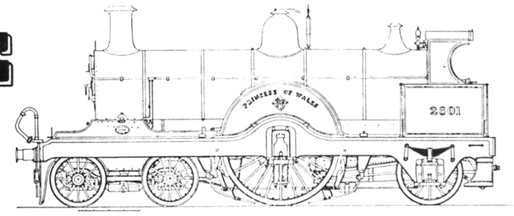
THOUGHTS ON THE MODELLING OF A SIMPLE LOCOMOTIVE



Midland No.2601. Scale 2mm-1 foot

Tim Watson decided to make a simple 2mm scale locomotive. Only it didn't quite work out like that...

... but the result was worth all the work

Introduction

Mention the word 'Single' to most modellers and they will immediately think of the Dean 'Lord of the Isles', the Stirling 'Eight-footers' or a Midland 'Spinner'. All of these locomotives have the same wheel arrangement, of course, but the designers have treated the same basic formula in widely different ways. Many locomotive styles are encompassed between Dean's flamboyant gothicism and Johnson's carefully planned elegance. It has been said that a Johnson Single, in motion, 'poured itself along the track'; a sentiment which is easy to understand with such a free flowing design.

Apart from being Johnson's masterpiece my reasons for modelling a 'Spinner' were, as I was soon to find out, completely the wrong ones. 'Big Bertha', my last locomotive, had taken a year of my modelling time; I, therefore, wanted a locomotive that could be made quickly. A Spinner would be relatively simple with no chassis and no quartering problems to worry about. Finally, what could look more effective than a compound piloted by a Spinner?

Prototype information was obviously needed and I was lucky enough to procure a copy of the GA drawing for the '115' class from a friend in the Model Railway Club. (No. 673, Ex 118, of this class is preserved in working order at Batterley by the Midland Railway Trust). A number of articles on these locomotives have appeared in print and the preserved specimen is a useful source of information. Ken Woodhead's drawings of Johnson tenders were used as a basis for the model. I decided to model the locomotive with Deeley smoke box. The original Johnson condition with characteristic chimney and flush boiler/smoke box was not chosen because:

a) This would have required the ornate full Midland livery—on a 2mm scale model this would tend to end up rather like a straw coloured locomotive lined out with crimson lake!

b) It is my opinion that the Deeley smoke box gave the locos a 'punchy' appearance—they looked rather languid before—OK so I'm a Philistine.

Number 672 was modelled because this particular engine seemed to be one of the more spritely singles and was almost identical to her preserved sister No. 673. With enough information to hand work commenced.

A False Start

It was soon realised that compensation would be a very good thing to incorporate into the model, as everyone seemed to be jumping onto the compensation band wagon. The principle behind compensation is that all wheels should be in constant contact and capable of movement to accommodate irregularities in the track. A three point suspension is one solution to this problem of close wheel/rail contact: it is rather like a three legged milking stool. Compensation should give improved electrical pick up; better adhesion and, perhaps most important, a smooth ride. A three point suspension could be achieved on the locomotive by treating the bogie pivot as one point; the driving and trailing wheels would be supported on two independent beams with fulcrums midway between the two axles, making the second and third pivot points. This system required a gearbox to allow for the movement of the driving axle.

After experimenting with various types of gear box the Mk IIb appeared. The specification for this is quite clear from the photo. No adjustment was allowed for, clearly, my luck was in when machining the perspex in the lathe. Small ball races and 2mm scale Association gears were fitted throughout, this produced a very free running assembly. Had the MkIIc ever appeared it would have been adjustable and much smaller. At this time I was experimenting with flywheels but could detect no improvement in performance; their use was not continued. I doubt that such a small flywheel can store enough energy to be effective.

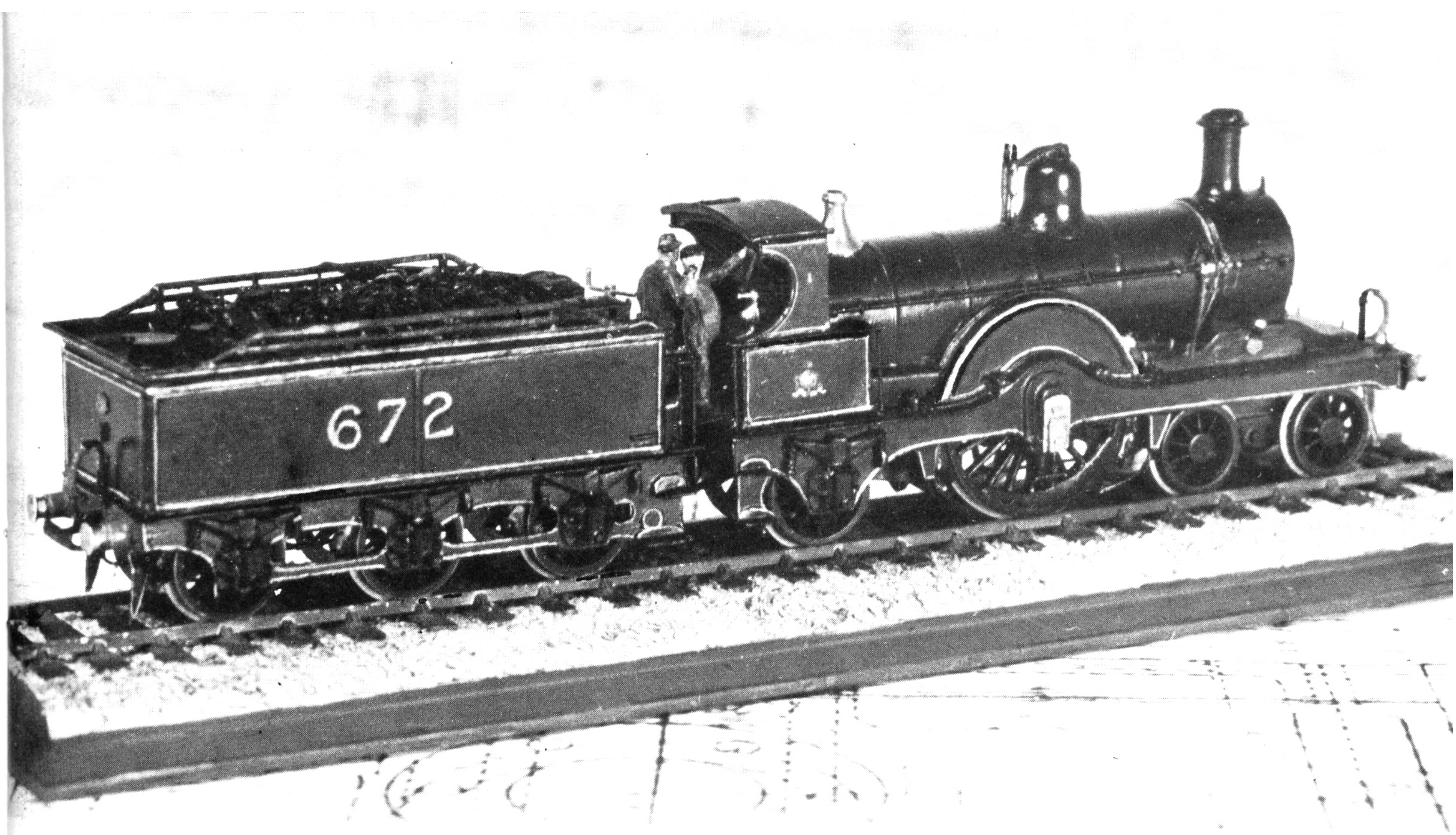
Single wheelers are notoriously difficult to make into powerful load haulers, although Mike Sharman would doubtless contest this point. With the locomotive compensated half the weight available for traction would have rested on a pair of unpowered wheels, this would not have enhanced the performance.

Whilst mulling over the problems with the engine, the tender was built from my customary .005in. and .010. Nickel Silver sheet. A Fleischmann motor was originally tried but this was subsequently scrapped in favour of a slow running Minitrix motor. Number 672 was proving to be anything but quick to make.

Modelling the prototype drive system

Turned down TT wheels were originally going to be used in the 'Spinner'. The 7ft 9in. driving wheels should have 22 spokes; clearly, no TT wheel would be suitable. Wheel wrighting seems to be a bit of a black art in railway modelling circles—the maker is required to use nasty things like slitting saws, jigs and to have pyromaniac tendencies. Luckily only two wheels were needed although seven were made before this pair appeared. A point which seems to elude many modellers is that wheels must be concentric and must not wobble. Whilst my lathe is reasonably accurate, a 3¼in. self-centring chuck will not centre accurately enough to allow wheels to be removed during machining. Consequently, the technique evolved had to take account of this. The wheels were made from 'free cutting' steel rod—steel not only looks right but seems to give improved adhesion compared with the more conventional model materials.

The tread was profiled; the centre drilled, brushed with Araldite and redrilled for the axle; finally, the wheel was parted off from the rod without once disturbing the chuck. Two semicricles of metal were subsequently removed with a piercing saw, leaving two roughly shaped spokes across the diameter of the wheel. These two spokes were filed to the correct oval section and the wheel placed on a disc of paper marked off with 22 radial lines. The two metal spokes were lined up with their counterparts on the paper; this acted as a guide for fitting the remaining spokes. Various materials were tried for the cosmetic spokes; styrene strips, force fitted between the hub and the rim were the final choice. Cyanoacrylate adhesive was used to hold these in place. When the whole assembly was secure the plastic spokes were shaped using a scalpel. The end result is a wheel which is strong, concentric and requires no heat or complicated jigs in its



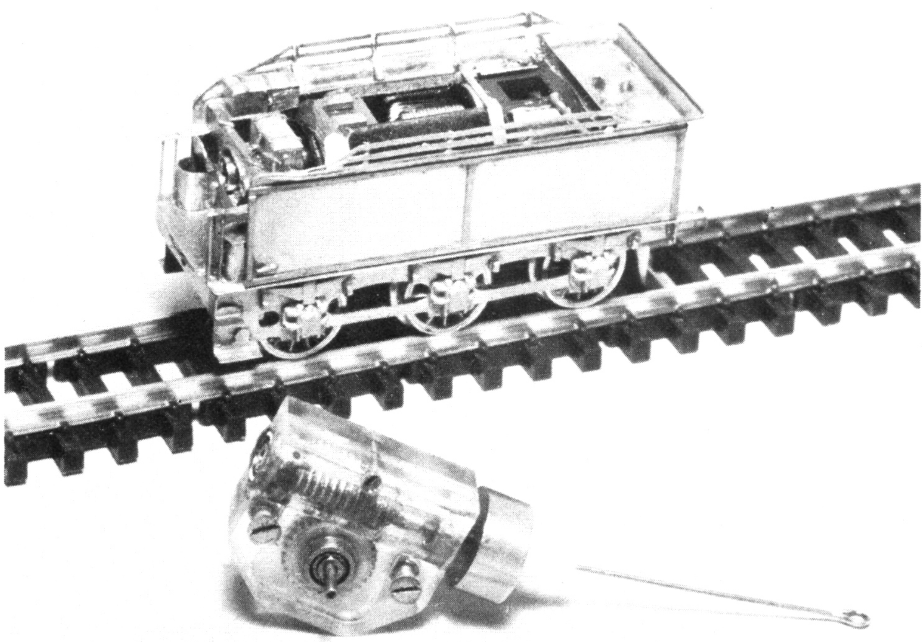
Offside view. The tender brake handle boss is produced by drilling through a syringe needle at 90°. This is facilitated by filing a small flat on one side to start the drill.

manufacture.

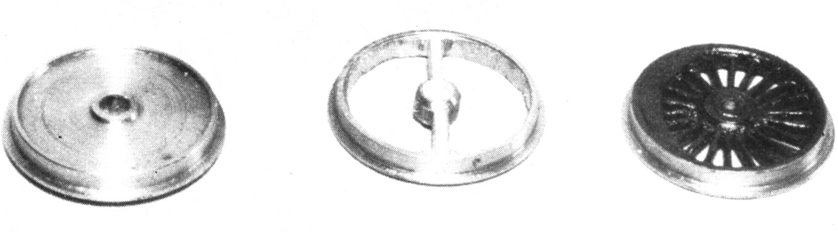
Colleagues at the MRC were very quick to point out that the only reason I was making a single was to avoid quartering problems. One of the amusing aspects of club life is the leg pulling which can be very productive. This sort of comment was not quite 'cricket', and so, armed with the GA Drawing I found that there was enough room between driving wheels for a gear wheel and a cranked axle. It seemed a shame not to make the motion between the frames work; there can't be many locomotives with inside cylinders which show quite as much of their wherewithal. Indeed it seems taboo to most modellers to actually model anything between the frames: why bother to count rivets on a 7mm scale model if the prototype drive unit is noticeable by its absence?

One of the advantages of choosing a double framed locomotive was that the inside frames could be dispensed with, and the outside axle boxes and hornways used. Having made a few enquiries, the general concensus of opinion was that the best way to make a cranked axle was to use a plain axle rod with the webs and cranks silver soldered into place; when everything is solid the axle is sawn through in the appropriate places. The drawbacks with this method when applied to the problems were, firstly; the components would have been incredibly small and difficult to hold in place; secondly there would have been eight joints in one axle; and finally, fitting the gear wheel in the midst of all this would have presented difficulties. The biggest problem, from my point of view, was the accuracy required to make the crank webs.

The alternative devised relies on accuracy obtainable from careful lathe work; there are only four vulnerable joints and the gear wheel can be incorporated quite easily (Fig. 1). One half of the axle is a force fit into the other, this in turn, force fits the gear wheel. The cranks are silver soldered to each half axle before the gear wheel is sandwiched between. Once the assembly is driven home the axle is cut, so freeing the cranks. This

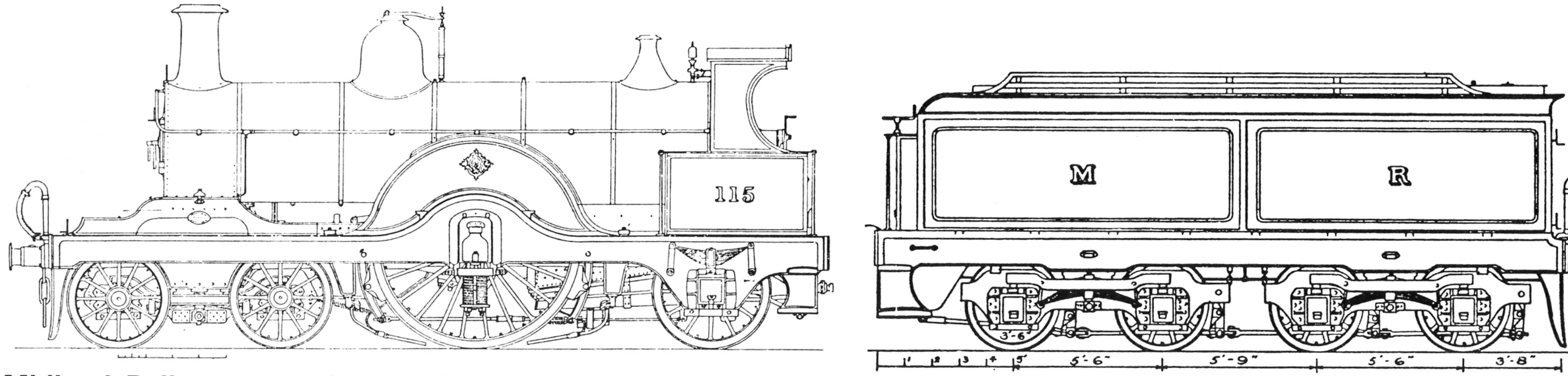


Tender for 672, with, in front, the original gearbox fitted with ball races and flywheel, original 'thick' drive shaft.
The shaft used on the locomotive is much thinner. Notice the shape of the bent wire

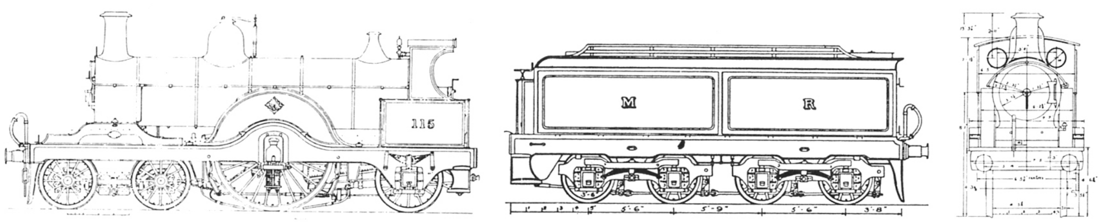


Stages in the manufacture of an N gauge driving wheel from L to R: disc turned; two semi-circles cut out; extra spokes added in .020in. square black styrene sheet.

THE MIDLAND SPINNERS



Midland Railway 4-2-2 No.115 Scale 4mm-1 foot



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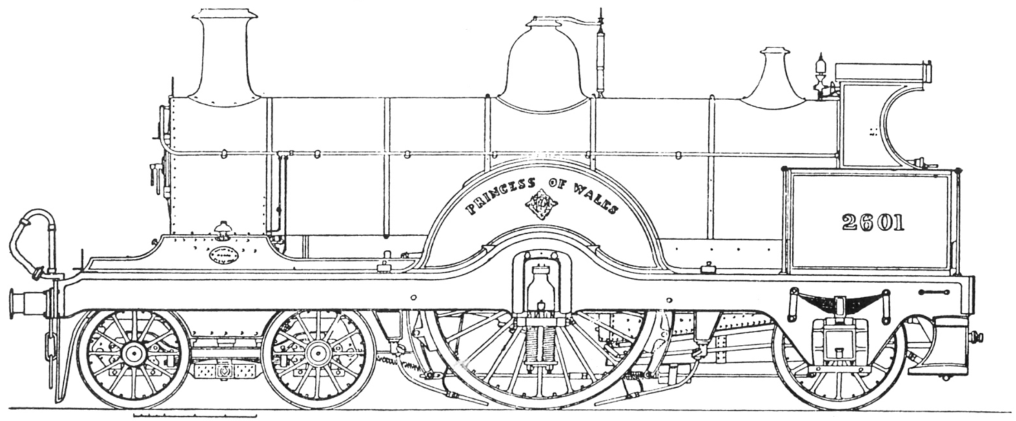
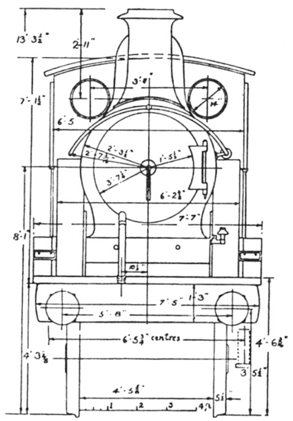
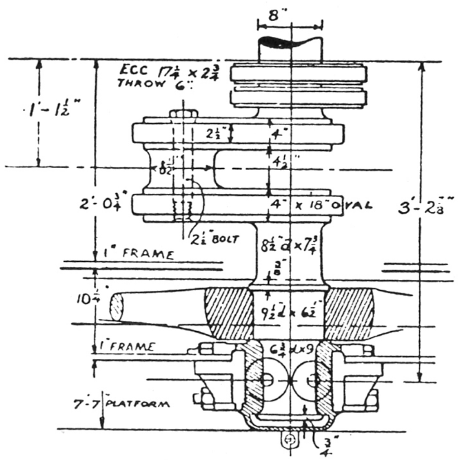




Midland Railway 4-2-2 No.2601 Scale 4mm-1 foot
Drawings by the late F. C. Hambledon



Detail of Crank Axle.

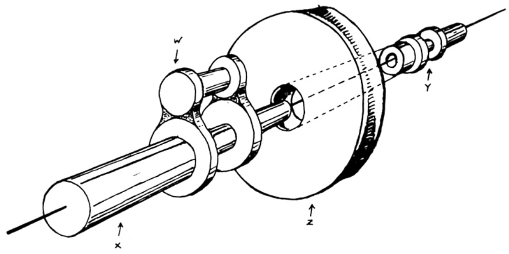


Fig. 1 CRANK ARRANGEMENT BEFORE ASSEMBLY
Half axle X force fits into half axle Y whixh is in turn a force fit into wormwheel Z. Crank W silver soldered to axle X which was subsequently cut after assembley.

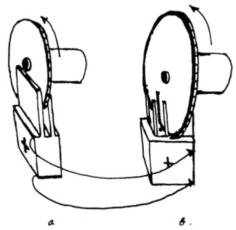


Fig. 2 MACHINING CYLINDERS
a) Cylinder block milled with slitting saw to leave two fins behind.
b) Rotated through 90° and milled again to leave four slide bars per cylinder. The slide bars for one sylinder are already cut out in this diagram.

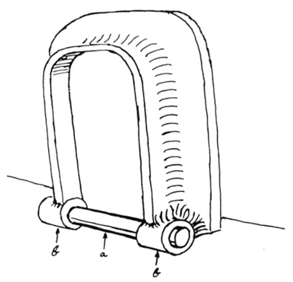


Fig. 3 HORNWAY PIN
Pin A is a good fit in syringe needles which are soldered to the flanged hornway. Axle box is omitted for clarity.

produces a strong axle in 2mm scale; a fact borne out by the dropping of one half on the floor whilst held in the pin chuck. The axle bent but the joints did not break. Lightning shouldn't strike twice in the same place but it did: four half axles were made! (I now wear an apron pinned to the underside of the bench to catch such errant objects—2mm scale modellers either have lightning quick reflexes or spend half their modelling time on their hands and knees!)

Having made the axle, which surprised me by running true, attention was turned to the cylinder block and slide bars. Each cylinder has four slide bars; this seemed a bit of a tall order for fabrication. Once again the lathe came to the rescue and the whole assembly was machined out of one lump of steel (Fig. 2). (Lump isn't quite appropriate because it was only ¾in. of ¼in. square bar to start with.) The cylinder centre lines were marked on the steel and drilled to clear the piston rods. This gave the reference for the slide bars. The lump was milled for approximately half its length using slitting saws running in a mandrel held in the headstock chuck. The vertical slots were cut first and then with the steel turned through 90° in the vice on the vertical slide, the horizontal slots were milled out. Machining in this way produced quite a strong assembly without requiring much skill—it also avoided the burnt finger syndrome.

The frames and front end were assembled around the cylinder block. The hornway, a casting on the prototype, was fabricated from 8 thou nickel silver strip. The brass axle box slides in this hornway and is retained by a pin across the bottom; this engages in two lengths of syringe needle soldered to the bottom of the flanges (Fig. 3). The axle boxes were machined on the lathe, final detailing was achieved by careful filing. By using the outside boxes a decent bearing surface of 1.5mm thickness could be accommodated.

The crossheads were filed up from brass and the piston rods soldered into the end. The little end of the phosphor bronze connecting rod is held in place by an interference fitted pin. The big ends had to be easily removable for maintenance purposes. This was achieved by soldering two lengths of syringe needle to the top and bottom big end forks and pinning between them (c.f. axlebox/hornway). The driving wheels were pushed onto the axle: packing had been inserted between the crank web beforehand. The 'engine' was tested using a small 30psi air jet playing on the spokes of the wheels. The effect was dramatic; instant 'running in' was achieved—the assembly screamed rather like a high speed dental handpiece—after five minutes the two big end pins shot out and testing stopped.

The Drive

Efficient though turbines might be, the motor in the tender still had to drive the loco wheels. It would have been pleasant to conceal the drive below footplate level. The problem with this was that the driving axle was high and the trailing axle conveniently in the middle of any proposed drive shaft; an underslung worm would have been visible and, as a consequence, unsightly. The simplest solution was to take the drive staight across the air gap between coal hole and fire box door—the driver would then get a cheap thrill every time the loco traversed a sharp curve. The drive was one of the John Greenwood 'bent hairpin' pattern. Instead of the usual ball and pin joint at each end the shaft is bent to form the drive (Fig. 4). The advantage of this system is that there are no joints to make (or break); consequently the shaft can be fashioned out of ridiculously thin piano wire. I have not disclosed whether or not both ends of the shaft are at 90° to each other—some Aunt Sally's are best left undisturbed—in practice I don't think that it makes any significant difference.

The drive is transmitted to the driving wheels via a 32:1 worm/wormwheel set. The worm runs in a semi-enclosed housing which was machined out of perspex on the lathe. Adjustment is achieved by tightening one of the two screws at the back of the housing. Miniature ballraces are fitted either end of the worm; even if they don't make a startling difference to the free running they will certainly wear well.

The Body

With the mechanism just about complete, work continued with the body work. It is now my policy to make locos split into component parts wherever possible. On this loco the body splits into three units: the frames, running plate and splashers form one unit; the boiler, firebox and smoke box another and the cab the third. This construction method aids in the servicing of the locomotive and considerably simplifies its painting. The boiler was turned from brass tubing. Each end was annealed, slit and bent down to reproduce the flare for the smokebox and firebox. As with all models adding the details is very absorbing, but also very time consuming. Handrails and associated plumbing often seem to be a weak point on many models. On the 115 class most of the boiler's handrails were also pipe runs; as a consequence, they are quite hefty. Syringe needles were used for these items—they have the advantage of being straight, (unless second-hand!) very strong, and ideal for arranging the changes in outside diameter so common at the smoke box end of handrails. Overscale handrail knobs are fortunately not available in 2mm scale. The twisted wire method was employed for the knobs. After fixing the wire was filed around the rail so as to make it less conspicuous (see Fig. 5).

The boiler fittings were turned in brass: at last 672 began to look like a locomotive! It was suggested that the whole engine should be cast in gold. The futility of this was pointed out to the lecturer concerned, after

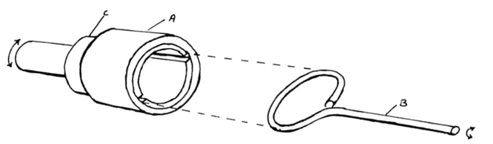
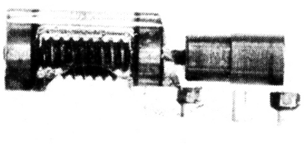


Fig. 4 UNIVERSAL JOINTS
Sleeve A stops thin wire drive shaft B from moving sideways in female half of universal joint C. The loop of B engages in the slots in C.



Final design of worm housing, milled from perspex.
Ball races mounted either end. Female half of universal joint (see Fig. 4).

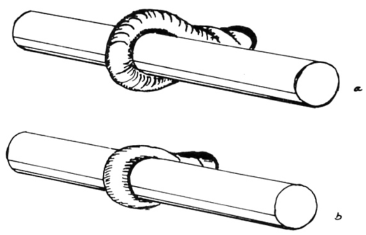
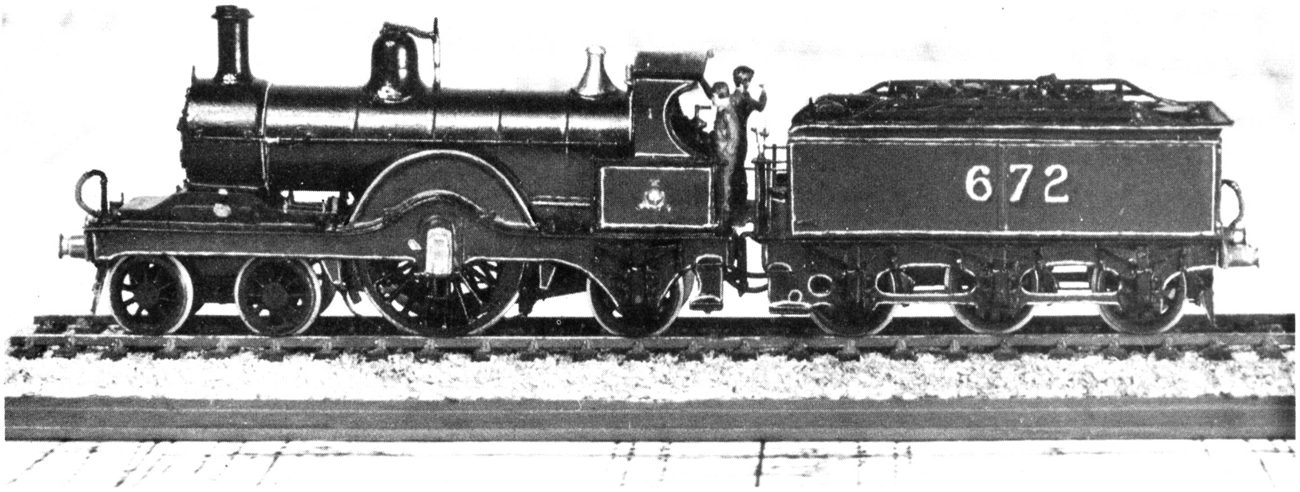


Fig. 5 HANDRAIL KNOBS
a) Round wire twisted around handrail.
b) Soldered to boiler and handrail and then filed to a flatter section around handrail.



Nearside view of 672. The track is moulded from acrylic.

all, most of the loco was to be painted crimson lake! The germ of an idea had been sown: Gold does not tarnish and would be the ideal material for representing the polished brass of the safety valve.

To this end a silicon rubber impression was taken of the brass 'master'. This mould was subsequently filled with blue inlay wax, sprued with wire and the wax invested in a refractory investment material. The wax was burnt out, the sprue wire removed and gold centrifugally cast into the mould. Dental casting of this kind is exceptionally accurate; the lost wax process is a trifle long winded, even so not many locos can boast a 22ct safety valve—all that glitters might well be! (Modellers are advised to read the M.A.P. publication 'Lost Wax Casting' by G. Leybourn - Needham for further information.) The driver and fireman were made from copper wire and solder.

Balancing up

This was where the fun began. Following in the footsteps of Mike Sharman and Stewart Hine it was obvious that a weighted tender bearing onto the loco was called for. Unfortunately the front of the loco could not counter balance the weight of the tender. The problem seemed insoluble until Keith Armes suggested that the loco/tender coupling should be rigid in the vertical but movable in the horizontal plane.

In practice, this was achieved by wire running in a close fitting tube about 4mm long. This solved the weight distribution problem but also produced, in effect, a rigid long wheel base wagon. In this form the loco had a strong dislike for staying on the track. The wheel turned full circle (so to speak) by the use of a midline pivot for the rear tender axle; a three point suspension and a fully compensated locomotive were produced! The remaining wheels are free to follow the track. There can't be many 0-2-2-0s around!

672 was originally built to run on 'N' gauge track. The photographs taken before painting show it in this condition. The loco was just finished in time to run on the Manchester MRS layout 'Gransmoor Castle' at their exhibition, in December 1977. The loco's performance was, frankly, disappointing. A good deal of this was attributable to the poor wheel/rail relation with 'N' gauge standards. Good contact between wheel and rail is essential when there is only one pair of driving wheels. The distance between 'N' gauge crossing noses and wing rails is so great that the driving wheels tended to fall into the hole—with an immediate 50% loss of power. The loco could haul about four reasonably free running coaches on the level, but, like the prototype, didn't want to know about gradients. Conversion to finescale was high on the list of New Year resolutions; the loco had been built with this in mind. In the rebuild the opportunity was taken to rationalise the motor mountings and tender chassis. The two front axles on the tender now run on independent beams which are lightly sprung downwards with .004in. stainless steel wire. Split axle electrical pick up is used on the tender and 33swg phosphor bronze pickups on the driving wheels. For about 9 months the loco ran as 6/7ths finescale. During this period it would only run on plain track set to 9.42mm gauge. The alarming slop between driving wheels and rails produced so much movement at the front end of the loco that the valence tended to lift the bogie off the track! New driving wheels were made with a vast improvement in both appearance and running: the slop is reduced and the loco has pulled 11 coaches on the straight and level—albeit with a bit of wheel slip before the train started to move! It is expected that the loco will run with 6-8 coaches on the MRC 2mm scale layout being built at the moment. Sadly, 672 was never a suitable locomotive for my own layout, 'Gouldby for Caldecote' (MR April 1978)—it could not tolerate the gradients and made the compound, which it was built to pilot, look incredibly crude. Incidentally, by the time this article appears in print, Gouldby will have been scrapped in favour of the MRC 2mm layout.

Conclusions

My thoughts about a 'Spinner' being a 'quickie' fell well short of the mark. Four hundred and seventy two hours were spent on 672 before its first public showing at Manchester. Now that the loco is converted to finescale the figure must be over 500; which is where I stopped counting. The loco cost me about £25; not a bad price for three years' enjoyment: it also made me realise the potential of my lathe—a Myford ML 10. The loco has aroused some interesting comments at exhibitions. However, I am sure that when the public sees the crossheads flashing backwards and forwards their immediate reaction is to expect something to drop off—one day perhaps it will.

Photographs by
Brian Monaghan
Martin Farquharson
Stalin Kariyawasam

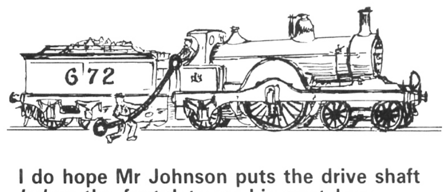
FOOTNOTE ON GOLD

There are two excellent reasons for making a 2mm scale locomotive entirely from gold.

The first is, of course, the extreme ease of working this most beautiful of metals. The second is that it is the third densest metal, denser in point of fact than Uranium! So the extra adhesion would be marginally useful.

The increase in cost would be significant, but the real problem is getting the stuff — it is hedged about by restrictions.

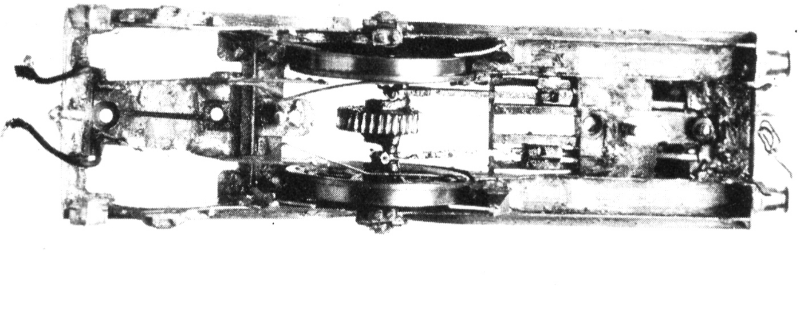
C. J. Freezer



I do hope Mr Johnson puts the drive shaft *below* the footplate on his next loco.

Acknowledgements

Without the constant comments, criticisms and advice from Dr Andrew Lumsden, Dr R. C. Patterson, Keith Armes and Mike Raithby, the loco would have been a good deal simpler, but not half as much fun!



Underside of engine, after running in but before cleaning up preparatory to painting.