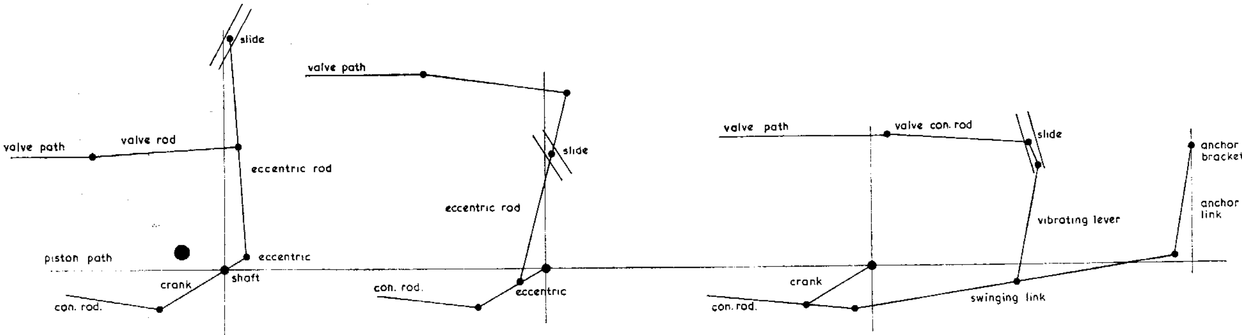


HACKWORTH NORMAL TYPE
(high slide)

HACKWORTH ECCENTRIC IN LINE WITH CRANK
(high valve line)

EARLY HEYWOOD (slide type)
(lower valve line & reduced slide angle)

guide. Normally the eccentric has about ⅓ the throw of the crank. In the Heywood gear the motion is derived from the big end via a long swinging link as shown at the right which reduces the vertical movement of the vibrating lever to half that of the pivot point on the big end. *Ella*'s gear as originally built was as shown on the diagram. The Greenly gear is similar but has the swinging link and slide forward of the big end.

An objection to the Hackworth and Joy gears which use a sliding block and guide is the wear and friction between these components. On Heywood's later engines and when rebuilding *Ella*, the straight slide was replaced by a link arrangement devised to constrain the pivot point of the vibrating lever to move in a straight line.

It will be appreciated that while the swinging link reduces the vertical motion of the vibrating lever, the horizontal movement is the full stroke of the piston, and the two top pivots must be very close together. This situation is relieved to a small extent by a dog-leg swinging link.

ON PARTING OFF

by George H. Thomas

FROM MY OWN EXPERIENCES and conversations with hundreds of visitors to the SMEE workshop at the last three M.E. exhibitions it would seem that parting-off causes more heartaches than all other lathe operations put together and this article has been prepared with the object of setting out the various causes of the difficulties experienced together with an account of my endeavours to overcome them.

That the troubles are not peculiar to readers of this magazine is made clear by Dr. W. A. J. Chapman in his *Workshop Technology* where he writes: "In theory, the process of parting-off in the lathe is simple. The tool is clamped in position and carefully fed to the work which it proceeds to part off without difficulty. In practice, particularly on a lathe which is beginning to show signs of wear, the process is far from easy, and when the reader has experienced the tool digging in and breaking, he will realise that theory and practice require considerable manipulation to make them agree."

The causes of trouble are probably to be found under one or more of the following headings:

1. Inadequate equipment, e.g. lathe too flimsy or in poor condition.
2. Tools not suitable or badly set.
3. The nature of the material being parted.
4. Type and quantity of lubricant being used.
5. Psychological. Many workers, especially beginners, after a "big bang" are apt to remain scared of the job and use speeds far too low etc.

During my working life, I must have seen parting-off operations performed countless times on all manner of materials and always it was treated as a matter of ordinary routine. Why so? Whilst "we" and "they" are both performing the same operation—cutting a deep groove into the same kind of material—"they" have a larger and much stiffer machine than ours enabling them to use a wider and deeper, consequently much stiffer, tool, the increased width of which provides improved egress for the swarf. Furthermore, industrial machines can almost invariably provide a copious flow of lubricant whereas, for a number of reasons, ours cannot. This very simple, and by no means complete, comparison between industrial and "home-worker" conditions highlights four very important points for successful parting-off, viz. use a rigid machine, a rigid tool, get rid of the swarf and, where applicable, supply plenty of the correct lubricant.

Some of the requirements for successful parting-off, apart from the above, are:

a. Keep overhang of work from front bearing to a minimum.
b. Use a top-rake less than that normally used on a turning tool for the same material.
c. Set the tool slightly below centre-line (for front-mounted tool).
d. Use a tool narrower at the back than at the front.
e. Set the tool accurately square to the lathe axis.
f. Lock the saddle to the bed whilst parting.
g. Use a turning speed approximately one-half of that normally used for ordinary turning on the same material.
h. Feed *slowly* by hand.

As the tools and methods which I shall describe are the result of my own experiences with a small lathe I think that it might be useful to recount briefly my own trials and tribulations. I started in earnest in 1920 with the purchase of a 3½ in. Drummond lathe—commonly known as the "flat-bed"—which has a sadly undersized mandrel, only 15/16 in. diameter in the long span between front and rear bearings. My attempts at parting-off were a nightmare and, thinking that the trouble was due to too much clearance in the front bearing, I tightened this up until it was almost impossible to treadle the thing! My tools were home-made and probably useless and the resulting chatter and digging-in reduced me to the final ignominy of parting-off with a hacksaw! That my inability to part off on this lathe was not due entirely to my own lack of experience is evident because two of my friends who still use these machines had exactly the same troubles at first, but both of them can now part off with comparative ease *because* both of these lathes have had larger mandrels fitted. In one case, the increase in mandrel diameter, right through from front to back, was such as to require almost a complete rebuild of the headstock. This does, I think, prove a point.

The acquisition of a J & S parting-tool holder with a loose blade enabled me to do a little better —because the tool was better—but I still had to cope with the inadequacies of the machine. All home-workshop activities ceased entirely from 1924 until 1946 when I became the owner of a heap of iron in the guise of a small (pre-war) lathe. Almost every important job done on it was preceded by an overhaul and re-fit which made life difficult until, in 1948, I bought an ML7 which was changed again three or four years later for a

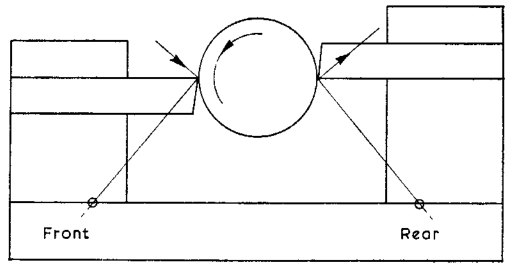


Fig. 1

Super 7. Each of these lathes represented, from the parting-off angle, an improvement on the last and it is significant that each of them had, also, a larger mandrel than the last. My efforts since those days have been directed towards easing the operation, having regard to the fact that even the best of small lathes is never as rigid as a good large one. Parting-off has become progressively easier due to the use of better machines, better tools and more experience.

One will often find it recommended that, as a cure for digging in, the tool should be mounted upside-down and the lathe run in reverse. This is hardly possible with a lathe having a screwed mandrel nose so the tendency is to mount the tool upside-down at the back and so retain the normal forward rotation. I have frequently been asked why the inverted tool gives less trouble than one mounted in the usual manner and I imagine that the main reason is that a tool subjected to a downward pressure tends to lean forwards and so dig in whereas upward pressure will cause the tool to move back and out of cut. The diagram, Fig. 1, though an over-simplification, will make this reasoning clear. It has been suggested that a contributary factor might be that the chips can more readily fall away but my experience indicates that this is more imaginary than real as friction between the chips and the sides of the groove holds them up to the cutting face of the tool. In fact, this matter of getting the swarf out of the groove easily still remains one of the major problems.

Fig. 2 indicates what can happen when the mandrel is too springy or the bearings are unduly slack. There is a tendency for the work to climb up on to the tool—in other words, to rotate about the point of contact of the tool, dragging the tool downwards and producing a dig-in. It is important that every part of the machine, from the tool down to the saddle, the bed, the headstock and fixings and the mandrel should be of ample stiffness to resist deflection under load. It was probably this tendency to "climb" which gave rise to such devices as the "Burnerd" P.O. Toolholder which was popular in the heyday of the more flimsy types of lathe. This toolholder incorporated an L shaped member which was so adjusted as to rest on the

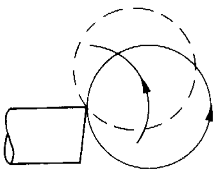


Fig. 2

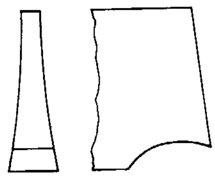


Fig. 3

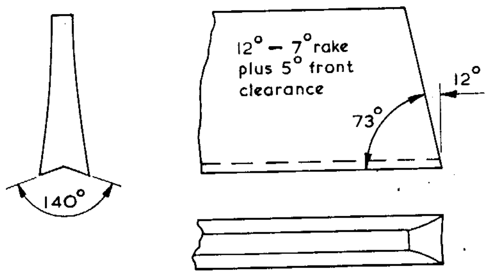


Fig. 8

top of the work and so prevented it from lifting. I have never owned nor used one, but I am told that they were quite effective and I have borrowed one in order to provide a photograph. I seem to recall that, over the years, there have been a number of somewhat similar devices described in the pages of M.E.

Yet another, and perhaps obvious, help is to use the tailstock to support the work being parted, but I imagine that it is very rarely that a finished component lends itself to being supported by a centre and one must always remove the support before final severance.

My parting-off problems were materially reduced when I bought a casting from a Mr. Haselgrove about 25 years ago. This was produced for a rear tool-post of "Duplex" design which had appeared in M.E. and which was intended to carry a parting-tool made from a $\frac{1}{4}$ in. square tool-bit. At about the same time I discovered "Eclipse" hollow-ground parting-tool blades so I made up my own form of rear tool-post having an "Eclipse" blade which was mounted horizontally and had a lip ground in it to give the desired top-rake. This arrangement gave good service for many years, though there were occasional troubles and "seize-ups" but never a real dig-in on classical lines.

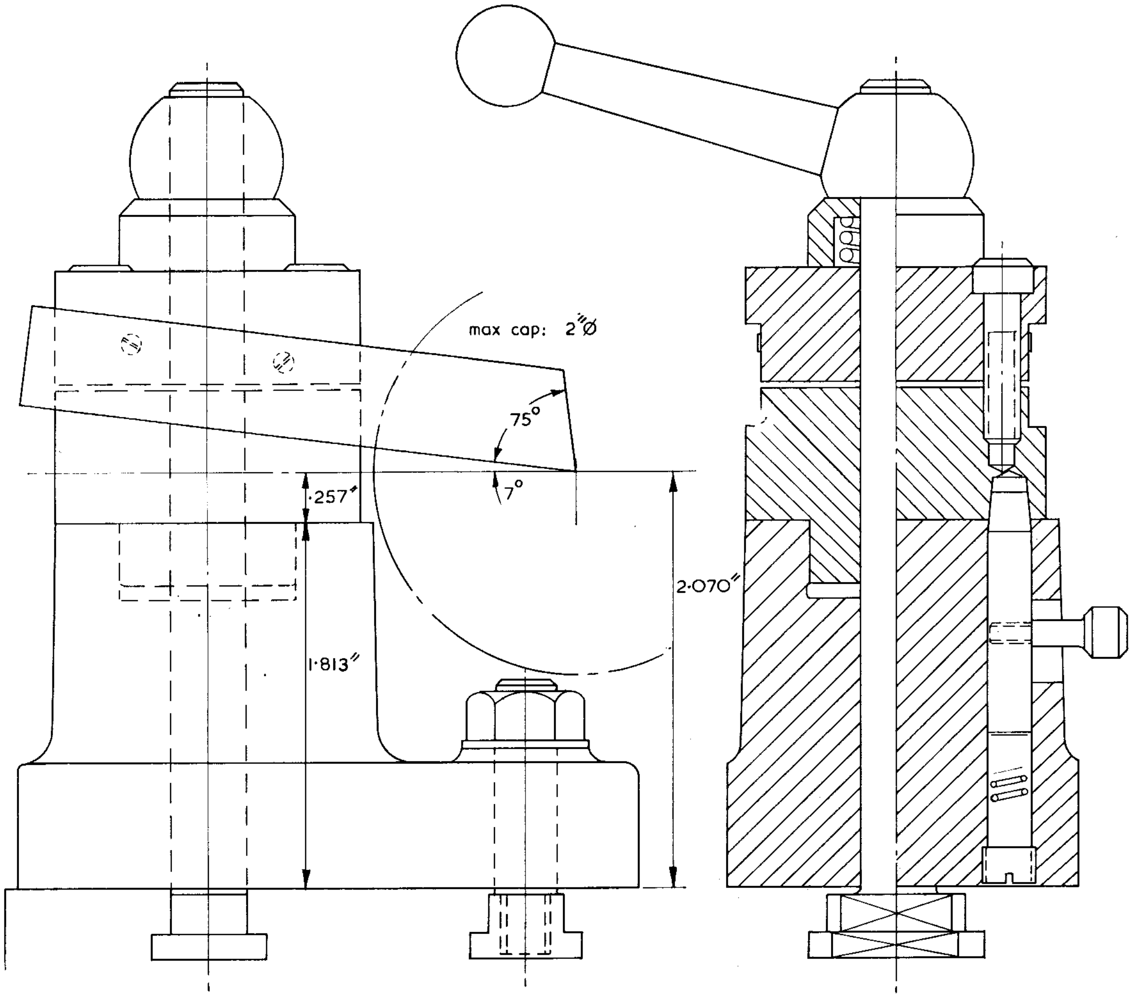
One day, when regrinding the tool, it occurred to me that the troubles I still experienced at times might be due to the fact that, as there was an angular lip in the tool, any further grinding, either at the front or in the lip, had the effect of raising the cutting edge. As the blade width was tapered upwards, the cutting edge was reduced in width as it was raised. Thus, the groove cut by the tool for the first $\frac{1}{4}$ in. or so was narrower than the main body of the blade further back, and when this wider portion (behind the lip) met the narrower groove there was trouble (see Fig. 3). The obvious remedy was, after a few sharpenings, to grind about $\frac{1}{4}$ in. off the end of the blade and re-form the cutting edge. This seemed a wasteful procedure so a new design was produced in which the whole blade was inclined downwards instead of having a lip ground into it. This required sharpening only on the front edge so that it was always maintained at full tool width. Following expert opinion, the rake was reduced to 7 deg. and in order to cater for materials requiring no rake at all, I included another blade set horizontally on the other side and provided a positive indexing arrangement to enable either tool to be brought quickly and accurately into position, square with the lathe axis. This tool I shall hereafter refer to as Mk. I, full details of which are given in Figs. 4 and 5 (right and next page).

For parting-off very small or delicate work, the 1/16 in. wide blade was found to be unduly large so some very narrow parting tools were made from 5/16 in. sq. tool-bits. These were ground up free-hand and were not at all easy to make as the centre-line of the blade had to be truly vertical with equal clearance angles of $\frac{1}{2}$ to 1 deg. on each side when the tool-bit was clamped down on to its underside. With very narrow blades the clearance angles have to be kept to the absolute minimum.

I had been using screw-cutting tools made from 3/16 in. dia. HSS boring bar bits which were used in a special tool-holder. Apart from the fact that at very small capital outlay one can have a dozen or more of these with tips to suit different numbers of t.p.i., they possess the added advantage that they can be turned in the holder to suit the helix angle of any thread. This was an answer to the small parting tool problem. Tools having widths of .015 in., .030 in. and .040 in. were ground up from the 3/16 in. dia. bits which was simpler, quicker and very much cheaper than using the 5/16 in. sq. material.

As remarked, the tool-holders for these small bits were made originally for use with screw-cutting tools and as they were intended to be used only in the square turrets, the hole to carry the bit was so placed as to bring the top surface of the tool exactly on centre-height when the bit had 1/32 in. ground off the top. I have three 4-tool turrets in use, two of which are to my own design (a constructional article on which is in preparation for submission to the Editor).

To be continued


max cap: 2"Ø
75°
7°
·257"
2·070"
1·813"

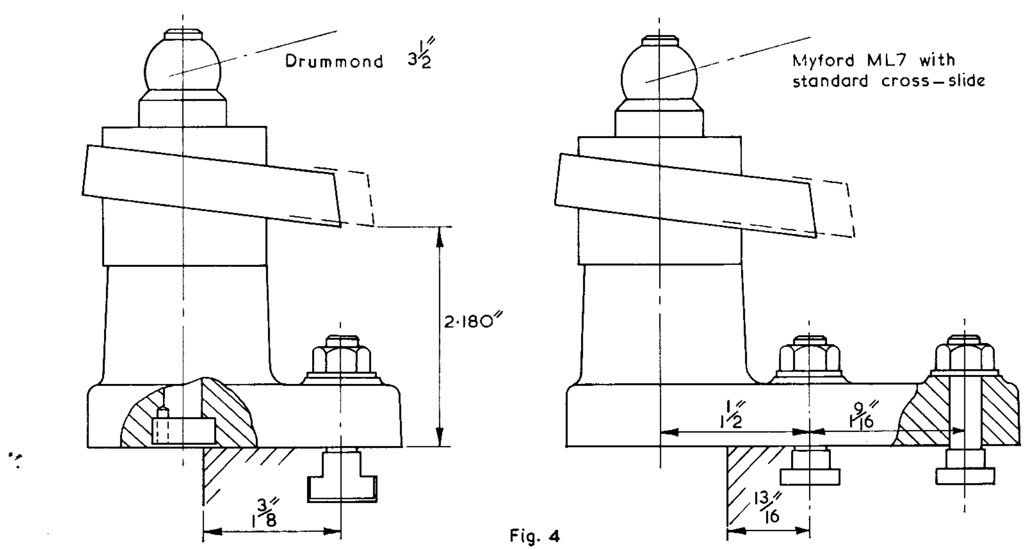

Drummond 3½"
2·180"
1⅜"
Myford ML7 with
standard cross–slide
1½"
1 9/16"
13/16"

Fig. 4

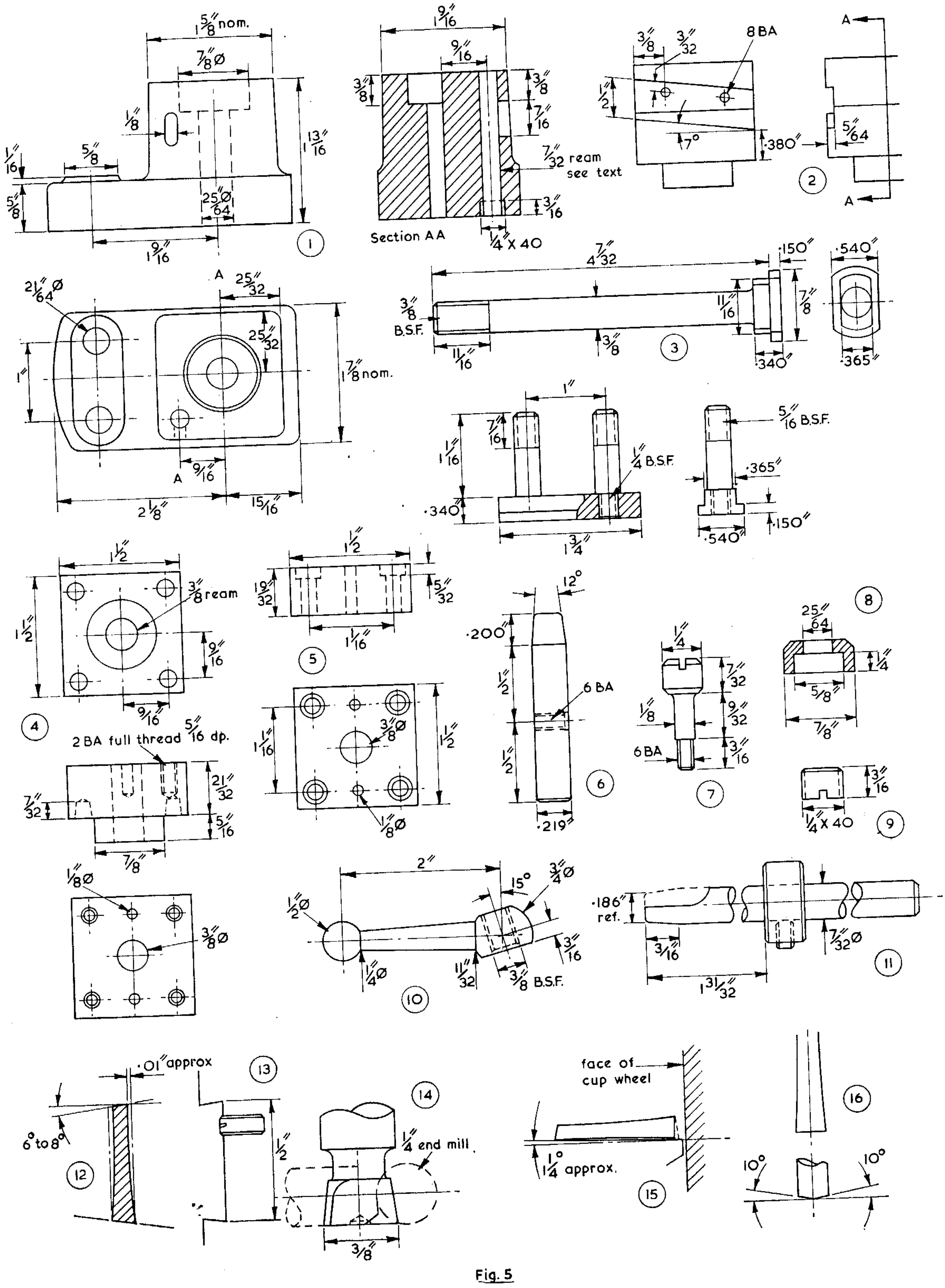

Section AA
8 BA
7/32 ream see text
1/4 X 40
3/8 B.S.F.
1/4 B.S.F.
5/16 B.S.F.
1 7/8 nom.
1 5/8 nom.
3/8 ream
2 BA full thread 5/16 dp.
6 BA
1/4 X 40
3/8 B.S.F.
·186" ref.
·01" approx
6° to 8°
1/4 end mill
face of cup wheel
1° 1/4 approx.

Fig. 5

THE STANIER TENDER

Details of the standard L.M.S. 4000 gallon tender for "Royal Engineer", also suitable for the "Rebuilt Royal Scot", the 5XP and 5P5F classes and the 2-8-0s

by Martin Evans

TO COMPLETE this series on building 5 in. gauge versions of the *Fury*, the "Royal Scot" class locomotive "Royal Engineer", and the "Rebuilt Royal Scot", here are the drawings of the Stanier 4000 gallon tender. This tender was not at any time used with *Fury*, but all the "Scots" had them, and of course many other Stanier designs, such as the "Rebuilt Scots", the 5XPs, the "black fives" and the 2-8-0s, with slight variations.

My drawing has been reproduced from the official drawings, and is to scale at 1 and 1/16 in. to the foot, except as regards the wheels, which have been made slightly smaller than scale, so that castings now available from the trade may be used. This has necessitated lowering the axleboxes and springs slightly, but I don't think this will be very noticeable.

There are certain similarities between the Stanier and Fowler tenders, notably in the shape of the frames, though the Stanier is of course longer. The shape of the body is however quite different, being considerably wider and with high coal plates sloping inwards at the top. The details at the front end also are very different.

To be correct to prototype, the control for the hand brakes is obtained through a pair of bevel gears. Similar gears are also used on the full-size tender to control the water pick-up gear. For a practical working model, two injector water valves, as detailed on page 27 (2 January) should be fitted, immediately ahead of the cross stretcher—whose purpose is to provide a "backing" for the buffers between engine and tender. The pipes from these water valves should be brought out at an angle, as shown, as this makes it much easier to get the rubber tubes on, to couple up to the engine.

Construction of the tender follows the usual practice for 5 in. gauge locomotives, with $1\frac{1}{2}$ in. x $1\frac{1}{2}$ in. x 3/16 in. angle for the buffer and drag beams, and $\frac{1}{8}$ in. b.m.s. for the frames. There are two simple cross stretchers between the wheels, which may be castings or built up from b.m.s. sections.

The floor of the tender body is from 1/16 in. hard brass, though for reasons of economy, steel could be used, with an inner tank of thin copper or brass. If using brass throughout, the sides, ends, front plate and tank top, also the coal plate, could be of 1/16 in. thick material.

The emergency hand pump is placed high up underneath the water pickup dome, which is made removable, so that no unsightly slot need be cut in the tank top to accommodate the handle of the pump. Also, a large bore drain cock or valve is placed immediately underneath the suction valve and filter of the hand pump, so that this valve can receive attention quickly should its ball stick on its seating.

Castings are available for the axleboxes, horns and springs, though built-up springs look very much better for those who are not frightened off by the extra work involved. For a good built-up spring, use $\frac{3}{8}$ in. x 22 s.w.g. spring steel (obtainable from Reeves) for the top leaf only, and tufnol strip for the other leaves; at a guess 11 or 12 tufnol leaves will be required to make up the required thickness, these being previously heat-treated as described in M.E. recently.

The axlebox castings will probably come in the form of sticks of three. In this case, the wheel face, the sides and flanges can all be end milled in the lathe, using the vertical-slide, although those who are fortunate enough to possess a horizontal milling machine will be able to machine the axleboxes much quicker using side-and-face cutters.

Some builders may have difficulty in getting the axle hole in these double-flanged axleboxes equidistant from the working surfaces. The method I use is to clamp each axlebox in the four-jaw chuck, using pieces of brass strip of $\frac{1}{4}$ in. x $\frac{1}{8}$ in. section in the "grooves". This gives just enough room for the probe of a D.T.I. to engage the groove, which is of course the working surface. The lathe spindle must of course be accurately indexed through 180 deg. to take the two readings, the D.T.I. probe being carefully pushed out of the way as the