring around the circumference is face upwards. Spring the end of the pre rolled boiler (part 25) around this ring and working from the outside and using plenty of flux, so that the solder is drawn underneath the boiler end, solder around the circumference. Repeat for the former at the other end and then dress back with a file.

4. Remove the fire box rear former (part 13) fire box front former (part 14) and front former thickening piece (part 15) from the front. Solder the thickener to the firebox front. Take the fire box wrapper (part 16) and form radii on the top corners to match the former profiles. I use a drill shank or length of tube to help with this. The holes for the mud hole doors are useful to indicate the centre line of the curved bend. Fix the front former face down to a flat surface and lining up the etched centre marks solder the formed wrapper around the former. Repeat with the back former. Then file a radius around the front of the firebox.



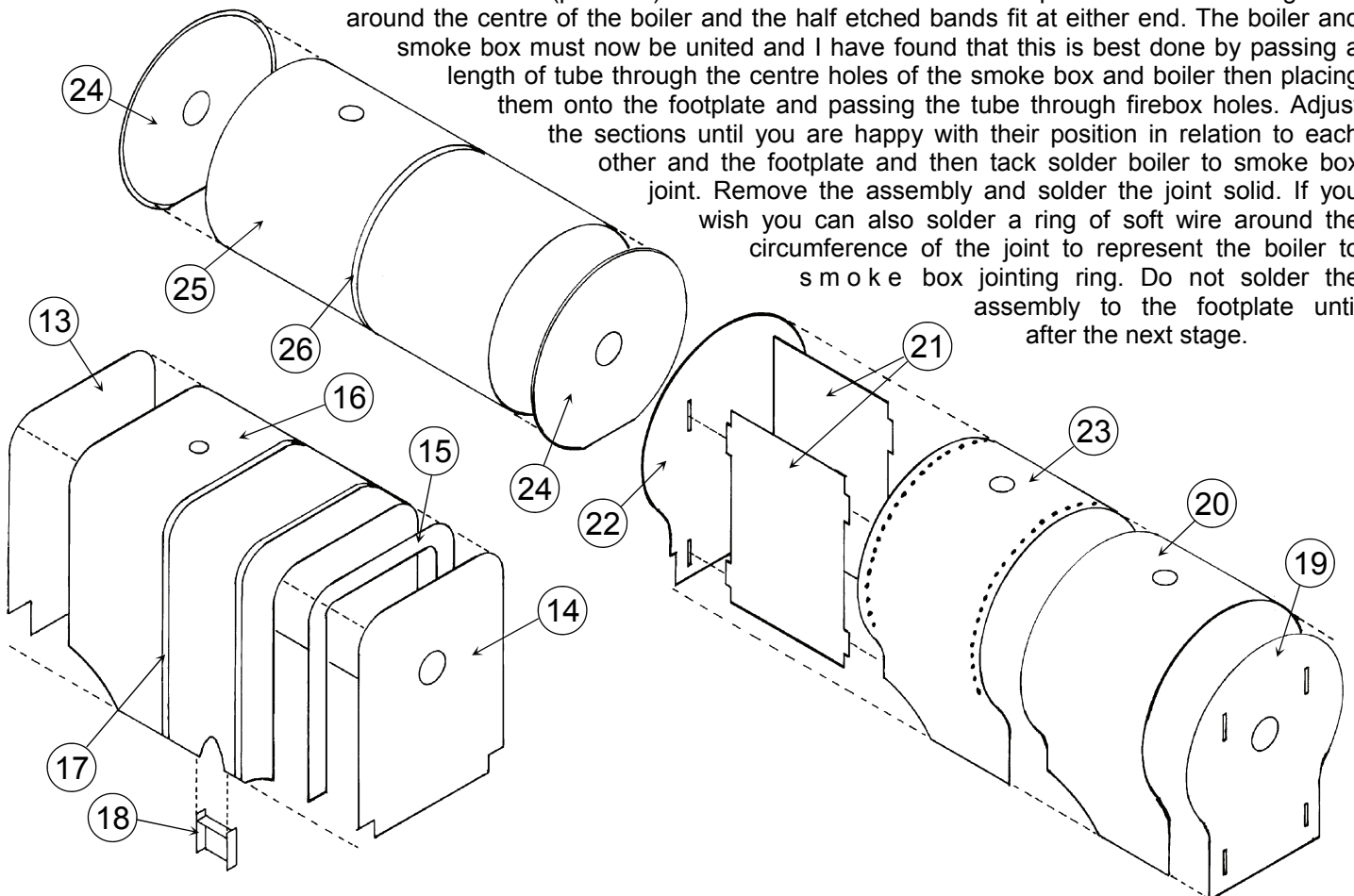
Solder a length of 0.7mm brass wire along the front edge of the loco to tender fall plate (part 12). Pass split pins over the wire through the slots in the cab floor and into the holes in the footplate. Solder the tails of the split pins to the underside of the footplate. Ensure that the fall plate moves freely at its hinge and then snip off excess of split pin tails.





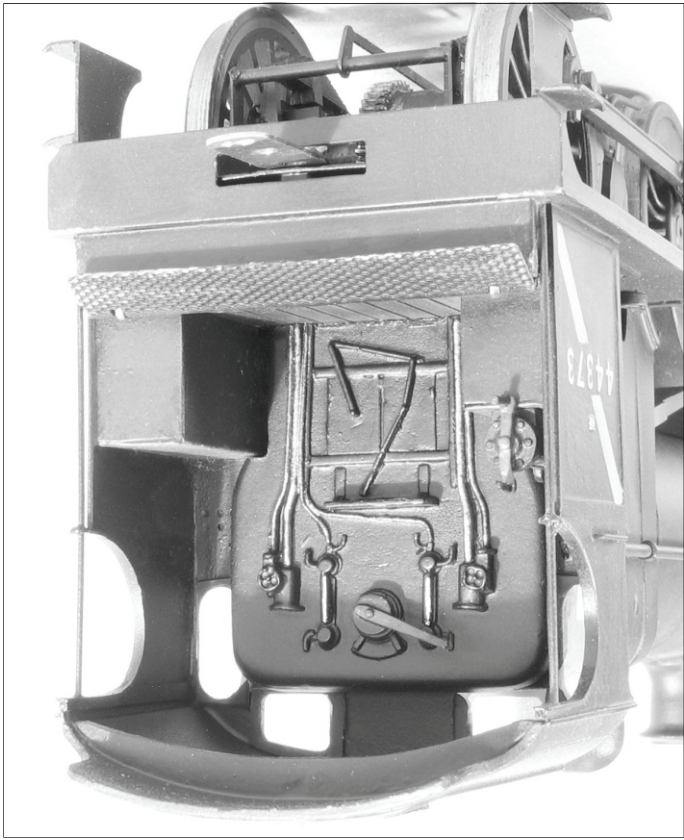
PAGE 24

Fit the boiler bands (parts 26). The band with the full metal strip fits into the etched groove around the centre of the boiler and the half etched bands fit at either end. The boiler and smoke box must now be united and I have found that this is best done by passing a length of tube through the centre holes of the smoke box and boiler then placing them onto the footplate and passing the tube through firebox holes. Adjust the sections until you are happy with their position in relation to each other and the footplate and then tack solder boiler to smoke box joint. Remove the assembly and solder the joint solid. If you wish you can also solder a ring of soft wire around the circumference of the joint to represent the boiler to smoke box jointing ring. Do not solder the assembly to the footplate until after the next stage.

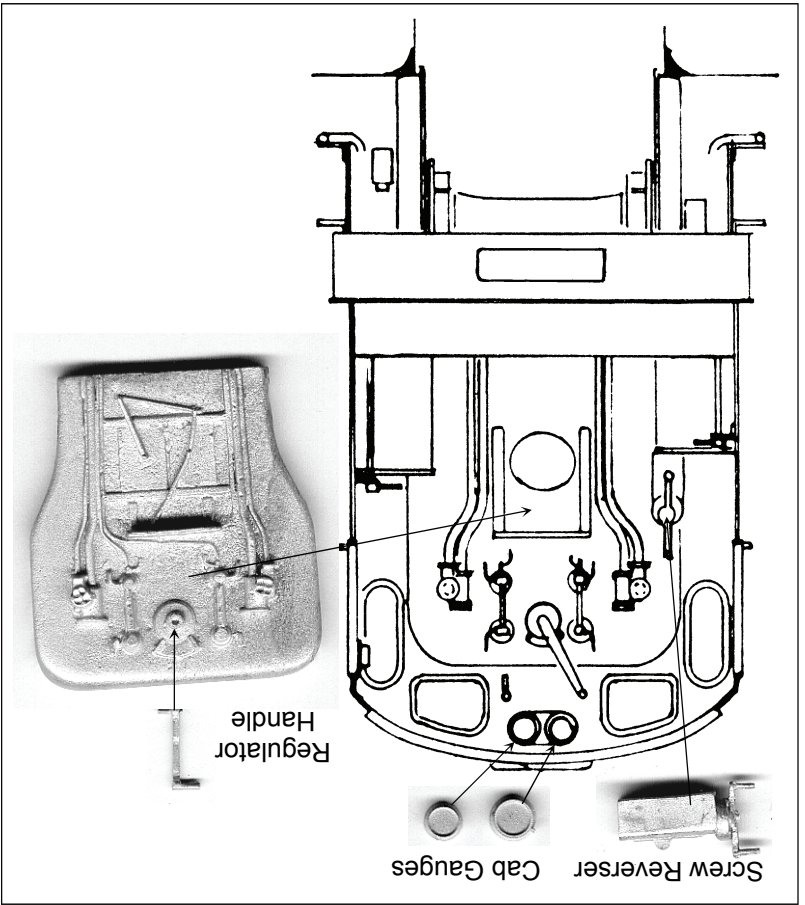


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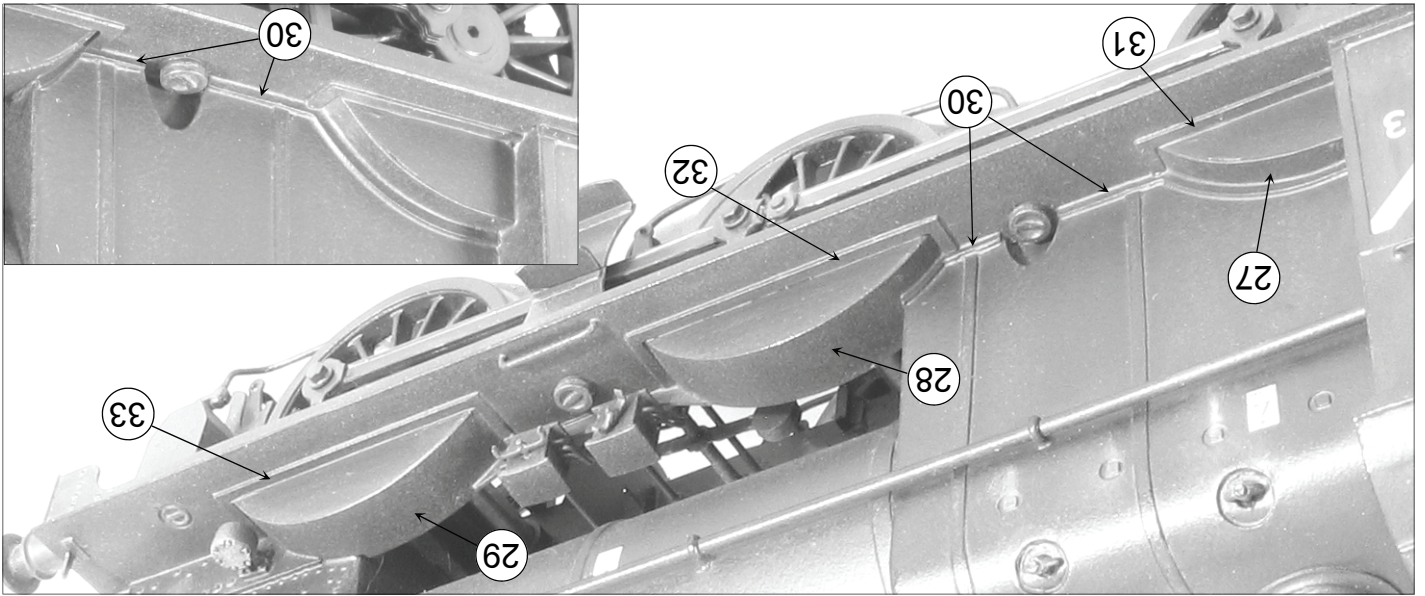




For transfers I would recommend the ones produced by the Historical Model Railway Society, 8 Gilpin Green, Harpenden, Herts, AL5 5NR. You will require sheet number 2, LMS yellow loco insignia or sheet number 14, BR steam era loco insignia. They are also stocked by some specialist model shops such as Home of 0 Gauge.



That should be about everything covered for the loco construction so now build the tender or if this is already built Livery is very easy as all 4Fs were black. You should have numbering details from your prototype research.

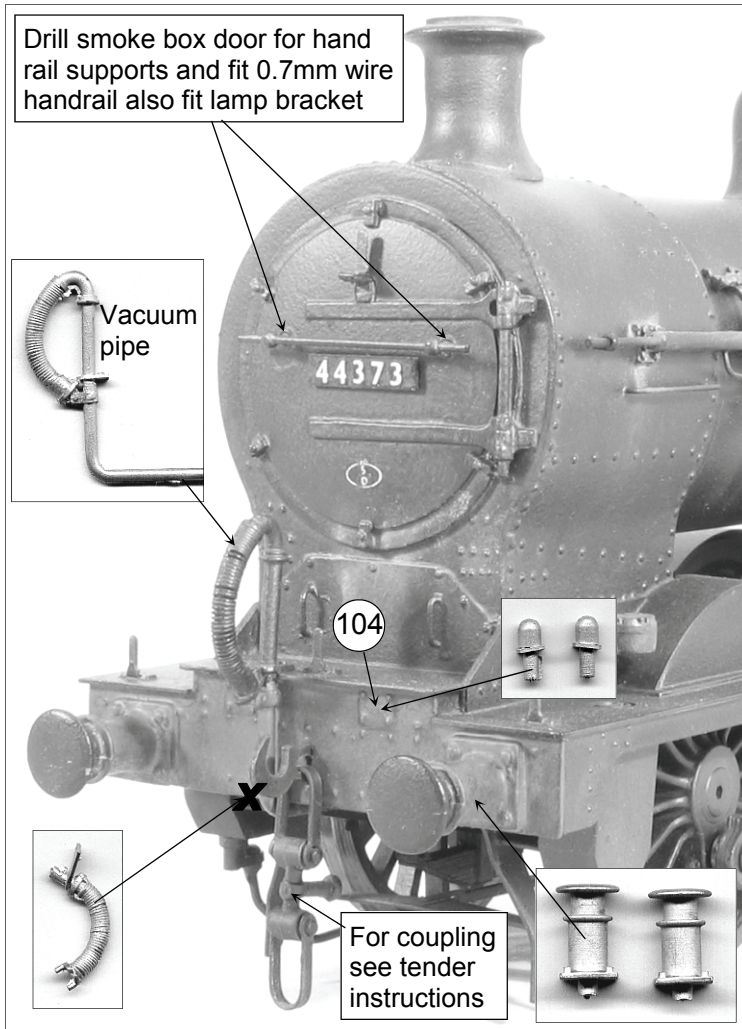


5. Fold the splashers fronts through 90° and fit the splashers tops. I fitted these before finally fitting the smoke box and boiler assembly but checked that the smoke box would fit snugly between the front splashers as I fitted them. You may wish to fit the boiler before the splashers but access is then a little restricted. First using a length of tube roughly pre form the splashers tops (parts 27) rear (parts 28) centre and (parts 29) front. Solder into place with the front edge slightly overlapping the splashers front so that you can then dress the splashers front with a flat file to achieve a crisp square edge. It may be necessary to trim the length of the splashers tops slightly.

Fit the splashers to footplate beading (parts 31) rear (parts 32) centre (parts 33) front. Again it may be necessary to trim slightly to achieve a snug fit. Using a generous amount of flux allow the solder to flood into the gaps and joints and then clean back with knife and fibre glass brush to achieve clean crisp edges.

Fit the firebox to footplate beading strips (parts 30). These are very useful to tidy up the joint.





Originally 4Fs were fitted with long travel valves and tail rod covers were fitted to the front buffer beam and I have provided castings for these. From around the mid 1930s these were removed and a blanking plate was fitted and for these I have provided etched plates (parts 104) so check your prototype photos.

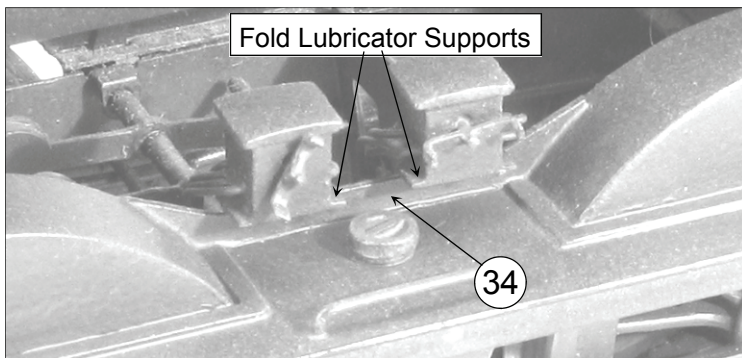
Make up the front coupling (see tender instructions for details) and solder solid into front buffer beam.

All 4Fs were vacuum brake fitted so fit a tall vacuum pipe. Some locos were fitted with steam heat pipes for working passenger trains. I have provided casting for this pipe but I tend not to fit them to models as I find that they can get in the way of coupling up on a layout. Also some locos that were fitted with steam heat sometimes had their pipes removed for the summer.

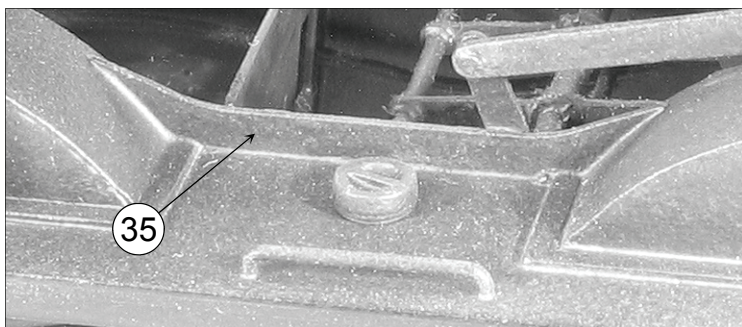
Drill out the smoke box to take the handrail supports and fit handrail made from 0.7mm brass wire. File the tails of the supports flush with the back of the smoke box door. Fit lamp bracket (part 47) to the smoke box door and then fit door to model. I prefer to glue the door into place using Araldite. Fit buffers into buffer beam.

For the cab interior detail I prefer to paint each item separately and then glue them into place after the main model is painted. The spectacle windows could be glazed with clear plastic sheet but I prefer to cut flat sheets from the clear blister packs that many items are packaged in nowadays and use these. This has a textured surface probably caused by the moulding process, which gives it a slightly opaque quality that I think represents dirty windows just right.

6. Take the right hand frame (part 34) and fold the two lubricator support plates through 90°. Fit the frames into the slots in the foot plate between the front two splashes.

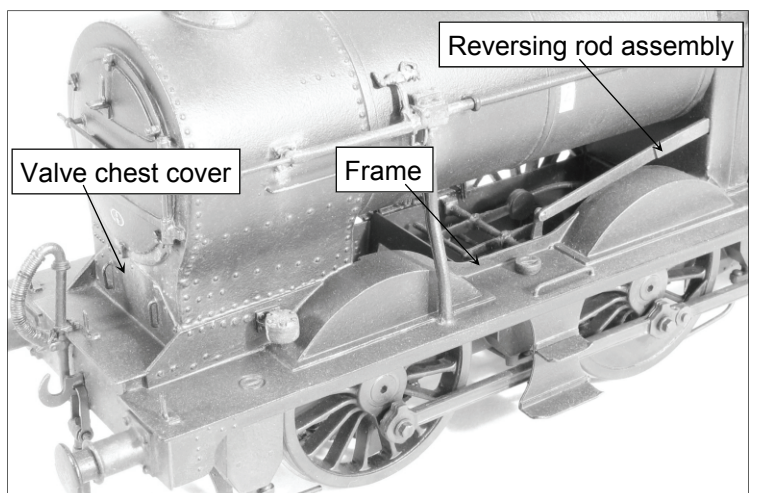
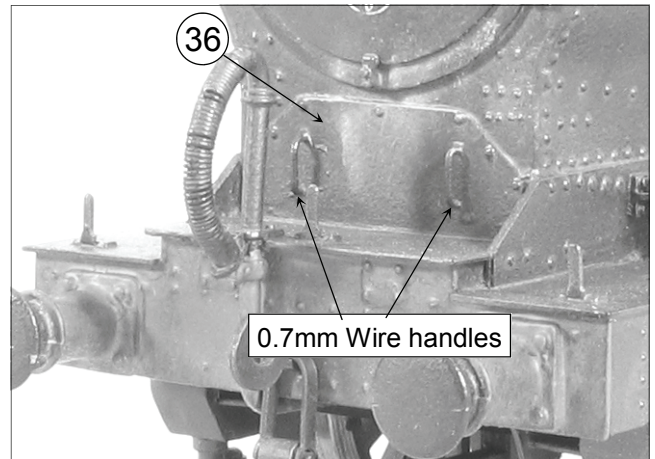


Take the left hand frame (part 35) and solder into footplate.



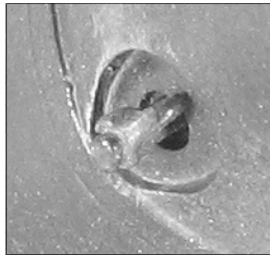
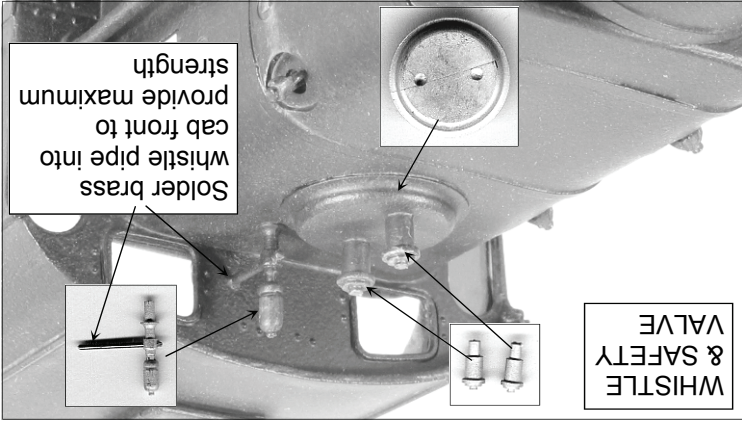
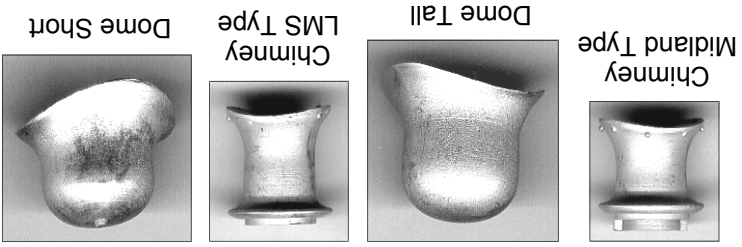
I now fit the smoke box and boiler into place on the footplate. Tack solder it into place first and check by eye from all directions that you are happy with its position and that the footplate is not twisted. Solder all joints solid by working in short sections and checking for footplate twist.

Fit the valve chest cover (part 36) to the smoke box front and fit two handles made from 0.7mm brass wire.

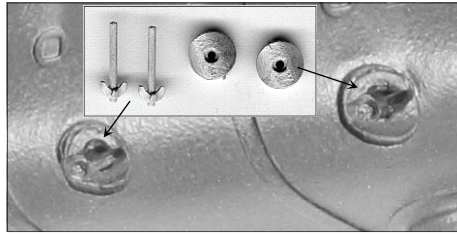




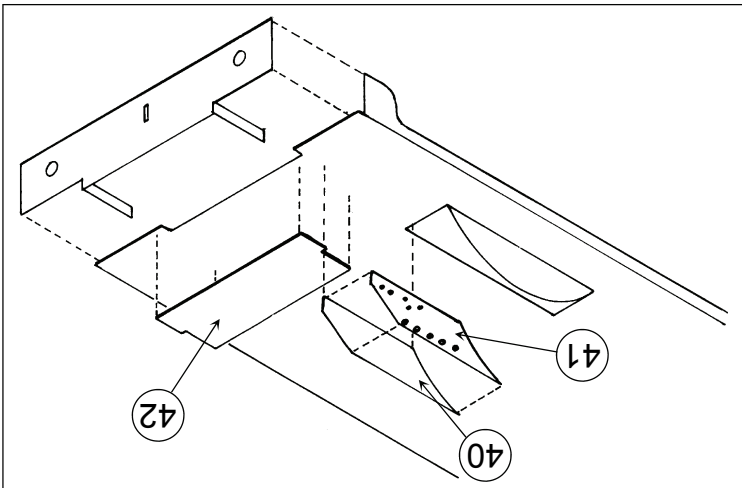
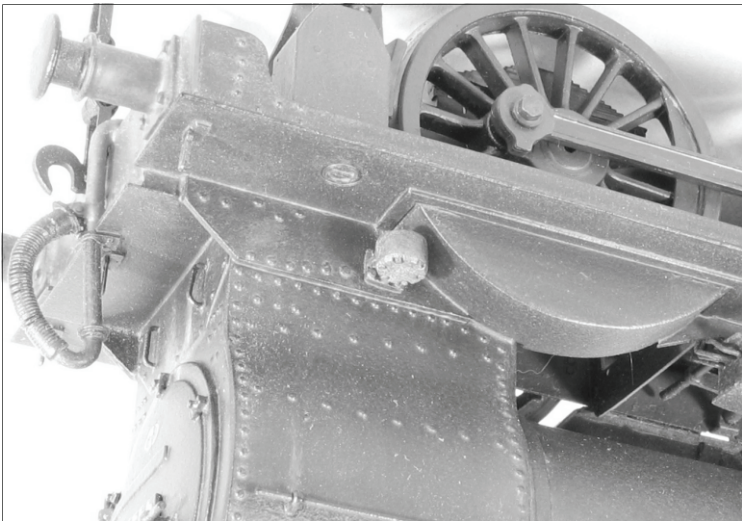
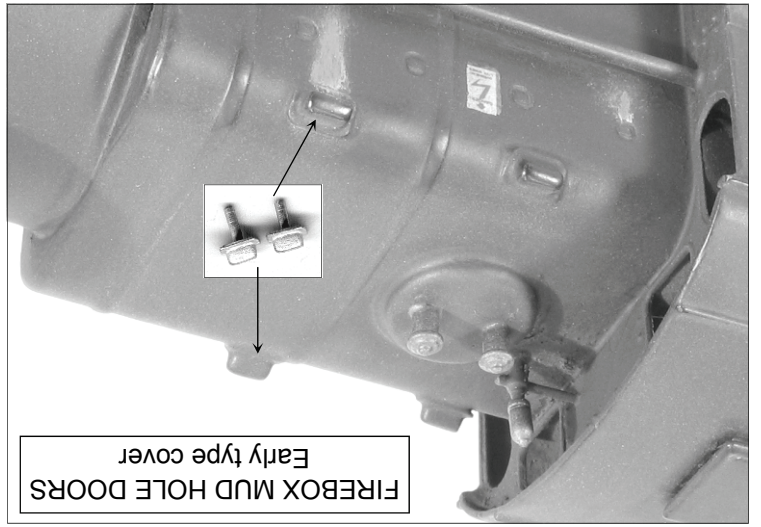
A number of different chimneys and domes were fitted to the 4F class over the years. I have provided two alternatives for each that cover the majority of the class but again check photos of your chosen prototype. As a rule of thumb in early years most of the class were fitted with the Midland type, with or without capuchin, and tall dome. In later years the taller LMS Stanier type was fitted with the short dome. My sample model is fitted with tall chimney and dome just to be different.



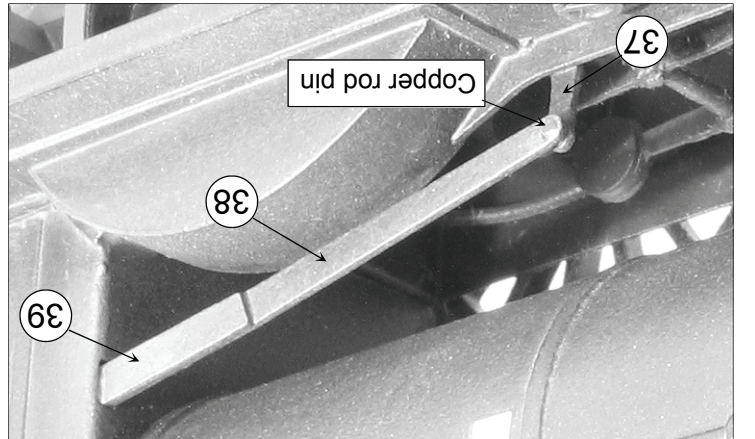
for fitting the early type cover so open these out using a tapered broach or reamer to 4.5mm diameter and remove any burrs from around the holes. Fit the cast clamp into the round body and then mount into holes from the inside of the firebox.



Mud Hole Doors later type. These seemed to be fitted to most locos in BR days but check your prototype photos. I have provided small diameter etched holes

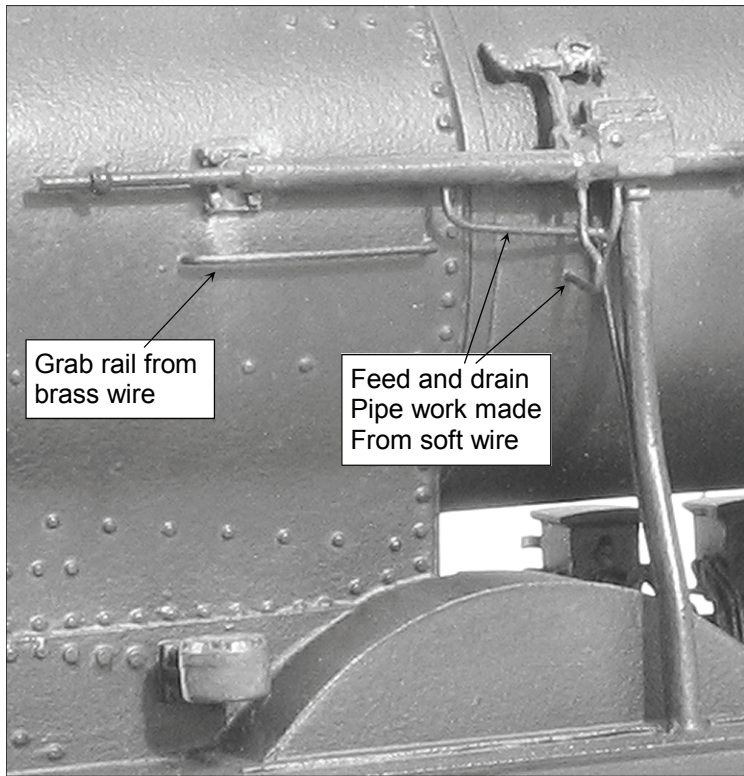


Take the front frames (parts 40) and laminate onto them the rivet detail overlays (parts 41). Solder them to the footplate making sure that they are tight up to the smoke box side and blend in to the splasher curve. Take the front footplate section (part 42) and solder hard against the smoke box front between the frames. It may be necessary to file the part to achieve a good fit.

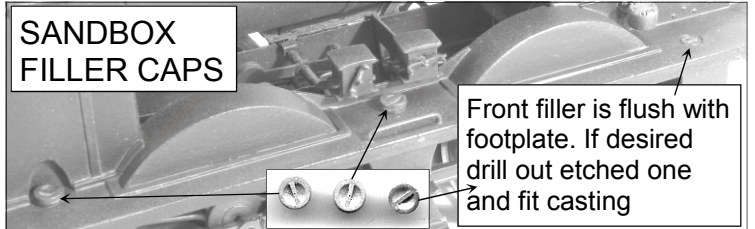
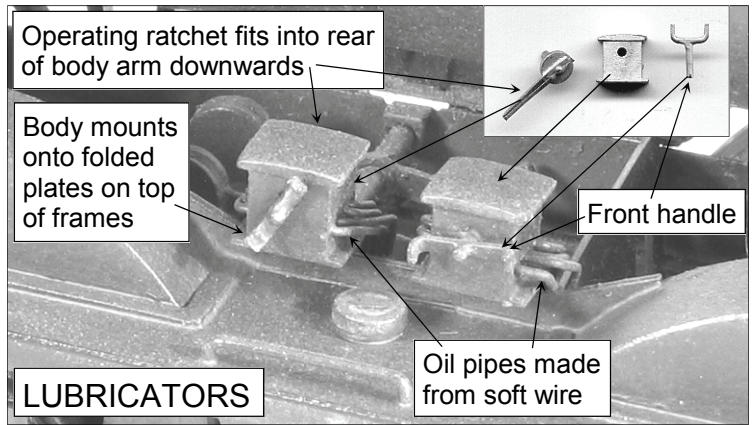


7. Take the reversing gear operating arm (part 37) and solder through the slot in the footplate. Solder a piece of copper rod through the hole in the top to form a joint pin. Take the reversing reach rod (part 38) and solder the cover plate (part 39) on top. Then fit the reach rod through the slot in the fire box front and slide the other end onto the pin in the operating arm.

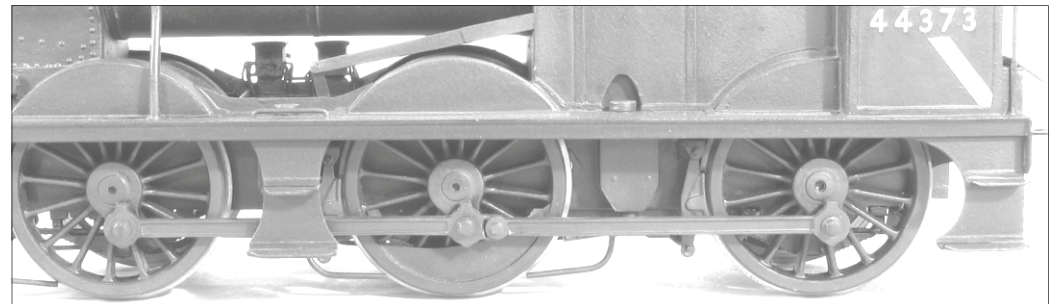
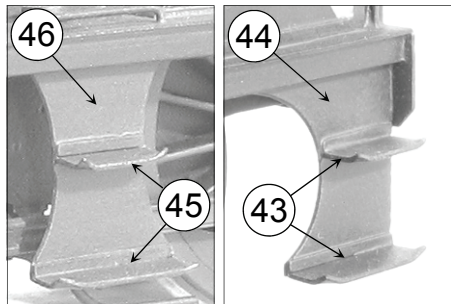
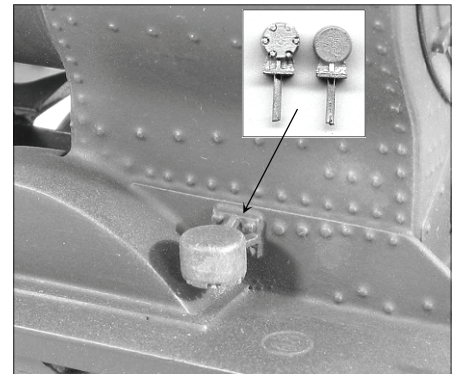




The vacuum ejector had plumbing that you may wish to represent using soft wire but check photos as the pipe runs seemed to vary on different locos. Also some locos had a grab rail below the ejector but this looked like a bodged on addition. Perhaps done at sheds where the loco crew were fed up with burning their hands.



Smoke box Anti Vacuum Valve. These fit either side with the bolt head detail on the underside. Some of the instruction photos show them fitted upside down. This just goes to show that even my own models have parts fitted upside down.

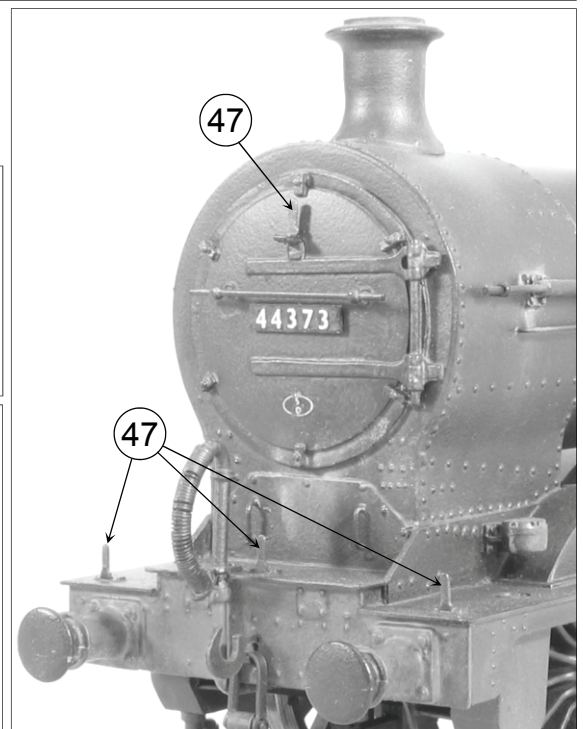
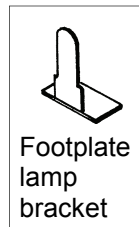


8. Fold the back of the rear step treads (parts 43) through 90° and bend up the two outer corners slightly. Solder the treads solidly into the etched rebates on the step support plates (parts 44) then fold the top forward through 90° and solder the assembled step to the underside of the footplate hard up against the valance. If you have been neat with your previous soldering you should find that I have allowed sufficient clearance in the top of the step to clear the cab side tab etc that projects through the footplate but if the step wont sit down snugly onto the footplate file away the top of the step until it does and then reinforce everything with solder.

Make up and fit the front steps in a similar way using (parts 45) treads and (parts 46) support plates. Fit the grab handles made from 0.7mm brass wire into the footplate above the steps.

Fold up and fit the footplate lamp brackets (parts 47) noting the etched marks to help positioning. Also fold up the smoke box door lamp bracket and place to one side for later use.

I now find that this is a good point to place the body to one side and construct the chassis. Once a running chassis is achieved we can determine that there will be no clearance problems with the body and then the castings and detail work can be applied. Alternatively you may wish to construct the chassis alongside the body.





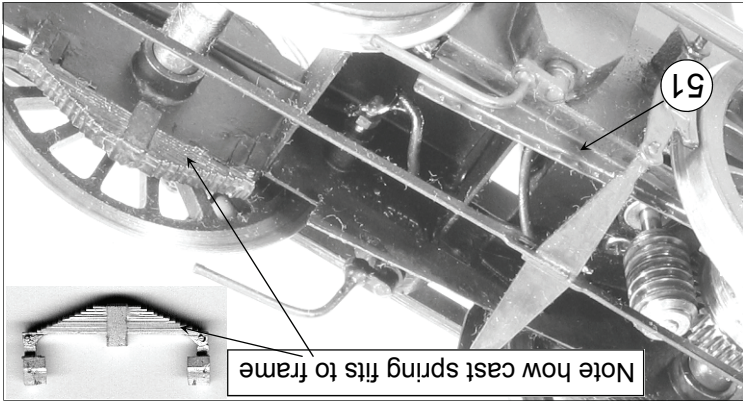
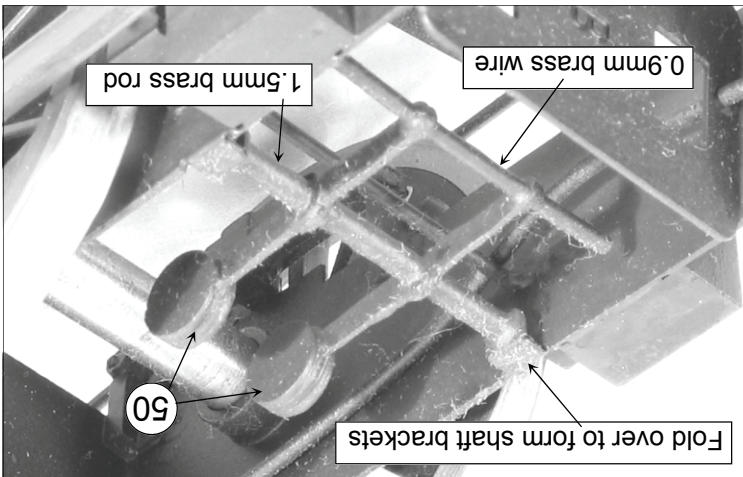
**LMS 4F CHASSIS ASSEMBLY**

9. Take the main frames (parts 48) and using a tapered reamer open out the axle holes so that the turned brass bearings will be a snug fit. If you are fitting plunger pickups then also open out the holes for these so that the housing will be a snug fit.

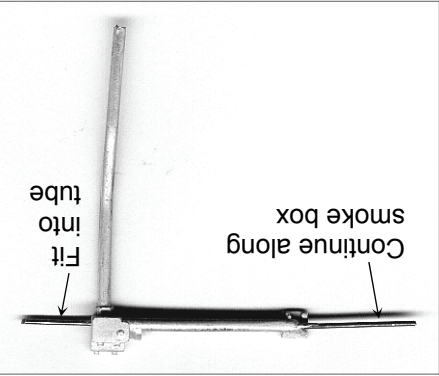
Take the frame spacers (parts 49) and where appropriate fold them through 90°. The rear spacer is slightly tight on the axle gear wheel and so you may wish to fold this one through 95° to give a little extra clearance.

Now pin one side frame down to a flat block of wood with the top of the frame slightly overhanging the edge of the block. Solder each spacer firmly into place. Fit second sidiframe checking with an engineers square that the two sidiframes are exactly opposite each other. Tack solder the second frame at the tabs only and start in the centre and work to each end. Remove the chassis from the wood block and check that it is square and not twisted. Once you are happy solder all joints solid.

Fold the reversing gear weight shaft brackets that project upwards from the top edge of the frames into inverted U shapes and reinforce the folds with a spot of solder. Laminate together the the reversing gear balance weights (parts 50) and fold over the circular ends to form four metal thicknesses. Cut a length of 1.5mm brass rod to a length that will be a spring fit between the frame brackets and thread the weights onto this and solder centrally 6mm apart. Fit a length of 0.9mm brass wire through the holes in the ends of the weights and trim down to slightly less than chassis width and then solder the 1.5mm brass rod weight shaft solidly to the chassis brackets.

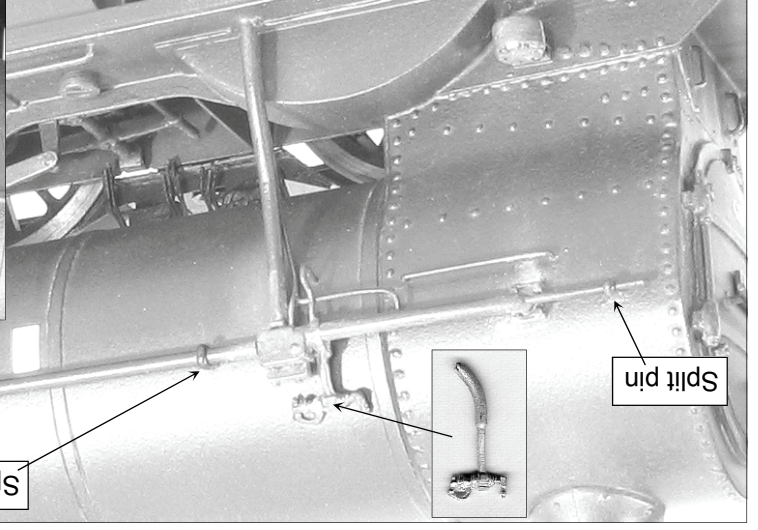
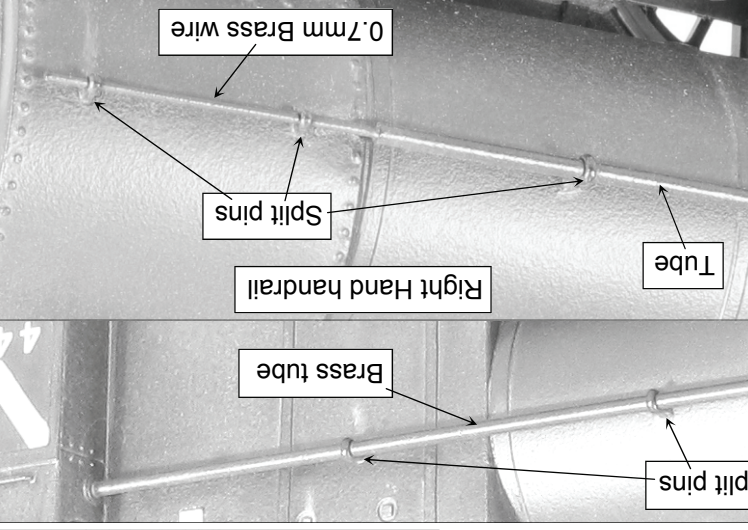


Fold up the ash pan sides (parts 51) and solder into the half etched rebates on the inside of the frames



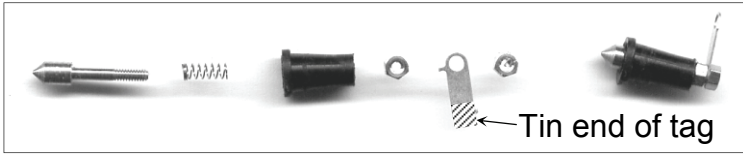
On the model these are represented with brass tube cut to length and opened out split pins threaded on. The split pins are gently squeezed closed at the back so that they form tightly around the tube and then mounted into the boiler. A length of 0.7mm brass wire is fitted into the R/H handrail along the vacuum ejector has 70° solder fitting two lengths of (tinned with 145°) soft wire at the joints between roof and cab side. Using plenty of flux allow a generous amount of 70° solder to flow over the wire and around the joints. Then scrape back with knife blade and clean up with fibre brush to reveal the wire rainstrips and blend the cab roof into the sides with no sign of a joint. Drill out hole in centre of cab roof and fit the roof ventilator.

16. On the prototype loco the boiler handrails were actually pipes the R/H one feeding the smoke box blower the L/H one feeding the vacuum ejector.





In this way I can solder the tinned end of the electrical wire very quickly onto the tag with no risk of heat getting to the plunger. I prefer to fit a separate length of electrical wire to each pickup and join the wires as I terminate them at the motor tags. I find that this is neater and easier than trying to link the pickups on each side together using jumper wires. You will find holes in the spacers that are useful for running the wires back to the motor.



If you are a little unsure about this you can solder the wire to the tag then lock it between the nuts and thread the wire and plunger through the hole in the chassis. Once the plunger is fitted into the chassis I run a ring of Araldite around the housing on the inside face of the chassis side.

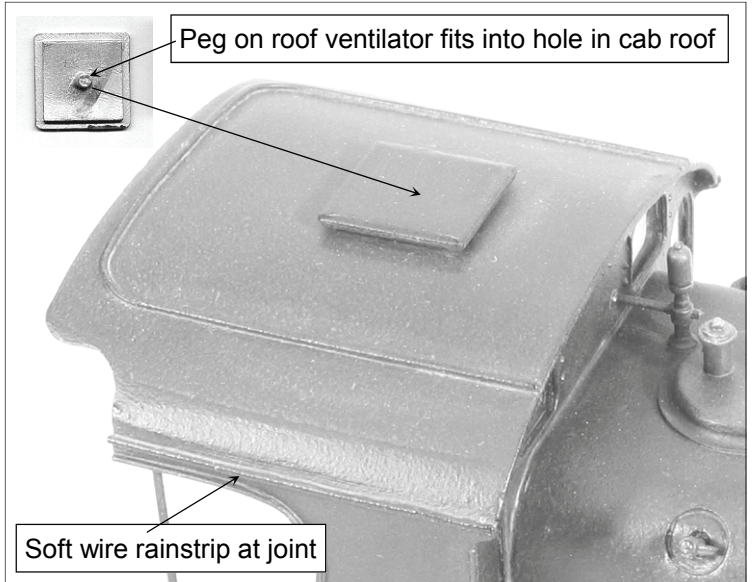
Now clear any paint from the inside of the bearings and refit wheels and rods (gently nip tight the crankpin nuts using long nosed pliers) fitting the gearwheel onto the back axle. Check that the chassis runs freely and then fit and wire up the motor. Hopefully you are fitting one of my motor/gear sets and full instructions for fitting and adjusting to achieve a sweet running chassis are included. If the motor is not one of mine I would happily send you a set of instructions on receipt of a SAE. You should now have a completed chassis that runs like a Swiss watch so its probably time for a cup of tea. While the kettle is boiling you can snip off the extra length of crankpin and dress back flush with the face of the nuts using a flat file. This should create a slight burr on the thread at the nut and this will help to keep the nut locked into place.

If required in the future a slight twist of the nut with pliers will break off the burr allowing you to remove the nuts.

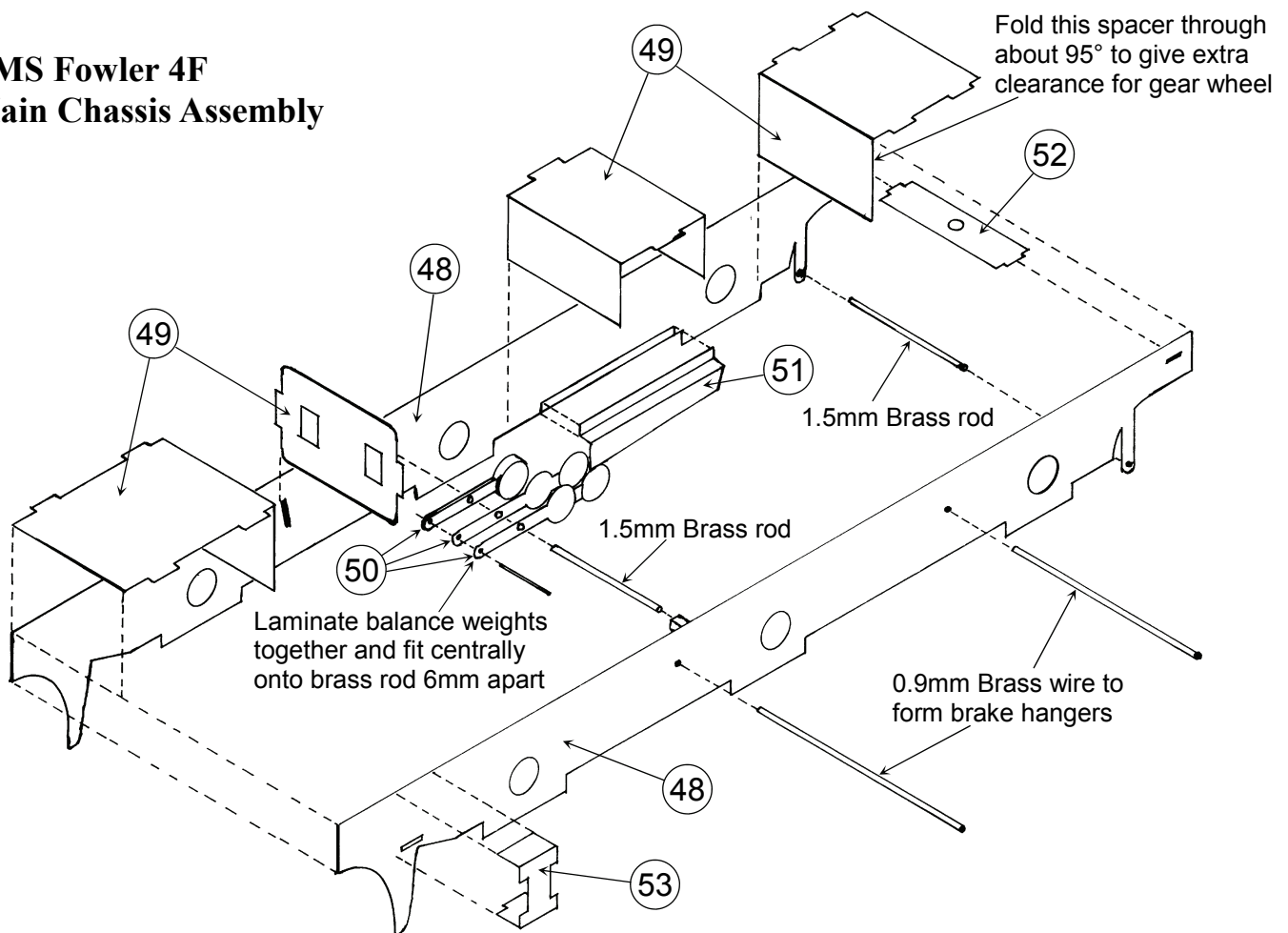
The chassis is fixed to the body using two 6BA screws into the captive nuts that you soldered to the footplate as one of the first operations. No matter how careful you are in building a loco body you will probably have built in a slight twist. It is important that the body does not twist the level chassis out of square so I recommend only locking tight one screw leaving the other slightly backed off.

### CASTINGS AND DETAIL WORK

15. Fit the cast cab roof. As this is a large casting and the cab roof will be very prominent on the finished model a little



## LMS Fowler 4F Main Chassis Assembly

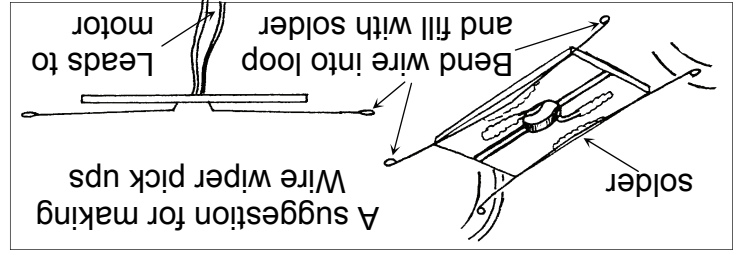




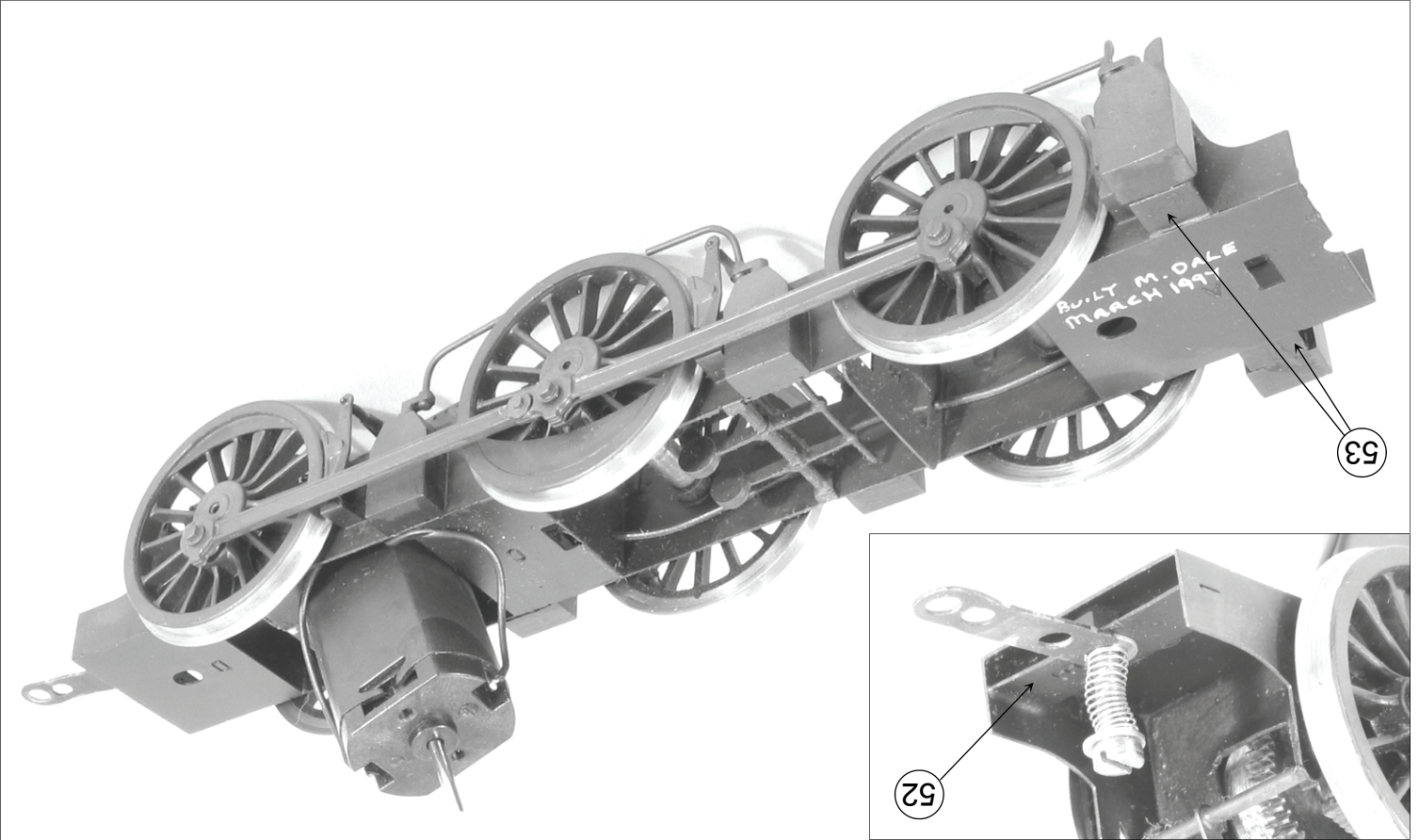
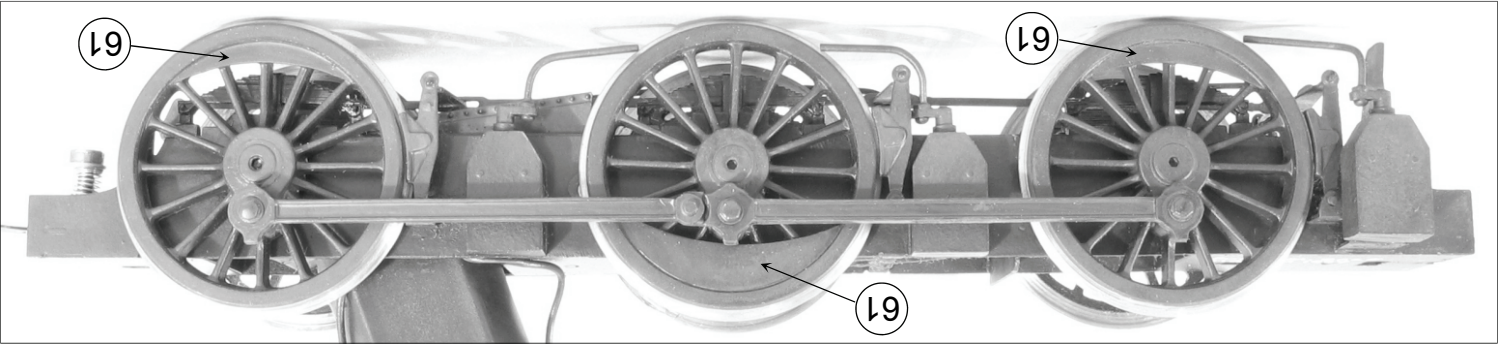
used them almost exclusively on all my locomotive chassis. I prefer to use Slater's plunger pickups and I have placed suitable holes for these in the chassis. I have found that Slater's plunger pickups require a little care in their preparation and fitting if they are to work reliably. Drill out the back hole in the plastic housing 1.4mm. I then run a 2.4mm drill down the inside of the plastic housing twisting the drill between finger and thumb. This will remove any wisps of plastic that may jam the plunger. By twisting the drill between finger and thumb there is no risk of the drill binding and drilling right through the end. Fit the spring onto the plunger and fit into housing running a nut onto the back end. When fully depressed the plunger should sit virtually flush with the end of the housing. It is important that you use the etched solder tag that is locked between two nuts on the end of the plunger. If you try to solder the electrical wire direct to the plunger you will melt the threaded end into the plastic housing. This will cause the plunger to jam in use even if it feels free before fitting (this is probably what people who don't like plungers have done). I tin one end of the etched tag with electrical solder before locking between the nuts.

Fit the wheel balance weights (parts 61) These are best glued into place using Araldite.

14. I prefer to strip down and paint the chassis before fitting the pickups and motor. There are two options for pickups, plunger pickups or wiper pickups. The choice of which is very much to personal preference I have occasionally used wipers (mainly for additional tender pickups on tender locos) and have had successful results fabricating them from 0.45mm spring brass wire soldered to PCB mounting plates Araldited across the chassis. I have included these materials and a suggestion for making them.



For myself I am a great fan of plunger pickups and have



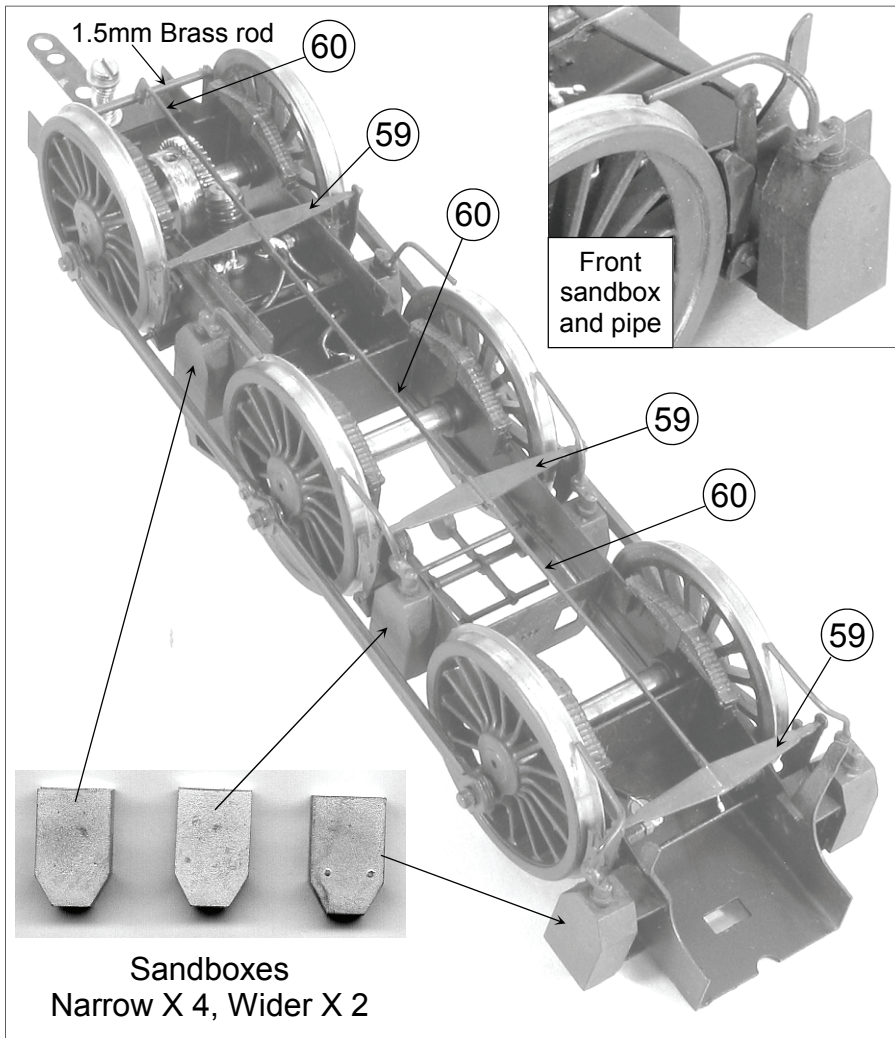
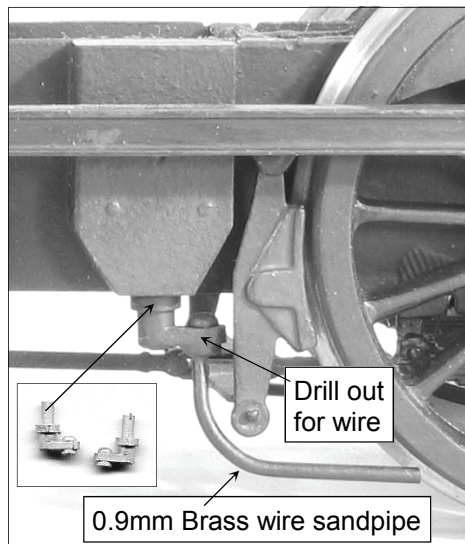
Fold up and fit to the chassis the front sandbox spacing brackets (parts 53). It may be necessary to adjust this bracket later when fitting the brake hangers.

Solder a 6 BA nut onto the top side of the loco to tender coupling bar mounting strip (part 52). Then spring between the frames locating into slots. The tender coupling bar will be mounted onto this using a screw with a spring.

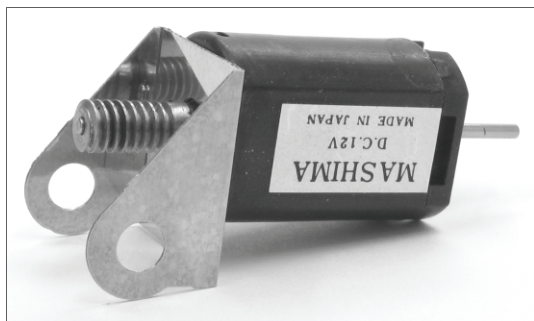


Take the brake cross shafts (parts 59) spring between the brake hangers and solder square and horizontal. Fit the brake pull rods (parts 60) by twisting into place and soldering so that they run straight down the chassis centre line. The rear pull rod is fitted to a cross shaft made from 1.5mm brass rod.

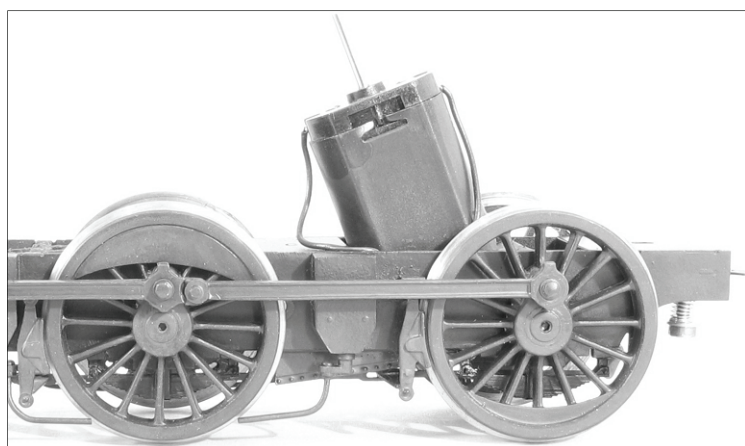
Drill out the bottom of the cast sand boxes to take the fixing peg of the sand chambers and fit these. Then carefully drill out the sand chambers to take a length of 0.9mm brass wire. Fit the sandboxes to the chassis sideframes noting etched positioning marks. Form wire to represent sandpipes and solder into sand chamber so that pipe lines up with the wheel.



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10. Open out the holes in the wings of the motor mount (part 54) to be snug clearance over the turned axle bearings. Then fold the wings through 90° and reinforce folds with solder. Now temporarily screw the motor to the mount and fit the mount between the frames locating into place with a couple of wheel bearings popped lose into the axle holes. Now offer the chassis to the body to determine the correct motor angle required to achieve clearance inside the fire box.



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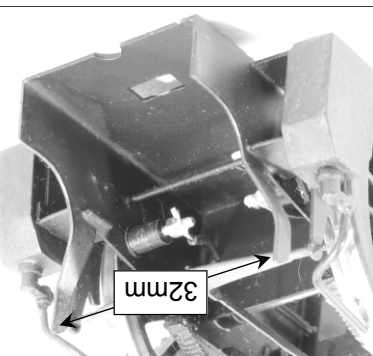
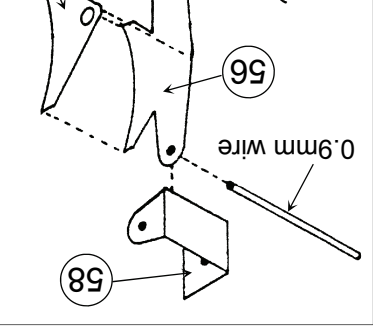
Once you are happy with the motor angle spot solder the mount into place and remove the motor. Solder the motor mount solidly between the frames but ensure that the turned bearings still remain removable. Now solder the turned bearings into the side frames. I pop them into the frames and then pass a lightly oiled axle through them to ensure that they are both correctly aligned. Don't worry if the axle is slightly tight in the bearings as the bearings can be opened out with a tapered broach to provide a nice running clearance once the bearings are soldered solid. It is a good idea to reduce the potential side play on the rear driving axle by packing out the bearings using spacing washers or by pushing the bearings outwards along the axle away from the side frames. A distance of about 28.5mm over the outside faces of the bearings is about right. Maximum side play on the centre and front axles is desirable to help the loco around curves so these should be hard against the side frames. I solder the bearings into place on the inside face of the chassis sideframes by using a generous amount of liquid flux and a hot iron carrying a good amount of solder. I place the iron tip at the joint between bearing and side frame so that the iron is heating both the bearing and the side frame. I find that after a few seconds when the heat has built up the flux pulls the solder off the iron bit and flows around the circumference of the bearing. I find that soldering a bearing this way is a lot more controllable than soldering on the outside face of the chassis side frame.

I would now recommend fitting the cast springs to the chassis side frames. You will have to shorten one leg of the back axle springs so that they will fit onto the ash pan.



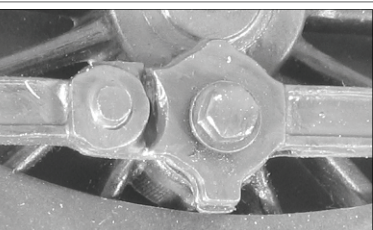
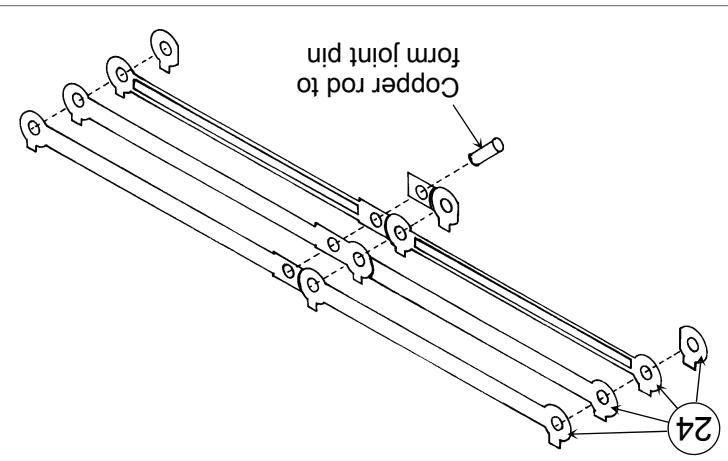
Check that the chassis sits level on a flat surface without rocking (twist slightly if required). The centre wheels are raised slightly to prevent the loco rocking on uneven track and so these wheels won't revolve if the chassis is pushed along the bench.

12. Make up the coupling rods (parts 55) by laminating together the three parts of each section and then fitting the separate bosses. The rods are designed to be jointed by overlapping on the centre crank pin. A short length of 1.8mm copper rod is fitted into the coupling rod at the section that cosmetically represents the prototype joint.



Using long nosed pliers bend sets into the front end guard irons so that they are 32mm (rail gauge) apart.

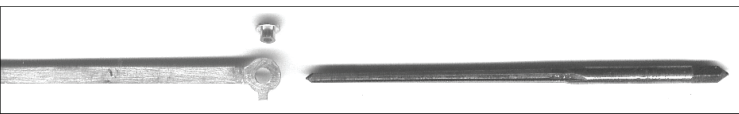
13. Take the brake hangers (parts 56) and solder brake blocks (parts 57) to them. Make up three hand sets. Thread lengths of 0.9mm brass wire across the chassis and spot solder to the inside of the sidestrames. Fold up the brake hanger brackets (parts 58) then thread bracket and brake hanger onto the wire. Solder the bracket to the side frame and line up brake block just clear of the wheel and solder to wire. I find it helpful to hold the brake hanger using a miniature electrical crocodile clip as I solder it in position. I fit all six brakes to roughly line up with the wheels first and then work around tweaking with pliers or resoldering until I am happy that they are positioned correctly with no risk of touching a wheel.



11. Now prepare the Slater's wheels. Remove any plastic flash or moulding pips from the backs of the wheel by rubbing them flat on a piece of fine emery cloth (this flash can sometimes interfere with the plunger pickups). The crankpin screw head needs to be flush with the back of the wheel (it may interfere with the shoulder of the bearing otherwise) so it will be necessary to drill a countersink hole. Use a 2.5mm drill in a hand held pin chuck. Drill gently and keep checking with the head of the screw until the hole is the correct depth. The screw is designed to self tap into the plastic and then lock itself. I don't trust this and prefer to screw it in until the head is just proud of the wheel back. I then fill the countersink hole with Araldite and then screw it in until it locks. Leave the wheels until the Araldite has set and then clean of any excess Araldite by rubbing the wheel on the emery cloth. This should leave the screw head embedded in Araldite and prevent the potential problem of the screw turning when you are trying to undo the crankpin nut.

You may find that the square axle end is a tight fit into the centre of the wheel and this needs correcting. With a fine flat file gently dress each of the four sides of the axle end. I find it helps to lay the bottom flat of the axle end onto the edge of a block of wood. This helps me keep the file parallel as I file the top flat. Offer the axle end into the wheel centre and repeat if necessary. You are aiming to get a gentle push fit but with no rocking or movement on the square. A good guide is to get it so that you can remove the wheel from the axle with just your finger nails around the steel tyre. If you have to grip the tyre with your finger ends to pull it off you will find it difficult to remove the wheels to paint the chassis. Once happy fit the wheel sets into the chassis remembering to quarter the wheels (the crankpins on one side should lead the other by 90°).

Now open out the crankpin holes in the rods to accept the brass top hat bearing bushes. This is best done with a tapered broach or tapered engineers reamer (I have one that tapers from 3mm to 2mm and is 40mm long (see yellow pages for a good engineers tool merchant they are not cheap but will last a lifetime). With the reamer gently work from both sides of the rod until the bush is a smooth free fit into the hole.



Now fit the rods and check that the chassis runs freely and that the wheels will turn without binding. If you do have a problem gently revolve the wheels with your finger tip until you hit the tight spot then check the rods. You should find that one rod still moves freely on the crankpins and this side is OK. You should find that the rod on the other side is tight on the crank pins and this is where the problem is. Normally the problem is a crankpin screw that is not square in the wheel (unless you have reamed the hole in the rod out of square). With a round file gently file oval the hole in the rod until it fits freely onto the crankpins and then refit the rod and check the chassis again.

At this stage don't worry about slight tight spots. If you can push the chassis along the bench without the wheels skidding along then all is OK. As the wheels are best removed for painting the chassis the chances are that they will not go back on in the same place. The correct point to make final adjustments is after painting and fitting pickups but before fitting the motor. If you have filed a crankpin hole in the rods oval it is worth marking this wheel so that you can