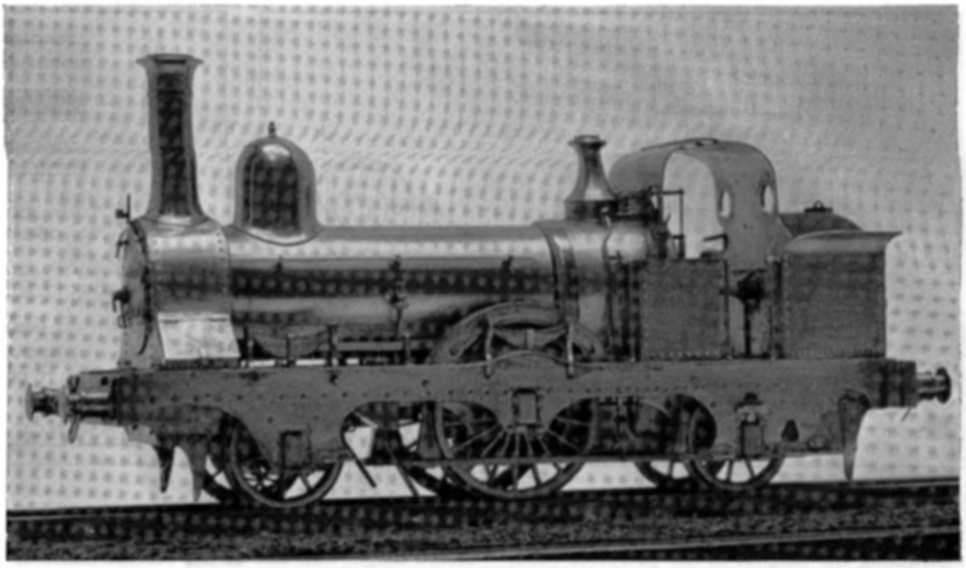
Old-time locos 1

Number 37

A Furness 2-2-2 well tank in 4mm-scale built and described by Ross Pochin

Photographs by Brian Monaghan

This model will be on show at Manchester, December 20–22



FURNESS Railway No. 37 was one of four well tank locomotives built in 1866 by Sharp, Stewarts in Manchester. The company already owned four similar engines and the class handled the main-line passenger traffic until the advent of the tender 2-4-0's in 1870. They then hauled the branch-line trains until superseded by the 2-4-2 tank locomotives (rebuilt from the 2-4-0's) in 1890. The well tanks were generally withdrawn from service in 1896 and No. 37 was scrapped in 1918 after 22 years as a stationary engine at Barrow.

The leading dimensions were: Driving wheels 5ft. $6\frac{1}{2}$in.; leading and trailing wheels, 3ft. 7in.; cylinders, 15ft. × 18in.; boiler pressure, 120lb. A notable feature of the design was in the frames. There were inner frames of $\frac{5}{8}$in.-plate running from the front buffer-beam to the front of the fire-box and outside sandwich frames consisting of two $\frac{5}{16}$in. plates with an oak or teak filling $3\frac{3}{8}$in. thick between them. These ran the full length of the loco at 6ft. 0in. centres which was also the buffer centre dimension. The buffer centre height from rail was only 3ft. 0in. as compared with the later standardised height of 3ft. 5in. The Furness well tanks ran through three main visible phases of "modernisation". As built they were fitted with front weatherboards only. Later a rear weatherboard was added, strapped to the front weatherboard but leaving a gap in mid-roof. In the final phase an all-over roof was provided but still without side-sheets. This phase coincided with fitting for vacuum brakes and the addition of a lot of extra, and from the modeller's point of view, tiresome "plumbing".

I have photographs of No. 37 in all three phases and my model represents her in the intermediate stage.

This choice of period raised the only major problem about prototype "gen". The brake wheel is situated in the front right corner of the bunker. In the "as built" condition, without the rear weatherboard, everything is straightforward. But its addition meant that it had to be cut away at one side to clear the brake wheel. But what shape was the cutaway? All the photographs of No. 37 and her sisters which might have provided the answer showed the fireman leaning nonchalantly on the brake wheel and blocking the view. The excellent colour illustration of No. 37 in Nock's *Steam Railways of Britain* tactfully avoids the problem by omitting fireman, brake wheel and cutaway, too!

My only recourse was to shape the cutaway so that it left room for a 4mm. fireman's hand to operate the wheel.

The model

The main reason for choosing this prototype to model, apart from its delightful appearance, was the challenge of the various constructional problems involved—the accommodation of an adequate motor, a concealed drive and the provision of enough weight to give reasonable adhesion.

A large photostat of the original Sharp Stewart general arrangement drawing (No. 4689) was used as a basis. Dimensions were taken from the drawing, converted to millimetres or "thous", and applied to the work without redrawing to a smaller scale.

However an accurate scale diagram (Fig. 1) was made of the motor position, drive and gear centres and many rough working sketches with actual scale dimensions noted were made of the bits and pieces as work went on.

The basic standards of modelling practice applied are: "Manchester" wheel standards; two-rail collection with split axles; flywheel on motor; unit construction, assembled with screws to simplify painting and polishing the lavish brightwork of the period.

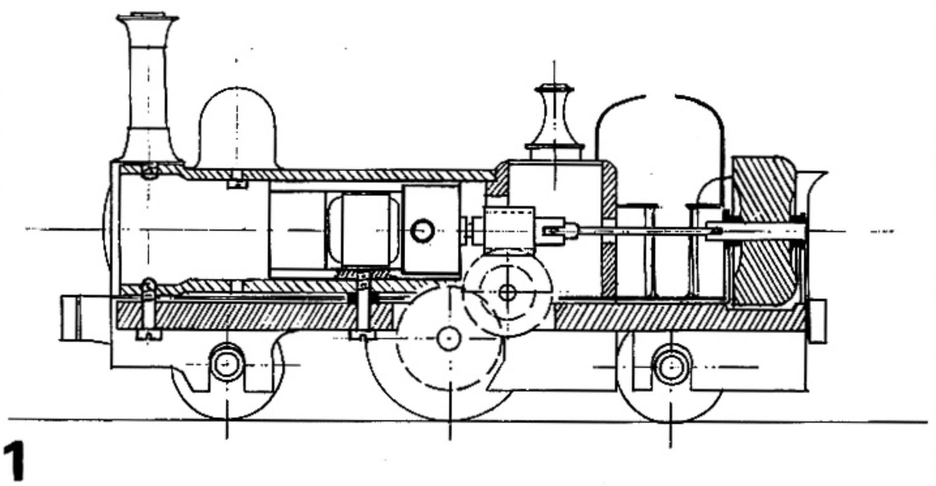
Because so much depended on getting an efficient motor within the confines of the 4ft. 2in. (outside clearing) boiler, this was the first job to be tackled.

The motor (see Fig. 2)

This started life as a Tri-ang X500 (Rocket) motor which was stripped down and everything discarded except the magnet, armature with commutator and worm. The last was removed undamaged by gripping it in the vice between two bits of wood and then punching out the armature shaft with a drift. It is important to apply a keeper to the magnet at all times when it is taken out of a magnetic circuit, and it is advisable to give the armature windings a coat of shellac to protect them against handling.

New polepieces were made from a piece of iron tubing from the scrapbox. This was bored for the armature tunnel and turned to fit the inside of the boiler barrel. It was then cross-drilled and tapped at the magnet end to take an 8 BA countersunk screw. The other end was cross-drilled and countersunk for 8 BA screws to locate the combined brush and bearing block. The tube at this end was cut away to form two lugs which slide into slots in the bearing block.

This block was turned in the finest grade of Tufnol, bored out to clear the commutator and drilled for the bearing. After slotting to receive the pole-piece lugs, it was drilled and tapped 8 BA for the fixing screws and drilled for the brush holders and their locking pegs.



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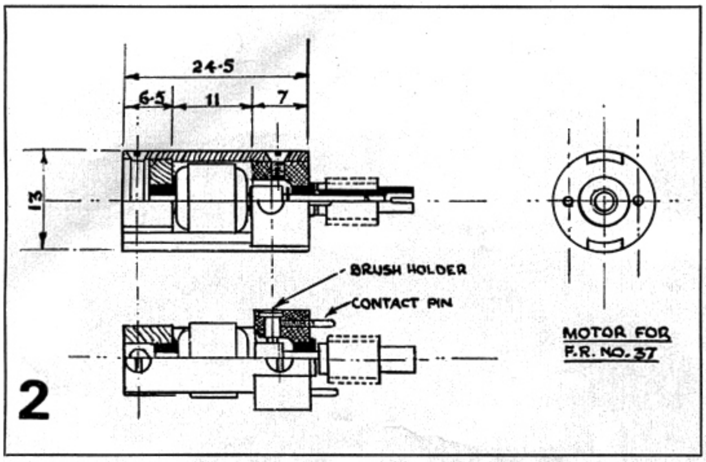
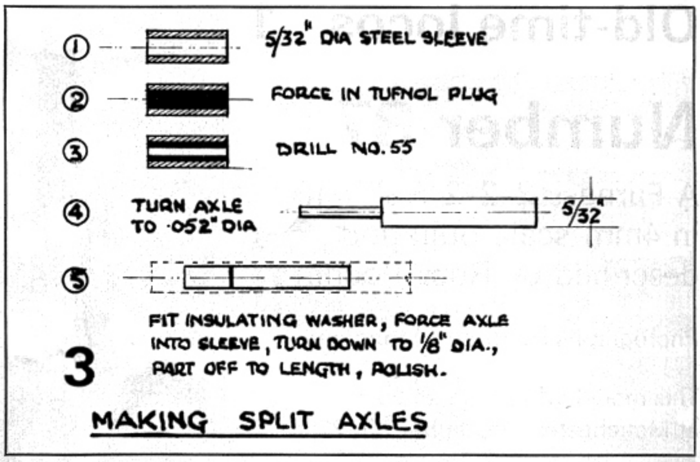
DIAGRAMATIC ARRANGEMENT OF DRIVE





The magnet bore and the Tufnol block had turned phosphor bronze plugs forced in. Then, assembling the magnet in the polepiece tube, its phosphor bronze plug was drilled for the armature shaft through a jig to ensure a true and concentric bearing. The jig is a cylinder of steel turned to a nice sliding fit in the tube and having a true hole through its axis of the same diameter as the armature shaft.

Now, removing the magnet (not forgetting its keeper), and fitting the Tufnol block in postion, its bronze plug was drilled in the same way. At this stage bearing alignment can be checked by fitting the magnet in position and testing with a length of $\frac{1}{16}$in. diameter silver steel.

After removing the magnet and Tufnol block, the tube was sawn lengthways to make separate polepieces and cleaned up with a file.

Brush holders were turned and bored from brass rod with a small lip at their outer ends. They are a push fit in the Tufnol and the lips are recessed therein just below the surface. The brush holder locking pegs are screwed 12 BA and run in finger-tight. Brushes are turned from copper/carbon and their springs wound in 0·007in. steel wire.

Boiler unit

The boiler barrel was turned from brass bar with a swell at the forward end to carry the smoke-box wrapper. It was bored out to a close sliding fit on the motor. The underside had milled recesses to clear the gears. The front end is fitted with a lead plug for ballast. A small brass distance piece was sweated to the belly to locate the boiler at the correct centre height and also at the correct meshing of the worm and wheel. An 8 BA screw passing through the frame spacer, the distance piece and the boiler barrel into a tapped hole in one of the motor pole pieces secures everything in position.

The smoke-box consists of a plate of $\frac{1}{32}$in. brass, profiled to shape, to which are soldered the wrapper of 0·006in. Monel metal and the front plate of 0·010in. nickel silver. The latter has an extension below footplate level between the frames to represent the front of the cylinder block and is fitted with cylinder and valve spindle covers turned from steel bar. The smoke-box door is a simple pressing with hinges soldered on. The smoke-box assembly slides closely over the enlarged end of the boiler shell and is located by the screw which fastens the chimney in position. This and the dome are turned from brass bar and the latter is secured by a screw from within the boiler shell.

Handrail knobs are fashioned from bronze wire and are a push fit in tiny flanged bushes in the boiler sides. Boiler bands (not fitted when the photographs were taken) are cut from 0·003in. shim brass.

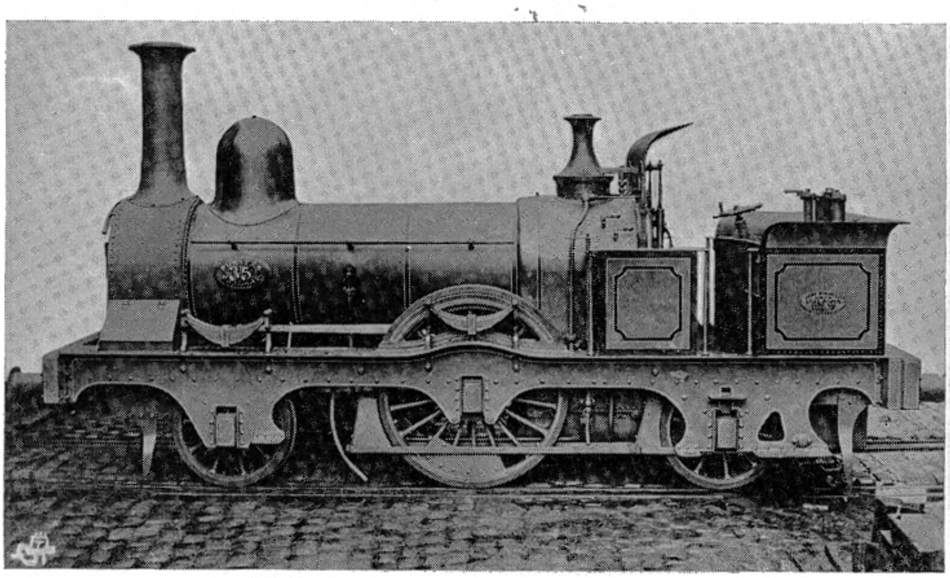
The chassis

The frames were cut from two pieces of 0·015in. nickel silver sheet, shaped as a pair, sweated together and then separated. The insulating frame spacer is Tufnol $\frac{3}{16}$in. thick and milled to width to ensure squareness and parallelism. The spacer was pierced to clear the gears and also to take a lead block over the leading wheels. The rear end of the spacer was scooped out to clear the flywheel. This runs in bronze bushes in two brass brackets screwed to the Tufnol. The frames have projecting lugs, fitted with insulating bushes, to carry the layshaft. The horns were slotted out to receive turned bronze axle "boxes". The boxes for the leading and trailing wheels are a sliding fit in the horns. The former are spring loaded with 0·013in. piano-wire fingers attached to the underside of the Tufnol with 12 BA screws. The trailing axle boxes are free to drop $\frac{1}{32}$in. below datum level but not to rise above it. This gives a lateral equalising action to the rear axle. The boxes for the driving wheels are a press fit in the horns and need no keeps.

The frames are screwed to the insulating spacer, each with four 12 BA screws so that $\frac{1}{2}$mm. of Tufnol is left projecting above the frames and at each end to insulate the chassis from the footplate. After assembly the frames were drilled for attachments—sandboxes, injector gear and brake gear. All these bits are fixed by 14 or 16 BA screws.

Ash-pan and well tank were fabricated from 0·010in. nickel silver, with rivets impressed, and filled with lead. The wheels were turned from brass bar using a tread profile tool to "Manchester" standards; the spokes being fretted out and filed to give that spidery look typical of the period. They are plated a dull nickel silver to improve appearance and running.

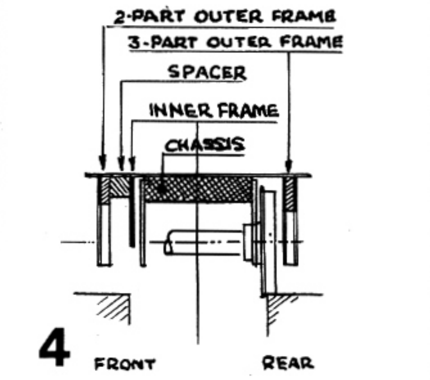
Split axles were turned from $\frac{5}{32}$in. silver steel and insulated with Tufnol as shown in Fig. 3. After force-fitting the parts together, the axles were reduced to $\frac{1}{8}$in. diameter, cut to length and polished.



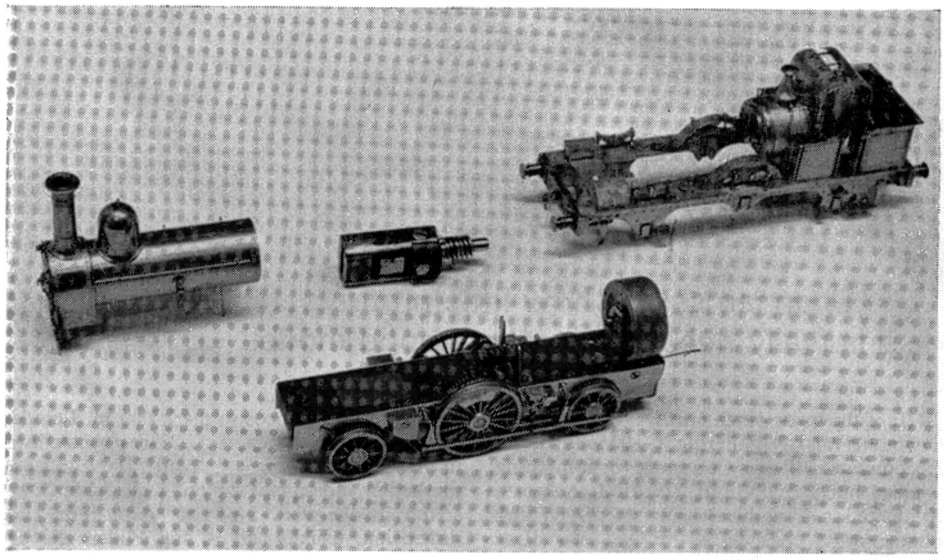
The drive

The first reduction on the gear drive uses the Tri-ang 2-start worm and 26-tooth wheel. The second reduction is by a 22-tooth spur pinion working into a 45-tooth gear on the driving axle. These came from some sort of meter via the junk box.

The worm was bored out to receive a steel bush with a projecting swell on one end, bored and slotted to take the driving end of the flywheel "prop shaft". The bush was forced into the work and is a tigh push-fit on the motor shaft. The worm wheel and spur pinion are forced on to a brass bush and revolve as one on the layshaft between the frames.



4 SECTIONS THROUGH FRAMES



Right: The model in its component parts. Facing page, bottom: Official F.R. photo of No. 37 in original condition.

The flywheel is lead, cast on to a steel centre. Its spindle is $\frac{3}{32}$in. silver steel, forced in, one end being recessed and slotted to receive the rear end of the "prop shaft" from the motor. The lead casting was trued in the lathe and carefully balanced on knife edges before assembly.

The "prop shaft" takes care of any slight misalignment and consequent binding of the motor and flywheel shafts in their bearings.

At this stage the boiler unit with motor and chassis were screwed together temporarily to check for free running and to ensure that the gears were accurately meshed. The model had its first track test and all went well.

The body unit

The first job on this part of the model was to make the sandwich frames. These consist of outer plates of 0·010in. nickel silver, cut and filed to shape as a pair sweated together. After separation "rivets" were impressed from the back. The prototype's wood "meat" in the sandwich was simulated by 18 gauge brass sheet shaped to the outline of the outer frame plates and sweated to them. The inner plates of the prototype's sandwich frames were omitted to give a bit of extra clearance for the wheels except under the bunker where the inner plates are of a different profile to the outer plates.

Buffer beams were made from strip brass. These and the sandwich frames were soldered together in a wooden jig.

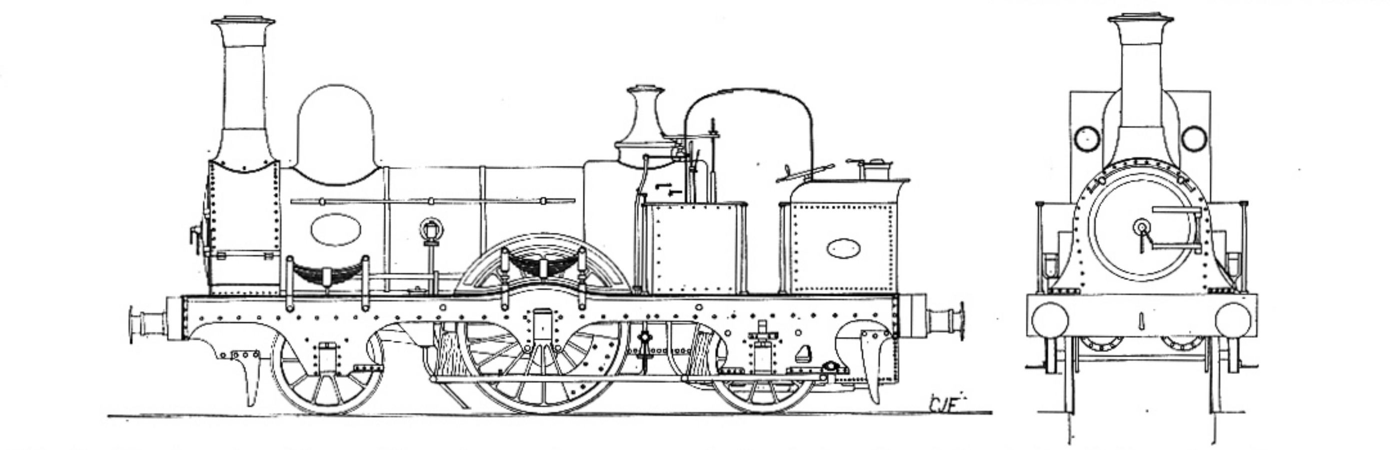
The footplate was then cut from 0·010in. nickel silver, pierced to clear gears and flywheel, and the raised portion over the driving axle bent and coaxed with the fingers to lie snugly over the frames. The footplate was soldered to the frames from underneath leaving good fillets of solder for strength and weight. Subsidiary frame plates were added; at the front end to represent the prototype inner frames, and at the rear for the inner plates of the sandwich frames (see Fig. 4). Guard irons were rivetted to both sets with entomological pins before soldering in position. The fire-box is based on two bits of brass sheet shaped to its cross-section with a wrapper of nickel silver bent to fit and soldered together to make a sort of miniature Nissen hut. A piece of brass plate $\frac{1}{8}$in. thick was mounted in the lathe and a spigot turned on one face to fit the bore of the boiler shell. The outline was filed to correspond with the shape of the fire-box and the edge rounded and polished to represent the brass cleading band between the boiler and fire-box.

After cutting out clearance for the gears, this plate was fixed to the fire-box with a couple of 12 BA countersunk screws. It is detachable so that its polish is not marred in the paint shop. To position the fire-box, the boiler unit was mounted on the footplate and chassis, and the fire-box spigot pushed into the boiler barrel. This located the fire-box on the footplate. It was then tack-soldered in place. Boiler unit and chassis were then removed and the firebox secured by soldering from the inside. The bunker plates were "rivetted", assembled and soldered to the footplate and the weatherboards soldered to the fire-box and bunker respectively. These were fitted with turned brass spectacle frames. The rear of the bunker is adorned with a lamp-iron and two hooks which used to carry a shunting rope. The bunker is ballasted with a block of lead on each side of the flywheel.

A beaten copper cover is a loose fit in the top of the bunker to hid the flywheel. This will carry a "load" of coal glued to it. Splashers are cut from nickel silver and a facing of shim brass decoration sweated to their sides. When turned out of the paint shop this will be polished. Shim metal is easy to cut and pierce with a fret-saw if it is soldered to a thicker piece of metal before shaping. The springs are dummy. They were cut from a plate of 0·100in. brass which had been scribed with concentric circles in the lathe to represent leaves.

[To be concluded

Furness Railway 2-2-2 well tank — Scale: 1:76 – 4mm-1 foot



Side elevation based on Sharp, Stewart general arrangement. Front elevation derived. Details based on photographs