HUDSWELL CLARKE
0-4-0 SADDLE TANK

The prototype of this model was built in 1937 (works number 1672) by Hudswell Clarke & Company of Leeds, a firm specialising in industrial locomotives. It was destined for Manchester Corporation's Stuart Street power station, where there was a requirement for a small shunting engine with a low axle loading for use on lightly laid track set out on several different levels. The engine worked at Stuart Street for more than thirty years, latterly under CEGB ownership, before moving to Willow Holme power station in Carlisle. It did little work here, however, before being sold for preservation. No 1672 arrived at the Tanfield Railway in Co. Durham in 1976, and has been beautifully restored to working condition. It now has vacuum brakes for operating passenger trains and is popular both with crews and visitors.

At Tanfield the engine carries the name Irwell, which is shown on official Hudswell Clarke works photographs of the newly completed locomotive, although it may not have borne this name in service. Indeed, according to the records of the Industrial Railway Society, the engine was named Coronation for at least some of its time at Stuart Street, in recognition of the coronation of George VI on 12 May 1937. It was even rumored to have been photographed alongside the newly completed LMS streamlined Pacific of the same name, in a classic 'dignity and impudence' portrait. No 1672 was painted in 'Coronation Scot' blue (latterly much blackened) and lined out in yellow but when it went to Carlisle it was repainted maroon; the engine now carries an elaborately lined livery of dark green.

Hudswell Clarke continued to build similar locomotives well into the post-war years, although No 1672 owed much to an earlier version - the general layout, in fact, dates back to the firm's small open-cab locomotives of the late 1800s. No 1672 has a 'haystack' firebox of archaic design and the cylinders are 11 in bore x 16 in stroke; the wheels are 2ft 9in diameter. Unusually, the dome is in the cab and the safety valves vent through the roof. The model has the original rear sandboxes, although the prototype now has one of the Austerity type fitted to the left-hand side.

GENERAL NOTES ON CONSTRUCTION

This kit is designed to take the Mashima 1220 or 1224 motor and 11mm diameter driving wheels (ref. G4835 followed by either OO/EM/P4) from Alan Gibson. As far as we know, no other commercially available wheel on a 1/8in axle has the correct crankthrow. If you use wheels with a larger throw, the crosshead may clout the motion bracket.

Read the instructions carefully - preferably more than once - before starting work. Study the diagrams until you become familiar with all the parts and the way they go together. We have tried to make these instructions as comprehensive as possible, which may make some assembly sequences appear more complex than they actually are. The kit can be built to OO/EM/P4 without modification - alternative parts are provided where appropriate.

This is a highly detailed kit containing many small parts, some of which you may choose to omit. We recommend solder assembly throughout, using a resistance soldering unit and/or a 25w iron with the smallest available bit, but the saddle tank can be glued in place with a two-part adhesive (Super Steel is perfect for this kind of work). If you prefer to glue the details, do so only when soldering of the main superstructure is complete. Heat from the iron will destroy glued bonds and some adhesives - notably cyano superglues - give off toxic fumes.

Leave the parts in the fret until they are required for use. This will protect them and makes identification simpler. Small holes can be drilled more easily while the parts are still attached. Where an accurate hole size is specified, holes are etched undersized so they can be drilled or reamed out to the correct diameter. Except where you have a visible outside edge, such as along the footplate or cab sides, it is advisable not to file off the cusp around the edges of components, especially with dimensionally-critical parts such as formers and spacers. The slight alteration to their dimensions could be enough to affect the way they integrate with other parts.

We built a number of kits from test etches - and revised the artwork accordingly - before we were satisfied that every part fits as it should, first time. Other than the routine filing-off of tabs as parts are detached from the

frets, you should not need to modify any of the components in any way. If something isn't right, think twice before reaching for a file. Any problem getting parts to fit is likely to be caused by errors earlier in the assembly sequence. Distortions and misalignments can build up and it becomes more and more difficult to get parts to fit until, eventually, the kit could become almost unbuildable. Backtrack through your work and look for things like excess solder, tabs not fully filed off, inaccurately formed parts or alignments that are not quite true. If you try to 'correct' any of the components, you might well make more trouble for yourself.

The brass sheet material used for etching is supplied as a roll, and this can cause some of the components – particularly the larger, half-etched parts – to curve slightly when separated from the main fret. Check all etched parts for flatness and tweak as necessary before use.

All fold lines are etched on the inside of the bends. When soldering parts in place, tack-solder first in one spot only, and then check that everything is as it should be before final soldering along the joint. Moving a part that isn't aligned correctly can be difficult if it has been tack-soldered at more than one point. As always, plan ahead and think through every move before soldering parts together. If you are patient and careful, you will find that building this scale model locomotive becomes an immensely rewarding experience.

This is a tiny locomotive with small wheels. Its power will surprise you but good current pick-up may be a problem unless you make the engine as heavy as possible. Fill every available space inside the body with lead ('Liquid Lead' is ideal for this). To keep the engine running well, you may need to clean the wheels and track more often than usual. At the same time, you can check that the pick-ups are still doing their job, adjusting them as necessary.

BODY ASSEMBLY

Footplate and smokebox
Refer to Figure 1. Invert the footplate (1) and solder on the valances (2 x2), up against the half-etched groove. Bend the bufferbeam locations (A) down through 90 degrees and strengthen the bends with solder. Bend up the small lugs (B) at the front of the footplate.

Bend up the smokebox (C) former and ensure it is exactly at 90 degrees to the footplate. Strengthen the smokebox former bend with solder. Ignore the firebox former (D) for the moment. Solder an M2 nut over the front hole in the footplate (on top) and at the rear (underneath)

Using a 0.3mm drill bit, open out the front lamp iron location holes in the smokebox front (3). Fit this into the footplate (the full-etched strip and ring detail face forward) and use a straight edge along the vertical side faces to check that it sits exactly in line with the former (C). When satisfied, solder the smokebox front onto the footplate.

Bend the smokebox wrapper (4) to shape, noting that the bend lines for the side angles are inside with the half-etched groove at the rear of the wrapper to the outside. Make sure the wrapper a good fit in the former and then solder it in place. Don’t worry if there’s a gap at the bottom of the wrapper, where it meets the footplate - this will be covered with a rivet strip. File the front locator tab flush with the smokebox face, taking care not to damage the etched smokebox door ring. Working up the drill sizes, open up the chimney hole to 2mm and smooth off.

Cab assembly
While it is still flat, drill out the holes on the firebox former (D) to accommodate the lost wax parts (21 and 22) illustrated in Figure 3 (use a piece of wood to support it as you do so). Now bend up the firebox former, checking it is at exactly 90 degrees to the footplate. Anneal the firebox wrapper (5) and then, using the firebox former as a guide, bend it to shape, but do not fix it yet. Note that the top of the firebox has a gentle radius, but the corners are sharper. Open out the dome location hole in the firebox wrapper, smooth off and then put the wrapper aside.

Drill out the two location holes in the front of the cab frame (6) to the sizes shown in Figure 1. Bend up the cab frame - all bends are 90 degrees - starting at the innermost bends (nearest the centre) and working outwards. Fit the cab frame onto the footplate. Tack only, making sure the solder does not go along the joint where the cab wrapper’s bottom edge will sit. If necessary, clean this area with a blade or square file.
Now fit the firebox wrapper. The slot (E) at the rear of the wrapper locates on the tab at top of the former, while the small locator at the front edge of the wrapper locates in the lower of the two central holes in the cab frame.

The bottom edges of the wrapper should sit just below the level of the footplate. Solder the wrapper in place, not forgetting to do the bottom edges (at the footplate joint) and the front edge where the wrapper touches the cab frame. (This wrapper is structural, being a brace for the cab front as well as part of the 'backbone' of the monocoque bodywork).

Punch in the handrail rivets on the cab sides (7 and 8) and do the same for the reverser brace ('J', Fig. 3 - RHS only). Fit the cab sides. When soldering them in place, make sure they are pushed right up against the cab frame and that there are no gaps along the bottom edges - i.e. the tabs are fully home.

Fit the cab front (9). It should sit between the protruding front edges of the sides Open up the blower pipe hole (F) and whistle hole in the cab front. Drill these holes right through the cab frame. Locate the rear end of the reverser rod (10) in its slot and use a piece of 0.4mm wire to locate the front of the rod on the inside of the small lever (G), which bends up from the footplate. Solder the rod in place and trim the outer end of the wire almost flush and the inner end completely flush.

The maker's plates (11 x2) can be soldered on now, or glued on after painting. Position the centre of the plate, as shown in Figure 2.

Fitting the saddle tank

Clean any flash or mould lines from the saddle tank casting (12). Drill out the handrail holes in the saddle tank, fit four short handrail knobs and then fix the handrails in place. Trim them to length, as shown in Figure 2. Solder or glue a length of 0.5mm wire into the central hole in the tank filler and trim the wire so about 0,5mm is protruding and then grind the wire flush on the inside.

Open out the large hole in the front of the saddle tank, so an M2 bolt is a snug fit. Drill a 0.8mm hole into the rear of the saddle tank and tap this with a 14BA C/S bolt, cut to about 4mm long. This is more easily done if the hole itself is slightly countersunk.

Remove both bolts, position the saddle tank on the cab front and fasten it with the 14BA bolt, nipped up (not too tight). This will position the rear of the saddle tank. The top edge of the tank should sit just below the window beading. Use a pair a tweezers to hold an M2 nut in the cavity between the rear smokebox former and the tank front, and screw a bolt through the former, into the nut and finally, into the saddle tank. Lightly nip the nut up against the former. The front of the tank can now be positioned by moving the M2 bolt vertically and horizontally in the former. If you can't gain sufficient height at the front of the tank, try looking for excess solder inside the wrapper, around the top of the former.

Sight the tank from the front and check that it protrudes by equal amounts at either side of the firebox. When you are satisfied with the position of the tank, and the footplate and the rest of the structure are seen to be straight, solder or glue the bolt into the smokebox former. There may be a slight gap between the back edge of the smokebox and the front of the tank, but this will be covered with a rivet strip. Solder or glue around all other points of contact, and clean up as necessary. Fit the small tank supports (13 and 14) onto the cab front, at the underside of the saddle tank's bottom rear corners.

Trim off the temporary cab cross-braces on the cab front, and grind them flush with inside of the firebox. Grind away the protruding tank mounting bolts, so they are flush with the inside faces of the tank.

Cab fittings

To make assembly easier, the cab interior is designed to be completed before the cab rear and roof are fitted. The boiler backhead and the steam dome should be treated as sub-assemblies, with fittings already in place before being added to the cab. Be careful not to bend the side sheets while working on the cab details - as a temporary reinforcement, you can bend up a u-shaped length of thick wire and solder it to the inside top edges. Remove this brace before fitting the cab rear.

As well as providing a host of small parts, the kit gives you the option of adding super-detailed pipework between the various cab fittings, using either annealed 0.3mm wire or 5amp fuse wire (not supplied). In some cases, you will probably find it easier to solder the pipework in place while the parts are still in the sprue, although the final plumbing-in will be done once the components are in place. Study the diagrams carefully so you know what goes where. This super-detailing can be quite a challenge and if you don't wish to go quite so far, then you can skip some or all of these parts. Ignore the instructions where they suggest using 0.3mm wire

and don't bother drilling out the brass fittings. It is, however, important to fit these parts in the correct order, as described below.

Referring to Figure 3, bend a sharp angle in a piece of 0.5mm wire and solder it into the inner hole in the footplate and the hole in centre of the right-hand bunker, to represent the water feed pipe (H). Sharply bend the legs on the cab seat (15), right under the seat, and fit the seat tab into its location on the same bunker. At the same time, slot the legs into their holes. Fill the bunkers with finely chopped lead - it looks remarkably like coal when painted - and dribble in some diluted PVA glue to hold it in place.

Drill out the water handle (16) and solder it onto a piece of 0.4mm wire, bend the end upwards and push it into its location in the cab floor next to the water pipe, leaving the underside of the handle about 6mm above footplate level. Drill a 0.4mm hole in the reverser (17), as shown, and fit the reverser into its slot in the footplate. Run a piece of 0.4mm wire from the hole in the reverser, under the water handle and into the indent (J) on the right-hand cab side. Solder the wire in place and trim the end so it is slightly proud of the reverser face.

The cab steps (18 x 2) will be bent up after they are in position, as shown in Figure 1. Form the rivets on the steps and then manoeuvre them through the footplate slots and solder in place. Bend the bottoms up through 90 degrees and then finally, using flat-nosed pliers, turn the side edges up through about 30 degrees. Reinforce with solder and be careful not to bend the steps during later stages of assembly.

Refer back to Figure 3. Fit the coupling spring cover (19) to the cab floor (20) - cutaway facing downward - and then fit the floor into the cab. It is supported on the tops of the steps and the two lugs at the sides fit into the doorway opening. Watch you don’t damage the cab seat when manoeuvering the floor into place.

If you're going to town with the cab fittings, drill out the hole in the top of the Detroit lubricator (21) to accept 0.3mm wire and use the drill start in the bottom of the steam brake (22) to make a 0.7mm hole (don’t drill this too deep). Use small angled cutters (or a piercing saw) to remove the lubricator and brake from the sprues. Before removing lost wax parts, study the diagrams in order to ensure that you leave the mounting pins/feeds long enough to locate the bits correctly.

Fit the Detroit lubricator and the steam brake into their locations on the firebox former and grind the locator pegs flush at the back. Using the drill starts provided, drill small holes in the firebox wrapper, just behind the brake and lubricator mounting brackets, (marked ‘K’, Fig. 3). Bend the end of a length of 0.3mm wire to 90 degrees and locate this in the hole behind the lubricator bracket. Run the wire so it disappears down the left-hand side of the firebox, as shown in Figure 4.

Position the whistle (23 - see Fig. 1) so the back of the whistle body is 1.5mm from the front face of the cab, solder it in position and trim the pin flush on the inside. Solder a length of annealed 0.3mm wire into the small whistle feed pipe hole, inside the cab, below the whistle mounting hole. Leave other end of this wire free for the time being. Drill 0.3mm holes in the angled (24) and straight (25) taps. Now drill the ends of the steam turret (26) and - very carefully, and only if you feel confident in doing so - drill a third 0.3mm hole on top of the steam turret, using the drill start provided. Drill out the dome (27) to accept these parts, then solder or glue the two taps (noting that they are different) and the steam turret into the dome. Use epoxy to fix the dome in place on top of the firebox.

Bend a length of 0.3mm wire to run from the left-hand side of the steam turret, into the top of the lubricator. Link the angled horizontal tap on the right hand side of the dome, with the hole in the firebox wrapper, behind the steam brake. Use 5-amp fuse wire to link the straight vertical tap on the dome, with the small hole just under the back of the whistle. Run 0.3mm wire from the right side of the steam turret, so it disappears down the side of the firebox. Then fix the etched safety valve lever (28) into the dome assembly.

Refer to Figures 3, 4 and 5. Using the drill start provided, drill a 0.3mm hole in the bottom of the steam pressure gauge (29) and solder in a length of 5-amp fuse wire. The wire runs around the top of the gauge, back towards the steam turret, passing around the side of the angled tap (on top of the dome) before finally locating in the small hole in the centre of the steam turret. Try and form the wire as near to shape as possible, before fitting the gauge and wire into the location in the cab frame and linking up the pipe.

Drill out the location holes in the backhead casting (30) to suit the various components, illustrated in Figure 3. Solder or glue the etched shelf (31) onto the backhead casting. Use 0.4mm wire to locate the etched firedoor

lever assembly (32), secure in place and trim the wires almost flush. Bend up the end of the regulator (33) and use a piece of 0.4mm wire to locate it on the backhead. Trim the wire almost flush. Fit the gauge glasses (34 x2) to the backhead.

Drill out the injectors (35 x 2) to 0.5mm and solder two lengths of annealed wire into them. Fit the injectors to the backhead. The injector pipes nearest the backhead run straight down and should be trimmed flush with the bottom of the backhead (offer up the backhead to the firebox to check the fit and trim off more if necessary). Bend the outermost pipes around the side of the backhead, so they will disappear along the sides of the firebox when the backhead is in place. Push the injector handles (36 x 2) into their holes until they sit slightly proud of the front of the injector bodies and fix them in place to make the injectors a handed pair.

File off any mounting pins protruding at the back of the backhead casting and then offer up the assembly. Tweak the injector pipes as necessary. When satisfied with the fit, glue the backhead in place, so it sits centrally in the floor well and on the footplate. You will notice that the backhead is a different shape to the firebox, which is how it is on the prototype.

Refer to Figure 5. Take a length of 0.3mm wire, make a 180? bend in the wire, and then squeeze the bend with pliers to make it as sharp (and narrow) as possible. Shape the wires as shown, and then thread the bent-over end up through the slot in the cab floor, behind the outermost injector pipe, and locate it in your pre-drilled 0.7mm hole in the underside of the steam brake valve. Tweak as necessary and solder the double pipe run into the valve and into the slot in the floor.

Once the cab detail is complete, remove the wire cross-brace. You may like to paint the front half of the cab interior before fitting the cab rear - stay away from the back area as the cab rear and bufferbeam have yet to be soldered on. Alternatively, the interior can be painted before the roof is fitted.

Refer back to Figure 1. Make sure the cab rear (37) is flat and tweak if necessary. Bend the handbrake cover top outwards, bend, and fit the handbrake cover back (38). Trim the excess cover from the inside of the cab rear. Slot the rear lamp iron (39) through its location, solder it in place and then bend it up through 90 degrees at the outside

Carefully centralise the cab overhang (40) on the bottom edge of the cab rear and then solder it in place. Use the sides of the overhang for vertical location of the cab rear, making sure the ends of the overhang are hard up against the short underside edges of the cab sides (Check with a straight edge across the top edges of the cab front and rear - this is of vital importance as it will affect fit of the cab roof). The cab rear sits between the sides. Tack the cab rear - top and bottom - before running the solder all the way down the corner joints. Fit the handbrake stanchion (41) into its location in the cab floor.

Gently curve the cab roof (42) to match the profile of the cab and then fit the dummy vent top (43) to the underside of the roof. Trial-fit the roof - it may be necessary to trim the top of the dome's vent stack so the roof sits fully down – and then put it aside for painting before fitting it to the cab, using a high-quality adhesive such as Super Steel.

Footplate and smokebox details

Punch out the rivets on the bufferbeams (44)(45). Fit the buffers (46X4) and file the locators flush at the back.

Use a 14BA bolt, or a piece of 1mm wire, to locate the beams using the small hole at the top of the lug ('A') on the footplate. When the beams are level and vertical solder them to their tabs and to the footplate edge. Remove the bolt or wire. Fit the rivet strip (47) to the rear bufferbeam, under the cab overhang and then fix the coupling details (48 x2) to both beams.

Refer to Figures 1 and 2. Fit the short chassis top rails (49 x2), followed by the long cranked rivet strips (50 x2) along the side of the smokebox and finally, next to these, the straight footplate rivet strips (51 x2) on the footplate top. Slot the tabs on the cover plate (52) into the smokebox front, so it rests on the two bend-up supports (B) and solder in place. It should be level. The small cutaway at the front edge of the cover plate should face downwards.

Curve the smokebox top rivet strip (53), fit it on top of the smokebox, and check the chimney fits into the cutaway. File a little more from the cutaway if necessary, remove the chimney and solder the strip in place.

Now fit the semi circular tank mounting flange (54) on top of the strip, up against the front face of the saddle tank.

Fit the front sandboxes (55) and attach couplings of your choice (not supplied).

Refer to Figure 2. Bend of a piece of 0.4mm wire to 90 degrees and fit this into the hole on the smokebox side to represent the blower pipe. Run the wire along, under the saddle tank, and into the hole in the cab front.

Using the drill start provided, drill out the small hole in the side of the Roscoe lubricator (56), and solder in a length of annealed 0.3mm wire. Now open up the hole 'L' in the smokebox. Drill the chimney (57) to accept the Roscoe lubricator, fit the lubricator and then fit the chimney assembly. Carefully thread the wire from the lubricator into the small hole on the smokebox top.

Fill the smokebox with lead. Push the smokebox door handle (59) into the hole in the smokebox door (60), solder in place and then fit the door (Fig. 1). File off any tabs below the footplate.

ASSEMBLING THE CHASSIS

The chassis can be built either rigid or with simple three-point compensation, which is easy to install and will greatly improve the running quality. Study Figure 7 before starting work - this will help you understand the underlying principles.

Remove the chassis frames (61 and 62) from the fret, being careful not to snip off the triangular railguards (yes, they do look like location tabs). Form all the rivets, including the three rivets arranged in a triangular pattern, but ignore the hole at the centre, which is an anchor point for the inside motion.

Ream out the axle holes in the frames to accept the 1/8in bearings as a tight push-fit. If you're building a rigid chassis, you can solder them in place at this stage (modellers working to 16.5mm gauge should file the rear axle bushes flush with the inside of the frames to allow clearance for the gearbox). For a compensated chassis, leave the front pair loose for now.

Open out the brake hanger pivot holes in the frames to accept 1.6mm O.D. tube. Solder the spring details (63 x2 and 64 x2) to the inside of the frames. The bottom edge of the spring should line up with the small marks above the axle holes. (If building a compensated chassis, omit the front springs or fit them after the hornguides are in place).

Assemble the frames using the appropriate spacers (65-8) according to gauge. The mid-way spacer (67) represents the bottom of the motion bracket and should be tilted back so the edge lines up with the bottom of the motion bracket location slot.

Grind off excess locating tabs. Fit the ashpan detail (69) to the back face of the rear spacer - it might be better to omit this part until the gearbox is installed, which would give you more room to manoeuvre the boiler into position and also allow you to observe the rotation of the gears. When the chassis is running well, you can lightly glue the ashpan in place.

For a compensated chassis, open up the hole in the front spacer so a length of 1.5mm rod is a snug fit. With the front top-hat bearings in place, push an axle through and then thread the rod through the hole so it rests on the axle, with the minimum amount protruding from the front face of the spacer (this is to stop it fouling the cylinder assembly, which is fitted later). Check that the rod is level and parallel to the sideframes, and then solder in place. Remove the axle and the bearings and then, following the half-etched marks, saw away the cut-outs and clean up.

Solder short lengths of tube firmly into the holes for the brake pivots and then, using the appropriate brake assembly guide (70) (dimension ‘M’ equates to the chassis width) file the outer faces of the tubes flush with the guide faces (dimension ‘N’). Cut away the excess tube inside the chassis and file flush.

Solder the valve guide rods (0.5mm wire) between the spacers (65, 66) and trim to length. Cut a piece of 0.7mm wire to be a tight fit between the frames. Use a short piece of 0.4mm wire to layer up the counterweight

assembly (71,) (72 x3) and trim the wire slightly proud on either side. Drill the counterweight lever along with the dummy inside motion (73 x2) and thread them on to the wire. Move the parts to the centre of the wire and solder the wire so it sits in the half-etched marker holes (in the centre of the triangular area of rivets). Now swing the end of the inside motion down and clip it into its location in the spacer and then – after checking that the motion is parallel to the frames - solder it in place on the spacer and the wire. Leave the counterweight assembly free to rotate at this stage.

Fit the webs (74 x2) to the chassis. Locate the rear sandboxes (75 and 76) in their holes, secure them and grind off the excess locators on the inside of the chassis. If you're going to be using a wheelpress, fit the sandboxes once wheeling-up and quartering is complete (they'd get in the way otherwise).

Fit the chassis end details (77 x4) to the chassis, rivet details on the inside. When the body is fitted, these parts sit right up against the backs of the bufferbeams and must be fully home in their locations on the chassis. Offer up the chassis to the body, check the fit and ease if necessary.

Use flat-nosed pliers to crank the railguards ('P') outwards, as shown in Figure 8, so their bottom edges are approximately in line with the wheel flanges. Restore any railguards you accidentally snipped off while removing the sideframes from the fret.

Fit the various rivet strips (78 x4, 79 x2, 80 x2) to the chassis.

Coupling and connecting rods

Whilst in the fret, tin the connecting and coupling rods (81- 88) and ream out the holes to suit the crankpin bushes, as shown in Figure 11. Identify which rod is which and remove them from the fret one pair (i.e. inner and outer) at a time to avoid confusion.

Layer the pairs together as accurately as possible, noting that there is strengthening rib which runs along the back of each rod. Check the bushes still fit (solder may have flashed round the edge of the hole). When assembling the connecting rods, slip a piece of paper between the layers at the crosshead end, exactly where the strengthening rib finishes. This will prevent this area from becoming soldered together, thus making it easier to form the crank in the rod. (The rods really are cranked on the prototype - this isn't a compromise that we've introduced to make life easier).

Form the offset shown in Figure 14, solder the reminder of the rod together and then open up the hole to accept a lace pin. Use small pliers to make the bends as sharp as possible. For the rod to swing smoothly across the front face of the crosshead, area 'R' must be completely flat with the bend far enough away from the pin to clear the rear of the crosshead.

For a compensated chassis, use the rods in conjunction with jig axles to set the position of the hornblocks in the front frame openings. Whatever make you use, you'll probably find it necessary to trim the bottom part of the hornguide and possibly the hornblock itself, so they don't foul the track and/or show on either side of the wheels. Our pilot models used Brassmasters axleboxes (minus the springs) and with the bottom edges filed well down. You can now fit the 'missing' dummy front springs over the hornguides, should you wish.

The clearance between the crosshead and leading crankpin is limited in P4. To prevent them touching, the rods should be cut as shown and the top hat bush reversed after being filed to length. The top hats on the rear crankpin should also be reversed so the connecting rod is parallel to the frames. Optional crankpin spacer washers (89 x4) are provided, although it will only be possible to use these if the crossheads are fitted without their backing pieces (see below).

Cylinders and motIon.

Open up the holes in the cylinder saddle (90) - (see Fig.13) - so a length of 1.6mm O.D. tube is a tightish fit. Before forming to shape, modellers in EM and P4 will need to file the half-etched areas to allow for the different frame width. Now fold the cylinder saddle, slide into position in the chassis and check that it sits correctly. Make sure the vertical faces are at right angles to the top surface of the saddle. Secure with 14BA nuts and bolts (this makes the whole of the cylinder assembly removable at any stage - it shouldn't be soldered into the chassis).

Before cutting the slidebars (91 and 92) from the fret, gently open out the holes in the discs to accept the same tube. Handle the slidebars carefully - until they're soldered into the cylinder assembly, they're very fragile.

Refer to Figure 12. Bend up the slide bars at the motion bracket end and then bend the discs at the other end. The slidebars can be lightly clamped while you are doing this to avoid distortion. Add little fillets of solder to strengthen the bends. Use 0.7mm wire to pin the two halves of the motion bracket together, solder them together and then file the wire flush.

Remove the cylinder saddle from the chassis, hold the slidebars at 90 degrees to the saddle and manoeuvre them into their slots in the rear cylinder faces. Swing the motion bracket/slidebar assembly down through 90 degrees so the slidebars fit snugly in their slots as shown in Figures 13,16 and 18, at right-angles to the motion bracket and the cylinder rear face. Fit this assembly into the chassis so the top of the motion bracket is level with the top of its own slots in the chassis. Don't force anything - relieve the chassis slots if necessary with a blade. There may be a slight gap between the slidebar disc and the front cylinder face. This will not affect the running.

Dress and lightly countersink one end of a length of 1.6mm O.D. tube and push this through the front of the cylinder/slidebar assembly, until the dressed end is level with the end of the narrowed area of the slidebars, as shown in Figure 16. Check the alignment of all the parts by pushing a piece of 0.7mm wire into the tube (it should project down through the rear wheel centre). Check that the motion bracket and the cylinder faces are correctly inclined and that the wire runs centrally between the slidebars. Now solder the slidebars to the cylinder saddle and tube at each point of contact. Solder the slidebar disc to the front cylinder face and the tube into the cylinder faces. Trim the front end of the tube flush using a file or carborundum disc (avoid cutters - they may collapse the tube end and impede the motion of the piston rod). Then remove the cylinder assembly and complete the detail work, as follows.

Bend and fit the cylinder wrappers (93 and 94). Form them to shape as exactly as possible (make sure the half-etched lines are on the inside and the cutaways to the rear, at to the top). The wrapper is fitted so it is almost flush at the front and rear. If you solder the straight sections only to the formers, you will avoid dislodging the slidebars. Now punch out the rivets on the cylinder covers (95 x2) (96 x2) - if you have difficulty doing this, an alternative etched set (97 x2 and 98 x2) is supplied - and then tin the rear faces. Fit the rear covers over the slidebars and solder them in place (Figs. 13,16 and 18). Whilst they are still in the fret, carefully open out the holes in the piston gland flanges (99 x2) to 0.8mm diameter. Use an oiled drill bit to locate the gland centrally and vertically at the end of the tube. It's probably best to fix this in position with glue to avoid disturbing the alignments.

Fit the cylinder front covers. Use a length of 0.4mm wire to locate the front cylinder detail (100 x2) on the cylinder front and trim the wire flush at the back (the wire must not protrude past the inner face of the cylinder cover or it may impede the travel of the piston rod). Fix the details in place and bend the end of the wire down to represent the cylinder lubricators.

Boiler assembly

The boiler is also removable and simply clips into place on the chassis (Fig 11). Only the bottom half of the boiler is modelled. Having this as part of the chassis rather than built into the bodywork enables you to fit a comparatively large can motor and a high-reduction gearbox into a very small locomotive, without any of the mechanism being visible.

Form the rivets on the appropriate firebox/rear boiler mounting (101,102 or 103) for the gauge to which you are building the loco. Carefully bend the boiler (104) to shape so that it exactly matches the front boiler mounting (105) and the top edges fit between the inside faces of the boiler width gauge (106) - it is worth spending some time doing this as the fit of the boiler is vital when the various sub-assemblies come together. Solder the boiler to the mountings. The outer face of the boiler sits on the larger radius of the front mounting. File the protruding ends of the boiler flush with the vertical faces of the mountings. Grind the central locator tab on the rear boiler mounting flush with the inside of the boiler.

Try the assembly in position, with the front mounting locating in the rear slot in the cylinder saddle and the lugs on the rear mounting in their slots on top of the chassis. Now remove the boiler and offer it up to the body. The boiler should fit between the inner edges of the saddle tank. Check that front boiler mount is a snug fit inside the back of the firebox, with the top of the locator lugs touching the underside of the footplate. If it will not go fully home, run a blade around the outside edges of the mounting to remove the cusp.

The accuracy of the fit depends on the accurate forming and positioning of a number of components that are already in place. Do not try and force the boiler home. Instead, check that it is not fouling on something that may be slightly awry. A gentle tweak of the boiler (especially along the top edges) will remedy any slight misalignments. There should be no need to file anything to get the boiler to fit.

Once everything fits comfortably, try the boiler on the chassis again and offer the complete assembly up to the body. Do not proceed further until you are satisfied that the various components can readily be fitted and separated.

It might be wise to paint the boiler at this stage, and you might also like to think ahead to where the pick-ups will located and how they will be wired to the motor. The most straightforward and unobtrusive way of routing the leads is to have them passing along the motor sides (tape them in place) down through the cutaways in the gearbox, and out at the bottom. This will allow the cylinders to be removed if necessary.

Boiler bands, represented by Sellotape, can be added now or later, as you prefer. Stick a few inches down on a sheet of glass and cut strips 0.8mm wide. These can be lifted up on the point of a scalpel and manoeuvered into position, as shown. The front boiler band is positioned (working from the centre of the band) 1.5mm from the front boiler and the rear band is 2.5mm from the firebox front, with the remaining two bands equally spaced between them.

Brakegear

This method of assembly creates a set of brakegear that is fully removable as well as totally prototypical in appearance. If it seems over-elaborate - some of the parts are very small - you can always simplify the arrangements - Do not solder anything until the instructions specifically say so.

The first step is to drill out all brakegear components (107-116) to the sizes shown in Figure 7. Make sure that all the wires will pass through their holes without forcing.

To represent the cross-shaft, thread a length of 1mm wire approximately 20mm long through the chassis, the two actuating levers (107 x2), the handbrake lever assembly halves (108 and 109) and the steam brake lever (110), making sure the top of the latter is also located in the hole the rear chassis spacer. When the shaft is in place solder the top of the steam brake lever into its location in the rear spacer.

Fit the detail pieces (111 x2) over the ends of this wire, outside the frames, and then solder them in place along with the cross-shaft, making sure the actuating levers are well out of the way so they remain free to rotate. Trim the faces of the shaft slightly proud of the detail.

Solder a piece of 0.4mm wire into the notch at the back of the spacer (68) so it is vertical and protrudes about 6mm below it. Position the handbrake lever halves on the cross-shaft so that the grooves at the end sandwich the 0.4mm wire and solder the lever to the cross-shaft and the wire into the rod halves (the die block). The top edge of the lever should be roughly horizontal.

This might be a good time to paint the chassis, if you haven't already done so. The details that are still to go on are removable, and can be painted as they are finished.

Use 0.5mm wire to locate the brake shoes (112 x4) on their hangers (113 x4) - noting which is the top and which is the bottom of each (see drawing) - and solder up two left and two right-handed hanger assemblies. Trim the wires slightly proud of the brake shoe faces to represent the fixings.

Note the shape of the brake rods whilst they are still attached to the fret. When fitted to the loco the rear sections of the rods should be inclined very slightly.

Solder the detail pieces (114 x2) (they represent the hexagonal adjusters) to the brake pull rods (115 x2). The pull rods are quite fragile and can be strengthened by soldering on the backing pieces (116 x2) to the rear sections.

Push a length of 0.7mm wire through the rear brake hangers and tubes, at their top pivots. Two separate shorter lengths must be used for the front. Position the brake assembly guide (70) on the chassis just ahead of the front

wheels. Sit the brake pull rods in the slots in the guide and push a length of 0.7mm wire through the bottom of the hangers and the brake pull rods.

Refer to Figure 9. In EM/P4 the actuating levers sit right up against the inside of the frames with the pull rods, in turn, between the inner faces of the rods. For OO gauge, leave a 0.4mm gap between the actuating rods and the frames, and position the pull rods against the outside faces of the levers.

In order to provide clearance required for the removal of the brake rods, it is necessary to file a very small flat on the bottom of the steam brake lever (part 110 for EM/P4) or on the bottoms of the cross-shaft pivots (parts 111 x2 for OO). This will allow the rear end of the brake rod to slide along the wire and must be done before the wire is soldered on place, as described below.

Slot a length of 0.5mm wire through the rear of the pull rods thus attaching them to actuating levers. Move the actuating levers on the cross shaft so they pull the brake gear up to the wheels, making sure they are not so close that they cause a short. When you are happy with the position of the brake shoes in relation to the wheels, solder the actuating levers to the cross shaft. Solder the piece of 0.5mm wire that runs between the actuating levers, into the levers, but not the brake rods. For EM/P4, trim this almost flush on the outside and 1mm protruding inwards. In 00, trim it flush on the inside and with 1mm protruding outwards.

Push the hangers up against the guide so they hang vertically and then, with the guide still in place, solder the front brake hangers to the bottom wire. Solder the wire into the front pull rod holes. Reposition the guide just ahead of the rear wheels and repeat the assembly sequence.

Pulling the wires out of the hanger tubes and springing the rods at the actuating levers will release the brake gear. With the brakegear guide removed, solder 0.7mm wire into the pivot holes on the hangers and trim so the wire protrudes slightly at the front faces and by about 0.5mm at the rear.

To represent the front sandpipes (Fig. 11), solder a length of annealed 0.5mm wire, suitably shaped, to the outside face of the front brake hangers and trim to length. Try the cylinders in place to check that the pipes don't catch them.

To refit the brake gear, simply spring the hanger pins into the tubes and the rear of the brake pull rods on to the actuating levers. Finally, rotate the counterweight on the inside motion until it is horizontal and then solder in position. Remove the brake gear and the wheels, cleaning up as necessary.

When the wheels are off, fit 0.5mm wire into the holes at the rear of the chassis, to represent the injector pipes (see Figure 10). These pipes run under the cab steps, as shown (fit the body to get the shape right). If you want to be absolutely prototypical, you can route these pipes up behind the ashpan so they line them up with injector pipes on the backhead.

Using the drill starts provided, drill out the holes in the bottoms of the rear sandboxes and fit 0.5mm wire for the sandpipes, and shape the pipes, as shown in Figure 11.

Crossheads and connecting rods

Whilst still on their sprues, carefully drill out the piston rod location hole in the end of the crossheads (117 x2) to accept 0.7mm wire. Stick a piece of masking tape over the front face of the filing guide ('X' on the nickel silver fret) and cut away the tape from the hole with a scalpel, as shown in Figure 17. Remove a crosshead from its sprue, slot it into the guide and file the back until it is flush with the back of the etch. This creates clearance for a smooth sliding fit for the crosshead on the slidebars. Repeat with the other crosshead and solder in a piece of 0.7mm wire to represent the piston rod. Trim this wire so the total length of the crosshead is 14mm (Fig.15) and remove any burrs from the wire.

Offer up the crossheads to the slidebars. They should slide smoothly but without any slop. If they're tight, or won't slide at all, run a sharp blade along the slidebars to remove the cusps. Work a drop of Brasso in to get everything silky-smooth. Now slot a lace pin through the small end of the connecting rod and into the crosshead, making sure the rod is correctly oriented and that it pivots freely. Put a tiny drop of oil on the slidebars and then, using the smallest possible quantity of solder, fit the crosshead backing plates (118 x2) over the protruding pin. When soldered in position, trim the pin flush. Clearances are very restricted in P4 and life may be easier if you omit the backing plate - the crosshead won't fall off (pretend you didn't hear this . . . it worked well enough on one of our pilot models).

Fitting the gearbox/boiler and cylinder/slidebar assemblies
Though this sequence is described as it would be done on the final, working model, it is best to practice it several times first, so you are sure of where the various parts and sub-assemblies are to go and how best to get them into position. Remember that nothing is soldered or otherwise fixed permanently in place unless specified.

At this preliminary stage, you can try out the assembly sequence (Fig 11) using just the folded up gearbox mount (see the gearbox section overleaf) before the gears themselves are fitted. Temporarily screw the mount to the motor, holding it inside the boiler so the gearbox butts up against the rear edge of the boiler. Still holding the motor and boiler together, locate the lugs on the rear boiler mounting in the slots in the chassis. Make sure the boiler is not twisted in any way. Push an axle through the bearings. If the gearbox shell is square and the chassis bearings are correctly aligned, it should be free to revolve. If these are fine but it is still tight, then the boiler is probably off centre on its mounting lugs.

To fit the cylinders, tilt the gearbox back slightly without forcing and at the same time lift up the front of the boiler sufficiently to slip the cylinder/slidebar assembly into place. The tab on the front boiler mounting locates in the slot in the cylinder saddle rear face. If you get stuck, do not force anything. Remove the assembly and check for any excess solder, slots that are not fully opened up or excess whitemetal flash inside the saddle tank.

Offer up the chassis to the body and secure using M2 bolts. If the chassis will not go fully home, right up against the footplate, the cylinders are probably fouling. Check that the cylinder saddle is sitting fully down in its location, and that cylinder wrappers are a good fit. When all is well, dismantle the assembly.

108:1 Gearbox assembly
Before cutting the gearbox etch (119) from the fret, progressively ream out each of the holes to suit the various shafts and bushes, as shown in Figure 6. Components should be offered up until they are a push-fit in their holes. Once the gearbox is assembled, the shafts are fixed but the gears are free to revolve. Remove burrs from both sides of the etch by inserting the tip of a drill bit (of much larger diameter than the hole) and gently rotating it between your fingers.

Solder the 1/8in bushes into place with the larger-diameter shoulders on the opposite side of the etch as the bend lines. File the inside (non-shouldered) face of the bush flush. Remove burrs as above. Check that the motor mounting screws will pass though their holes and into the motor, carefully opening out the holes in the etch with a reamer if necessary.

Now cut the etches from the fret and fold up the sides of the gearbox, using flat nosed pliers to grip the motor mounting plate near the bend lines when doing so. This will prevent the plate from accidentally buckling across the hole centres. AII bends are 90 degrees, with the bend lines on the inside of the gearbox.

Fold up the idler pivot - starting with area ‘S’ and followed by ‘T’ and then finally area ‘U’. Again, all bend lines are 90 degrees. Push an uncut length of 1.5mm shaft through both idler locations and across into the opposite side of the gearbox. This will to hold the idler location accurately for soldering. Now add fillets of solder to the inside of all the folds to strengthen the gearbox. Be sparing at the idler pivot or the solder will foul the gear.

Using a carborundum disc in a mini-drill, cut 2mm silver steel gearshafts, so their lengths equal the overall width of the gearbox. Cut the 1.5mm idler shaft to 3mm long. Wear effective eye protection – cutting discs can and do disintegrate if they snag. Remove any burrs with a fine file. If shafts are a tight fit, you will only be able to pass them through both sides of the etches if they are truly square. If they won't go through, then the etches haven't been folded accurately. Light finger tweaking should put things right.

Push the worm onto the motor shaft until it is flush with the end of the Mashima 1220 motor shaft (i.e. 10mm from the motor face). Some brass worms supplied to us are fractionally tighter than others and if they aren’t an easy push-fit, they can be gently forced on to the shaft in a vice. Alternatively, they can be reamed slightly oversize and then secured with a small drop of Loctite 601 at the outer end.

Fit the motor assembly into the gearbox using the screws supplied with it. The motor can be removed or refitted at any stage of construction. With a 1220 motor there is room to fit a small flywheel, but check that it doesn't foul the inside of the boiler. A 1224 will need its rear shaft trimming short.

Fit the stage 1 gearshaft, double gear (27/10T.) and collar into the gearbox and then lightly glue the shaft in place at both ends. Adjust the collar so the 27-tooth gear is central under the worm and secure the collar with a tiny amount of glue.
Fit the idler shaft and 12T gear into their location and check the gear is free to revolve. Make sure the shaft is flush with the outside of the etch. If it protrudes it may catch the stage 2 gear. Secure the shaft, as above, making sure that no glue seeps through onto the gear.

Now fit the stage 2 gearshaft and double gear (20/10T) into the gearbox.

Temporarily fit the final brass 20T. gear and 1/8in axle into the gearbox making sure the gear is correctly meshed with the idler. If the motor is not fitted, check that all the gears revolve smoothly. Now test the gearbox under power by fitting the motor and worm assembly as described above. When the gearbox is fitted into the chassis, it is advisable to fit washers between the gearbox sides and the frames in order to prevent the gearbox from moving sideways on the axle, which will effect the mesh of the gears. It is also advisable to fit washers behind the loco wheels on this axle in order to eliminate any sideplay.

The gears are effectively self-lubricating but a little plastics-compatible grease will do no harm. Do not use general-purpose modelling oil, which attracts dust and grit. Metal-on-metal contact areas (motor bearings, axle bushes) should be lubricated with a tiny amount of Zeuthe ultra-adhesive oil.

Fitting the wheels
When the gearbox is completed and you are ready for the final assembly sequence (Fig 11), offer up the motor/gearbox/boiler sub-assembly as before but this time with the leads from the motor brush tags passing down through the firebox. As you fit the rear axle, slip on the final drive gear but do not secure it yet. Fit and quarter the wheels - the right hand cranks lead by 90 degrees. (The kit includes axle washers of varying thickness, which should be used to eliminate all sideplay on both axles.) Glue the balance weights (119 x4) to the wheels to make two handed pairs - epoxy is best for this. They should be positioned off-centre, towards the leading side of the wheel, with their edges in line with the spokes (see fig. 19). Make sure they lie flat and don't foul the rods. For extra strength, you can pack more epoxy into the cavities behind the balance weights. Fit the bushes to the crankpins, add the coupling rods and check for free running. Fit the securing nuts to the front crankpins and trim the crankpins to length.

Secure the cylinder assembly to the chassis using 14BA nuts and bolts. Attach the connecting rods to the rear crankpins and make sure the chassis runs smoothly without any tight spots. Once satisfied, cut off the surplus crankpins and secure the nuts with a tiny drop of Loctite 601 retainer. Finally, secure the final drive gear with Loctite - and test under power once more.

Pick-ups
Most modellers have their own preferred method of fitting pick-ups. Suitably shaped wiper pick-ups (phosphor-bronze or 0.33 hard brass wire) can be run to the wheel rims from busbars running between strips of gapped copperclad fixed across the chassis at suitable points, such as on the front spacer, under the smokebox and between the inside motion, in front of the rear axle. Make sure you allow adequate clearance around the chassis components to prevent shorting. The motor leads can be fed down through the firebox and, after being cut to length (allowing a reasonable amount of slack), they can be soldered to the copperclad strips.

Once the body is in place it acts as a retainer for the various sub-assemblies. Check that the boiler and cylinders are correctly positioned and lower the body on to the chassis. Slip a small piece of packing or Blu-tack between motor and body to deter the motor/gearbox from trying to rotate about its own axis (but don't make this too thick as there isn't much clearance). Invert the loco and fit M2 bolts at either end. Fit the brake gear as described earlier and test the loco on the track. Don't rely on running in to eliminate tight spots of any kind - dismantle the loco, find what's binding, and put it right. The mechanism has sufficient power to bend the motion work.

We hope you've enjoyed building and running your Hudswell Clarke saddle tank. For more information contact:

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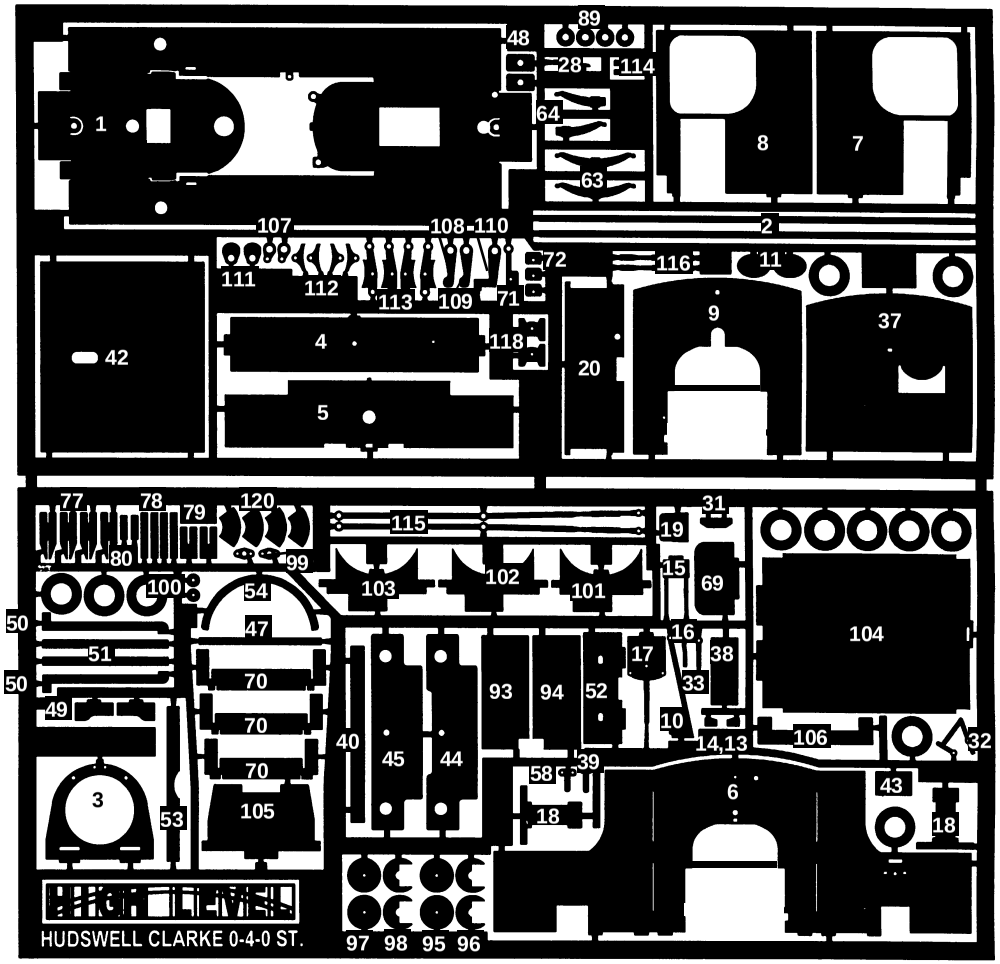
E MAIL - ENQUIRIES@HIGHLEVELKITS.CO.UK

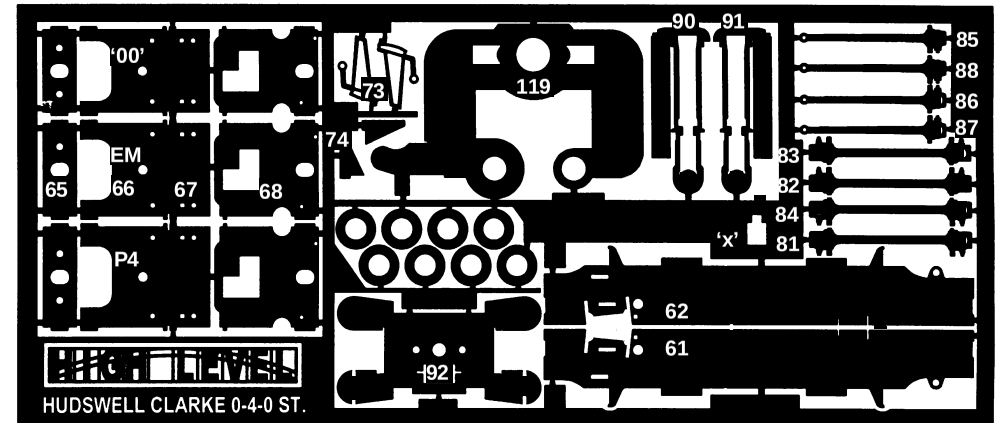
HUDSWELL CLARKE 11’’ 0-4-0 SADDLE TANK

1. Footplate
2. Valance (x2),
3. Smokebox front
4. Smokebox wrapper
5. Firebox wrapper
6. Cab frame
7. L/H cab side
8. R/H cab side
9. Cab front
10. Reverser rod
11. Maker’s plates (x2)
12. Saddle tank (WM)
13. L/H saddle tank support
14. R/H saddle tank support
15. Cab seat
16. Water handle
17. Reverser
18. Cab steps (x2)
19. Coupling spring cover
20. Cab floor
21. Detroit lubricator (LW)
22. Steam brake (LW)
23. Whistle (LW)
24. Angled tap (LW)
25. Straight tap (LW)
26. Steam turret (LW)
27. Dome (W/M)
28. Safety valve lever
29. Steam pressure gauge (LW)
30. Backhead casting (W/M)
31. Backhead shelf
32. Firedoor lever assembly
33. Regulator
34. Gauge glass (x2) (LW)
35. Injector (x2) (LW)
36. Injector handle (x2) (LW)
37. Cab rear
38. Handbrake cover back
39. Rear lamp iron
40. Cab overhang
41. Hnadbrake stanchion (LW)
42. Cab roof
43. Dummy vent
44. Front bufferbeam
45. Rear bufferbeam
46. Buffer (X4) (WM)
47. Rear bufferbeam rivet strip
48. Coupling detail (x2)
49. Chassis top rail (x2),
50. Cranked rivet strip (x2)
51. Straight footplate rivet strip (x2)
52. Cover plate
53. Smokebox top rivet strip
54. Tank mounting flange
55. Front sandbox (x2) (WM)
56. Roscoe lubricator (LW)
57. Chimney (WM)
58. Front lamp iron
59. Smokebox door handle (LW)
60. Smokebox door (W/M)
61. L/H chassis frame
62. R/H chassis frame
63. Front spring details (x2
64. Rear spring detail (x2)
65. Front spacer (small)
66. Front spacer (‘L’ shaped)
67. Mid-way spacer
68. Rear spacer
69. Ashpan detail
70. Brake assembly guide
71. Counterweight lever
72. Counterweight layer (x3)
73. Dummy inside motion (x2)
74. Web (x2)
75. L/H rear sandbox (WM)
76. R/H rear sandbox (WM)
77. Chassis end detail (x4)
78. Chassis end rivet strip (x4)
79. Motion bracket rivet strip (x2)
80. Web rivet strip (x2)
81. LHS side rod (inner layer)
82. LHS side rod (outer layer)
83. RHS side rod (inner layer)
84. RHS side rod (outer layer)
85. LHS conn rod (inner layer)
86. LHS conn rod (outer layer)
87. RHS conn rod (inner layer)
88. RHS conn rod (outer layer)
89. Crankpin spacer washer (x4)
90. LHS slidebars
91. RHS slidebars
92. Cylinder saddle
93. LHS cylinder wrapper
94. RHS cylinder wrapper
95. Front cylinder cover (x2)
96. Rear cylinder cover (x2)
97. Alternative etched front cylinder cover (x2)
98. Alternative etched rear cylinder cover (x2)
99. Piston gland flange (x2)
100. Front cylinder detail (x2)
101. ‘OO’ rear boiler mounting
102. EM rear boiler mounting
103. P4 rear boiler mounting
104. Boiler
105. Front boiler mounting
106. Boiler width gauge
107. Actuating lever (x2),
108. LH handbrake lever
109. RH handbrake lever
110. Steam brake lever
111. Brakeshaft detail (x2)
112. Brake shoe (x4)
113. Brake hanger (x4
114. Hexagonal adjuster detail (x2)
115. Brake pull rod (x2).
116. Pull rod backing piece (x2)
117. Crosshead (x2). (LW)
118. Crosshead backing plate (x2)
119. Gearbox etch
120. Wheel balance weight (x4)

(WM) Whitemeatal casting

(LW) lost-wax casting





MAIN BODY ASSEMBLY

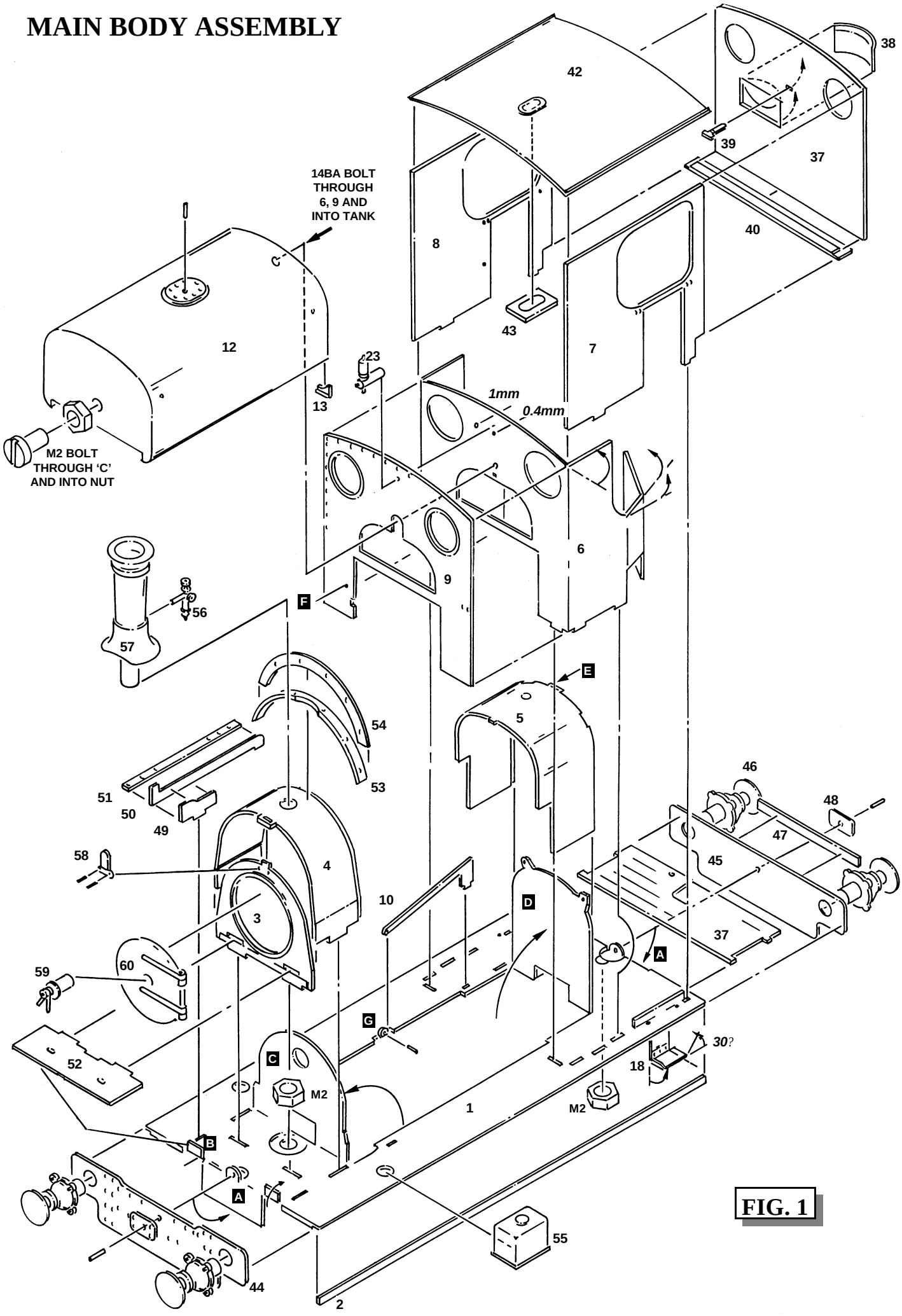
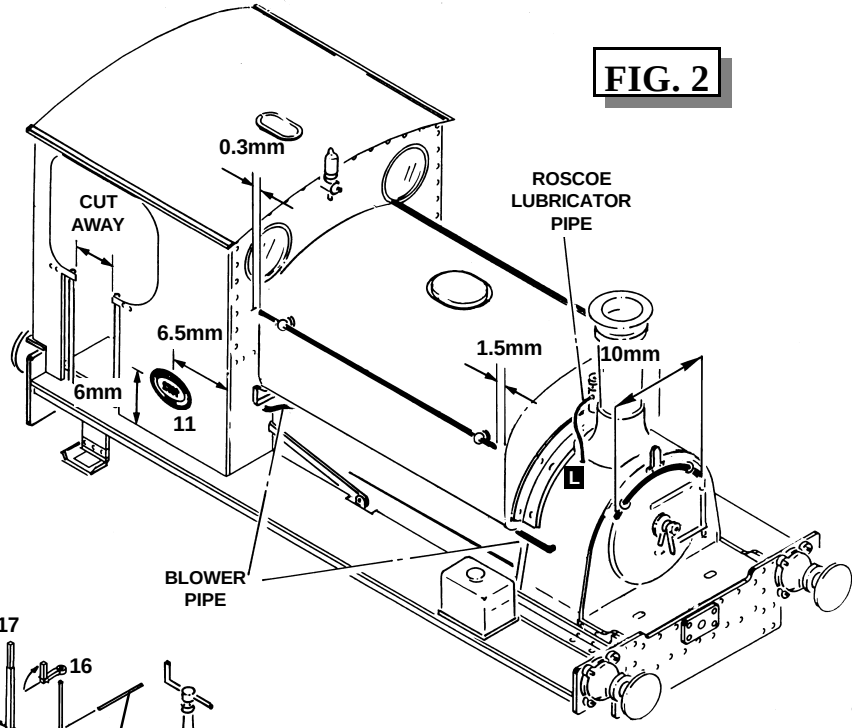


FIG. 1

FIG. 2



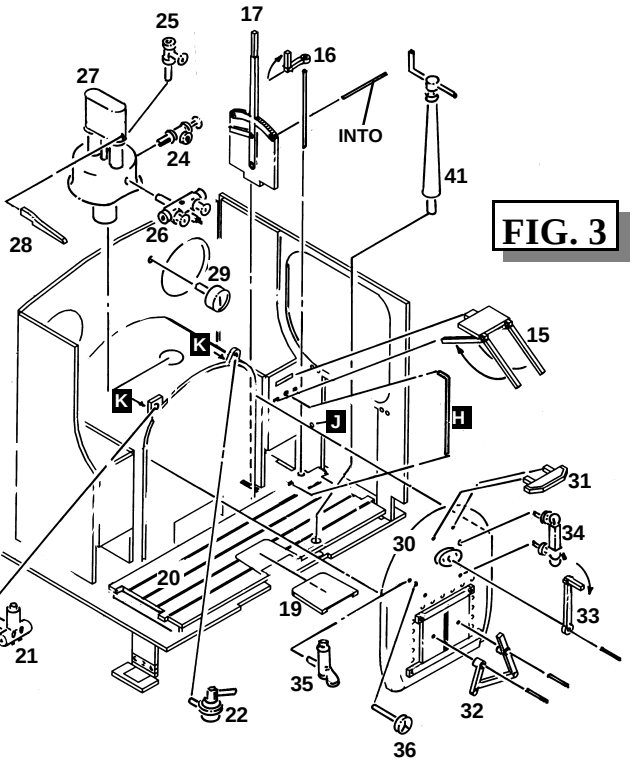


FIG. 3

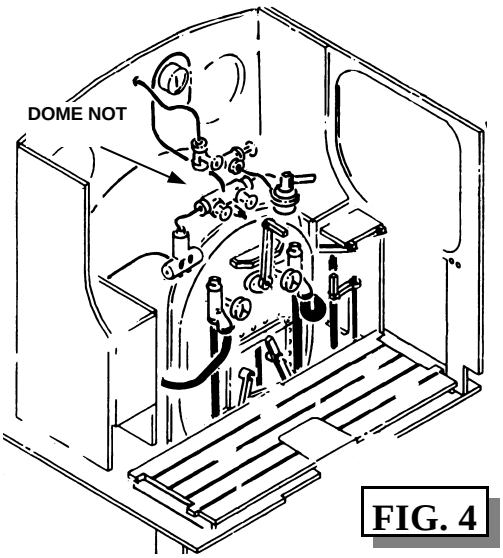


FIG. 4

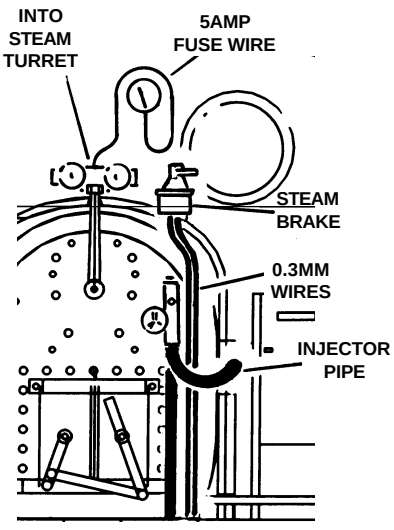
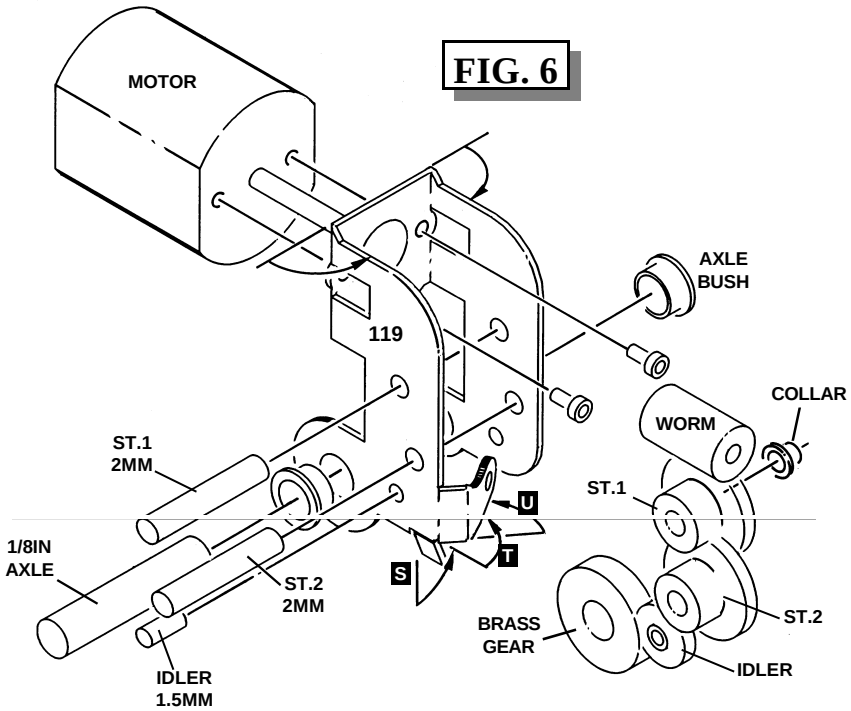


FIG. 5

FIG. 6



CHASSIS ASSEMBLY

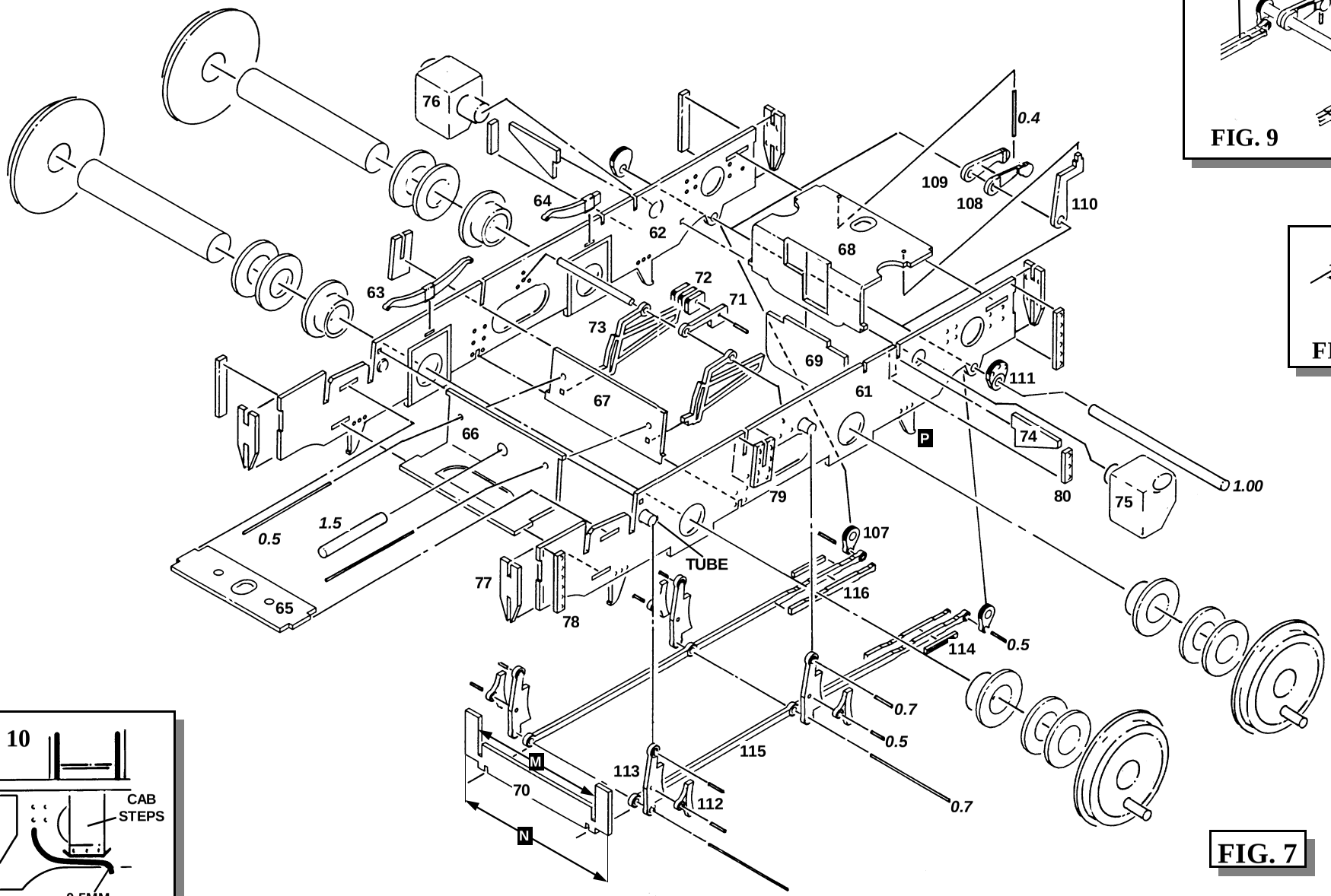


FIG. 7

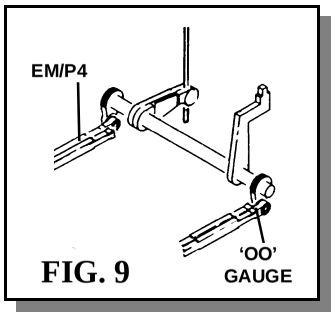


FIG. 9

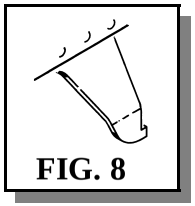


FIG. 8

FIG. 10

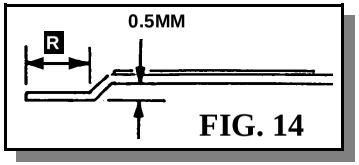


FIG. 14

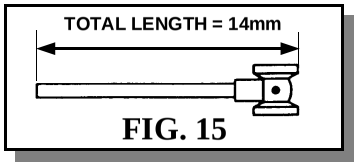


FIG. 15

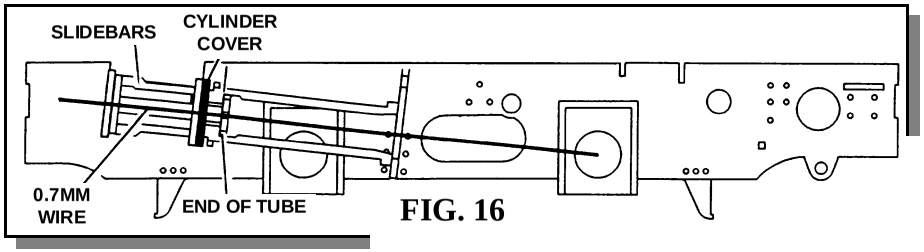


FIG. 16

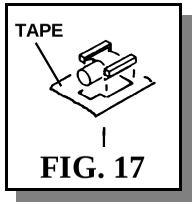


FIG. 17

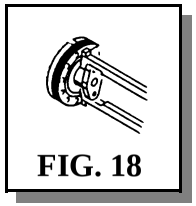


FIG. 18

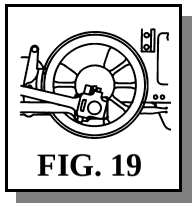


FIG. 19

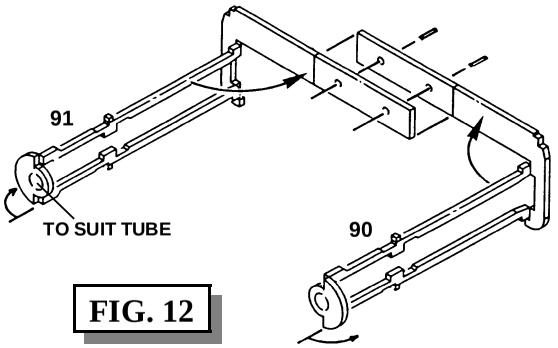


FIG. 12

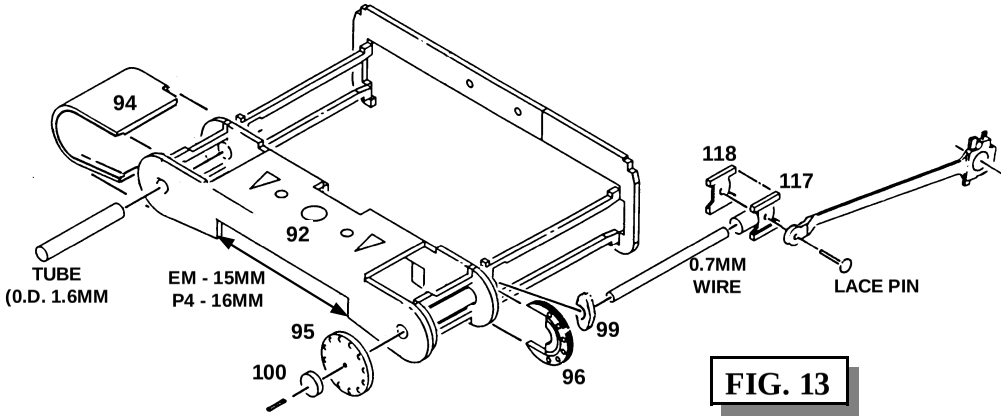


FIG. 13

FINAL ASSEMBLY

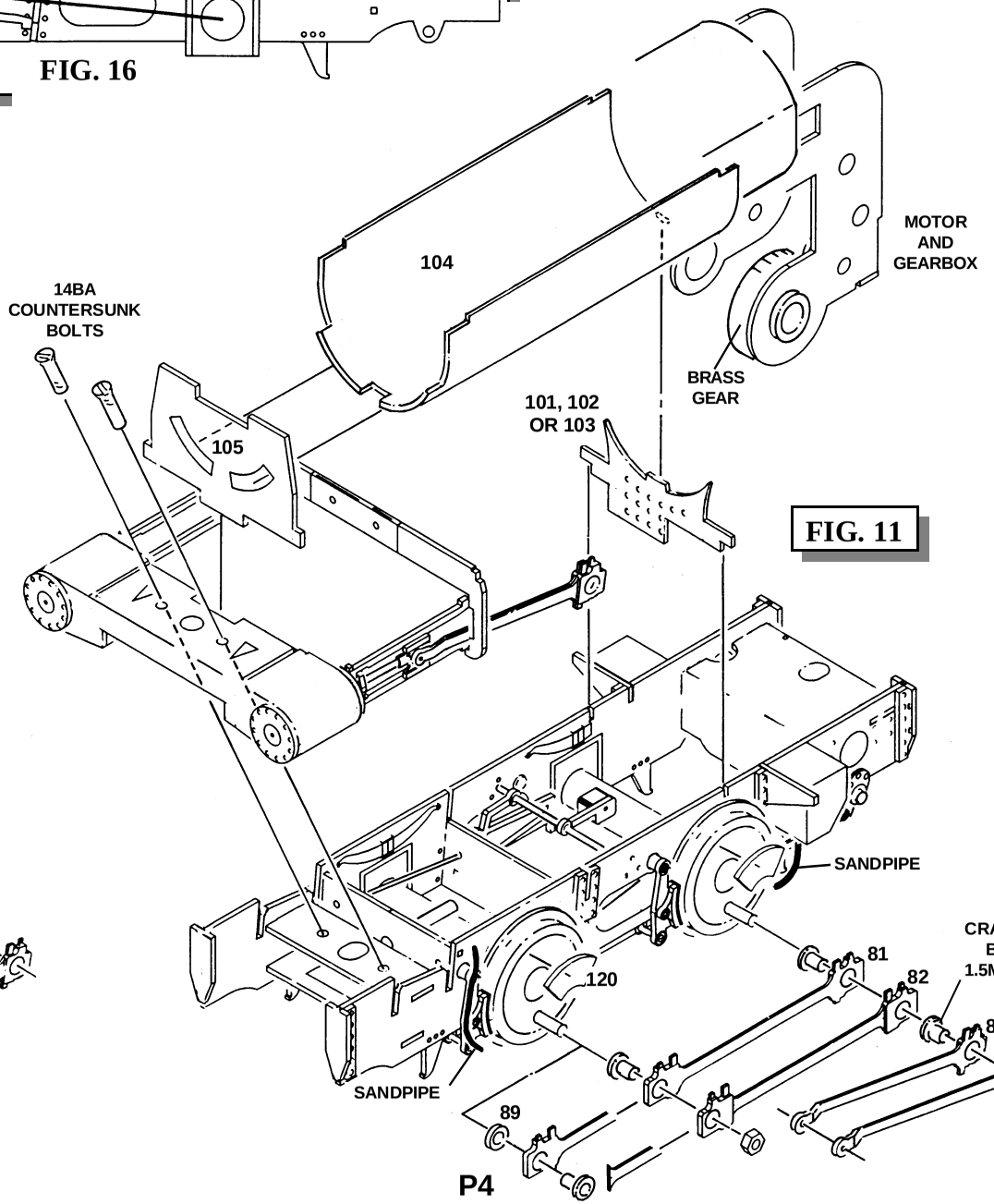


FIG. 11