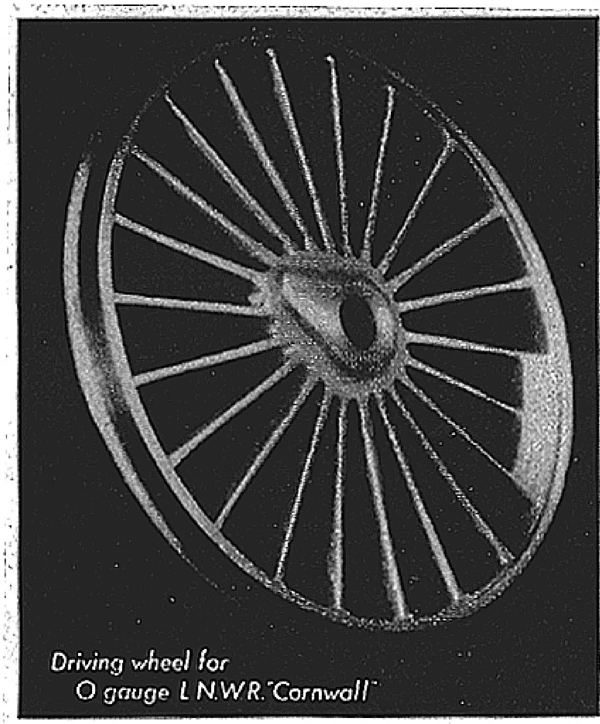

Driving wheel for O gauge L.N.W.R. "Cornwall"

MAKING SPOKED WHEELS

Conclusion of this informative article by S. STUBBS

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Cutting out the spokes

FOR this operation to be effected in 4 mm. scale, a piercing saw frame and metal cutting fretsaws are needed; larger scales will be ignored for the moment.

The fretsaw blade is loosened at one end of the frame, the wheel blank threaded on, the blade then tightened up and the vee-shaped piece between the spokes is sawn out. The saw is loosened and passed through the next hole, and so on right round the wheel.

Use the familiar vee-shaped sawing table as for fretwork, take things easily, sit down to the job and use a medium blade, not the coarsest, not the finest. When the balance weights are reached, the vee sawn out will be smaller, and the vee will not be as deep nor as pointed at the sides and apex of the crank.

It is this sawing job which seems to deter most people, who imagine that one must be a super craftsman with infinite patience to tackle such a job. Nothing could be further from the truth. Six 4 mm. wheels in brass can be cut quite easily in one evening, without breaking a saw, although it is worth changing the saw every so often as it is a slow job cutting with a blunt one (they are cheap enough, anyway). The well-known "Eclipse" piercing saw blades and frames are ideal for this job and are readily obtainable at most tool shops, but here I must add the usual disclaimer. A normal fretsaw frame will serve, but it is not really stiff enough for metal and one can expect more broken saws and frayed tempers.

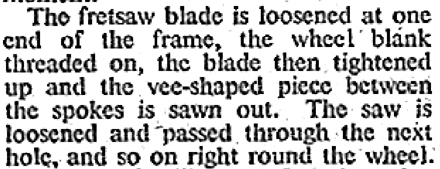

FIG 11

For "O" gauge wheels, a coarser saw is needed and, if working in steel, fretsawing is a long job, though unavoidable perhaps on the smaller wheels. For larger wheels and for Gauge "1" wheels, the initial hole may be large enough, with perhaps a little filing with a rat tail or square file, to admit the blade of a "Junior Eclipse" saw and this makes short work of the job with the wheels held in the vice. "Tyler" spiral blades, rather like the well-known "Abrafile," have also been used in a hacksaw frame. Whatever cutting out methods are used, however, cut as near as possible to the scribed line to avoid too much subsequent filing, but be careful not to go over the line on to the wrong side, or bad spokes will result.

It but remains to finish the spokes and balance weight profiles by filing. This is done in the vice and is a sitting down job with the eyes fairly close and level with the work. Fibre vice jaws are advised, otherwise the constant clamping up of the jaws as the wheel is reset for each spoke will damage the finish on the edge of the wheel rim beyond repair. For 4 mm. wheels in brass, 14 cm. or 16 cm. needle files are used, but for 7 mm. or larger, small size normal hand files can be introduced into the space between the spokes and, having a coarser cut than needle files, they speed up the work. For 4 mm. work use a medium to coarse cut for shifting the metal, and a fine cut for finishing.

By far the most useful file is the "knife" file as shown in section a, Fig. 11. It is as well to grind the back of this file lightly to give a good edge with the sides and to ensure that it has an equal angle with each side, otherwise, difficulty may be experienced in getting into the corners where the spoke joins the rim. To file the underside of the rim, a square section file proves best as at b, Fig. 11. Be careful if tempted to use a triangular file as at c; it tends to cut sideways into the spokes.

Do not forget to cut down well into the roots of the spokes, using the edge of the knife file and remember that the distinctive shape of the balance weights is created at this filing stage. Do not try to file a vee section spoke but remember, this section is provided on commercial wheels to enable the stamping or diecasting to "draw" easily from the die whilst, at the same time, the apex of the vee being at the face of the wheel gives an illusion of thin spokes. In fact, real spokes are roughly rectangular with rounded corners when taken in cross section, the greatest dimension of the rectangle being from front to back of the wheel. Sometimes this rectangle becomes nearer to an ellipse but never by any means a triangle. Therefore, keep your file square across the wheel when filing the spokes and balance weight. Finally, take the sharp edge off the spokes on the wheel face side using the tip of the file to scrape, as much as cut, as it will be found very difficult to get a file in place to file a radius, especially near the spoke roots.

The wheels can now be put on a bolt, nipped up between a nut and the bolt head and spun in the lathe to give a final polish with emery and to knock off the sharpness of the spoke edges by this polishing.

We did make mention of turning the profiles of wheels after drilling, when no form tool is available. Here, the point of waiting till the drilling is done is that the blanks can be mounted on the mandrel, Fig. 5b, with small bolts through the holes and screwed into tapped holes in the face against which the wheel rests. These bolts act as drivers in addition to holding the blanks in place.

The finished wheels, shown in course of manufacture in Photos 6 and 8, are illustrated in Photo 12. They are in steel, 59½ mm. in dia. for an "O" gauge model of the L.N.W.R. 2-2-2 *Cornwall*. In order to mount them on a ⅜ in. diameter mandrel in the dividing head, a ⅜ in. bore was put in to begin with, as shown in Photo 6. The cranks in this case were made by turning a ⅜ in. steel spigot with a thin flange and filing the flange to the shape of the crank, these two pieces being illustrated in Photo 6. After the wheels have been drilled for the spokes, these cranks are fitted, adjusted relative to the balance weights, and the spigots forced home, the whole being secured with a little solder all round the crank. Here, then, is another way of dealing with the problem of providing cranks.

Alternative methods of making wheels

Some two or three years ago, Messrs Bond's O' Euston Road advertised unmachined driving, tender and bogie wheel stampings in brass for 4 mm. scale wheels. These have the spokes, balance weights of crescent shape and crank bosses integral as bought, and they cover 26, 24, 22 and 19 mm. driving wheels, the former two with 20 spokes, the latter two with 16 spokes, also 12-spoke tender wheels, 16 mm. dia., and 8-spoke bogie wheels, 13 mm. dia. A number were procured and it was found that they had sufficient metal on to clean up to 27 mm. drivers and to cover the whole range down to 19 mm., as far as the drivers were concerned, and to meet the need for 4 ft 4 in. trailing wheels on a Johnson single, using the tender stamping, as well as covering the 4 ft 2½ in. tender wheels. Moreover, by introducing the fretsaw blade between the spokes, after machining, it was found possible to cut the ends of the crescent shaped balance weights away leaving square ended balance weights slightly less than 180 deg. to the cranks, as needed for a certain engine. For an outside framed engine, the cranks were machined off leaving the correct circular boss, and the spokes were then filed down at the root to this boss.

Thus, it will be seen, by using these stampings, one can save all the work involved in dividing, drilling and sawing out the spokes. A sample wheel stamping is illustrated in Fig. 13, and it will be seen that there is a boss provided at the rear for chucking purposes, this being cut off after the tread, front and bore have been turned, leaving only the turning of the back. To get the outward taper of the spokes towards the wheel centre, a machining cut is needed across the front face of the spokes and, as they are of triangular cross section, they look rather queer after this machining, being wide at the rim and narrow at the boss which is all wrong, but it is, in any case, necessary to thin the spokes down by filing as for the home-made product, and when this is done, the wheels are quite presentable once more. Much the same remarks apply to the cast iron castings which have been available for many years for "O" gauge and Gauge "1." It is necessary to file the spokes, and probably to modify the balance weights, after the turning and boring has been carried out, but a great deal of work is undoubtedly avoided if the castings are of such a size as to be capable of modification.

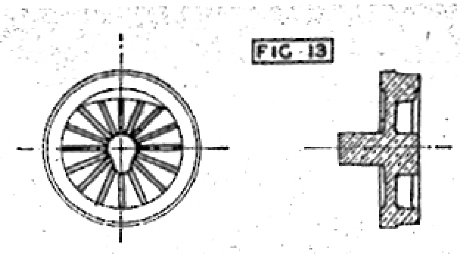
FIG 13

There remains one other method of wheel making, applicable to those wheels which have neither cranks nor balance weights, namely bogie and tender wheels (and possibly the odd inside cylinder, single-wheeler). The principle here is dealt with in Fig. 14, where it will be seen that centres comprising the spokes and boss are forced into rims having the tyre profile. If the form tool, previously discussed, is available, the rims can be turned in one long "stick" and, having bored the lot at one go, they can be parted off and possibly used without any further machining, depending on how well you part off.

The centres are made with about 0.001 in. to 0.002 in. force fit inside these rims and, again, it is most convenient to turn a bar to size for this force fit and then machine and part off blank wheel centres, drilling them before parting off. The owner of a lathe with collets and step chucks will find the latter a great help on this job, as the front faces, bosses and drilling can be done in the step chuck leaving only the initial parting off of plain blanks, which is a quick and straightforward business.

Having prepared a number of centres sufficient for the wheels in hand plus, perhaps, a few spares, a mandrel is made to take about six or eight blanks threaded on, and with a nut at the end of the mandrel to clamp the blanks up tight in a bunch. The mandrel is then fitted to the dividing head, which is set up to give a number of divisions equal to the number of spokes and a fine slitting saw is mounted up on the lathe spindle. The saw for 4 mm. scale should not exceed 0.02 in. wide and can with advantage be much thinner, whilst 1/32 in. wide should cover even Gauge "1" wheels. Offset the saw so it is not quite on the centre of the mandrel but is cutting down one side of a spoke, sink it in to boss dia. of the

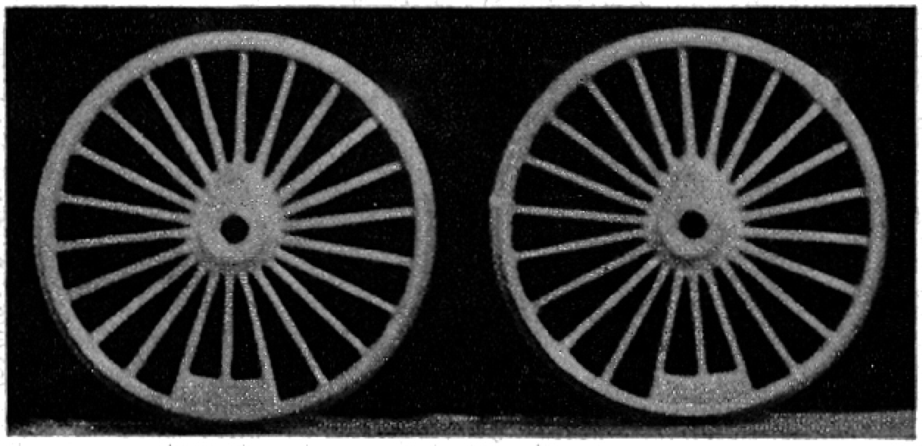
FIG 12

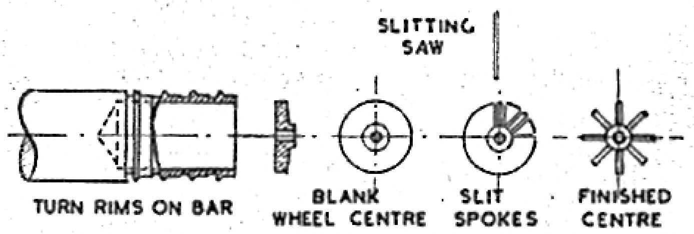

FIG 14

blanks and feed the whole row of blanks under the saw. Withdraw, index one spoke and repeat the cut and so on right round the blanks until number one cut is back in line with the saw. Now set the blanks over such that the saw is cutting down the other side of the spoke and repeat the cutting. As each cut is made, a wedge shaped piece of metal will come away from between the spokes on each blank and, having gone all round, one is left with a mandrel full of star shaped blanks all ready to drive into the rims to serve as spokes. A touch of solder paste under the rim and round the tops of the spokes, a whiff of heat, and the wheels are as good as solid, and very quickly so too (personal record: twenty wheels in one evening, which is not too expensive in terms of time). It is, however, a good practice to cut the spokes a bit thick and to treat the finished wheels as solid sawn-out blanks to be filed up afterwards. Somehow, this makes the spokes look more like spokes and less like sawn-out stars fitted into rims, if you see what I mean.

Nickel plating and finishing the bores, etc.

Brass wheels should be dull nickel plated, as they do not pick up dirt quite so easily if so treated, and they do pick up electricity rather more readily. When a large number of wheels are to be made, it is worth while making one's own electroplating bath, and, once having collected the necessary items for such a bath, other parts may, with advantage, be plated at will. However, it is not proposed to enter into the details of electroplating in this article. Let it suffice to state that, if electroplating is to be done in the home workshop, the wheels should be boiled in a solution of caustic potash (1 oz. to 1 pint of water) before plating, and should not be touched by the fingers after this boiling but suspended on a wire and washed in water. If oxidised, they should be boiled for a short time in weak (1 : 10) solution of hydrochloric acid. To get a first class, durable nickel plate, the wheels should first of all be copper plated. Most people will, however, prefer to take the wheels to a local electroplating firm of which most towns boast at least one. In the past, the cost of nickel plating a dozen wheels has worked out at about 2s 6d.

The bore originally given for 4 mm. drivers was No 31 drill (0.120 in.). The intention is to provide a force fit on $\frac{1}{8}$ in. silver steel axles and the final job, after plating, is to open the initial bore out to provide a force fit on $\frac{1}{8}$ in. diameter (0.125 in.). The wheels can be chucked lightly and truly in the lathe and a taper broach or a reamer entered until the bore is 0.0005 in. below $\frac{1}{8}$ in. or, a "D" bit can be used, Fig. 15. To make the "D" bit, turn and polish a diameter of 0.1245 in. on a piece of silver steel and harden this portion in water in the same way as the wheel form tool was hardened. Grind the diameter away for about $\frac{3}{16}$ in. of its length until the "D" bit is exactly half diameter measured across the flat and grind a 10 deg. front rake as shown. Finally, bring the flat and the end to a high finish with a smooth slip of oilstone so that all edges are really sharp. This bit, used like a drill, will open out the bore to 0.1245 in. exactly and will leave a fine finish, thus ensuring a really good force fit. For other bore diameters and axle sizes, the reader is left to follow normal practice in these matters, but it is suggested that bogie and tender wheels should be 3/32 in. axles, unless insulated bushes are to be fitted, in which case $\frac{1}{16}$ in. axles are used in 4 mm. scale.

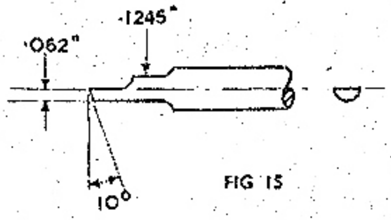

FIG 15

Crank pin holes can now be drilled and here it is suggested that a hole is marked out and drilled in one wheel only and a dowel is then put through the bore of this wheel and a second wheel located on the dowel and drilled for crankpin from the first. The remaining wheels are then treated in the same way using the first wheel as a jig, thus making sure that all crank throws are identical. The author recommends a forced in crankpin with the end shouldered down to take a washer and nut for retention of the coupling rod. In 4 mm. scale, the pin diameter is 0.052 in. shouldered down to 16 B.A., giving a very neat assembly indeed. A screwed pin tapped into the wheel is *not* recommended, as the tapping is liable to wander and upset the throw.

Modifying commercial products

As many readers will not have a lathe, a few notes are included to assist those who wish to modify commercial wheels. The obvious improvement is to file the spokes to correct scale thickness and here the reader is referred to the notes under the heading "Cutting out the spokes."

This is a job well worth doing as the appearance of many wheels can be improved out of all proportion to the work involved. Diecast wheels are equally capable of improvement in this way, although too much thinning may make the wheels rather fragile.

Whilst on the subject of cutting out and filing, it is quite in order to modify commercial crescent shaped balance weights to the square ended variety by fretsawing the unwanted ends of the crescents away and filing to shape the part left. If the balance weights provided are not in the correct position relative to the crank, they may be sawn and filed away completely. New ones, made by cutting the correct shape from very thin brass, may be sweated on to the face of the spokes, afterwards filling in with solder from the back and cleaning up with a file. Discs of brass should be marked out, cut and filed to exact size of the under rim dimension of the wheel and the balance weights can be cut from these. Sometimes, the balance weight stands out from the spokes, in which case, thicker brass should be used, as needed. This may apply in the case of wheels made from scratch and here the additional thickness is applied over the balance weight already provided, or one can save some work in making the initial wheel by leaving the balance weights out to start with and adding later with solder to fill in from the back.

In the case of alloy wheels which will not solder, the new balance weights can be stuck on with one of the new adhesives, the best of which, for this job, probably being the latest "Araldite."

There is, of course, no reason why lathe owners should not take commercial wheels and re-machine them on diameter if a commercial wheel will satisfy requirements when so modified, but the full treatment involving wheel profile, thinned down spokes and new balance weights may well prove as much work as making from scratch.

On certain wheels, notably those fitted to the Stanier engines, the balance weights have rivet detail which can be embossed on thin brass or copper foil and applied in the form of added balance weights on top of the originals.

Finally

The wheels described are intended to be forced on to axles. It is a very difficult matter indeed to provide squared holes for "quartering" and, in any case, one should not disfigure good wheels by the use of locking nuts with screwdriver slot.

For 2-rail, the best method of current collection is by using split axles so that the two halves of the axle are insulated from each other, but each half is in electrical metal-to-metal contact with its own wheel bore. The current then passes via the axle bearing bush to the metal frame, the frames on each side being insulated by using "Tufnol" stretchers between them, and leads from the left and right-hand frames feed the motor.

The design of strong, workmanlike, split axles is shown in Fig. 16, which also gives dimensions for "EM" gauge, to be modified in proportion for other scales and gauges. In this instance, the half axles are $\frac{1}{8}$ in. silver steel; the Tufnol bush is drilled $\frac{1}{8}$ in. and, being forced into the outer tube, it closes sufficiently to give the half axles a force fit. Note the little card insulator disc between the axle ends, and also note the hole through one half axle to release trapped air when assembling. This hole terminates in a No 76 (0.02 in.) hole at the outer face of the axle to simulate the usual centre on which the wheels are turned in real practice. Don't forget a small centre at the other end, too. It looks correct and is handy for the compass point when wheel rims have to be lined out after painting. The best way to force fit the two half axles is to grip each in a chuck, one mounted on the lathe headstock and one on the tailstock. The half axles are then pressed home simultaneously by screwing out the tailstock barrel. This method ensures that the axle is assembled in line.

Similarly, the wheels are best pressed home between the machined ends of two pieces of steel bar held in chucks in the headstock and tailstock. Do not forget to put the axleboxes on the axles *before* pressing the wheels home. From this, it will be seen that proper horns will have to be provided in the frames, and this is not nearly so difficult as it sounds—but it is where we came in, and the start of another story. Perhaps, if this article is received favourably, others may be written on such matters as locomotive springing, floating oilbath gearboxes and even more serious subjects, but for the moment—good luck with your wheels !

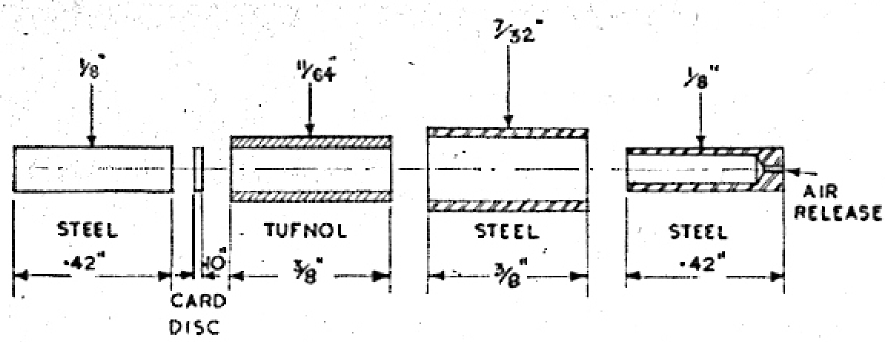

FIG 16