

CLAYTON UNDERTYPE STEAM WAGON

to 2 in. scale

by Robin Dyer

Part I

THE WELL-KNOWN FIRM of Clayton and Shuttleworth Ltd. built their first road engine in 1862, and continued building vehicles for seventy years. They adopted the above title in 1894 and eventually occupied a 100-acre site in Lincoln employing 5000 people and including a steel and iron foundry, forge, boiler and erecting shops, all using power from their own generating station.

Clayton Wagons Ltd. of the Titanic Works, Lincoln, was formed after the First World War as a subsidiary of Clayton and Shuttleworth Ltd., in order to concentrate on the production of steam wagons. From the outset it was decided to build both overtypes and undertypes. For the benefit of the newcomer these terms refer to the manner in which the engine is mounted in the wagon. An overtype has the engine mounted on a locomotive type boiler as in a traction engine, whereas the undertype has it slung beneath the chassis, usually with a vertical boiler mounted in the front of the cab. The latter arrangement gives more payload area for the same vehicle length, but results in long steam and exhaust pipe runs. However, this form of layout eventually resulted in sophisticated wagons with multi-cylindere engines, gearbox transmissions and shaft drives.

The first Clayton undertype was completed in 1921, but production of the wagon lasted only eight years with forty-five units being completed. Unfortunately the design was somewhat dated with its single-speed engine; most other manufacturers at this time were introducing multi-gearred, shaft-driven wagons.

The production wagons featured a vertical boiler with cross water tubes set in a large single flue which formed the firebox at one end and superheater housing at the other. In way of the cross tubes this flue was swaged down to a square cross section with some of the tubes acting as stays. The firebox was fitted with a rocking grate to assist with the clearing of ash and clinker. The engine was a twin-cylinder duplex type, 6½ in. dia. bore x 10 in. stroke. Reversing gear was in the form of a novel sliding eccentric system mounted on a layshaft which was gear-driven from the crankshaft, a water pump also being driven from this layshaft.

A 13-tooth sprocket mounted on the offside end of the crankshaft transmitted the drive via a roller

pitch chain to a 50-tooth sprocket on the rear axle. A differential assembly drove the divided rear axle in the normal way. A pin inserted through the off-side hub cap and wheel would lock the two parts of the axle together when driving on slippery ground. Wagon bodies took different forms and were invariably built to customers' requirements.

It would appear that the design was not fully developed, and although two wagons were in use up to the Second World War, none has survived to the present day.

The Model

A constructional series on a steam wagon is a rare event in *Model Engineer* but I understand that there have been requests from readers for such a model, so I hope that the Clayton will go some way to fulfilling this demand. A wagon model always attracts a lot of attention at meetings and rallies, as I have found when driving my little 1¼ in. scale Thornycroft: it makes a change from seeing all those 3 in. scale Burrells scurrying around!

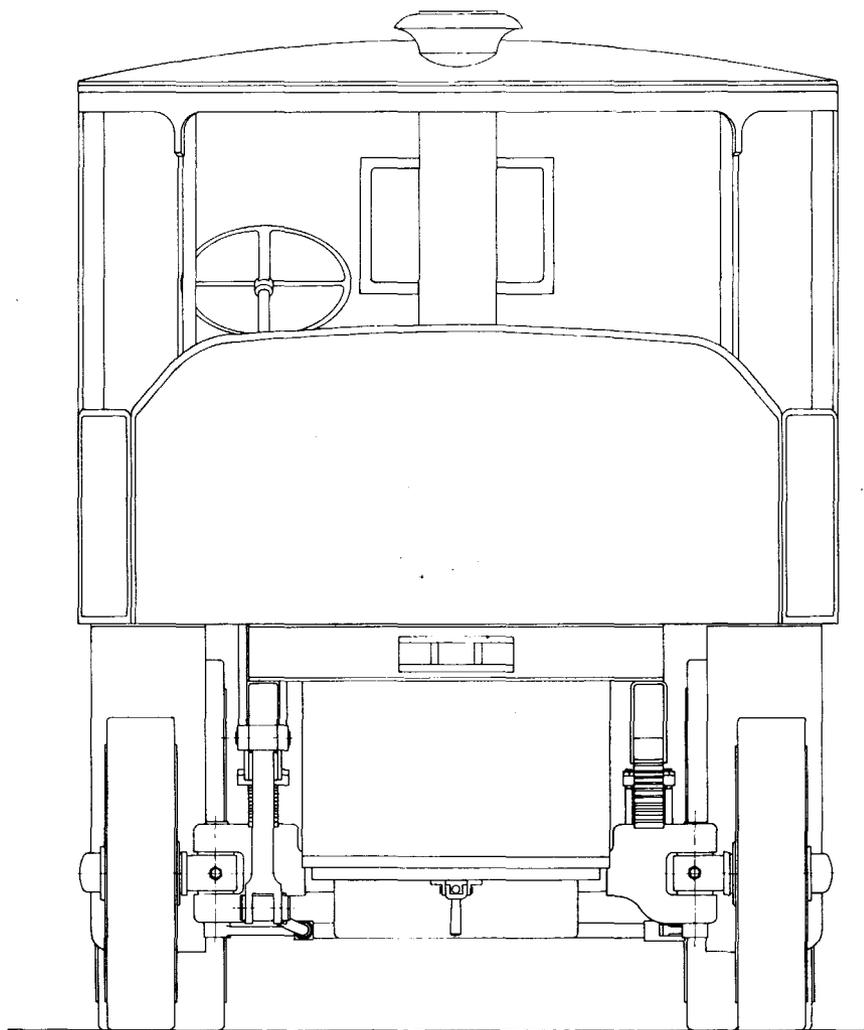
For anyone about to embark on the construction of a model road vehicle the Clayton should make a good introduction. The most difficult part of a traction engine to construct is the boiler, the most tedious being the wheels. With a vertical boiler (only two flanged plates) and cast wheels, the wagon builder will have a relatively easy time of it.

The scale of 2 in. to the foot makes the Clayton compatible with John Haining's Aveling roller and Ransomes tractor, and in fact comes out somewhat larger than the latter. However, it will be lighter and less powerful; a wagon after all did not haul such a large payload as a traction engine.

The general dimensions of the wagon are as follows:

Overall length	31 in.
Overall width	13¼ in.
Overall height	18 in.
Wheelbase	18⅝ in.
Drive ratio	4:1
Estimated weight	70 lb.

An articulated version of the undertype was supplied to John Penglaze of Chipping Sodbury, and I have chosen to detail this version. A 2 in. scale wagon is a little too small to be sat on by the driver, and so an articulated version will permit the use of a

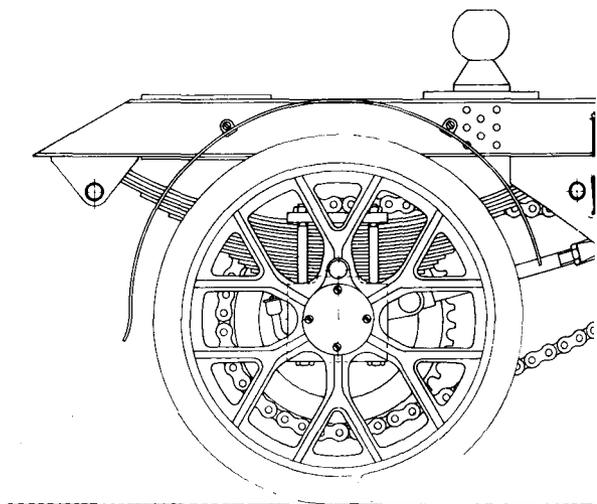


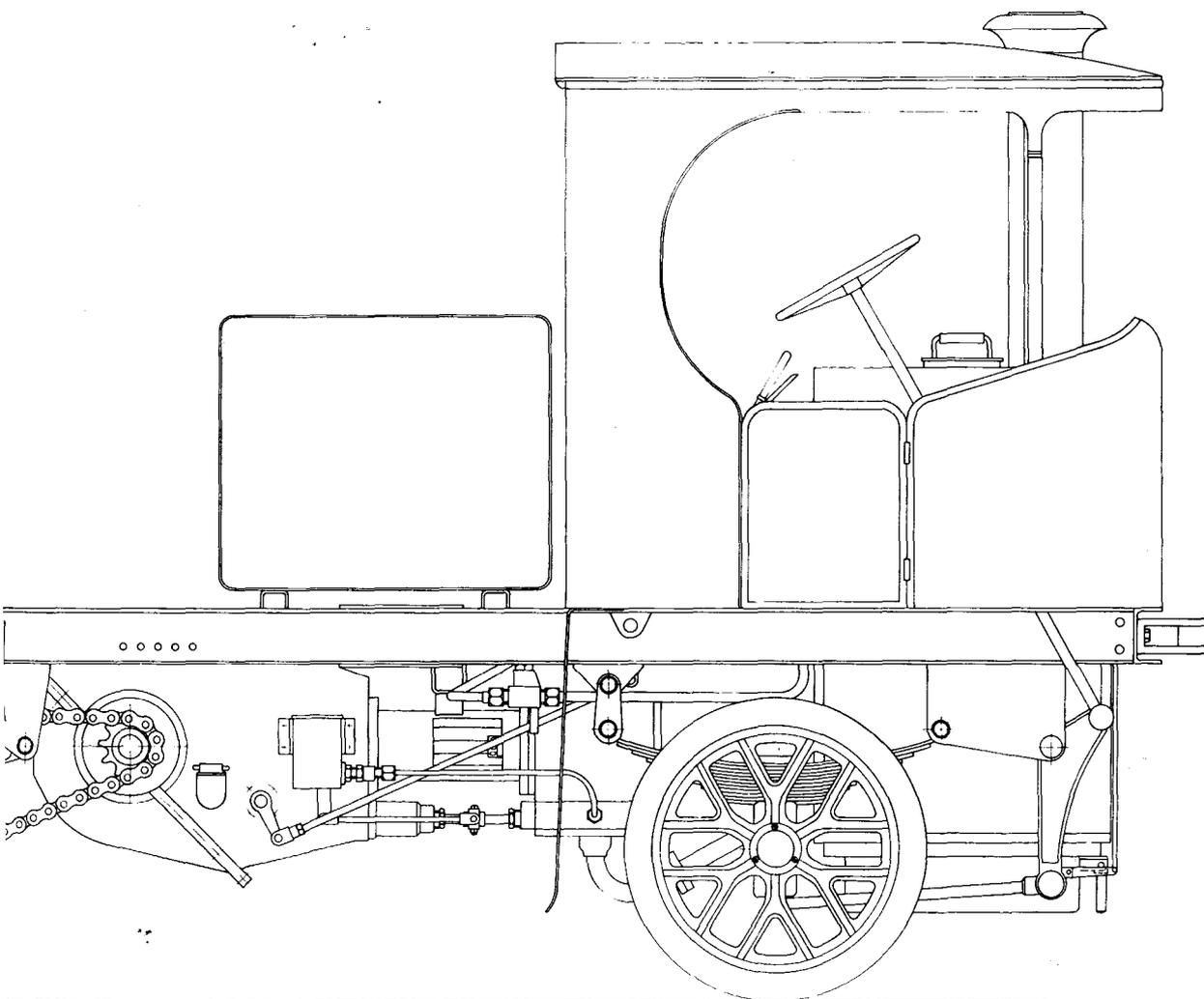
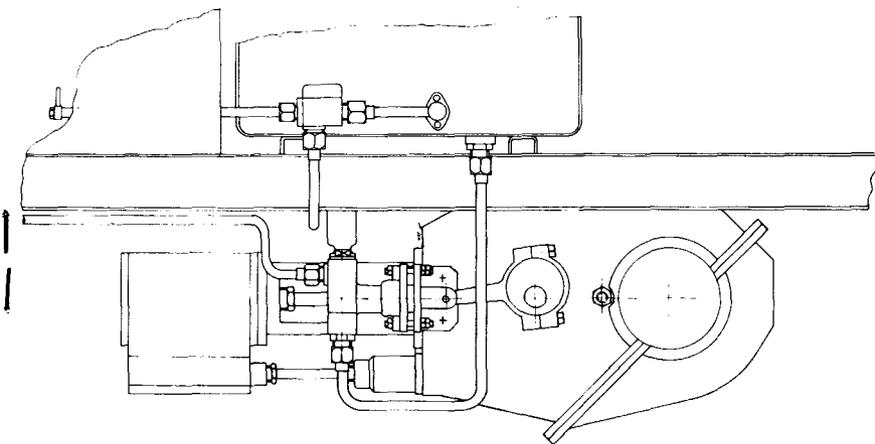
two-wheeled driving trailer and will bring the rider closer to the controls. For the eager beaver, a scale trailer body coupled to the tractor unit would make a very handsome combination.

All the information for this wagon has come, so far, from the book *The Undertype Steam Road Wagon* by Maurice A. Kelly, supplemented by details common to the oertype from that same author's companion volume *The Oertype Steam Road Wagon*.

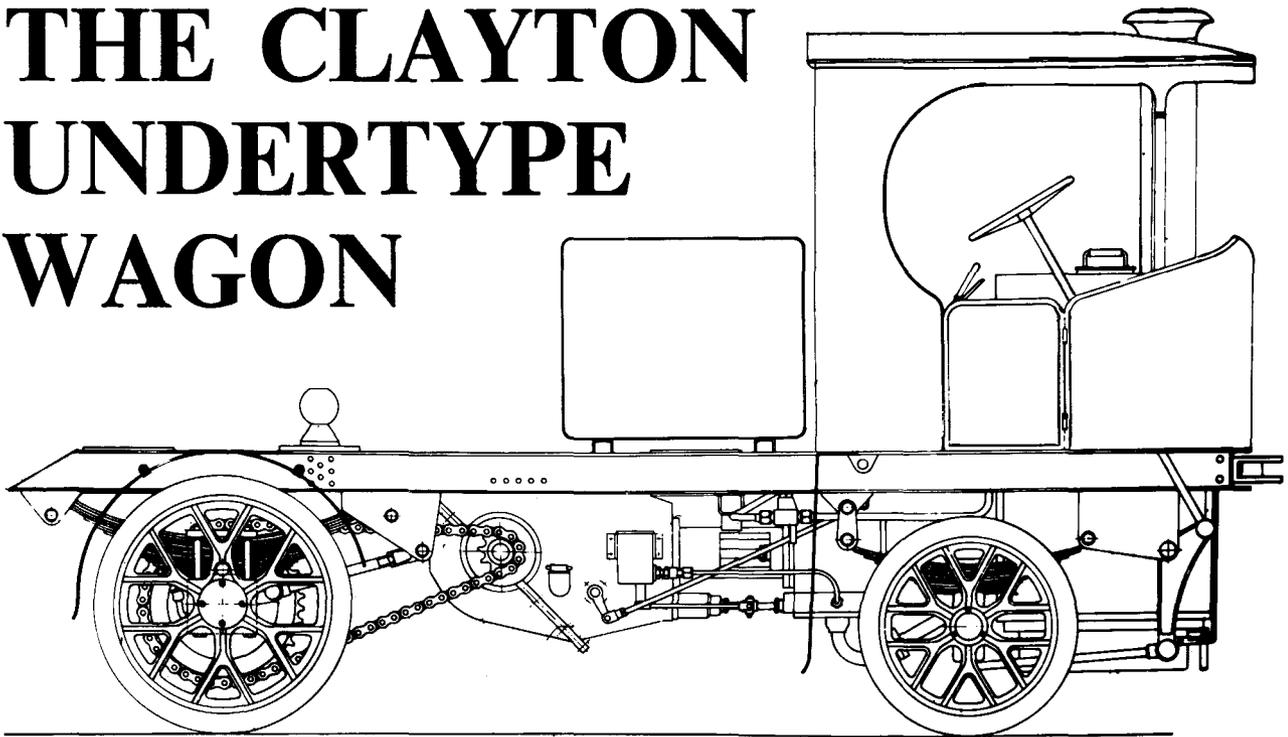
As a conclusion to this introductory article I would like to say that if any reader has information or photographs that could be used in this series, I would be delighted to hear from them via the Editor.

To be continued





THE CLAYTON UNDERTYPE WAGON



This particularly attractive design of a Steam Road Locomotive has been prepared by Robin Dyer in 2" Scale. By arrangement with the designer we will be supplying the following castings and materials. Patternmaking has reached an advanced stage and castings are now coming into stock for sale at our "Over the Counter" retail dept or through our World Wide Mail Order Service. Constructional details and drawings are being published in the Model Engineer and prices will be announced in our advertisements as they become available, but up-to-date lists will be forwarded on receipt of an S.A.E. to builders of this design.

Drawings By M.A.P. Ltd.

Axle Jaws
Rear Axleboxes
Steering Quadrant
Front Hub Caps
Front Wheels
Rear Wheels
Differential Centre
Rear Axlebox Collar, nearside
Rear Axlebox Collar, offside

Rear Hub Caps
Chassis Front Drawbar
Cylinder Block
Valve Chest
Valve Chest Cover
Slide Valves
Front Cylinder Covers
Rear Cylinder Covers
Piston Blanks
Trunk Guides

Valve Spindle Guides
Crossheads
Sump Casing
Big-end Brasses
Boiler Top Ring
Smokebox Top
Chimney Base
Chimney Cap
Regulator
Water Pump

Boiler Flanged Plates
Full Boiler Matl. Set
Roller Chain, 8 mm.
10 Tooth Pinion
40 Tooth Sprocket
Differential Gears
Pump Gears. 45t x 32dp.
Pump Gears. 30t x 32dp.
1" sq x 16swg Chassis Tube
1 1/2" dia. EN1A BMS Rear Axle and Sleeve
Further items if required by builders

All prices plus postage plus VAT at 8%. Current 15 June 1978
The June issue of our Catalogue and price list is now available at 50p post free Inland.
Overseas Airmail or Surface post extra.

A. J. REEVES & CO. (BIRMINGHAM) LTD

Incorporating DICK SIMMONDS & COMPANY

HOLLY LANE, MARSTON GREEN

BIRMINGHAM, B37 7AW Tel: 021 779 6831-2-3



STEAM AGE

BUILDERS OF FINE LOCOMOTIVES

**59 CADOGAN STREET
LONDON, S.W.3
Tel: 01-584 4357**

Tuesday-Friday: 9.30-5.30 (Closed 1-2)
Saturdays: 10.00-2.30
Nearest Station: Sloane Square
District and Circle lines

Pressure Gauges:	$\frac{3}{4}$ " Dia. 0- 80 lb. p.s.i.	} £5.94
	0-120 lb. p.s.i.	
	1" Dia. 0- 80 lb. p.s.i.	
	0-120 lb. p.s.i.	
	0-150 lb. p.s.i.	
	2" Dia. 0-160 lb. p.s.i.	

Mechanical Lubricators:	1" x 1"	£7.56
	$1\frac{1}{4}$ " x $1\frac{1}{4}$ "	£8.37
	2" x $1\frac{1}{4}$ "	£8.64
	2" x 2" (twin ram)	£10.43
	Assemblies only	£5.40

Blowers:	3 volt	£6.48
	Suitable for Gauge 1-5" Gauge locos.	

Water Gauges:	Glass $\frac{1}{8}$ " screwed $\frac{3}{8}$ " x 40T	£3.24
	Glass $\frac{1}{8}$ " screwed $\frac{1}{4}$ " x 40T	£3.78
	Glass $\frac{1}{4}$ " screwed $\frac{3}{8}$ " x 32T	£4.32

Injectors				
14 oz. per min.	3/16 pipe scr.	5/16 x 32T	£6.48	
24 oz. per min.	3/16 pipe scr.	5/16 x 32T	£6.51	
53 oz. per min.	1/4 pipe scr.	3/8 x 32T	£7.72	
4-6 pt. per min.	1/4 pipe scr.	7/16 x 26T	£8.91	

Globe Valves	1/8 pipe	£2.59
	5/32 pipe	£2.70
	3/16 pipe	£3.02

Also in stock: check valves, by-pass valves, steam valves, hand pumps, unions, etc.

Bassett-Lowke Commemorative Catalogue
£4.10 in soft cover, £6.60 in hard cover (incl. postage)

Kindly add postage at **5p** in the **£** (10p min.) for inland, **20p** overseas. Enquiries and full list s.a.e. please.

ALL PRICES INCLUDE 8% VAT

SHOWROOM: LONDON

WORKS: MANCHESTER

THE CLAYTON UNDERTYPE WAGON

This particularly attractive design of a Steam Road Locomotive has been prepared by Robin Dyer in 2" Scale. By arrangement with the designer we are supplying the following castings and materials. Patternmaking is nearly complete and the following priced items are now in stock and further items are arriving daily for sale at our "Over the counter" retail dept or through our world wide Mail Order Service. Construction details and drawings are now being published in "The Model Engineer" and further prices will be announced in subsequent advertisements.

Drawings M35	Each	£1.25	Front Drawbar	G.M.	76p	Water Pump	G.M.	£1.06
Axle Jaws	C.I.	£1.35	Cylinder Group. 9 items	G.M.	£12.10	Boiler Flanged Plates	Cu.	£5.80
Rear Axleboxes	G.M.	£5.60	Piston Blanks	G.M.	£1.28	Full Boiler Matl Set	Cu.	£24.79
Steering Quadrant	G.M.	68p	Trunk Guides	G.M.	£4.23	Roller Drive Chain, 8 mm		£3.50
Front Hub Caps	Br.	38p	Valve Spindle Guides	G.M.	76p	10 tooth Pinnion		£2.68
Front Wheels Pair	A1	£4.00	Crossheads	G.M.	£1.36	40 tooth Sprocket		£2.46
Rear Wheels Pair	A1	£8.00	Sump Casing	A1	£1.60	Differential Gears		£14.60
Differential Centre	G.M.	£2.87	Big-end Brasses	G.M.	83p	Pump Gears 45t x 32dp	Pair	£4.00
Rear Axlebox Collar, Nearside	G.M.	30p	Boiler Top Ring	C.I.	£1.75	Pump Gear 30t x 32dp		£2.00
Rear Axlebox Collar, Offside	G.M.	30p	Smokebox Top	C.I.	£1.75	1" x 1/2" x 16 swg MS		
Rubber tyres, chassis plates matl.			Chimney Base	G.M.	68p	Chassis Channel		£3.00
Rear Hubcaps	Br.	£1.06	Chimney Cap	Br.	£1.13	1 5/8" dia EN1A for Rear Axle and Sleeve		£2.80
			Regulator	G.M.	53p			

All prices plus postage plus VAT at 8%. Current 1-10-1978

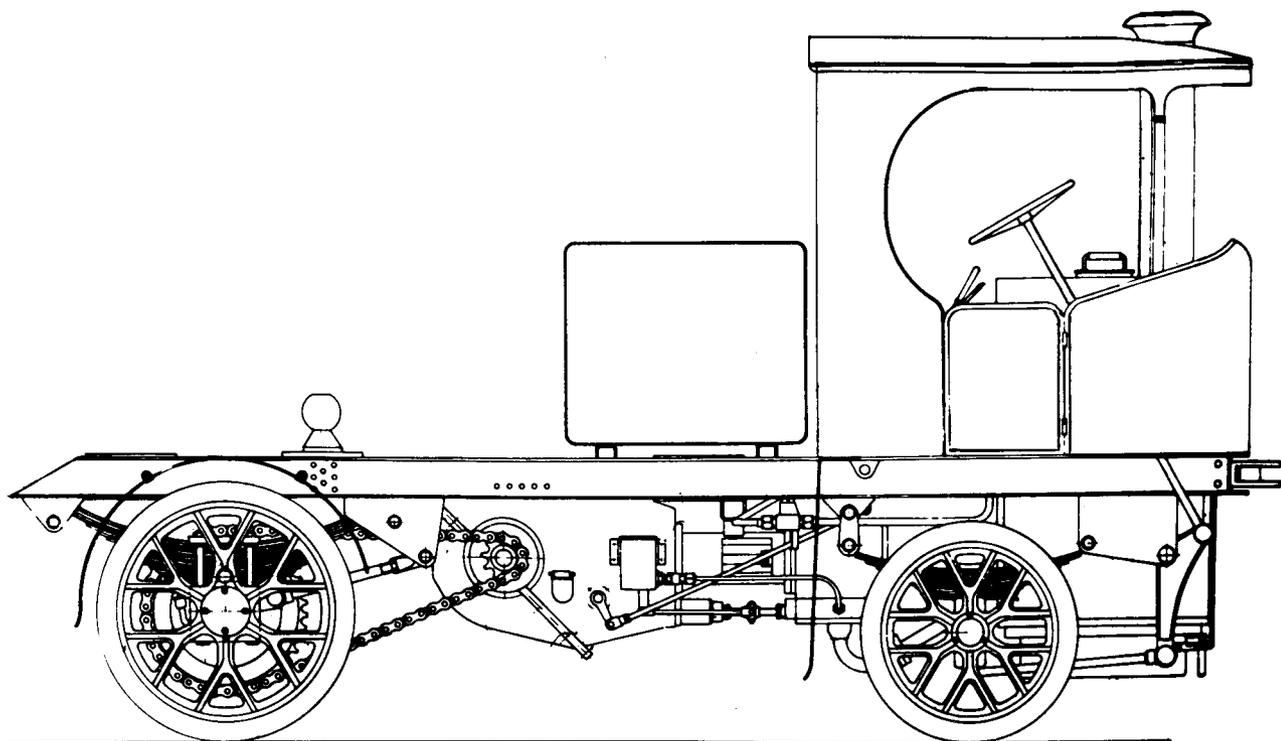
The June issue of our Catalogue and price list is available at 50p post free inland. Overseas Airmail or Surface post extra

A. J. REEVES & CO. (BIRMINGHAM) LTD

incorporating DICK SIMMONDS & COMPANY

HOLLY LANE, MARSTON GREEN

BIRMINGHAM, B37 7AW Tel: 021 779 6831-2-3



CLAYTON UNDERTYPE STEAM WAGON

to 2 in. scale
by Robin Dyer

Part II

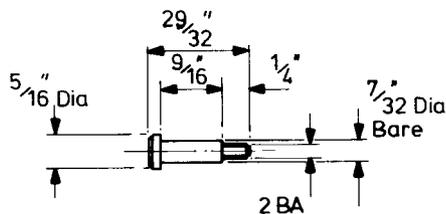
From page 835

THE CHASSIS OF our Clayton wagon is the backbone on which all the other components are mounted. The chassis of the full size wagon was constructed from 6 in. x 3 in. steel channel and since this comes out at 1 in. x 1/2 in. for the model it seems reasonable to make use of 1 in. square steel tube. K. R. Whiston of Stockport can supply 1 in. square tube with a wall thickness of 18 s.w.g. Although this is a bit thin it would do. I have used 1 in. x 16 s.w.g. in my model, but those builders with access to a press brake can go to town and fold their own channel from 14 s.w.g. or 2 mm sheet.

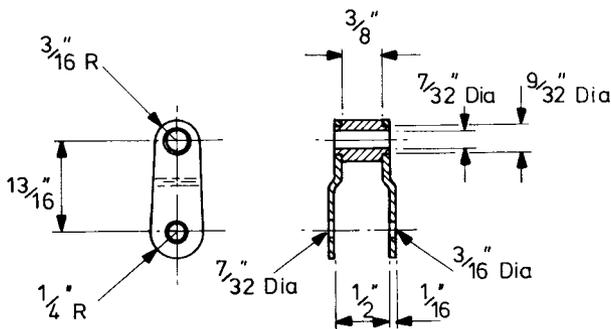
Assuming the use of square tube, the total length required will be about 9 feet. Cut two lengths sufficient for the longitudinal members of the chassis and scribe centre lines down two opposite sides.

Check where the weld is and arrange to have this in the scrap piece. With a new blade mounted sideways in the hacksaw frame saw down the length of the tube. Take it slowly, aiming to keep the scribed lines just visible on one side of the saw slot. I found the process much easier than I thought it would be, and more accurate than using my bandsaw, the blade of which tends to wander. Clean up each new channel section with a smooth file and then repeat the process for the crossmembers. Each crossmember except the front one is 6 1/4 in. long.

Finish off one end of each side member at 30 degrees, as shown on the drawing, observing that you should now have a handed pair. Place these channels back to back and scribe across the top flanges the positions of the leading edges of all the crossmembers, and scribe across the lower flanges



MOUNTING PIN 12 Off. M.STL.



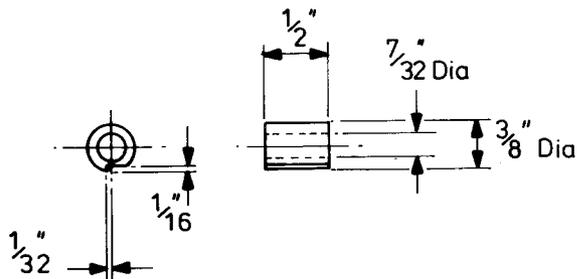
SPRING SHACKLE 2 Off.
M.STL. Fabrication.

in position and check with a square. Finally, drill through the gussets into the crossmembers and bolt up with temporary screws. It would be best to assemble the front crossmember next, using 1/2 in. x 1/8 in. steel angle or angles made from pieces of the square tube. Check that the 6 1/4 in. spacing between the longitudinals is maintained. The other crossmembers can now be positioned at their various stations and the whole chassis may be riveted up with the exception of crossmembers 2 & 3 which have yet to be drilled for engine bearers. A special dolly will have to be made for holding up the 3/32 in. dia. rivets which secure the gussets since it has to fit between the chassis flanges. I personally dislike riveting as I can never raise a decent head, but the Clayton chassis was liberally sprinkled with neat snap heads and so our model ought to follow suit.

We now need eight U-shaped brackets of various types to house the spring ends, radius rod ends, and, at the front offside, to form a mounting for the steering bell crank. I found the easiest way to make these was to fold the 16 s.w.g. sheet around something 1/2 in. thick, tapping down tight and flat, and then, using the scribing block, mark the outline of the bracket and hole centres. Note that all the brackets have their outer flange drilled larger than the inner flange. This is so that the mounting pins can be clamped up tight. All the brackets are secured to the chassis with 6 BA screws and nuts. Note that certain screws are countersunk where the ends of the rear springs bear. Use the previously scribed lines to position the brackets. The front brackets although of different shapes, must have their spring mounting holes in line, otherwise the front axle will not be square with the chassis. Pass a straight length of 5/32 in. dia. silver steel through the holes after fixing one bracket and square it with the chassis before securing the other bracket. It will not be such a disaster if the other brackets are not exactly in line since they are not used as positive locations. The position of the rear axle is adjusta-

ble; like the rear wheel of a bicycle it can be moved fore and aft to adjust the tension of the chain.

As a change of scene we can now remove the dust sheet from the lathe in order to make the twelve mounting pins using 5/16 in. dia. M.S. bar. For a "production" run such as this it will obviously pay to set up as much as possible to ensure a repeatable product and to cut down manufacturing time. Whilst at the lathe it might be as well to make the four front spring eyes, and the two spacers which form part of the spring shackles. Also, turn up a little stub mandrel with a 2 BA thread on it, and use it to skim twelve 2 BA nuts to 3/32 in. thick. These nuts are used to clamp the mounting pins in their brackets.

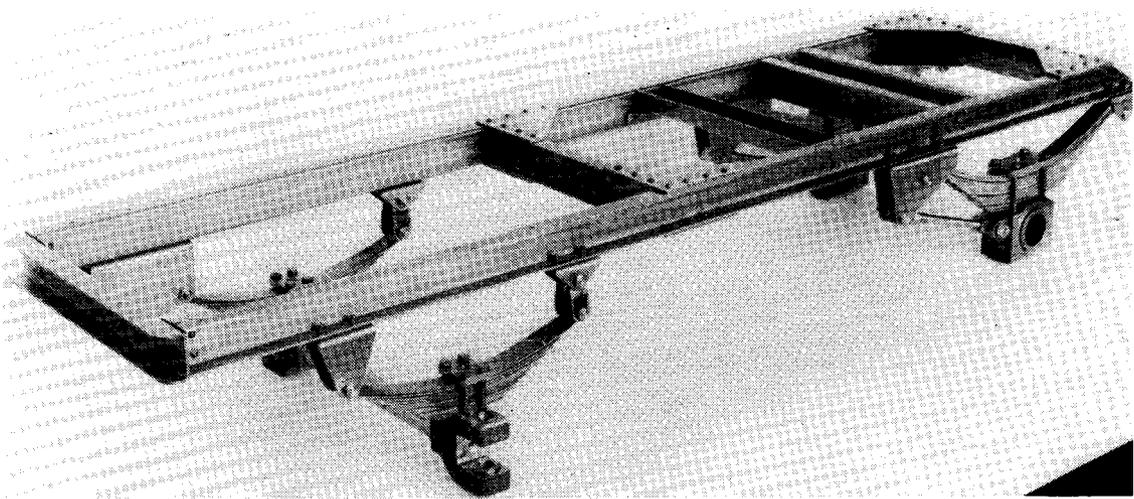


FRONT SPRING EYE
4 Off M. STL.

Silver solder to top
spring leaf.

The spring shackles are made from pieces of 16 s.w.g. steel. Leave them oversize at first, whilst putting in the joggle, then mark out the shape, drill the holes and file to the outline. Drill both lower holes 3/16 in. dia. to start with, then a piece of 3/16 in. dia. aluminium rod can be put through to hold the parts in line whilst silver soldering to the spacer. Easyflo silver solder paint would be useful for this job.

To be continued



CLAYTON UNDERTYPE STEAM WAGON

to 2 in. scale
by Robin Dyer

Part III

From page 964

Front axle

Two forms of front wheel attachment were used on Clayton undertypes, one of which required a much larger wheel hub than normal. This was because the axle beam was carried right into an inner hub, this acting as a journal for the wheel hub itself. The second system followed the more usual practice of an axle jaw mounted at each end of the centre beam, a short stub axle swivelling between the jaws. I have detailed the second system because to follow the first would have entailed a larger-than-scale wheel hub in order to accommodate a king pin of sufficiently robust proportions, and also an adequate steering lock.

Our good friends, A. J. Reeves of Marston Green, Birmingham, have undertaken to supply the castings and other parts required on the wagon, and the first of these are the front axle jaws. Readers with access to suitable material could make these from mild steel, but I will describe the operations on a casting.

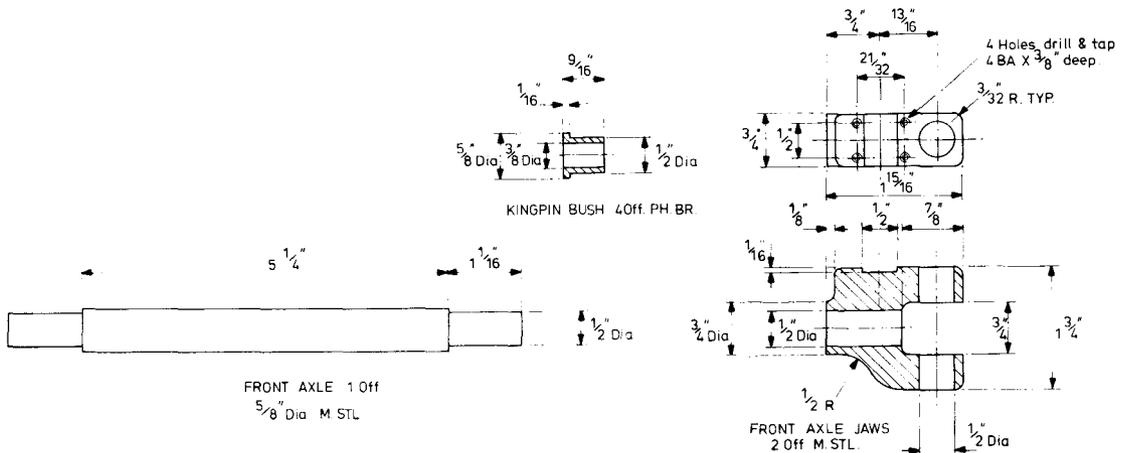
Remove any knobs or flash from the castings and scribe centre lines on the boss for the 1/2 in. dia. hole for the axle end. Centre punch, and mount the casting in the 4-jaw chuck with this boss facing outwards. Two of the chuck jaws will clamp the top and bottom of the casting, but the other two may

fall into the slot. If so, cut some pieces of stout mild steel strip about 1 1/2 in. long and use them to straddle the slot.

Set the centre pop to run true and check that the top surface of the casting, that is the surface against which the spring will be clamped, is square to the surface of the chuck. Face back the boss until it is 1/8 in. from the main surface of the casting. Centre, and drill to 7/16 in. dia., then bore out to 1/2 in. dia. using a piece of 1/2 in. dia. bar as a gauge. The reason for boring is that a 1/2 in. drill may wander as it cuts; the actual dimension is not critical as the axle end can be turned to fit. Repeat the above procedure with the other jaw casting.

Use the scribing block to mark on the lower surface of the casting the centre of the king pin hole. Centre punch and then chuck in the 4-jaw with the centre dot running true. Drill and bore as before to 1/2 in. dia., running the boring tool through several times on the last cut to remove any spring. Repeat with the second casting.

Scribe across the top surface the position of the 1/16 in. deep slot then mount one of the castings in the machine vice mounted on the vertical slide. Use a suitable end mill to machine the slot taking light cuts to avoid snatch. Turn the casting round and clean up the main slot, placing 3/4 in. width equidis-



tant from the top and bottom surfaces. If preferred, this could be done with a file, using something 3/4 in. wide as a gauge. Finally, mark out, and drill and tap the 4BA holes 3/8 in. deep.

With both axle jaws complete the axle beam itself can be taken in hand. If the 5/8 in. dia. bar will not go up the mandrel, clamp in the 3-jaw and tap the outer end until it runs true. If you possess a steady, use this, otherwise clamp tight and very carefully centre drill. Use a centre in the tailstock to support the bar as the end is turned to fit one of the axle jaws. Aim for an easy but not slack fit. Reverse the axle and turn the other end to fit the second axle jaw. Slip the jaws on to the axle and check that the inner edges of the spring slots are 6 1/4 in. apart. Finally, degrease and use Loctite 270 (which will gap-fill between .002 in. — .010 in.) to secure the jaws to the axle.

The Springs

It is now time to start making the many components which are secured to what is at the moment a rather flat, empty chassis, and it would be as well to commence with the springs. Now I confess to having only the sketchiest knowledge of spring theory, and the only notes I have seen on laminated springs in *M.E.* have been concerned with model locomotive types where many springs of short span share the total weight.

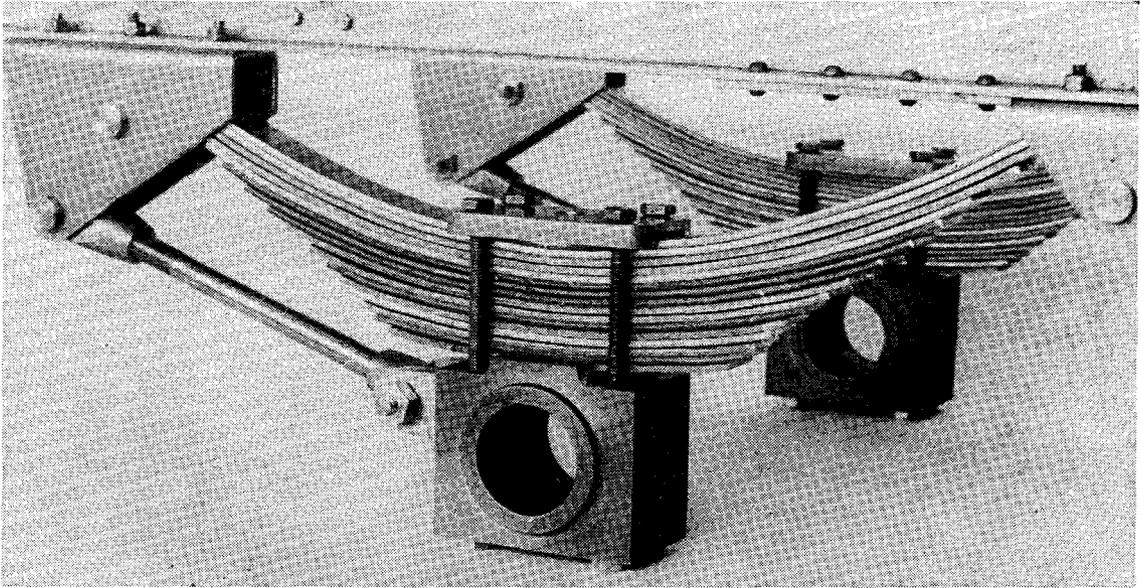
On our wagon we have the problem of four springs of long span supporting a vehicle of, as yet, unknown weight! It does not actually matter if our suspension ends up stiff as a board — better that than have the model slowly sink to the ground under its own weight. In fact, the chassis itself will possess a certain amount of flexibility, and so it seemed to me that mild steel strip would be a suitable material for the spring leaves. It is cheaper and easier to use than either spring steel or Tufnol.

A total length of 24 ft. is required, 16SWG x 1/2 in. wide. Cut the strip into lengths according to the

chart and lay them out in order, to prevent them becoming muddled. As each piece is worked on, place it back in its own position and do not allow meddlers anywhere near them! The front spring eyes can be silver soldered to the top leaf of each front spring, which will at least identify this pair. Those modellers who have made the bending rolls which were described in *M.E.* 3456 are now sitting pretty; just run each leaf through to give somewhat more curvature than is ultimately required.

I used the lathe faceplate as a former, working each leaf a little at a time round its edge. After curving, each leaf can be drilled, No. 43 (2.25 mm) for a length of 8BA studding. After each of my stacks was clamped up I found the resulting curvature quite reasonable. Each spring was then flattened until, when laid on the drawing, the ends came about 1/4 in. higher than shown. (It is easier

FRONT SPRING		REAR SPRING	
LEAF No.	LENGTH	LEAF No.	LENGTH
1	6 1/4"	1	9 5/8"
2	5 3/4"	2	9 5/8"
3	5 1/8"	3	9 5/8"
4	4 5/8"	4	7 5/8"
5	4 1/8"	5	6 7/8"
6	3 3/4"	6	6 1/2"
7	3 3/8"	7	6"
8	3"	8	5 1/2"
9	2 5/8"	9	5"
10	2 3/8"	10	4 5/8"
11	2"	11	4 1/4"
12	1 3/4"	12	4"
		13	3 3/4"
		14	3 1/2"
		15	3 1/4"
		16	3"



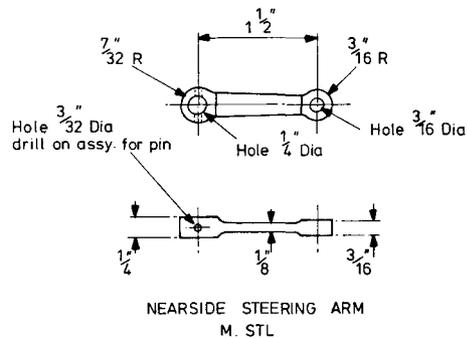
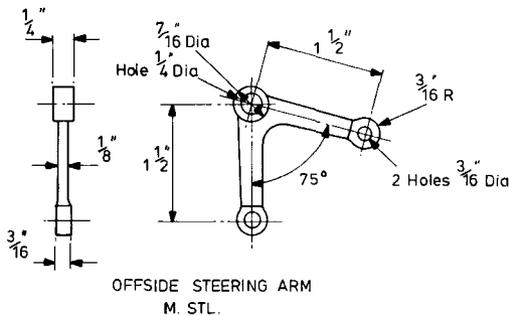
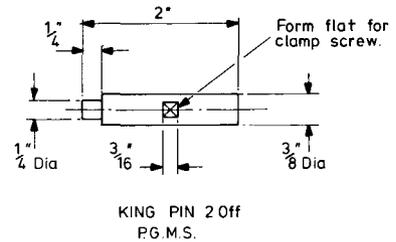
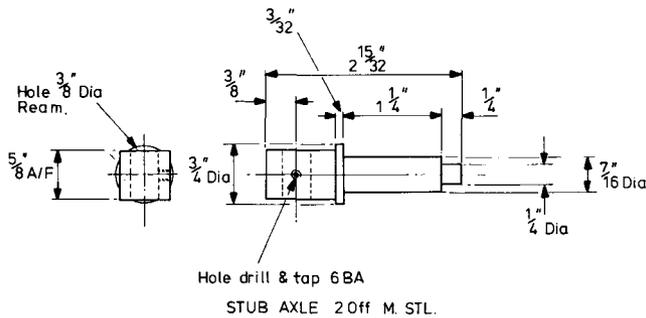
Rear spring mounting bracket.

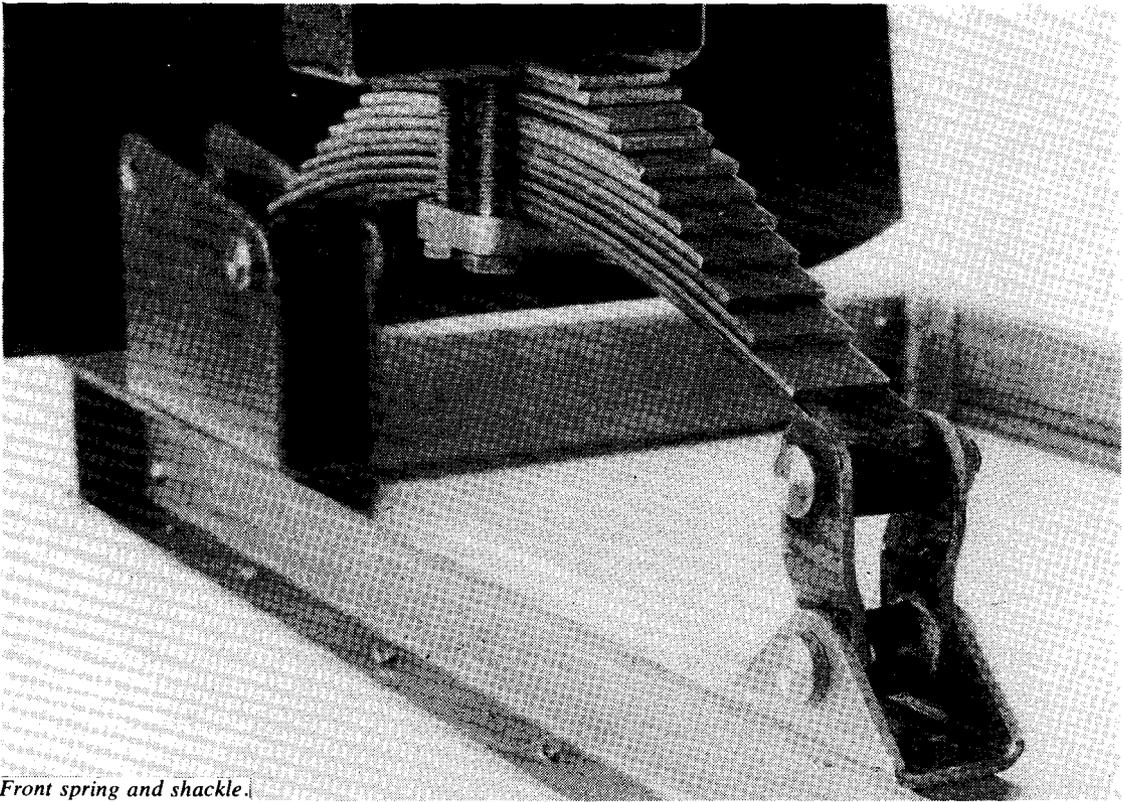
to flatten each spring a bit more later on than have to take each one apart to recurve each leaf).

Each end of the rear springs can be clamped against a piece of 1/2 in. dia. bar in the vice and eased round to give the required turnover. Finally trim the ends flush with a hacksaw. If the mild steel springs should prove inadequate in service, it would not be too difficult a job to substitute a few spring steel leaves.

Place on a surface plate or the lathe bed until the Loctite has cured. Modellers preferring more traditional methods can use 3/16 in. dia. x 3/4 in. long roll pins.

The king pin bushes are a straight-forward turning job in phosphor bronze or gunmetal. Ream the bore 3/8 in. dia. for the king pins. Leave the flanges a little over 1/16 in. thick at present until the stub axles are fitted. The king pins themselves would be





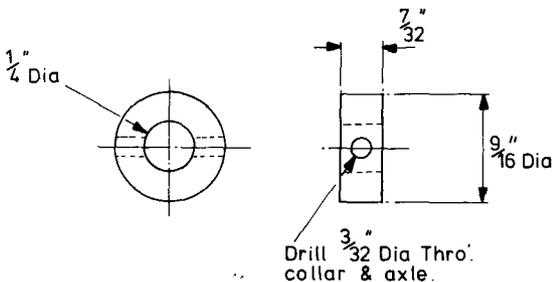
Front spring and shackle.

best made in 3/8 in. dia. precision ground mild steel; use a narrow file to make a small flat to take the end of the clamp screw. This will prevent any burr scoring the bore when the pin is removed.

Stub axles

The stub axles can be made in a couple of different ways. 5/8 in. square mild steel can be turned down to size, a washer then being sweated on against the square shoulder. An alternative way is to make the square part first, including the 3/8 in. dia. cross hole. Then drill a small shallow hole in the end of the material. Turn a stub on the axle proper to locate in this hole and silver solder the two together. It might be as well to drill a small vent hole into the cross hole to prevent any tendency for the two parts to spring apart when being heated up.

The wheel retaining collars can be made from



WHEEL RETAINING COLLAR
2 Off M. STL.
2 X FULL SIZE

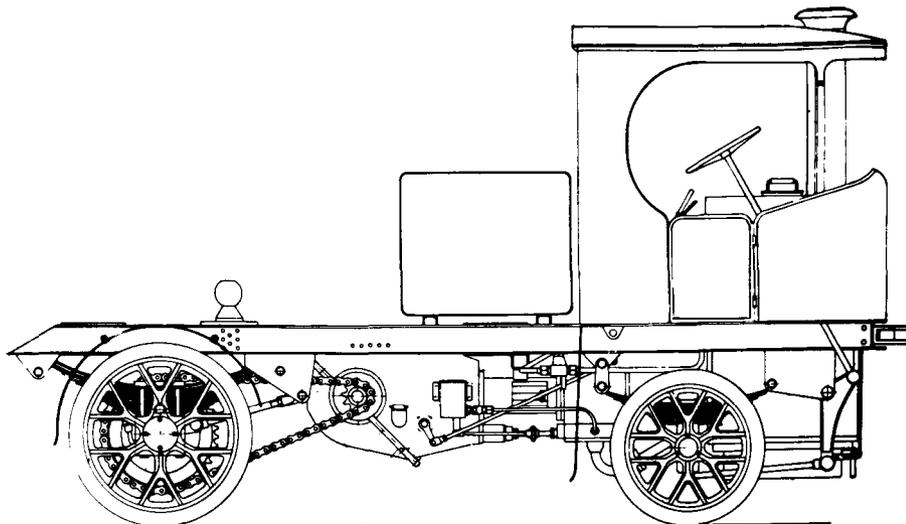
one of the many short lengths of bar end which must litter most workshops, afterwards mounting on each stub axle end in order to drill the 3/32 in. cross hole. Wire the two parts together, or mark them in some way so that each collar goes back on the correct stub axle.

Mark out on a length of 1 in. x 3/16 in. rectangular mild steel the outline and hole centres for the front spring caps. Drill the holes 5/32 in. dia., and if your spring stacks are held together with 8BA studs and nuts then drill a 7/32 in. dia. hole in the centre of each cap to clear the nut. (Do the same to the axle jaws.) Saw each cap off the strip and file to the outline. Finally use a square file to put in the radius on the underside of each cap to accommodate the curvature of the spring.

Prepare the eight 4BA studs and screw the short threaded ends into the axle jaws. The front springs can now be installed in the chassis using the shackles and mounting pins previously made. Now offer up the front axle complete, sliding the studs over the springs. Wangle the spring caps into position over the studs and secure with 4 BA nuts.

Insert a pair of king pin bushes into an axle jaw and try a stub axle between them. The chances are it will not go since we left the flanges overthick. Remove the bushes and skim the flanges until the stub axle will just fit between them without any vertical movement. Degrease and secure the bushes with Loctite 242 (medium strength).

To be continued



A CLAYTON UNDERTYPE STEAM WAGON

in 2 in. scale

by Robin Dyer

Part IV

From page 1082

AT THE END of the last article we left the Clayton chassis sitting up in the air on the front axle, so it would be a good idea to level it off by making the rear axleboxes. I originally thought of making these in brass or even aluminium and fitting split liners. However, splitting the liners and soldering them back together again for machining is a tricky process so I have decided to make the axleboxes in a bearing metal, gunmetal or cast iron — I do not know which at the time of writing. The rear axle turns quite slowly, there is a generous bearing area and with adequate lubrication the journal should last a very long time before a refit becomes necessary. And so to work

Clean up the bottom surface of the casting with a file (an old one for cast iron but a new one for gunmetal or it will just skid over the surface) and mark out the four stud holes. Also, find the centre of the cored hole and scribe right round the casting. Drill the holes No. 32 (3.00 mm.), then saw the casting in half. Tap the holes in the top half 4 BA and drill out the lower holes No. 25 (3.80 mm.). The lug on the front of the axlebox accommodates the rear end of the radius rod, the purpose of which is to maintain a constant chain tension during suspension movements. Open up the gap in the lug to 3/8 in. but leave the 3/16 in. dia. hole for now.

With the two halves of the casting clamped together with screws, set up in the four-jaw chuck with the cored out hole running true. Slip a piece of 3/8 in. square bar in the lug for one of the jaws to clamp on. Bore out to 7/8 in. dia. then face off to

leave the centre line of the lug 19/32 in. from the edge, then continue to face back to form the 1 3/16 in. dia. boss 3/32 in. high. Reverse the casting in the chuck, setting the bore to run true again, and face off to leave the overall width 1 3/16 in. Machine the 1 3/16 in. dia. boss as before. The casting can now be cleaned up on the other faces, taking care to keep the bore central. The spring location slot can be machined as on the front axle jaws, leaving only the radius rod hole and the oil pipe hole to complete the casting.

Radius rods

The radius rod bosses hardly need any description, the drawings being self-evident. Note that the front boss is 1/2 in. x 3/8 in. while its rear partner is 3/8 in. square. The radius rods themselves can either be machined from 5/16 in. A/F hexagon stock to leave the narrow hexagon in the centre, or more economically, they can be made from 1/4 in. dia. bar, with a 2 BA nut drilled out to 1/4 in. dia. and secured in the middle of the radius rod with Loctite 270. When the spring caps and studs have been completed the rear suspension components can be assembled to the chassis.

Steering components

The Clayton undertype shared with the Atkinson and the Foden C type a form of steering in which a nut ran up and down a thread on the steering column, inside a long steering box. Lifting arms connected the nut with the steering quadrant.

The problem with the steering box is holding all the bits together for silver soldering. I found the best way was to cut the strips for the sides of the box about an inch longer than required. These strips can be held to the top block with 8 BA countersunk screws, and another block can be made to slip inside the lower end of the box. With the assembly silver-soldered up, the surplus can be sawn off the bottom at the correct angle. The mounting flange should be made a tight fit on the box, filing the front and back edges of the hole so that the box sits at the correct angle. Silver-solder to the steering box flush with the bottom edge then smooth off and generally clean up the assembly.

The steering nut starts as a piece of 1/2 in. x 3/8 in. phosphor bronze or gunmetal 7/8 in. long. When these dimensions are achieved the 1/4 in. Whit. hole can be drilled and tapped, making sure that it is both central and square. In the absence of 1/4 in. Whit. thread-cutting equipment then M6 is the next coarsest, with 1/4 in. B.S.F. very close at 26 t.p.i. Those builders who like a challenge might care to try cutting a square two-start thread! The coarser the thread, the less turns on the wheel. With the thread cut the nut can be held in the four-jaw chuck in order to turn the trunnions at either

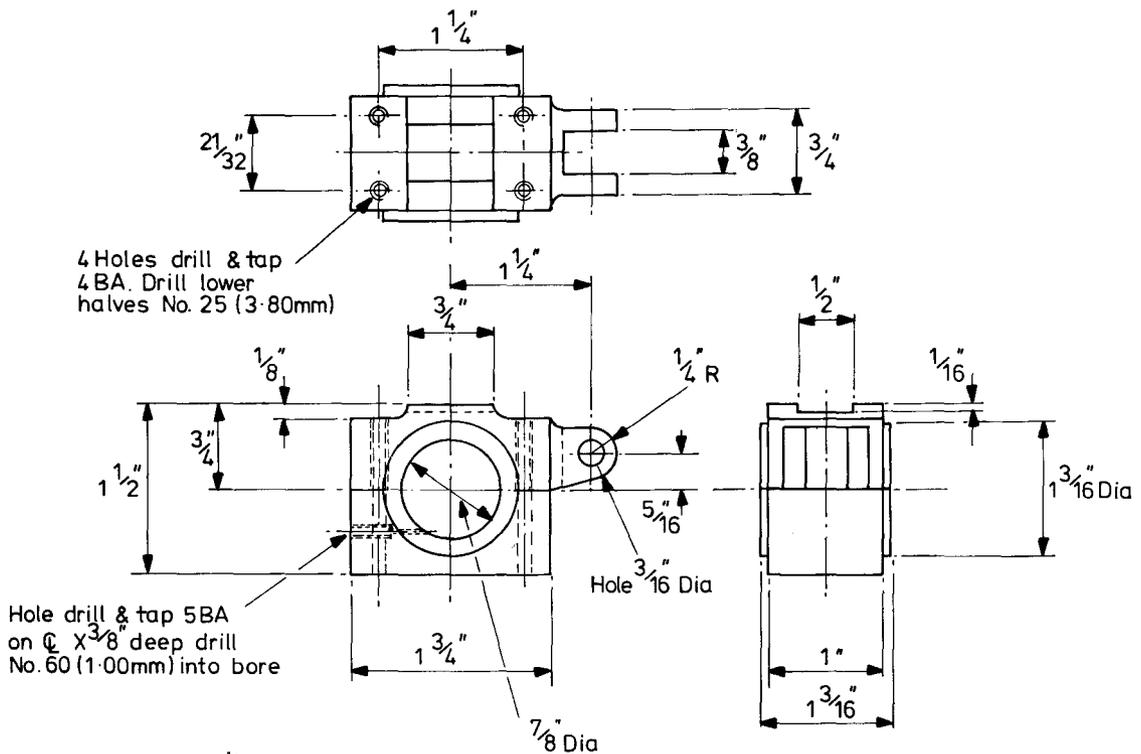
end. The nut when finished should slide up and down the steering box without jamming.

The steering column on my model is made in three parts, the collar and 3/16 in. dia. main column being pinned to the 1/4 in. dia. portion with 1/16 in. dia. pins. To avoid the risk of the 1/4 in. Whit. die not cutting square I partially screw cut the 20 t.p.i. thread before finishing off with the die.

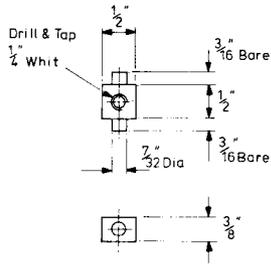
Two lifting arms are required, and it is important that both pairs of eyes end up the same distance apart. I succeeded by careful measurement but jig and tool experts can do their own thing as on Stephenson valve gear eccentric rods. When the steering column bush and a couple of 1/4 in. x 40T nuts have been made, the parts can be assembled and tried for ease of movement; it may be that, like mine, the nut runs easier when assembled a different way round.

Steering wheel

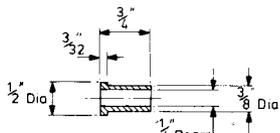
Being a dished wheel this is probably best made by fabrication, although the more adventurous may care to carve it out of a slice off a 3 in. dia. bar! For a fabricated wheel the rim is rolled up from a length of 5/32 in. dia. mild steel rod, taking a turn and a half round something about 2 1/2 in. diameter. When released it will spring open somewhat, but what is



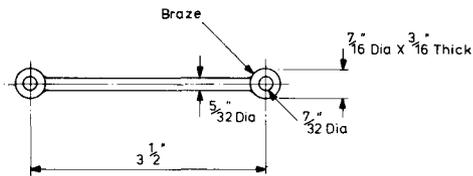
REAR AXLEBOX 2 Off Cast Iron



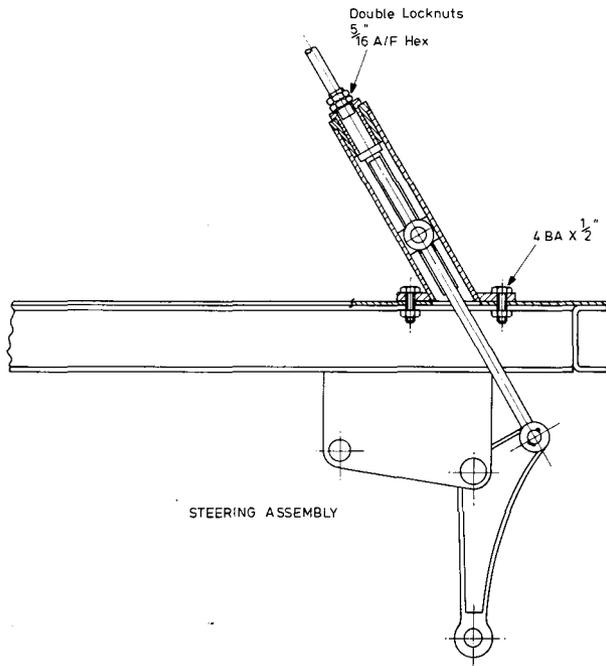
STEERING NUT 1 Off PH BR



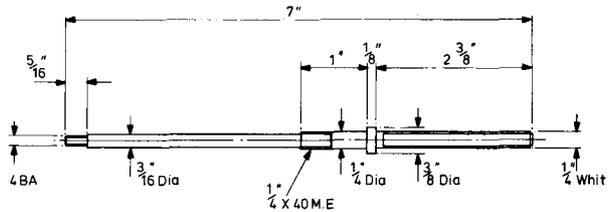
STEERING COLUMN BUSH
1 Off PH BR



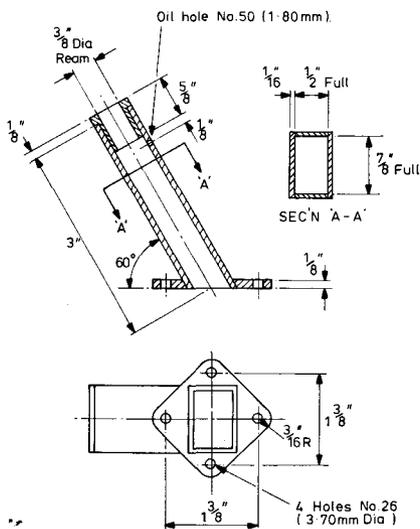
LIFTING ARM 2 Off M STL



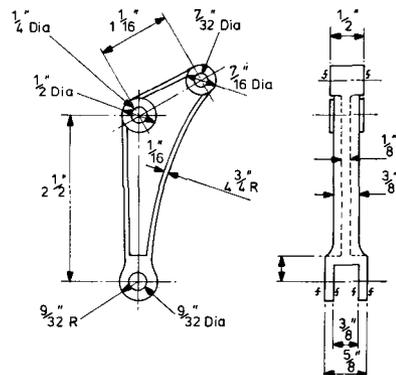
STEERING ASSEMBLY



STEERING COLUMN 1 Off M STL



STEERING BOX 1 Off
M STL FABRICATION



STEERING QUADRANT
GUNMETAL CASTING

needed is a true circle 3 in. outside diameter. When this is achieved saw through the rod, align the cut ends and silver-solder the joint using a high melting point alloy such as C4. The spoke spider is sawn from 12 s.w.g. steel sheet, and when the spokes have been shaped and smoothed off they should be bent to produce the dishing. Chamfer the ends so that the spider lies within the rim but resting on it, and position it so that the joint in the rim lies midway between two spokes. Flux the joints and silver-solder with Easyflo No. 2 securing the central boss at the same time. A bit of fiddling and bending may be needed afterwards to correct any distortion — my steering wheel still has a wobble in it!

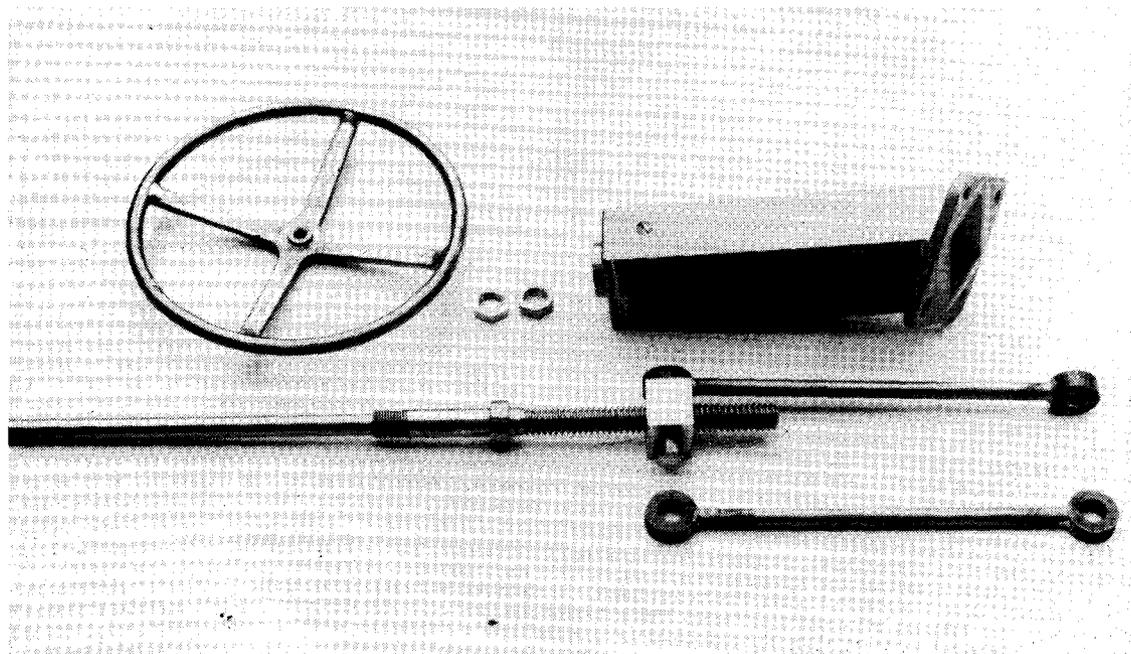
Steering quadrant

This will be available as a gunmetal casting and the first operation should be to smooth off the cast surfaces. Find the centres of the three bosses, centre punch and drill the appropriate sized holes in each. The quickest way to finish the bosses to width is to file them. The centre boss should be a snug fit in the chassis bracket, and the top boss should be an easy fit between the lifting arms. The fork end will probably be cast solid and this should be sawn and filed or milled 3/8 in. width. The various pins for the quadrant are detailed together with the track rod, this latter being a straightforward job. When making the clevises it would be as well to make a third for the drag link, this being identical to the long adjustable track rod clevis.

Next we come to the two steering arms which involve more fiddly but necessary filing unless the constructor is a wizard with the end mills. The arms are held to the king pins with 3/32 in. dia. pins, and on the basic Ackermann steering system the steering arms, if projected rearwards, should meet in the centre of the rear axle with the front wheels in the straight ahead position. The track rod is then adjusted to give a small amount of 'toe-in', an operation best left until the front wheels are fitted.

Before the steering components can be fitted the cab floor needs to be made, but only to be detailed with the basic cutouts. Further apertures to clear pipework, etc. are best left until later. Steel is the most appropriate (and cheapest) material for the floor but there is no reason why brass should not be used. Other modellers may think differently but I find the easiest way of producing large cutouts is to chain drill closely spaced holes then chop between them with a small cold chisel onto a block of scrap steel. The holes are then finished by filing. When the cab floor has been fitted to the chassis the steering box can be bolted on with the lifting arms straddling the offside chassis side-member. Make sure that the arms can be wound up and down without binding.

The final part of the steering gear is the drag link and this can now be made and fitted, adjusting the bends to line up the ends with the steering arm and the quadrant. A drop of light oil on all the moving parts should ensure a free action. *To be continued*



Steering box components

A CLAYTON UNDERTYPE STEAM WAGON

in 2 in. Scale

by Robin Dyer

Part V

From page 1208

FIRST OF ALL, by way of a carryover from the previous article, it has dawned on me that all the steering force is being transmitted by means of a 6BA screw clamped on a flat on each king pin. This could be beefed up, if required, by using a 4BA screw and drilling right into the king pin. Before leaving the steering mechanism I ought to say that the front suspension layout on the model is based on intelligent guesswork and the practice of other steam wagon manufacturers since I have no details of this part of the Clayton.

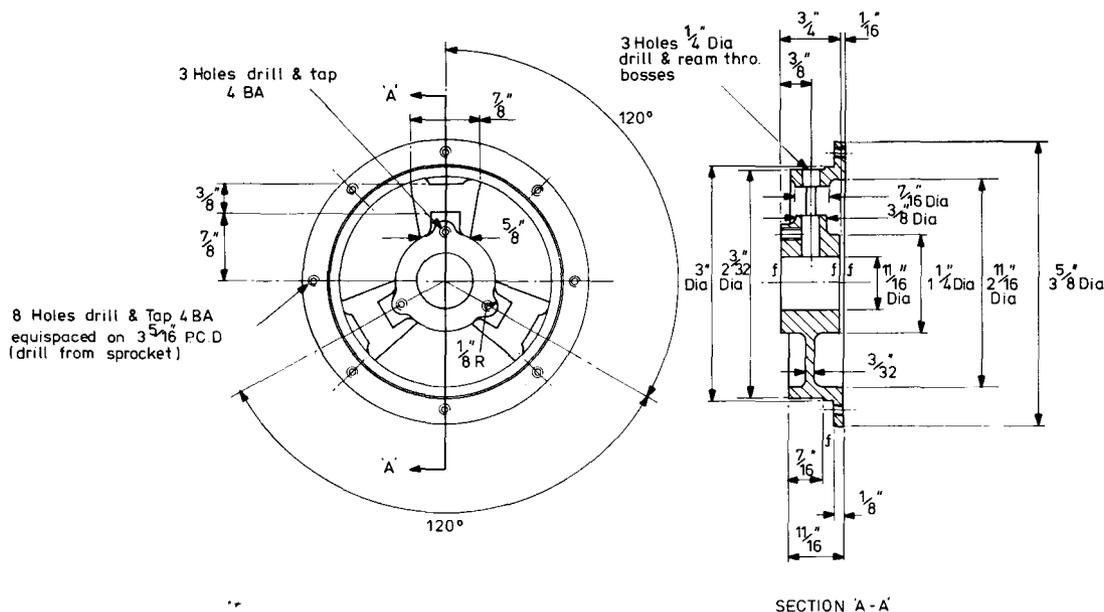
Moving now to the rear of the model and in particular to the differential assembly, this utilises the bevel gears supplied for the Allchin traction engine; in fact the compensating centre on my model is a much modified Allchin casting.

Clamp the casting in the four jaw chuck, flange outwards, adjusting to run as truly as possible. Face off the flange until it lies $\frac{7}{16}$ in. from the

centres of the three pinion bosses, then face back the centre hub until this lies $\frac{1}{16}$ in. behind the flange face. Skim the top of the flange to $\frac{3}{8}$ in. dia. then change to a boring tool and bore out the hub to $\frac{11}{16}$ in. dia. Remove from the chuck and turn a stub mandrel a wring fit in the bore then push the casting on, flange innermost, and machine the other surfaces except for the face of the hub. Note that the 3 in. dia. locates the drive sprocket, and if a ready made part is available (not known at the time of writing) then the casting should be machined to fit.

Knock the mandrel out of the bore and chuck the casting in the four jaw by the flange and face back the hub until it is $\frac{3}{4}$ in. long.

Having finished all the turning and boring it is now time to mark out and machine the pivot pin holes and apertures for the pinions. The late Bill Hughes described one way of doing this in his

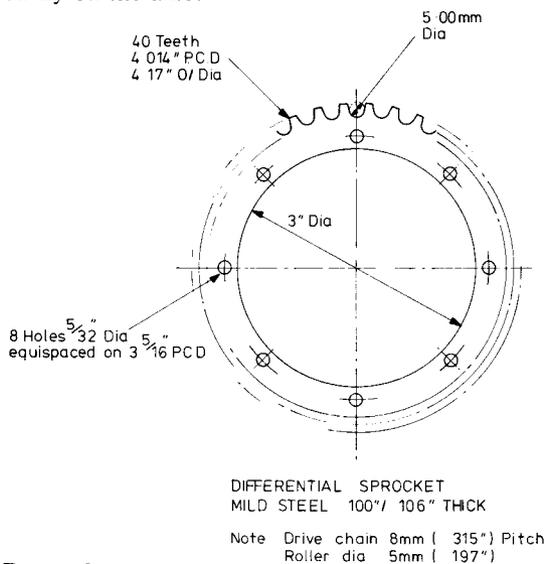


DIFFERENTIAL CENTRE
GUNMETAL CASTING

series on the Allchin, but to give readers a choice I will describe the way I tackled it.

The radial positions of the pivot holes can be marked by setting up in the lathe with a suitable method of dividing into three parts. The accurate meshing of the gears depends on this marking out so it will pay to take some trouble over it. The axial positions of the holes can be marked by setting the scribing block to 7/16 in. and placing the casting flange down on the surface plate. A mandrel or locating spigot can now be clamped to the crossslide on the centreline of the lathe such that the casting can be dropped over it, packed up to the required height and also clamped so that it cannot move while each pivot hole is drilled and reamed 1/4 in. dia. The photographs should help to explain the method.

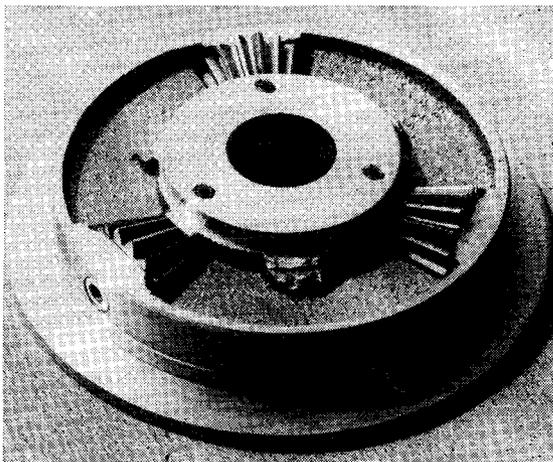
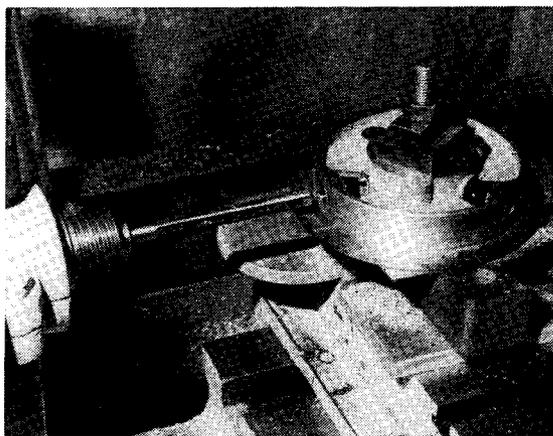
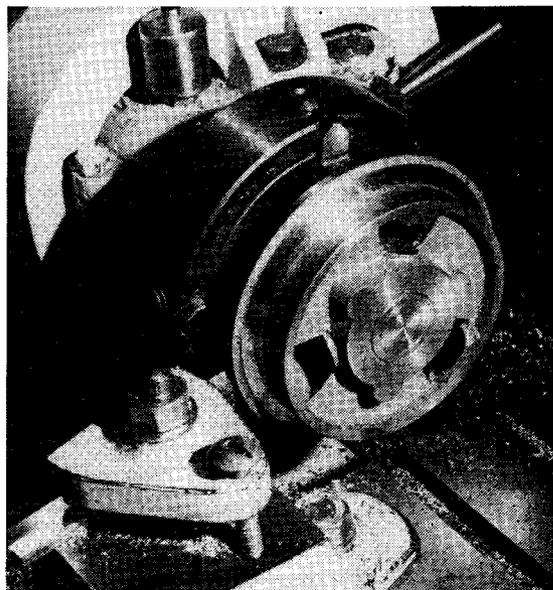
The windows or apertures for the bevel pinions can either be planed in the lathe as described by Bill Hughes or filed. I tried the latter operation as a simpler alternative and found it relatively easy, the important part being to keep the faces square with the pinion axes. A special snap gauge made as in the illustration will help to get things right. I found that a certain amount of fitting (boding?) was necessary to get the differential assembly running easily on the axle.



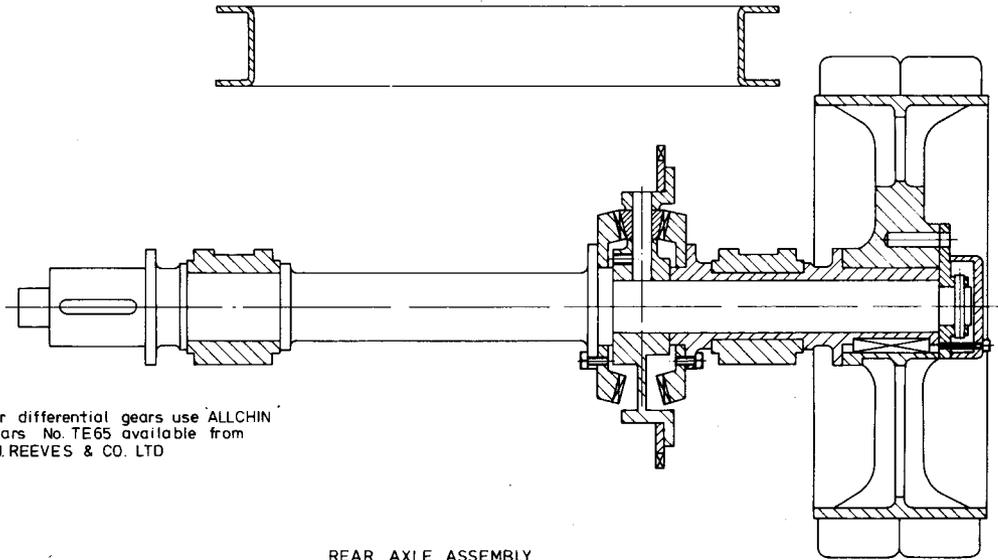
Rear axle

This requires a length of free cutting mild steel bar 1 5/8 in. dia. by about 18 in. long. A. J. Reeves Ltd. can supply the material ready sawn into the two lengths (for the main axle and the sleeve) and although a lot of this lovely metal has to be machined away, it would be better in this case to make the axle from the solid rather than try welding flanges on to a smaller piece.

The first operation on my axle was to have the sleeve drilled 11/16 in. dia. as a "foreigner" as my

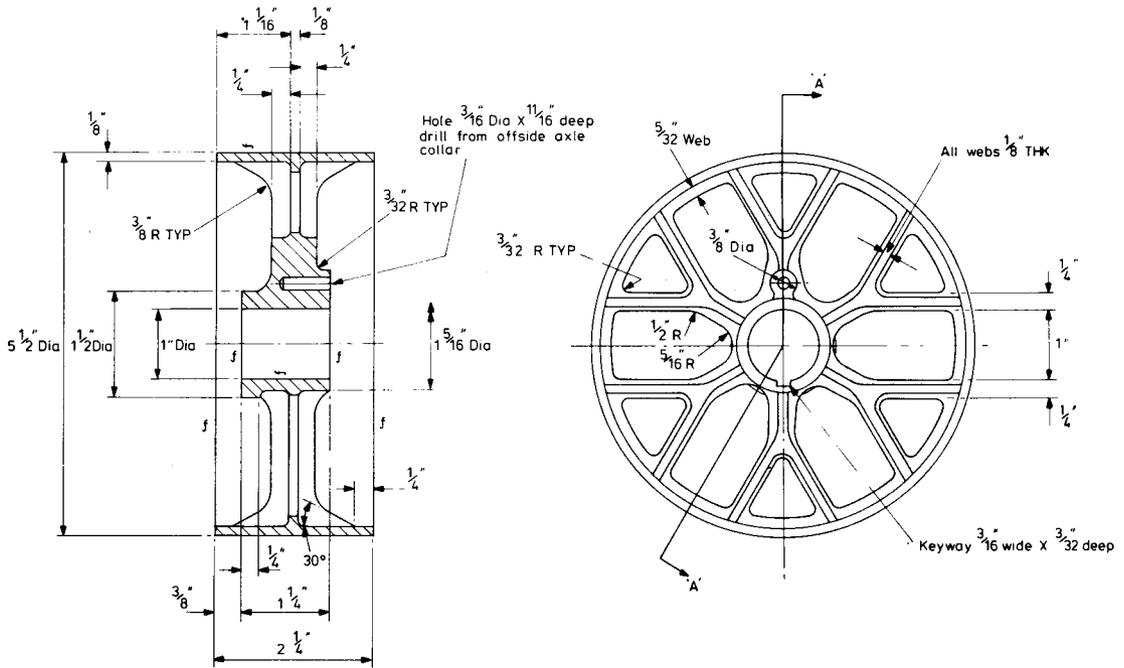


Above: Various stages in machining the differential assembly using the Allchin casting.



Note - For differential gears use ALLCHIN gears No. TE65 available from A.J. REEVES & CO. LTD

REAR AXLE ASSEMBLY
(Viewed from rear)



SECTION 'A-A'

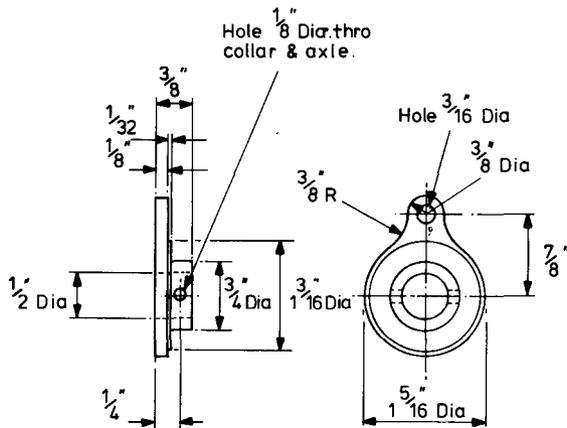
REAR WHEEL 20ff
ALLUMINIUM CASTING

wheels, but should this not be possible the tyres can be built up with two layers of 1/4 in. thick rubber sheet secured with Araldite or Evostick. When the rear axle is assembled in the axleboxes (a job best achieved with the chassis inverted) any stiffness might be cured by a slight adjustment of one of the radius rods, but final adjustments will have to wait until the chain is fitted.

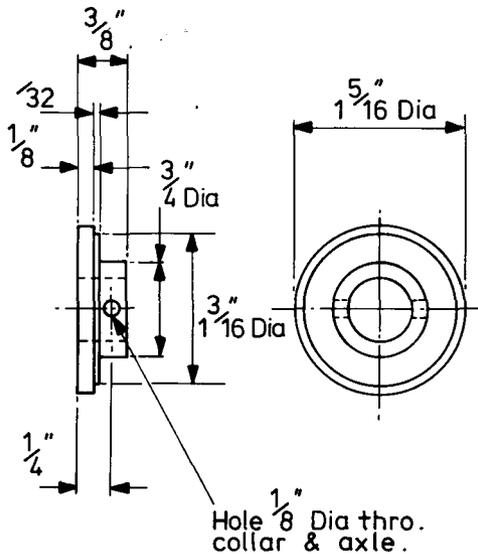
Final chassis parts

The front drawbar is a simple casting which only needs smoothing with a file and drilling, but it could be fabricated from odd pieces of 3 mm mild steel sheet.

The reversing stand is made from 2.5 mm M.S. sheet and follows normal locomotive practice except for being canted forwards. It is mounted



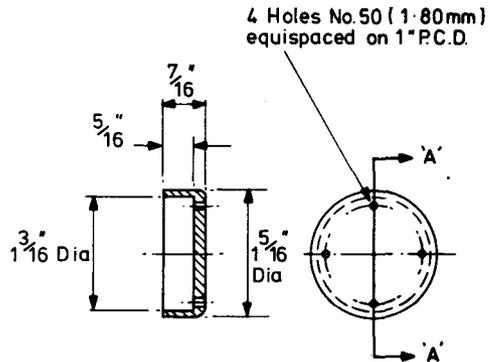
AXLE COLLAR - OFFSIDE
GUNMETAL CASTING



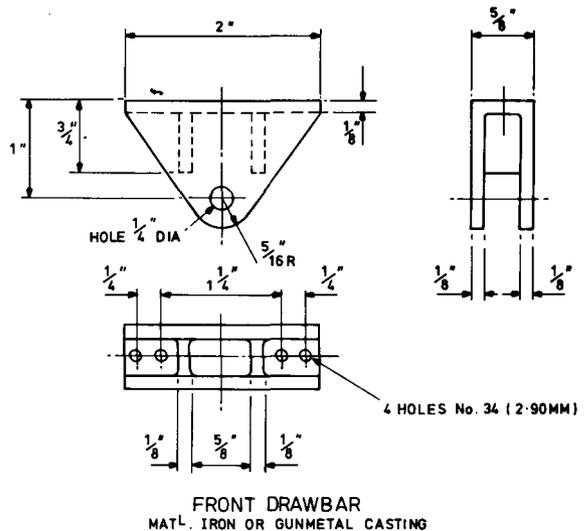
AXLE COLLAR - NEARSIDE
GUNMETAL CASTING

towards the rear of the cab and, in fact, sprouts out of the driver's seat; the latter will have to be fitted round the stand which is bolted firmly to the floor by means of a piece of 1/2 in. x 1/2 in. steel angle. The cutout in the floor will need opening out a little to permit full movement of the lever.

The mid-gear position of the lever can be fixed by filing the notch in the stand, but the other positions should be left until the engine is assembled. When the stand is erected, pin the weighshaft in position and secure the plummer block to the cab floor. Assemble the inboard reversing arm with Loctite such that it hangs vertical with the lever in mid-gear; when cured it can be pinned without fear of



HUB CAP 20ff
GUNMETAL CASTING.



FRONT DRAWBAR
MATL. IRON OR GUNMETAL CASTING

movement.

Readers will note that I have not detailed any towing system; this is because I do not know what is commercially available. I have been able to obtain a 1 in. dia. ball hitch and have shown this on the G.A. drawing but it would be rather a tricky item to make. A simple pin and eye would suffice in the absence of anything more elaborate.

This article brings us to the end of the chassis description and the next item to be considered will be the boiler, quite a simple affair with only two flanged plates and no stays. *To be continued*

M35 Clayton Undertype wagon

The following drawings are now available:

Sheet 1—General Arrangement.

Sheet 2—Steering assembly, front axle, front wheels and hubs.

Sheet 3—Chassis, springs, rear axle box, front axle.

Sheet 4—Rear axle details.

Price £1.35 per sheet from our Sales Office at this address. Overseas readers please contact local agents.

A CLAYTON UNDERTYPE STEAM WAGON in 2 in. Scale

Part VI

From page 1347

Robin Dyer describes the construction of the boiler

IN PART II of this series a method of making the chassis by using one inch square steel tube was described. Builders will doubtless be relieved to know that ready folded channel is now available from Messrs. Reeves, requiring only to be cut into the appropriate lengths.

The boiler

The boiler of the full-size Clayton wagon followed the practice of many wagon manufacturers in consisting of a vertical barrel containing a large central flue with 54 cross water tubes. Having schemed this arrangement out on the drawing board it became clear that there would be inadequate heating surface to steam the engine (2 cylinders, 1 in. bore x 1½ in. stroke). I have therefore opted for the "traditional" boiler with vertical tubes, and in fact the layout is very similar to that described by "Tubal Cain" in the issue for 18 August 1978. Firing will be as on the prototype, through a central, vertical chute, although a feature not found on the Clayton is a clinker door set in front of the boiler below the front chassis crossmember. A number of other makes of wagon were so fitted and it will make lighting up and raking of the fire more convenient.

Construction

The boiler shell is an 8 in. length of 5 in. dia. x 13 s.w.g. copper tube. After squaring the ends the tube should be marked out for the various bushes, mounting angles and the clinker hole. Squeeze the clinker tube oval and use it to mark out the shape of the cutout on the barrel, and also on the firebox. Cut out these two holes so that the tube is a snug fit in each, and drill the other holes for the bushes. Next, bend up the mounting brackets from 2.5 mm.

sheet and rivet them in position with three 3/32 in. dia. rivets each. Turn up the various bushes in phosphor bronze, and silver solder these and the brackets to the boiler shell. The clinker hole tube should be soldered to the firebox, preferably using a high melting point silver solder and making sure that it stays square to the firebox surface.

Only two flanged plates are required for this boiler, and the circular blanks should be cut from 2.5 mm. copper sheet. If you are only making one boiler the former can be made from a piece of hardwood about ½ in. thick. One piece will suffice, being turned down after flanging the smokebox tubeplate. A chucking piece should be turned on the back of the former to enable it to be relocated in the lathe to perform this operation, and all the tube holes can be marked out and drilled 1/8 in. dia. so that the former may also be used as a drilling jig for both plates. Drill the holes in the smokebox tubeplate 3/8 in. dia., and those in the firebox tubeplate 23/64 in. dia., skimming the ends of the tubes to suit. Note that the tubes are 3/8 in. dia. with a 16 s.w.g. wall thickness; the tubes being rather short a narrow bore will be an advantage. A thicker wall will also lessen the risk of burning a hole whilst silver soldering or even while steaming; I have seen two model boilers cut open and they were both scrapped because of a hole in one of the thin-walled firetubes, up against the firebox tubeplate.

After flanging, both plates should be skimmed or filed on their outside diameter to be an easy push fit in their respective tubes. The 35 tubes plus the stoking tube should be cut to length and skimmed as previously mentioned. Note that it will help when fitting the smokebox tubeplate if the 3/8 in. dia. tubes are sawn to slightly different lengths. It will be easier to solder the tubes into the firebox tubeplate before soldering the latter into the firebox so this should now be done, using the smokebox plate on the other end to steady the tubes. Next the tube assembly can be positioned in the end of the firebox and held in place with four rivets, noting that the tube nest must be orientated correctly relative to the clinker hole, and it will also be necessary to remove some of the tubeplate flange to clear it. With all that lot sorted out and with flux applied inside and out, the joint can be silver soldered, and for this sort of circular joint some form of turntable would be an invaluable aid. A bright ring inside the firebox will indicate a sound joint.

Before the final assembly and soldering operation the two bushes in the smokebox tubeplate can be made and fitted. Here I found it easier to drill and tap the superheater offtake bush before fitting — this required the offtake itself to be made so that I could spot through the fixing holes.

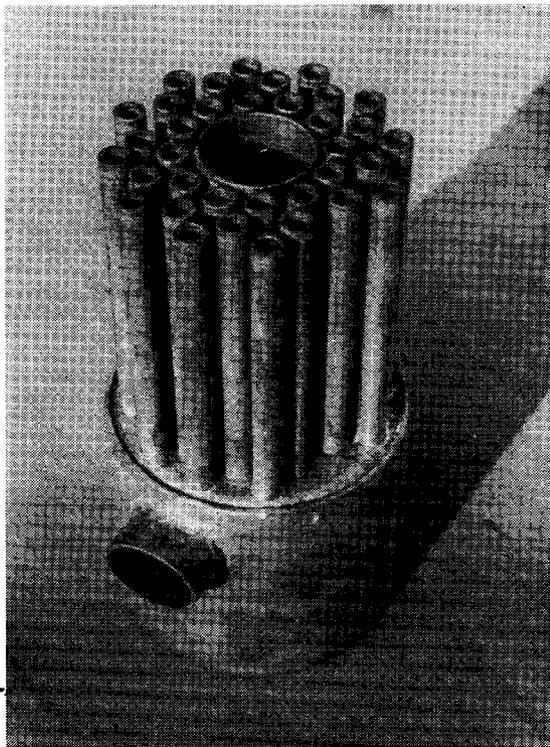
The foundation ring is a length of 1/4 in. x 3/8 in. rectangular copper bar rolled on its edge, as it were,

a near impossibility in the "as bought" state, but it will become as putty once it has been annealed. Roll it round something 4 in. dia. until the ends overlap and try it in the boiler barrel to see how it is going. Cut off the surplus and file the ends until the ring is a tight fit in the barrel. The firebox will be a slack fit in the ring and after final assembly the bottom edge should be tapped out to be a snug fit against the ring.

To assemble the various bits the foundation ring should first of all be removed. This will enable the firebox/tubeneast to be dropped into the inverted boiler barrel and the clinker tube to be poked through the hole in the barrel. If the smokebox end of the tubes can be supported on something 1/2 in. thick, the foundation ring can be wangled into position. Turn the boiler the right way up and feed the smokebox tubeplate into position. It will be necessary to file some of the flange away to clear the safety valve and upper gauge glass bushes, and some of the tubes will doubtless require tweaking with a pencil to enable them to come through the holes. Before the final assembly all mating surfaces should have been thoroughly cleaned and coated with flux. The joints should be fluxed again just before the big heat.

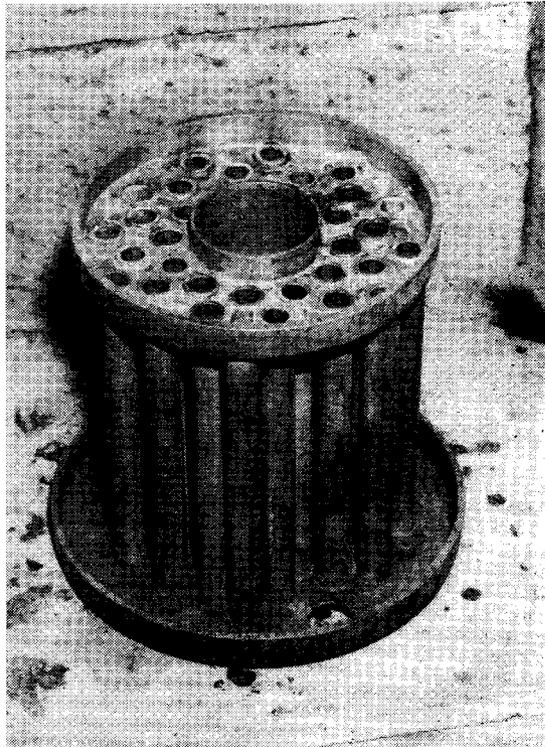
Below: The firebox and tube nest assembly.

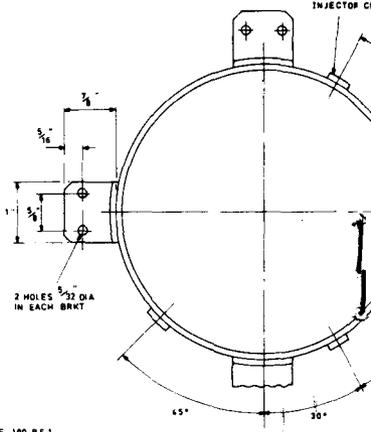
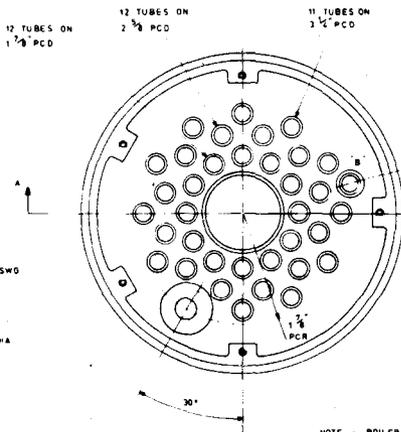
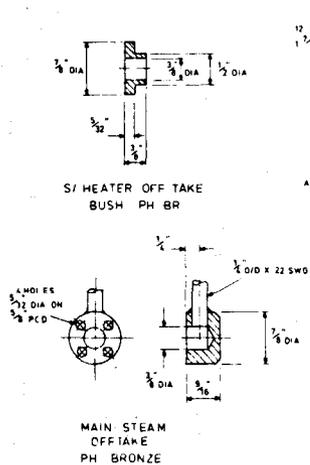
Right: Silver soldering the tubes to the firebox tubeplate.



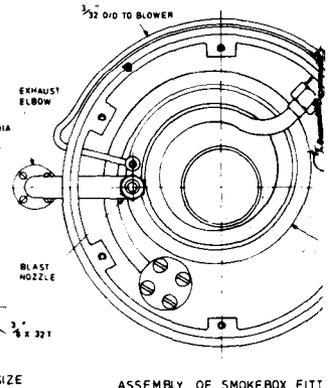
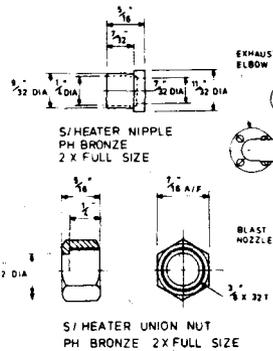
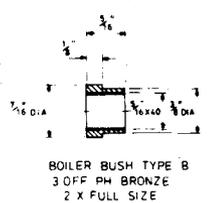
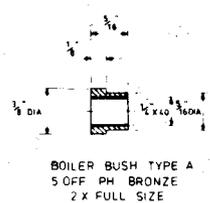
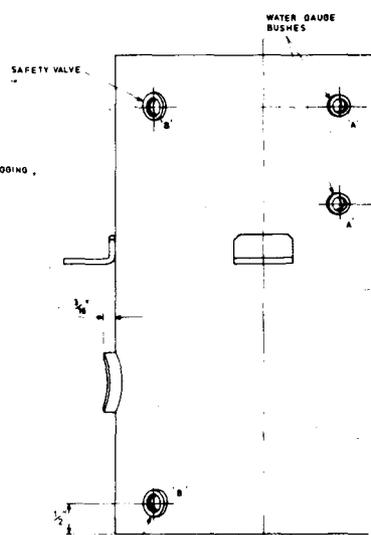
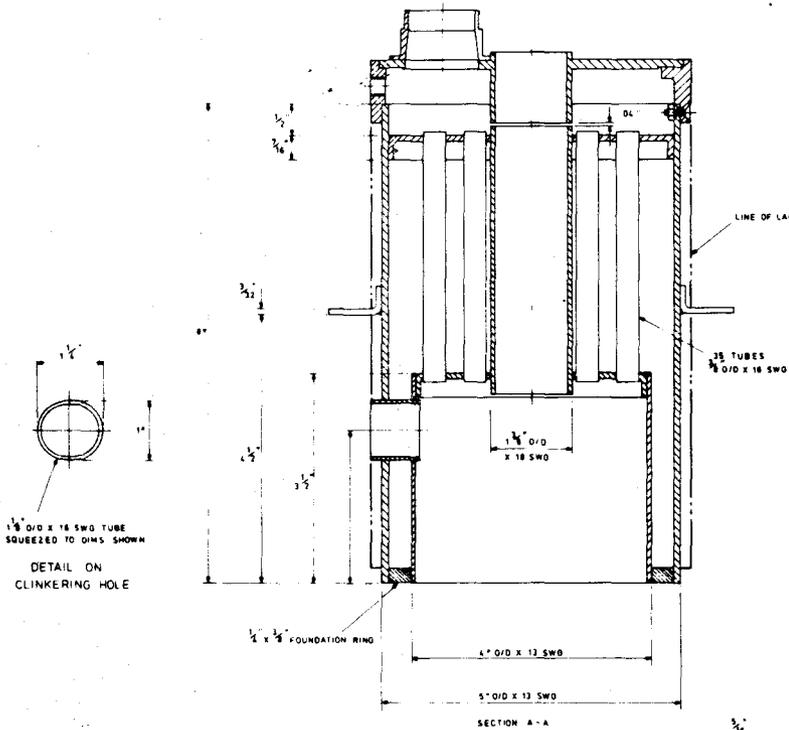
Having only modest heating equipment at my disposal (a 1½ pint blowlamp and a 500 g/hr. burner fed from an 18 kg propane cylinder) I purchased nine firebricks, arranging them three courses high to form a three-sided hearth. I was amazed at the boost in heating capacity that this simple layout gave; without the firebricks I had struggled to complete a *Minnie* boiler, but with their aid I managed the "kettle" for the Clayton. I completed the boiler by first soldering the foundation ring, then the clinker hole, and finally the smokebox tubeplate. Afterwards it was a good 20 minutes before I could safely lower the boiler into the pickle bath — be warned!

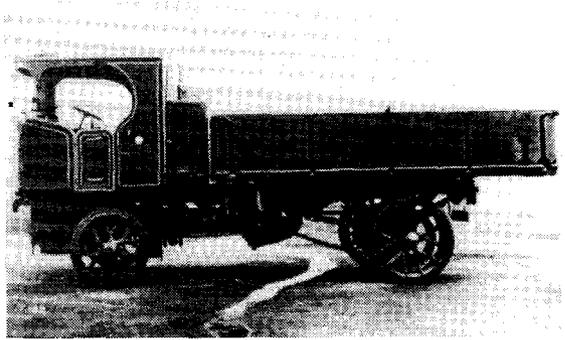
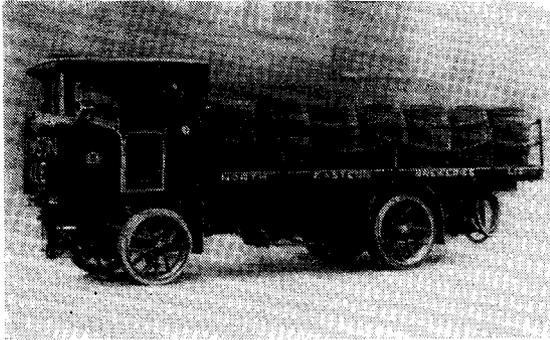
It will now be necessary to make or buy a hand pump to enable the hydraulic pressure test to be performed. Suitable designs are given in *Model Engineer* drawing number LO36, and they are also available from the supplier of the castings. One of the clacks should be made up (or bought) together with as many blanking plugs as are needed for the remaining bushes. The working pressure for this boiler is 100 p.s.i. (6.8 bar) and so the hydraulic test pressure should attain twice this figure. Particular attention should be paid to the firebox where any bulging will need tapping back and staying as for loco boilers. Leaks through silver soldered joints should be refluxed and heated again. With these heart-stopping trials out of the way, a rub over with wire wool will considerably boost the ego.



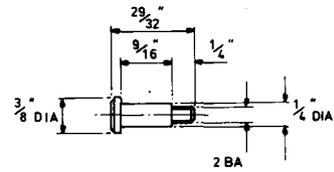
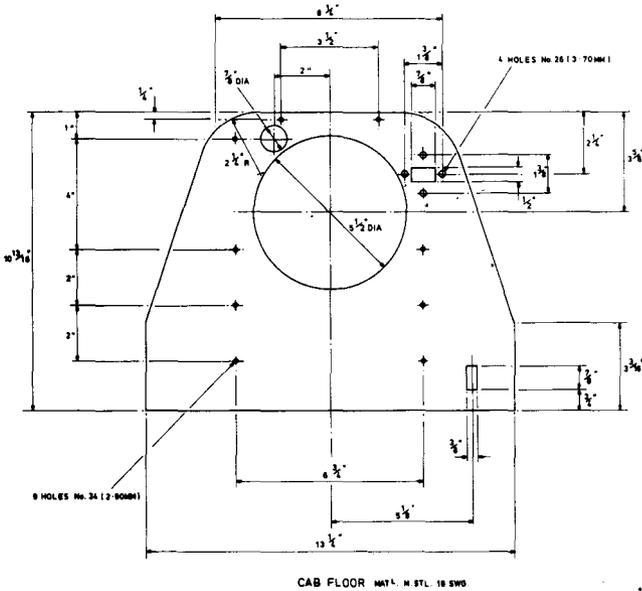


NOTE - BOILER WORKING PRESSURE 100 PSI
HYDRAULIC TEST PRESSURE 200 PSI
ALL JOINTS SILVER SOLDERED
BOILER MATERIAL - COPPER

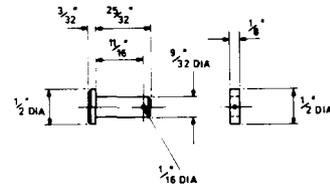




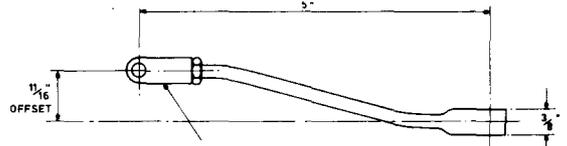
Two Clayton underframe wagons, that on the right being delivered to the Team Valley Motor Co. Ltd., Birtley.



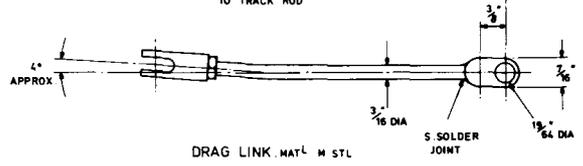
STEERING QUADRANT PIVOT PIN. MATL. M. STL.



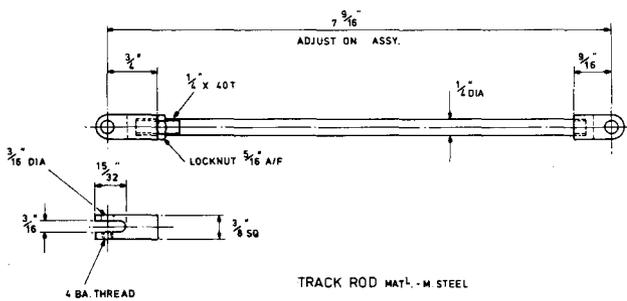
DRAG LINK PIN & COLLAR. MATL. M. STL.



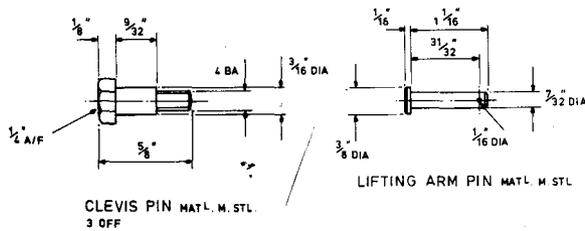
THIS CLEVIS SIMILAR TO TRACK ROD



DRAG LINK. MATL. M. STL.

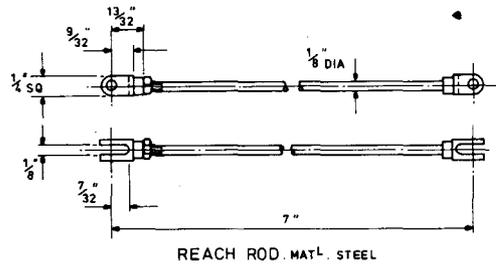


TRACK ROD. MATL. - M. STEEL.



CLEVIS PIN. MATL. M. STL. 3 OFF

LIFTING ARM PIN. MATL. M. STL.



REACH ROD. MATL. STEEL.

Some further Clayton drawings referring to previous parts in the series.

The outer end of the clinker hole tube needs to be curved to match the profile of the boiler; the door requires the same treatment but otherwise it is identical to the usual loco or traction engine door. The door hinge bracket should be secured to the barrel with 8 BA screws made from phosphor bronze, and screwed in with a smear of Hermetite or similar compound on the threads.

Smokebox

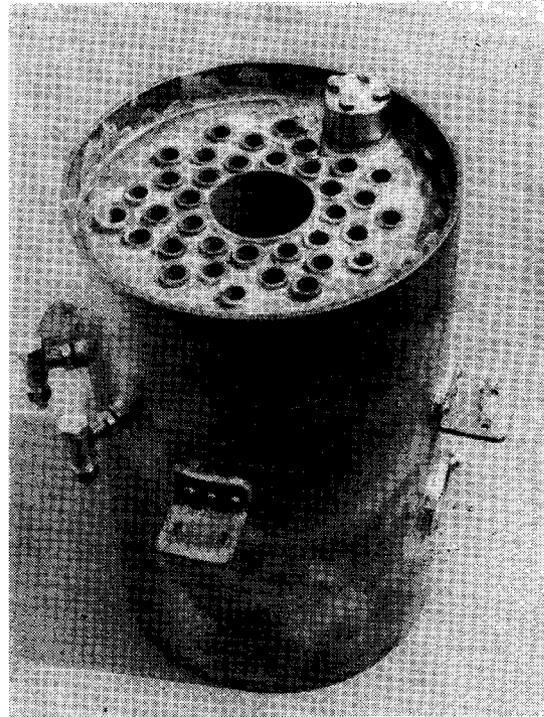
The smokebox is comprised of two iron castings, a ring and a separate top plate, and is a different arrangement to that on the full-size wagon. This is both in the interests of simplicity and because the internal arrangement is completely different.

The ring should be machined first, chucking on the outside diameter and setting to run as true as possible. Machine the internal 5 in. dia. step to be a firm fit over the boiler barrel, and then turn the 5 11/32 in. dia. spigot which locates the top edge of the cleading sheet. The ring can now be reversed to enable the outside diameter to be cleaned up, should it require it, and the seating for the top plate to be bored out. Mark out and drill the four radial holes round the ring, tapping 3/8 in. x 32T in the case of the exhaust fitting hole. The position of the 11/32 in. dia. hole for the manifold should be carefully checked with the standpipe in position; use the top edge of the boiler as a datum for checking the vertical position of the tapped hole in the standpipe.

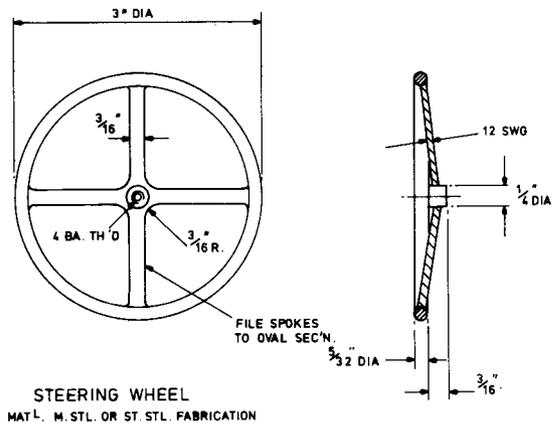
Smokebox top plate

This is another iron casting and so needs to be machined at a fairly slow speed — and a tungsten carbide tipped tool will enable this to be increased somewhat as well as maintaining its cutting edge for longer. Set the casting up in the four-jaw chuck by the long spigot so that the plate runs as truly as possible. Take a skim over the outside surfaces to clean up (known as machining to witness) and turn the outside diameter to fit the recess in the smokebox ring. Bore out to 1 3/16 in. diameter. This is smaller than the bore of the stoking chute so that any lumps of coal that get stuck will fall free once they have been pushed through the top plate. Reverse in the lathe, chucking by the bore, and machine a true seating on the underside of the plate. Mark out and drill the 6 BA clearance holes, then spot through onto the smokebox ring, checking that with everything assembled the chimney hole ends up on the centreline of the wagon. Note that with the smokebox in place there should be a 0.04 in. gap between the stoking chute proper (the bit soldered into the boiler) and the lower edge of the top part of the chute; this dimension is marked on the boiler section drawing. This is to restrict the hot gases coming up the chute in order that all the 3/8 in. dia. tubes may receive their fair share; that is the theory anyway!

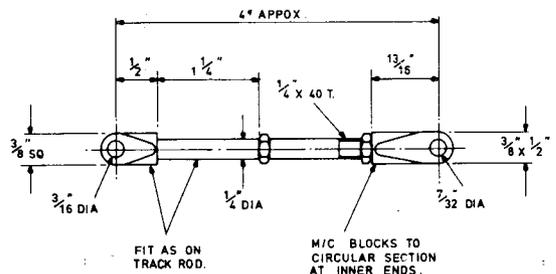
To be continued



The completed boiler less smokebox.



STEERING WHEEL
MAT'L. M. STL. OR ST. STL. FABRICATION



RADIUS ROD. MAT'L. M. STL. - 2 OFF.

CLAYTON UNDERTYPE STEAM WAGON

in 2 inch Scale

Part VII

by Robin Dyer

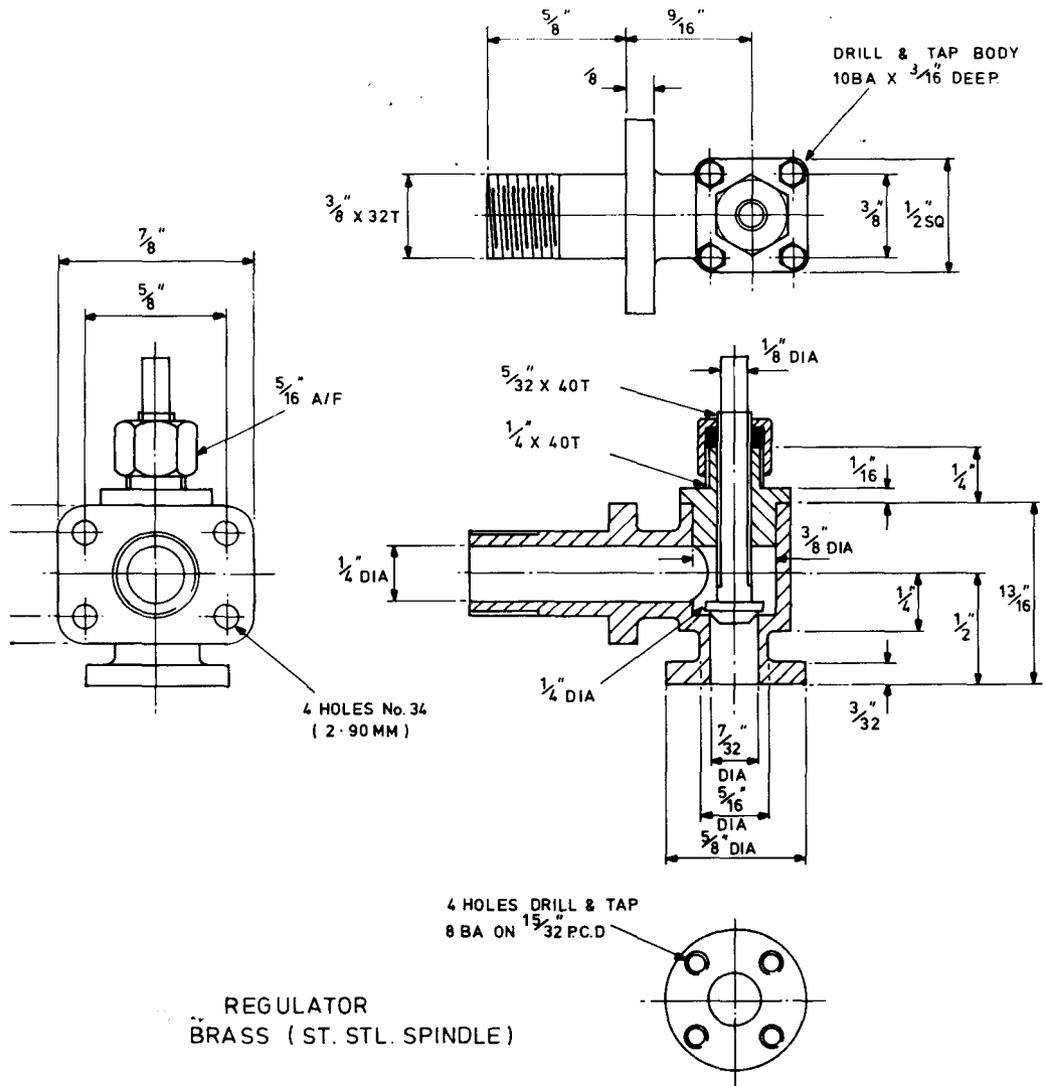
From page 161

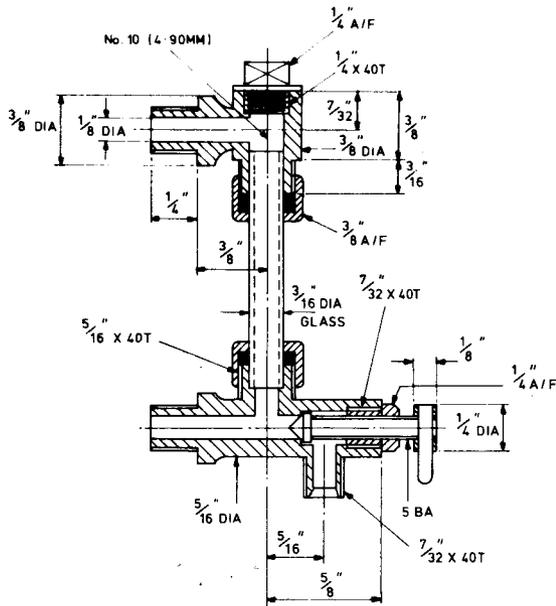
THE CHIMNEY OF THE Clayton wagon is a very simple affair, parallel in its length with a flat base. The base and cap are available from the casting suppliers, and the chimney barrel can be made from the same tube as the boiler stoking chute, 1 3/8 in. outside diameter. The base flange needs to be scal-

loped away to clear the stoking chute lip on the smokebox top.

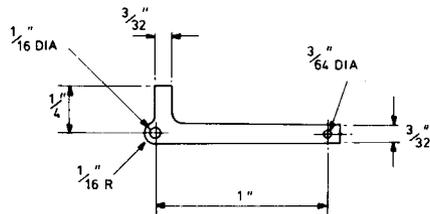
Boiler fittings

The superheater coil is made from thin walled copper tube 1/4 in. O.D. This should be annealed

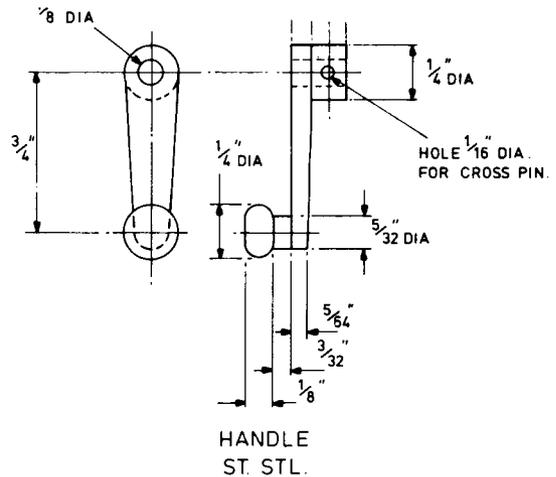




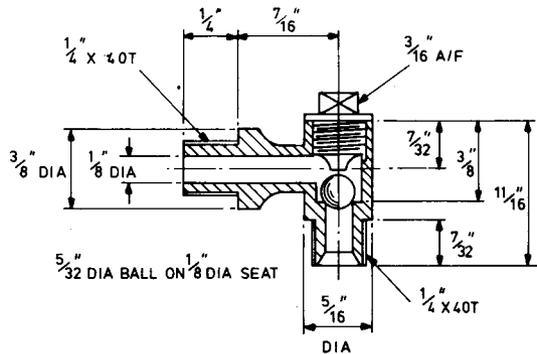
WATER GAUGE
BRASS. (ST STL. SPINDLE)



WHISTLE VALVE LEVER
ST. STL. 16 SWG.



HANDLE
ST. STL.

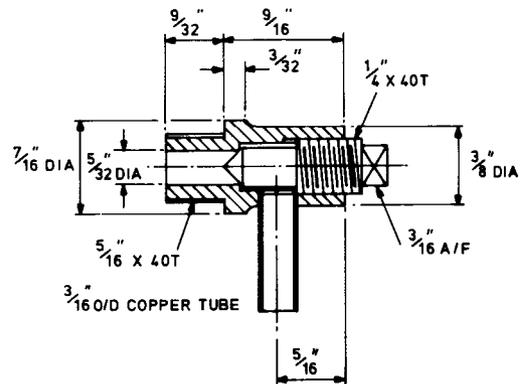


FEED CLACK
BRASS. 20FF.

before coiling, and soldered to the steam take-off and regulator nipple with a high melting point silver solder. A length of about 24 in. will be required, and three coils should be possible. The exit end should be turned outwards to face the hole in the smokebox ring which will house the regulator.

The regulator block is cast with chucking spigots to assist machining, and one of these should be used, in the four-jaw chuck, to enable the steam entry stub to be turned; this is the stub which receives the superheater union nut. The casting should be set up so that the 1/4 in. dia. entry hole, when drilled, will come out in the centre of the main body. Drill this hole and machine the stub to 3/8 in. dia. and face back the bolting flange. The final operation at this setting is to cut the 3/8 in. x 32 t thread.

Next, chuck by the other spigot, the one coming out of the steam pipe bolting flange, and adjust until the square body runs true. Face the top of the regulator block and complete the internal machining, finishing off the valve seat with a D-bit. Remove

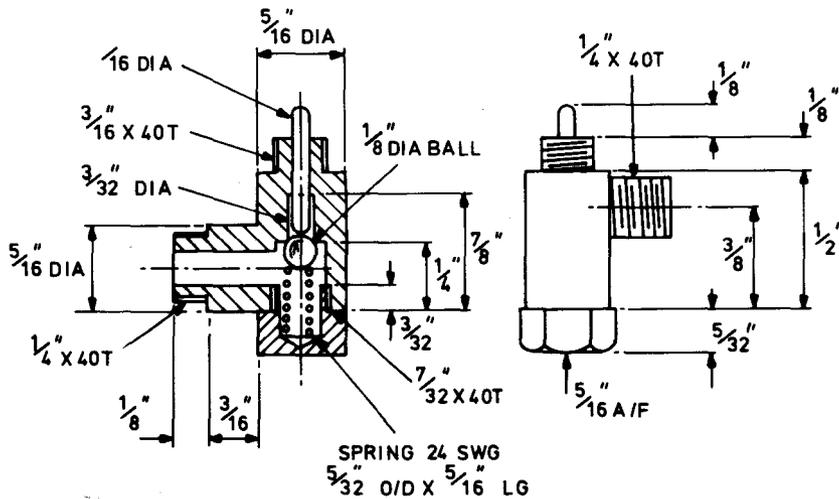
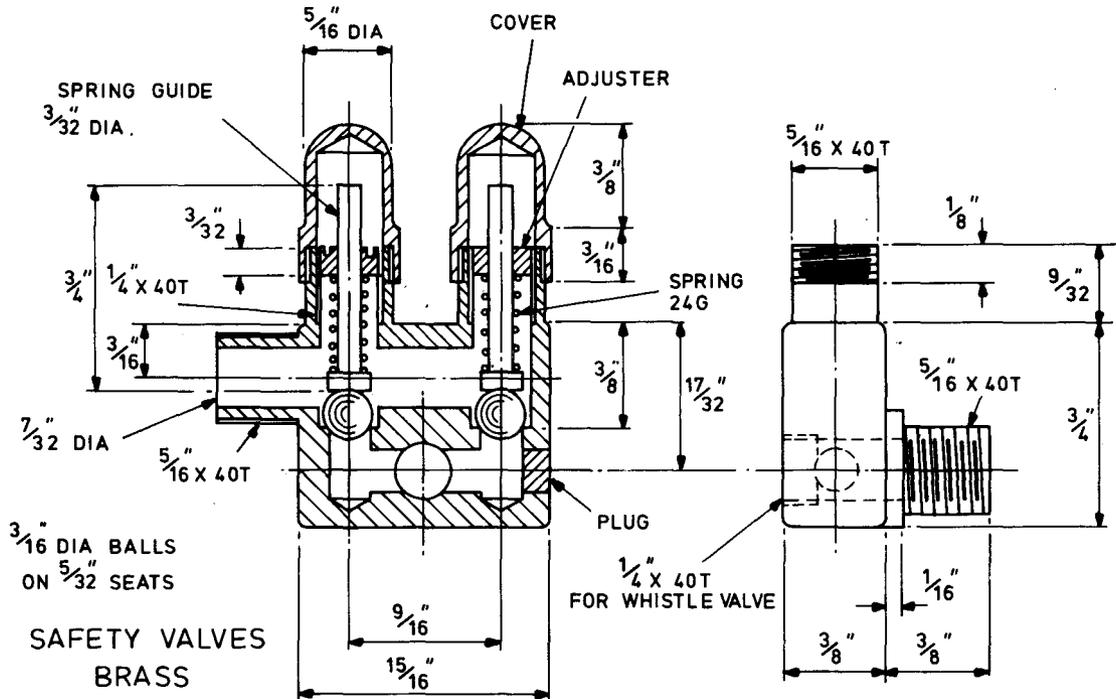


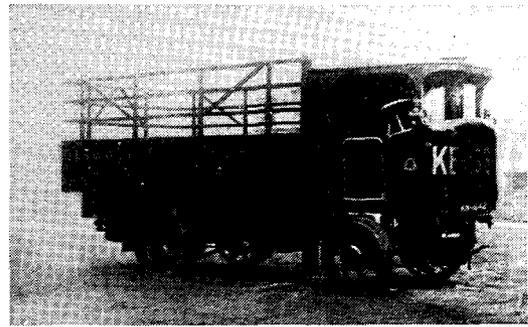
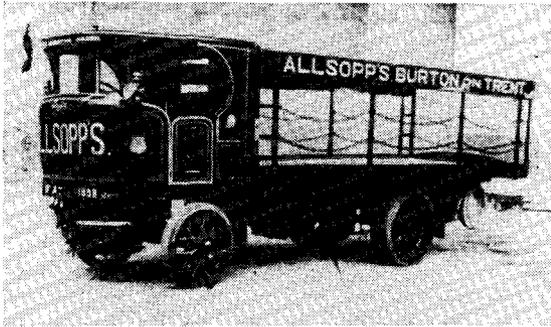
BLOWDOWN
BRASS (ST. STL. SPINDLE)

from the chuck, saw off the chucking spigots and turn up a stub mandrel a tight fit in the 3/8 in. dia. hole. Jam the block onto the mandrel and complete the machining of the bolting flange. The casting can be cleaned up to individual taste and the rest of the parts made up, the drawings for these being self-explanatory. To mount the regulator assembly it will be necessary to file a flat on the smokebox ring to form a bolting pad for the flange.

The feed clacks, blowdown and water gauge are

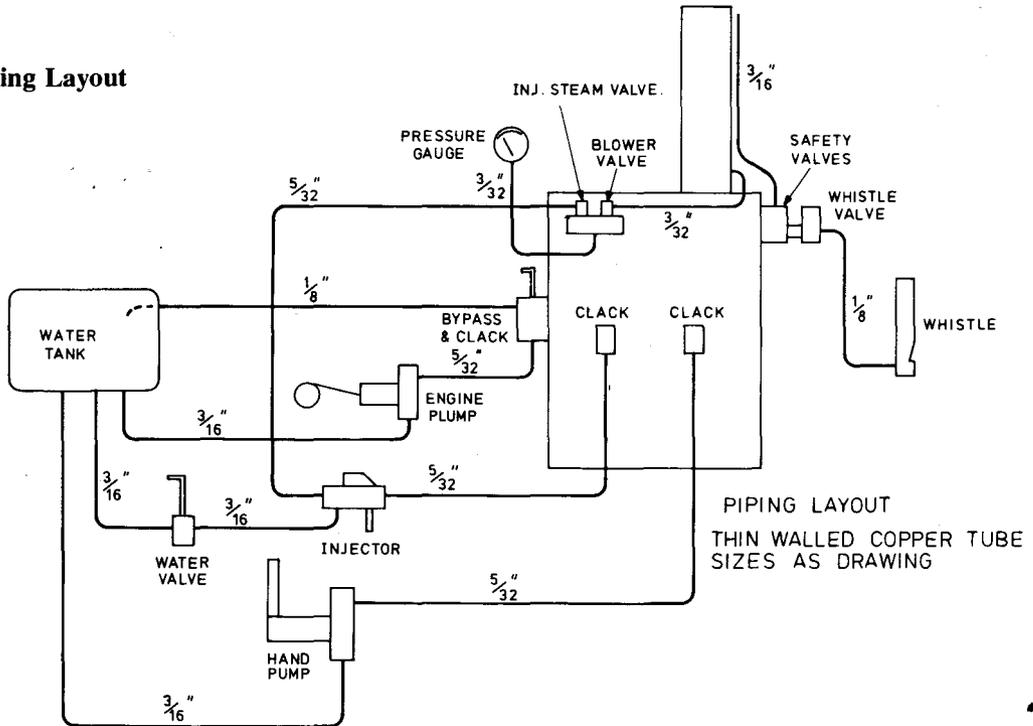
accepted *Model Engineer* designs and can be bought in from outside sources if desired. Readers who have been with *Model Engineer* for the last eighteen years or so will recognise the combined feed pump clack and bypass valve and also the safety valve/whistle valve assembly as being very similar to those fitted to John Constable's *Sentinel* shunting engine *Sirena*. These consist of brass bodies with brazed in nipples and require some mental planning to sort out the best order of operations.





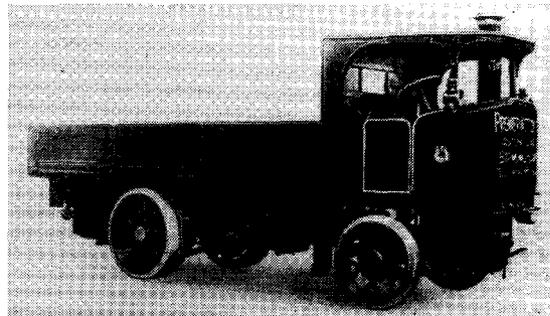
Two prototype Clayton wagons.

The Piping Layout



NOTE :- MAIN STEAM PIPE - $\frac{1}{4}$ " X 22 SWG
 EXHAUST PIPE - $\frac{3}{8}$ " X 22 SWG

More real-life Claytons.



A CLAYTON UNDERTYPE WAGON in 2 in. Scale

by Robin Dyer



Part VIII

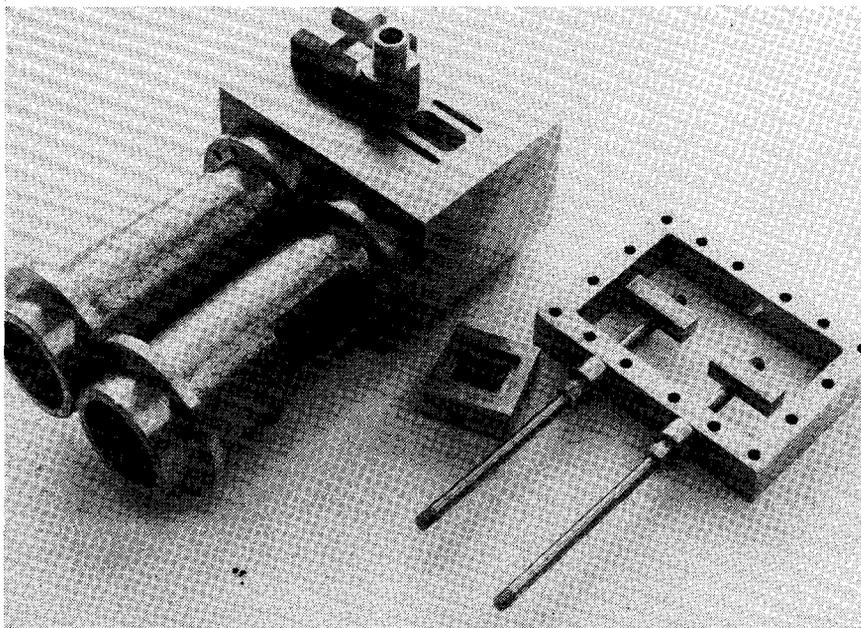
Bits and Bobs

It was gratifying to hear so many favourable comments about the Clayton at the 1978 Town and Country Festival at Stoneleigh (my partly-built chassis was on display in the model hall) and to meet old friends and make new ones; if the happy family with the 2 in. Fowler ploughing engine who live near Evesham would like to write to me via the Editor, I would very much like to know their

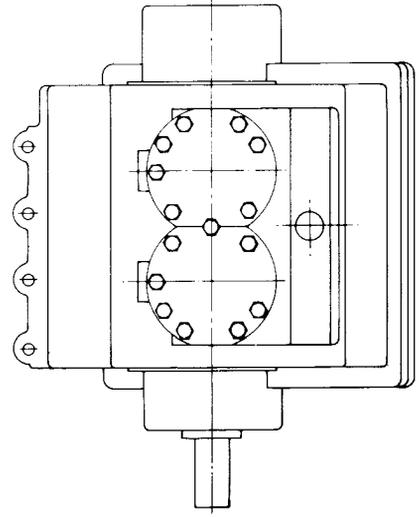
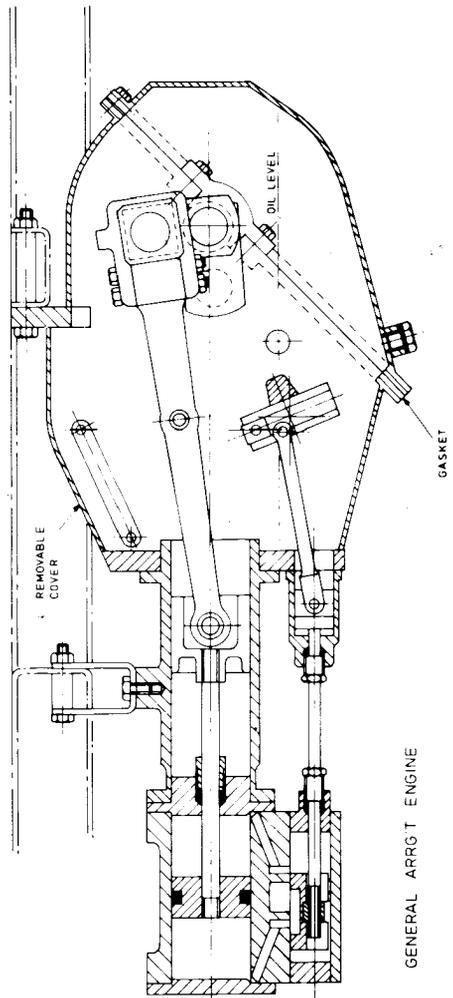
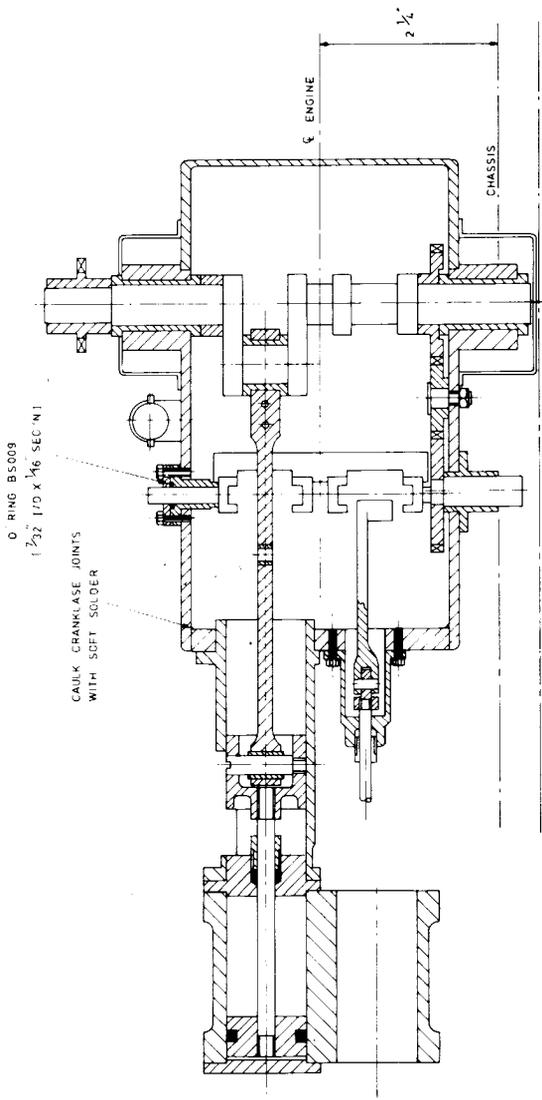
From page 204

address. I would also be interested to hear from any reader who can tell me how the tipping mechanism on the Clayton overtype 5 ton wagon was driven from the engine.

Back to the under-type, and we are well on with construction, with only the engine and cabwork as major items left to complete, followed by the water tank with its fittings, and odds and ends like the lubricator, ashpan and blastpipe.



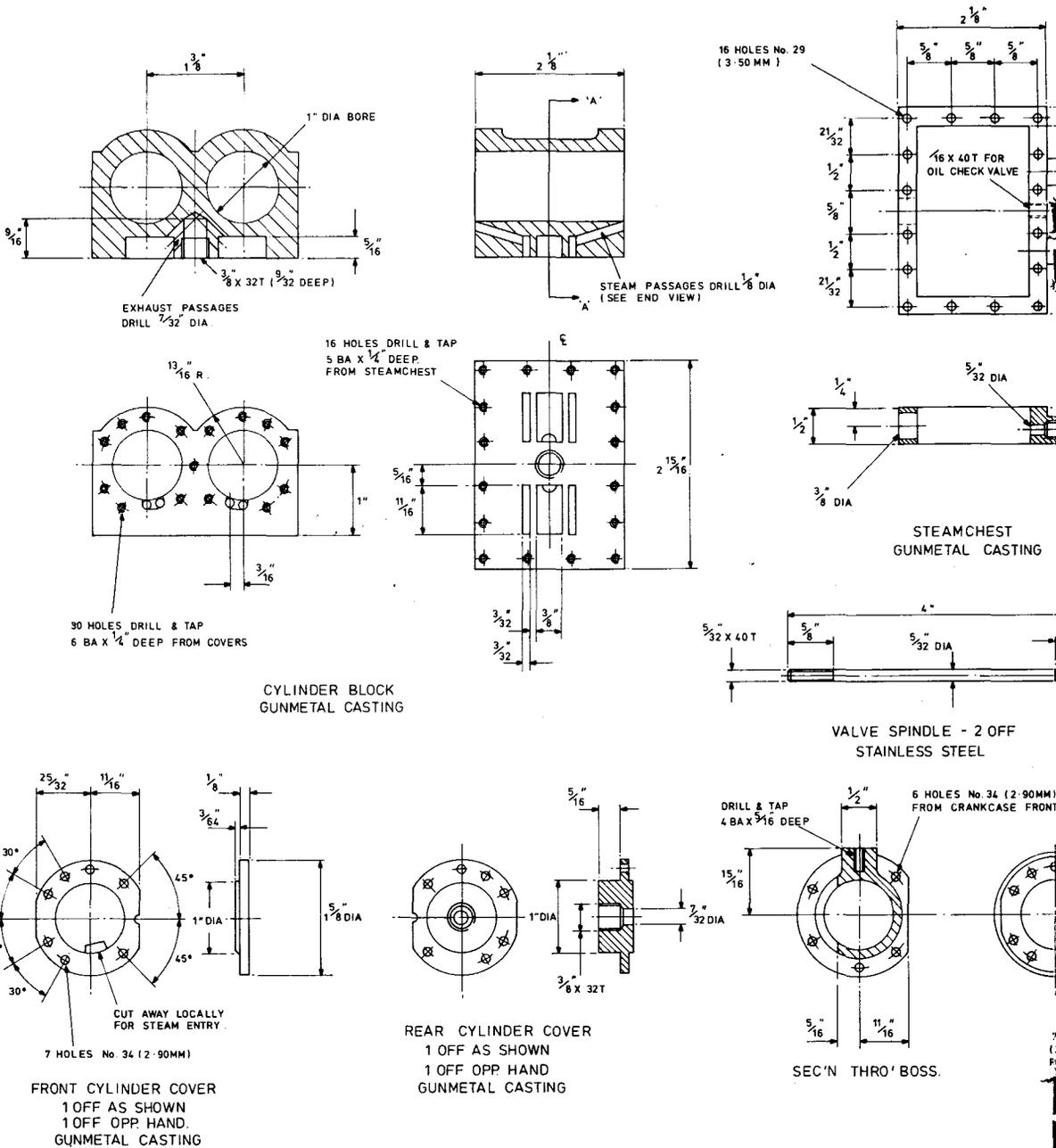
The cylinder and valve assembly for the Clayton.



The engine

A well detailed general arrangement of the Clayton under-type engine appears in Ronald Clarke's book "The Development of the English Steam Wagon". A comparison between this and the model engine arrangement drawings on this page will show that I have kept to the general outline whilst making certain internal modifications in the interests of simplicity.

The reversing gear on the full size wagon was a most ingenious mechanism which would be extremely difficult to copy (which is another way of saying that I could not possibly make it!) and so I have substituted the Joy valve gear as designed by



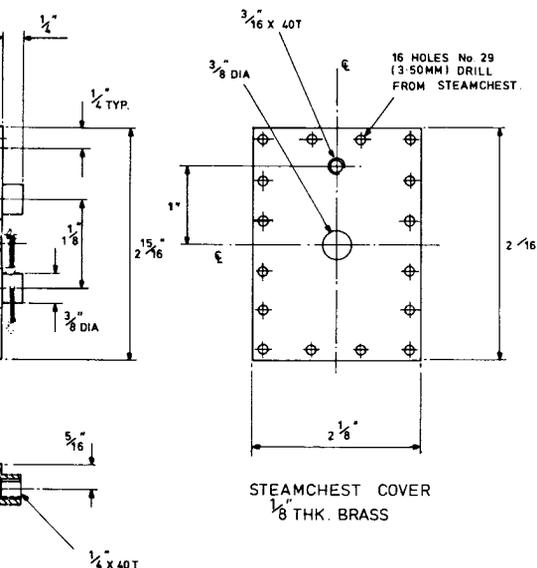
Don Young for the Derby 4F locomotive. The cylinder casting set is also largely a collection of 3 1/2 in. gauge locomotive parts which fit in surprisingly well with the Clayton arrangement (turned upside down) and it is with the cylinder block that we will commence construction of the engine.

Cylinder block

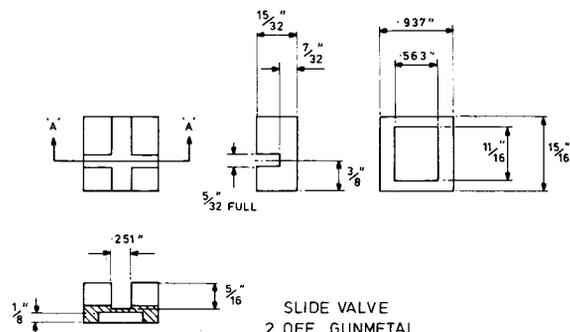
As mentioned this is a gunmetal casting originally intended for a locomotive and anyone who has

already built an inside cylindered loco will be on familiar ground here.

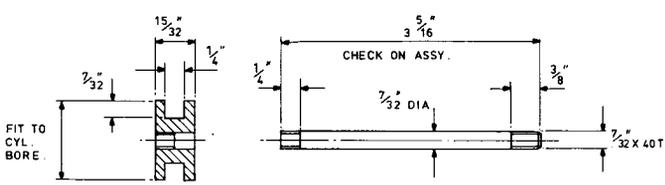
The port face should first of all be machined to give a flat reference surface, achieved by setting up on the crossslide and skimming with a flycutter held on the faceplate; the photograph shows how. There is not much spare material in our application and the face should only be machined enough to clean up. The bore centre line should end up as near as possible one inch from this face.



STEAMCHEST COVER
1/8 THK. BRASS

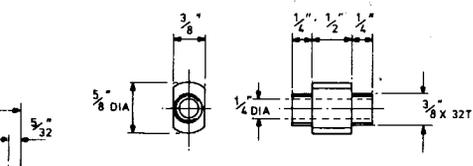


SLIDE VALVE
2 OFF GUNMETAL

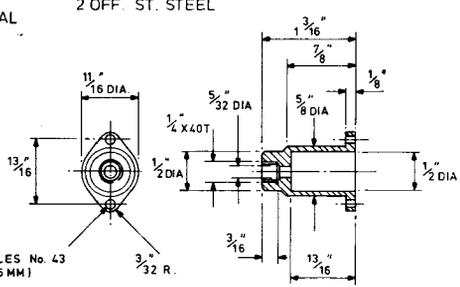


PISTON
2 OFF GUNMETAL

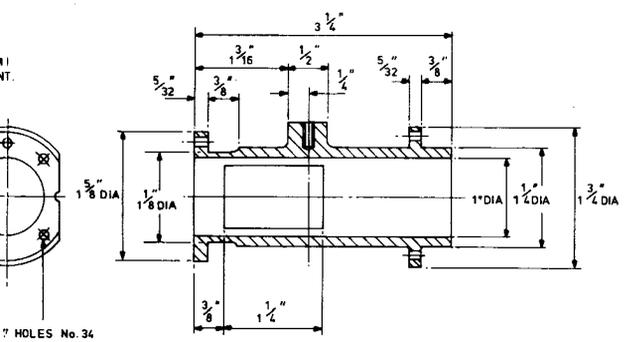
PISTON ROD
2 OFF ST. STEEL



EXHAUST FITTING
GUNMETAL OR BRASS



VALVE SPINDLE GUIDE
2 OFF - GUNMETAL CASTING



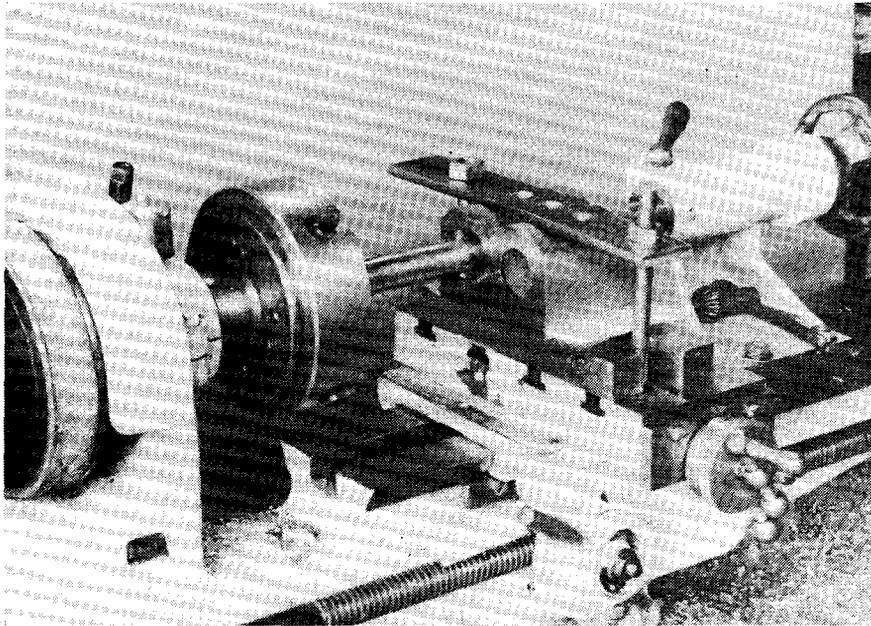
TRUNK GUIDE
1 OFF AS SHOWN
1 OFF OPP. HAND.
GUNMETAL CASTING.

7 HOLES No. 34 (2.90MM) FROM REAR COVER.

I would not recommend setting up the casting in the four jaw chuck as lathes are set up to face very slightly concave. This would result in the port face being saucer shaped if only very slightly so (very much so in the case of my vintage ML2) and it seems to me that we should have a dead flat surface here. With the port face clean and flat bring the overall width of the block to 2 5/16 in. leaving the cylinder bores symmetrical about the centre line.

Turn up two wooden plugs to jam in the ends of

the cylinder bores, coat them with marking blue, then mark out the true centres of the bores by placing the block face down on the surface plate and setting the scribing block to 1 in. Then set the block on one side and mark out the other centre lines 1 3/8 in. apart. It will probably be found that the cored out holes are somewhat off the true centres but sufficient material is left to machine out clean and true — we are working with ordinary sand castings after all.



Boring the cylinders. Note the sheets of paper to prevent the job sliding—these are placed between each metal to metal surface.

The casting should be returned to the lathe, packed up on the crossslide to bring the cylinder bore centres up to the lathe centre height. The bores may then be machined with a boring bar held between centres, or as in my case, between a chuck and tailstock centre. Once again the picture is worth a thousand words, but note that the clamp must be tightened with caution to avoid distortion of the bores.

An old trick I was taught was to place a sheet of paper under the job, and any packing, as this prevents slipping to a remarkable degree. Boring between centres will always give a round, parallel hole since the cutting tool is stationary relative to the bed (I think that is the reason) and the two bores will also be parallel to one another. With one bore complete the crossslide may be moved over exactly $1\frac{3}{8}$ in. as calculated on the handwheel dial, and the other bore machined.

When both bores have been finished (and the 1 in. dia. need only be nominal since covers and pistons are turned to suit) the end of the cylinder block can be faced off with the flycutter. Check that this face is truly square with the bores and if it is not, then slacken the clamps and tap the block round and try again. One face must be dead square with the bores — the front face is not so critical as only the covers are bolted to it.

Readers with shiny new lathes may be wondering at my references to inaccurate machines, but owning a less than perfect pre-war 3 in. lathe makes one aware that others may be in a similar situation and would appreciate an occasional nod in their direction.

Having produced a surface truly square with the bores the casting may be reversed and the other end faced off to bring the block to the correct length.

The port face should be coated with marking blue and most carefully marked out to show the two sets of ports. Mark the outline of the ports and their centre lines, then mount the casting by clamping through a bore on to the vertical slide (or the top slide mounted on an angle plate).

Use slot drills to mill out the ports, making life easier for the cutters by drilling a series of slightly smaller holes to the correct depth before milling. Take only light cuts because a $3/32$ -in. dia. slot drill is a fragile object; the exhaust ports can be cut with a larger size of slot drill. When complete remove from the lathe and file flats at the end of each bore where the steam passages are to be drilled. Set up on the vertical slide again, clamping everything at the correct angle to bring the drilled passages out into the steam ports, and centre drill each face before going in with the drill.

The final operation is to drill and tap the exhaust outlet in the centre of the port face and then to drill $7/32$ in. dia. from the inside corner of each exhaust port at an angle of 45 deg. to break into the bottom of the outlet hole. This latter operation is best performed by working up with increasing sizes of drills used in a pistol drill.

This completes work on the cylinder block for the time being (sighs of relief) and attention can be turned to the valve chest. Don Young described one way of tackling this by using the bosses as cast on the frame but, with appropriate apologies to the Reeves empire, I found it easier to saw off these

bosses (retaining the longer pair for future use) and treat the casting as a simple frame. Once this has been machined to size on the outside and filed to size on the inside it can be clamped to the top slide in order to drill and ream two 3/16 in. dia. holes to receive the separate gland bosses. These can be turned up from the two longer cast bosses and bonded in position with high strength Loctite.

Finishing off the steam chest is straightforward enough and when complete it can be clamped to the cover plate in order to spot through the No. 29 holes. However, do not drill the cylinder block stud holes as yet; we need the engine partially assembled in order to check alignment.

The exhaust outlet is turned up from a piece of 5/8 in. dia. brass bar. Undercut the shoulder on one of the threads so that it will screw right home into the port face. Screw it in tight with a pipe spanner and mark the two flats parallel to the bores of the cylinders, then remove and file to the lines. These flats allow us to use a spanner next time but their chief purpose is to make room for the D-valves which slide up and down each side of the exhaust outlet.

The valves themselves are supplied as part of the cylinder casting kit and although the legend "4F" cast in the recess reveals their ancestry they are just as suitable on our model! The working face should be skimmed up to start with, just sufficiently to clean up, then the back should be faced off to leave the valve 15/32 in. thick. Next take an equal amount off each side to bring the valves to 15/16 in. wide, thus leaving the cavity central. The final operation on the outside edges is to machine the ends so that the valve is 15/16 in. long but this is only a nominal dimension: The valve has a 3/32 in. lap so the length should be 3/16 in. more than the span of the steam ports on the cylinder block; one of my

valves has ended up .957 in. long because the distance across the outer edges of the steam ports came out at .770 in. instead of .750 in.

Each valve can now be clamped in a machine vice on the vertical slide in order to machine the slot for the valve bar. The rudiments of this slot are cast in and this may be used as a guide for setting up the cutter; the position of this slot is not critical but it must be square across the valve. I used a 1/4 in. dia. slot drill and this produced a perfect slot for the 1/4 in. square brass rod from which the valve bar was made.

The valve now has to have another slot milled across the back at right angles to the first and this should be marked out; this slot houses the valve spindle and governs the sideways position of the valve. The slot can be sawn out before finally cleaning out with a 5/32 in. dia. slot drill or end mill.

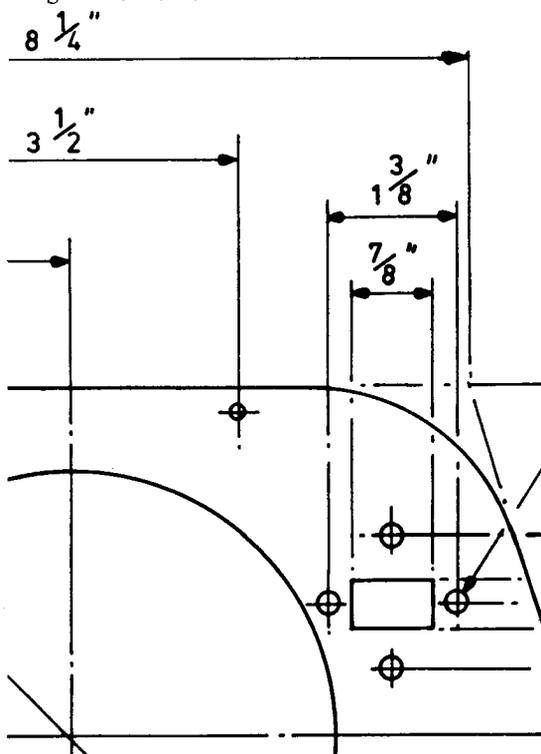
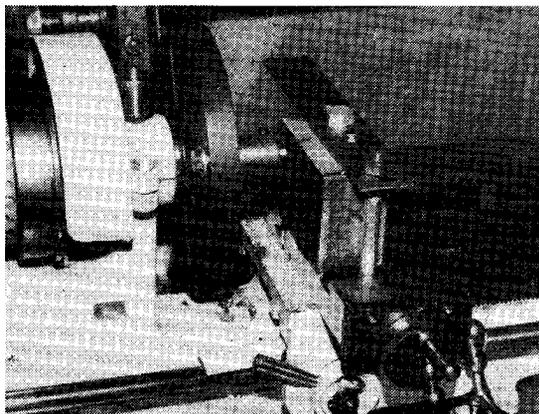
The depth of the slot should be such as to allow the valve just to fall back off the port face on to the valve spindle. When in steam this clearance will allow condensate to drain out of the cylinders into the steam chest where it can be got rid of through a single drain cock in the steam chest cover. This slight vertical clearance of the valves also ensures that only steam pressure holds them against the port face thus allowing the minimum amount of wear.

Take care when making your valves and enjoy the full potential that Joy valve gear offers for running at short cutoffs.

To be continued

Right. Unfortunately a slight mistake occurred on the drawing of the cab floor as published in the 16 February issue, the close-up here shows the correct positioning of the aperture for the steering column.

Below. Fly-cutting the cylinder block face.



CLAYTON UNDERTYPE STEAM WAGON

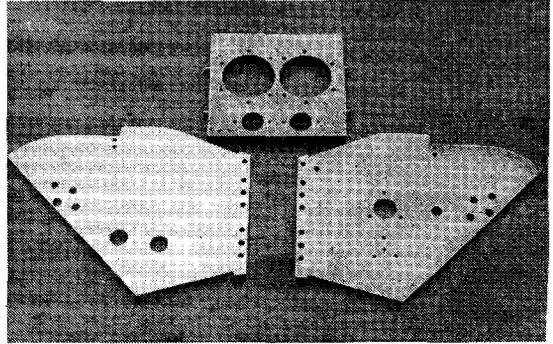
by Robin Dyer

Part IX

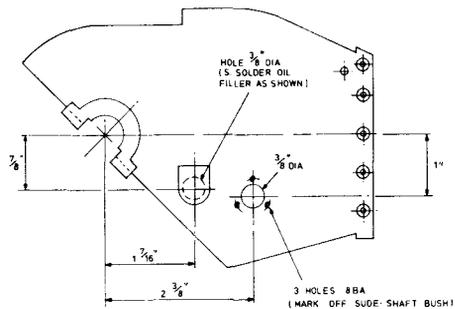
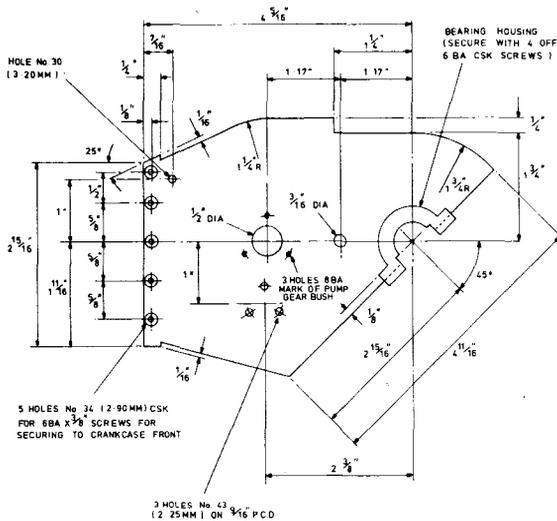
From page 353

EACH VALVE SPINDLE requires a length of $\frac{5}{32}$ in. dia. stainless steel, nice and straight. The threads can be cut with a button die held in the tailstock dieholder — the threads must be square or the valve bar will "shuffle" as it is screwed along the spindle, and since the crest of the thread will end up somewhat more than $\frac{5}{32}$ in. dia. a smooth file should be used to bring it back to this dimension.

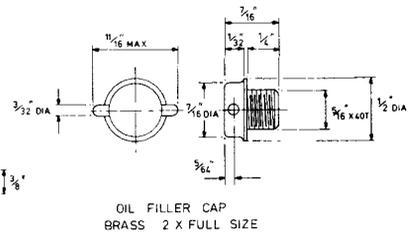
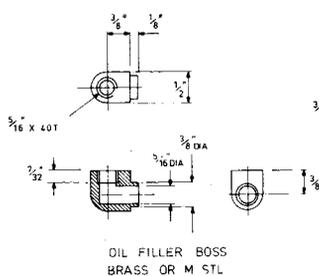
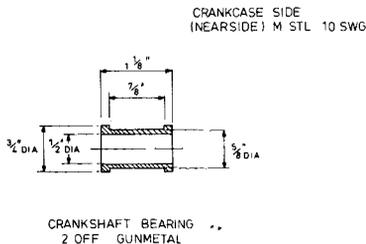
The spindle and valve bar should fit into the slots in the back of the valve without shake, but the valve must be free to drop off the port face under its own weight. The amount of movement must be quite small and can be set by filing out the bottom of the valve spindle groove. The valve spindle glands could usefully be made now as they will help to guide the spindles during these fitting exercises.

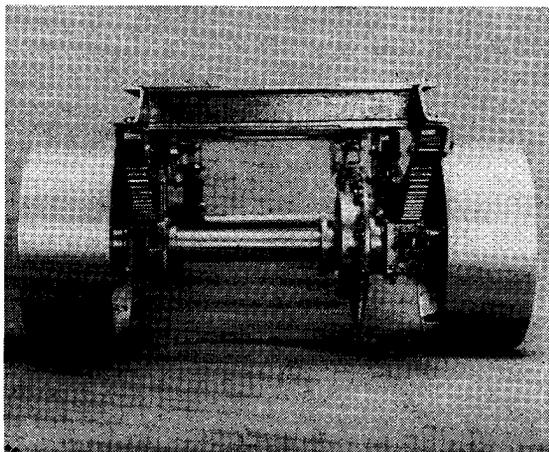
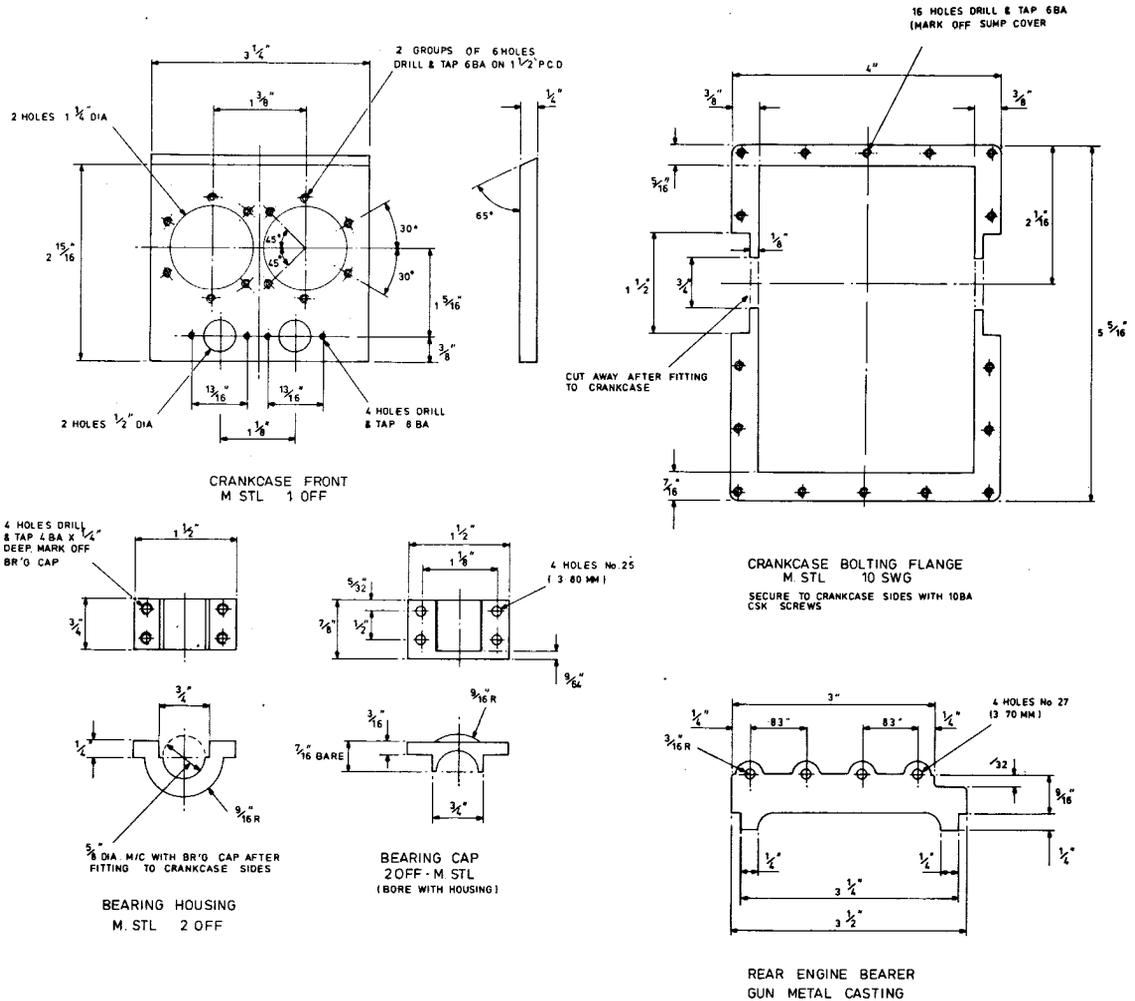


The crankcase components before assembly.



CRANKCASE SIDE (OFFSIDE) M. STL 10 SWG FOR OTHER DIMS SEE NEARSIDE





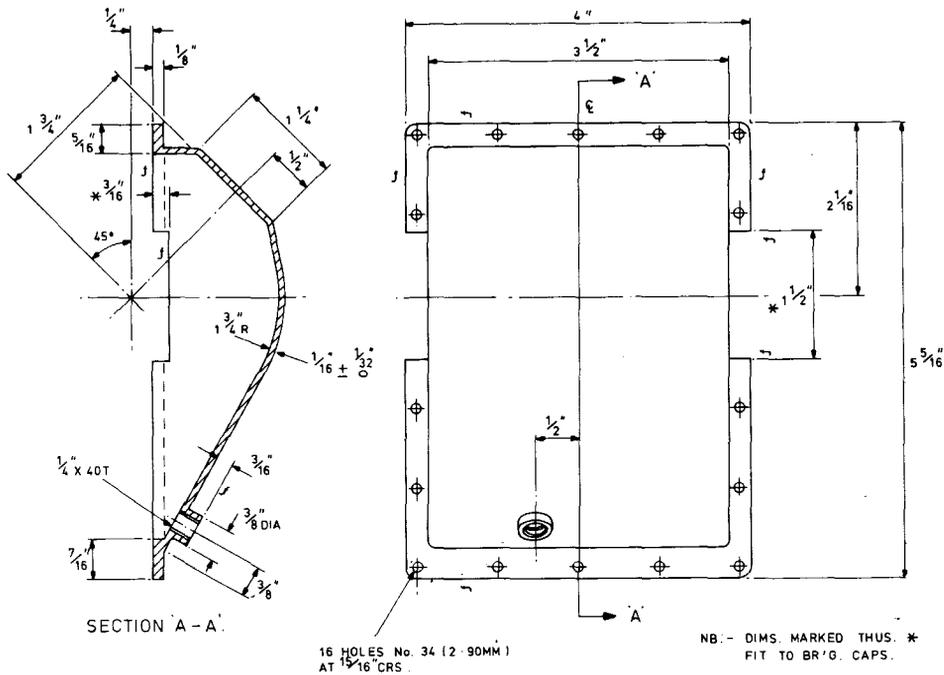
A rear view of a Clayton chassis being built by Mr. Eric Preston of Dalton, Huddersfield.

Trunk guides

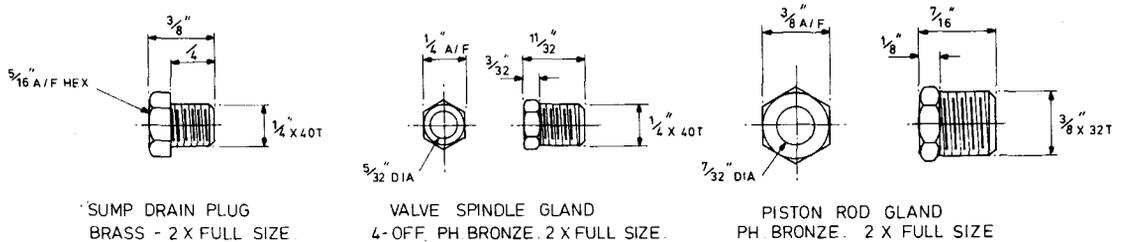
These need to be made before the rear cylinder covers because it is easier to bore a hole first and turn a spigot to fit than the other way round. I managed without a steady but possession of one will make the job a lot easier. Chuck by the part which will sit inside the crankcase using a four jaw chuck; set up so that the main body runs true. Lightly skim the 1 5/8 in. dia. flange and set the steady on this part.

Use a hefty boring tool and bore right through to 1 in. dia. The tool will probably need regrinding after the first cut unless you can clean the sand and scale out of the cored hole. Aim to get both bores the same because a plain mandrel mounted between centres is required to finish off the trunks. Modern technology can assist should the trunks be a loose fit on the mandrel; a drop of Loctite 222 (light strength) will hold each trunk firm.

If the mandrel refuses to move afterwards heat gently until the bond breaks (about 200 deg. C). When facing off the flanges remember that the dis-



SUMP COVER
ALLUMINIUM CASTING



SUMP DRAIN PLUG
BRASS - 2 X FULL SIZE

VALVE SPINDLE GLAND
4-OFF. PH BRONZE. 2 X FULL SIZE

PISTON ROD GLAND
PH BRONZE. 2 X FULL SIZE

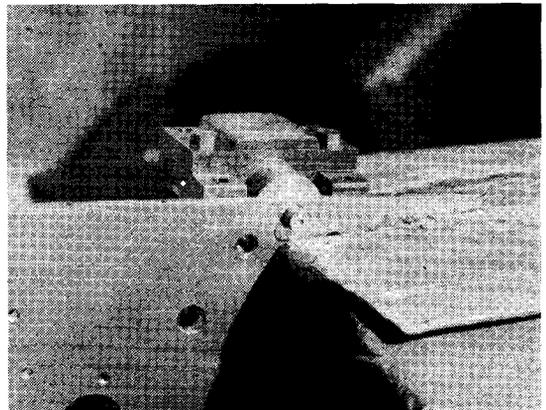
tance over the flanges of each guide needs to be identical, as does the thickness of each rear cylinder cover, otherwise the cylinder block will sit cockeyed relative to the crankcase. The access slot in the side of each trunkguide should be machined so as to produce one left hand and one right hand — don't forget!

The crankcase

The crankcase of the full size Clayton wagon took the form of a casting, as is usual on enclosed engines. The crankcase of the model, however, can more easily be produced by fabricating as each part can be largely finished while "in the flat". A very neat casting is available, however, for the sump pan.

The crankcase structure comprises five main parts; front plate, two side plates with attached main bearing housings; rear engine mounting, and a

bolting flange for the sump. A close study of the drawings and photographs should explain how it all goes together far better than trying to put it into words. The upper and lower surfaces of the casing



Assembling the bearing housing and cap.

are made up later from sheet material and I have suggested on the drawing that one of the top plates be made removable for inspection purposes. It will also help when the engine is finally assembled after caulking up the crankcase.

Because the slideshaft and valve spindles are immersed in oil they are provided with glands to make the engine reasonably oiltight when at rest. There will be some loss while the wagon is running but I think most builders will find this is acceptable.

Construction

The crankcase front plate is made from bright mild steel flat 3 in. x 1/4 in. and should be most carefully marked out since the various co-ordinates must be identical to those of the cylinder assembly. I managed it by marking out and setting up in the four-jaw chuck by eye but *M.E.* has published articles at various times on achieving accuracy for this sort of job; perhaps our workshop experts can spring to their pens on this one. I am definitely not a "workshop person" being of the breed that will produce with angle iron and a hacksaw what others will make with gauge plate and a surface grinder.

The fixing holes for trunk guides and valve spindle guides should be drilled tapping size and then used for spotting through on to the various bits, and the trunks should be assembled to the cylinder block and pushed through the front plate together. Before this latter can be achieved the inside edge of each flange will need to be filed away — a glance at the photograph of the cylinder assembly will show what is needed.

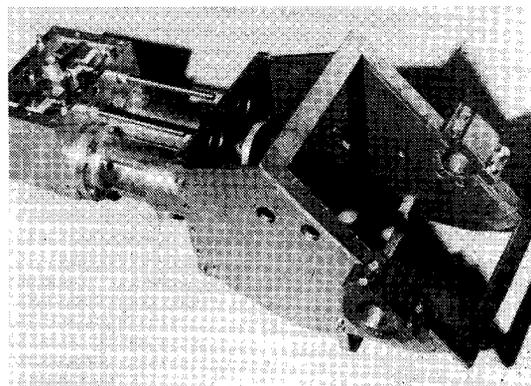
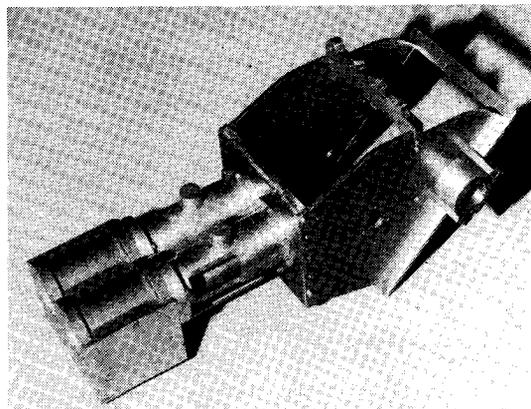
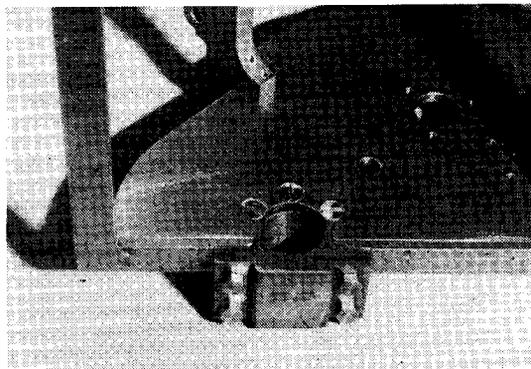
The crankcase sideplates are made from 3 mm material and can be marked out and finished to outline, but note that not all the holes are common to both plates. Drill both plates 3/16 in. dia. on the crankshaft centreline. To assist alignment of the plates while securing them to the crankcase front, the rear engine mount can be made and also a temporary spacer can be fitted across on the crankshaft centreline. The former is made from a gunmetal casting and can be held in place with a well fitted 4BA screw each side to take the load and a 10BA through the back into the edge of each crankcase side to pull it tight into the corner. The crankcase sides are held to the front plate with 6BA screws but I suggest that two 1/8 in. dia. dowels be fitted each side also. These will maintain alignment of the plates and also take the piston thrusts when everything finally goes into action.

The sump bolting flange is best made and fitted as a complete frame, being held to the rear edges of the crankcase sides with 10BA countersunk screws. It can be removed later for cutting and fitting round the bearing housings.

The bearing housings themselves can be made from 1 in. x 3/4 in. mild steel bar. Do not worry if you have to buy a foot or two; this sort of size

comes in handy for all sorts of jobs and tooling in the workshop. Each housing should be recessed for its cap, and with the latter also made the two can be bolted together and the assembly bored 5/8 in. dia. Each housing is secured to the crankcase with three 4BA countersunk screws, the countersinks being

The photos below show another view of the bearing assembly and two views of the assembled cylinders, trunk guides and crankcase.



on the insides of the crankcase. These holes should be drilled in the crankcase and a stepped mandrel turned up, one end a tight fit in the housings and the other fitting the 3/16 in. hole in the crankcase sides.

With the housings thus positively located, and the caps parallel to the sump bolting edge the holes can be spotted through onto the housings. This has to be done with the crankcase disassembled and I hope the photographs make the job clear. Finally, remove the part of the crankcase inside the bearing housing to blend in with the 5/8 in. dia. bore.

If the crankcase is reassembled the sump bolting flange can be sawn into two pieces and each half filed to fit round the housings and under the overlapping parts of the bearing caps, the idea of all this work being to produce eventually a crankcase which looks like a one-piece casting with removable bearing caps.

Unfortunately it has not yet been possible to include one or two details previously mentioned by Robin Dyer. These are the front wheels and associated axle collar and hub cap. Drawings of them will be included as soon as possible.

Sump pan

As previously mentioned, this is available from the suppliers as a very neat aluminium casting needing only careful work with a large smooth file to clean up the bolting flange. The cutouts round the bearing caps can be produced with a small hacksaw and a file, with constant reference to the crankcase assembly, and I also drilled and tapped the oil drain hole by hand although it could be done on the lathe. The casting is best clamped to the vertical slide with the drilling being done from the headstock.

Before the engine becomes any heavier it would be as well to have a trial assembly in the chassis and so the front engine mount and the five spacers should be made. With one chassis crossmember still to fit there will be enough room to hand drill the hole for the front mounting. Bolt the front mounting to the trunk guides and offer the engine up to the chassis, securing the front mounting to the cross-member. With the rear end propped up the remaining chassis crossmember can be positioned correctly in the chassis. This was the stage which I had reached with my own model when it was displayed at the 1979 Model Engineer Exhibition.

To be continued

CLUB

Dates should be sent at least five weeks before the event to ensure publication. Please state venue and time. While every care is taken, we cannot accept responsibility for errors.

DIARY

APRIL

- 20 **Bracknell Railway Society**. 4-3-2 Group — Binfield Memorial Hall from 7.30 p.m.
- 20 **Dublin S.M.E.E.** "Work in Progress".
- 20 **N.W. Leicester M.E.S.** Night running and supper — at Miners' Welfare, Coalville. All welcome 6.30 p.m.
- 20 **Romford M.E.C.** Talk — L. Hammond ("Tin Plate").
- 20 **Rochdale S.M.E.E.** General Discussion — Valve Grease, Springfield Park.
- 20 **Stockport & District S.M.E.** Vintage commercial model night — "O" gauge track promised.
- 20 **East Sussex Model Engineers.** "Locomotive Testing on British Railways", talk by Mr. D. R. Carling.
- 20 **Great Western Society Ltd.** "Myths and Legends of the Court of King Isambard", by C. J. Freezer. Black Horse Hotel, Bridge Street, Taunton. 7.45 p.m.
- 20 **Tyneside S.M.E.E.** Council Meeting (Restricted). H.Q. at 7.30 p.m.
- 21 **Great Western Society Ltd.** South West Group meeting. St. Paul's Church Hall, Newton Abbot. 6.30 p.m.
- 21 **Great Western Society Ltd.** "The Broad Gauge", by Prof. S. A. Urry. Ealing Town Hall, Ealing Broadway. 7.15 p.m.
- 22 **Andover & District M.E.S.** Sunday working party at Red Rice.
- 22 **Worcester & District S.M.E.** Public Running Day. Waverley Street, Digby, Worcester. 2.30 p.m.
- 22 **King's Lynn & District S.M.E.** Open and Club straight running scale/func. 25p per boat. Bawsey, 11 a.m.

- 22 **Ardeer Recreation Club — M.E. Section.** Track meeting.
- 23 **Clyde Shiplovers and M.M. Society.** Annual General Meeting — members only. Partick Halls, Burgh Hall Street, Glasgow. 7.30 p.m.
- 23 **Wigan & District M.E.S.** Meeting.
- 24 **Basingstoke & District M.E.S.** Annual General Meeting.
- 24 **Stafford & District M.E.S.** Club meeting. Doxey Arms. 7.30 p.m.
- 24 **Sutton Coldfield & N. Birmingham M.E.S.** Annual General Meeting. Wyde Green Library, Sutton Coldfield. 7.30 for 8 p.m.
- 25 **Cannock Chase M.E.S.** Meeting Lea Hall Club. "Building a Garden Railway", P. Booth. 7.30 p.m.
- 25 **Harrow & Wembley S.M.E.** Marine Meeting — St. Andrew's Hall.
- 26 **Leyland, Preston & District S.M.E.** Meeting.
- 27 **Bracknell Railway Society.** Peter Pribik slide show and talk on his latest globe trotting.
- 27 **Birmingham S.M.E.** Annual Dinner and Dance at the George Hotel at Solihull.
- 27 **Thames Shiplovers and Ship Model Society.** A Topic concerning the Royal Navy. St. Botolph's Church Hall, Bishopsgate, London EC2. 7 p.m.
- 28 **S.M.E.E.** Talk, "Reminiscences of Napier's", Mr. L. A. Sanson, O.B.E.
- 28-29 **East Midlands Vintage Model Railway Exhibition.** Leisure Centre, Hinckley, Leics. 10.30 a.m. to 8.30 p.m. 10.30 a.m. to 6 p.m. Adults 40p, Children 15p.

- 29 **Harlington Loco Society.** Public open day. 2-6 p.m.
- 30 **Peterborough S.M.E.** Meeting. Lincoln Road Clubhouse. 7.30 p.m.

MAY

- 1 **N.W. Leicester M.E.S.** Bits and Pieces Night. 7.30 p.m.
- 1 **S. Cheshire M.E.S.** A 5 in. Gauge "Boxhill" — Mr. R. Walker.
- 1 **Milton Keynes Model Society.** Meeting at the "Royal Engineer" to start at 8 p.m. Talk to be given by this year's prizewinners about their models.
- 2 **Peterborough S.M.E.** Committee Meeting. Lincoln Road Clubhouse. 7.30 p.m.
- 2 **Andover & District M.E.S.** Working evening at Red Rice.
- 2 **Bristol S.M.E.E.** "Burma-Siam Death Railway" — Hugh Balyntine.
- 2 **Harrow & Wembley S.M.E.** Committee.
- 3 **High Wycombe M.E.C.** Club Night. Bassettbury Manor, Bassettbury Lane, High Wycombe, Bucks.
- 3 **Loughton & District M.E.S.** "Skeleton Clocks", a talk by the builder of the prizewinning skeleton clock at the recent M.E. Exhibition. Loughton Hall at 8 p.m.
- 3 **Hull S.M.E.** Photographic techniques for models and workshops. Trades and Labour Club (Room 3), Beverley Road, Hull. 7.45 p.m.
- 3-5 **St. Albans & District M.E.S.** Exhibition of models — Public Hall, Harpenden. 2-9 p.m. Thursday, 10-9 p.m. Friday, 9-7 p.m. Saturday. Adults 30p, Children 15p, Family 60p, Pensioners Free.

A CLAYTON UNDERTYPE STEAM WAGON

Part X

From page 452

Robin Dyer describes the crankshaft and gives details of the motion

ON WITH THE ENGINE; the crankshaft is best made from ground mild steel which can be cut to length and turned down to $7/16$ in. dia. at one end to fit the small drive sprocket. However, it would be best to proceed with the main bearings before going any further with the shaft as it will be easier to use it as a gauge before putting the webs on.

Both bearings are cast as one piece and this makes machining very easy as each half can be gripped in the chuck in turn whilst machining the other end completely. Each bearing should be an easy fit endways in its housing, but a tight fit on diameter; the cap should nip the bearing and prevent it rotating. Use the embryo crankshaft to judge the fit of the bore.

Finally, saw the casting to produce two individual bearings and face to length.

Note that the bearings do not have to be split since they can be slid over the ends of the crankshaft before dropping into the housings. Assemble the caps and put in the screws. Tap the caps with a rubber mallet to settle the bearings and try turning the shaft. It will probably be quite stiff but if it locks up solid there is misalignment somewhere and should be investigated.

The crankshaft may now be completed and the way I recommend is to assemble the crankpins and webs with Loctite or by pinning or both, depending on your degree of pessimism. When cured, the bit between each pair of webs is sawn away and filed flush.

Connecting rods

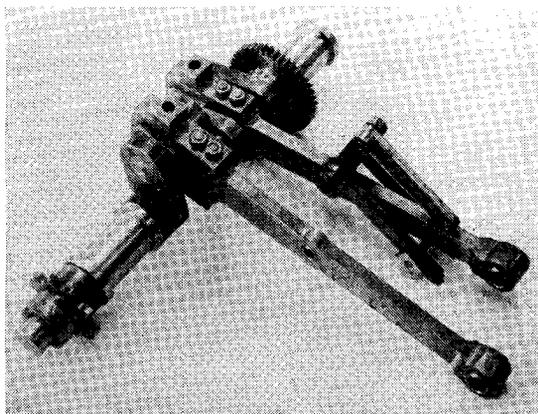
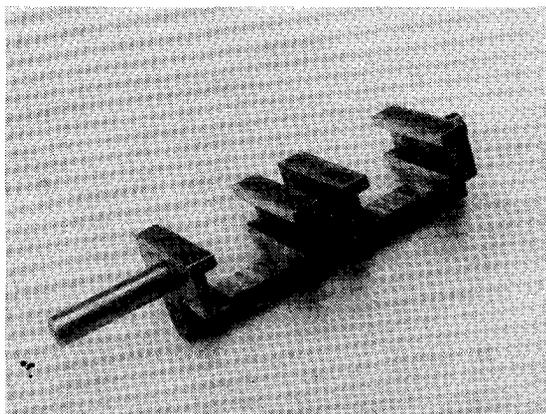
These are the same design as the Derby 4F locomotive model but there is nothing to stop the enterprising builder producing a scale Clayton big end if he wishes — no one will ever see it when it is finished!

The connecting rods themselves are made from $5/8$ in. x $3/8$ in. bright mild steel flat, being sawn and filed, or sawn and milled to profile. The connecting rod straps start off as $1/4$ in. x $3/8$ in. flat and the slot should be a sliding fit over the end of the rod. I sawed and filed mine almost to the scribed line then finished off by milling, as for a locomotive horn, in order to bring everything parallel and straight.

A cast gunmetal stick is available for the big end brasses and this should be sawn into four pieces. Soft solder together in pairs to make two big end blanks, these now being machined in the four-jaw chuck to $3/4$ in. square. Maintain the joint line across the centre. Centre-pop halfway along this line and scribe a $1/2$ in. dia. circle. This will enable the blank to be set up for boring, and the final operation is to face to width an easy fit between the crankshaft webs.

It only remains to mill the slot all round, gripping the piece in a machine vice clamped on the vertical slide. (The folks with milling machines just carry on

Below Left. The slideshaft. Below. The coupling rods and part of the motion assembled on the crankshaft.



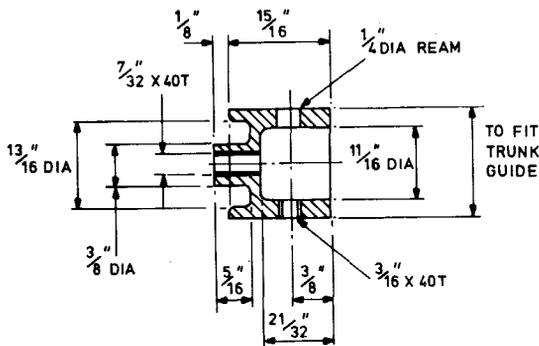
and do your own thing). Mill the top and bottom slots first, using the strap as a gauge. When satisfied, mill the front and back slots to drawing, this not being such a critical dimension. Each bearing brass and strap should now be adjusted so that the former can sit snug against the back of the jaws, then these two plus the connecting rod should be

clamped together for drilling the two bolt holes.

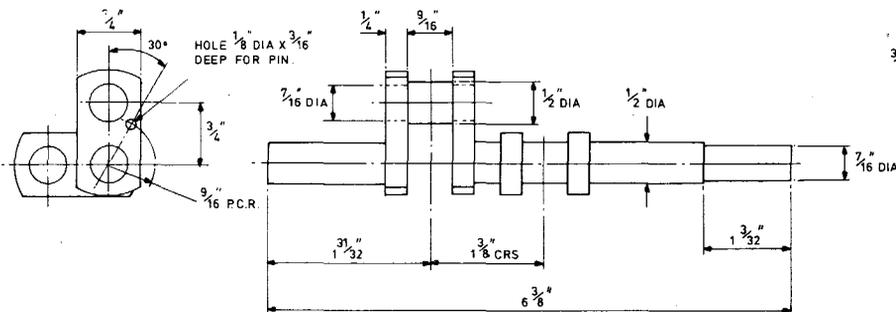
If the brass should rattle a little on final assembly a piece of brass shim can be inserted at the back of the jaw. Make sure the two halves of the brass are identified in some way before melting apart!

The crossheads should be made next, turning each one to fit its respective trunkguide. The 7/32 in. x 40T hole should be tapped in the lathe and I set up on the vertical slide to drill the crosshole for the gudgeon pin. When the latter have been made the whole lot can be assembled into the crankcase, using plenty of oil on the moving parts. Turn each crank to front dead centre and insert a depth gauge into the front of the cylinder, passing it through until it touches the front of the crosshead boss. The distance from the boss to the front of the cylinder can be used to calculate the length of piston rod required.

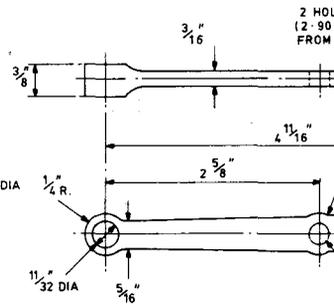
Pistons and piston rods are the usual design for small models, the main point being that the piston should be finish turned after assembling to its rod, the latter naturally having to be held dead true for this operation. The pistons should go through their bores without forcing but they should not fall



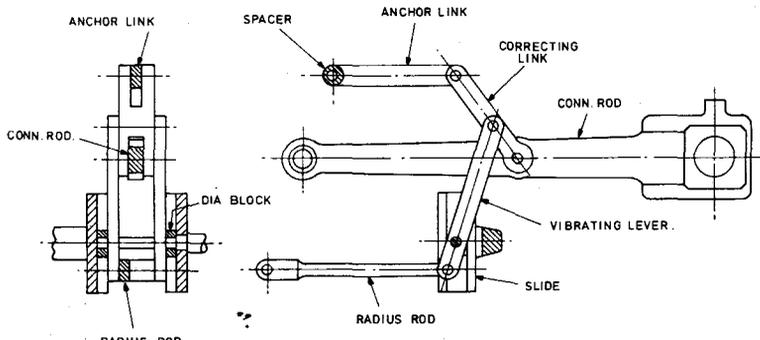
CROSSHEAD - 2 OFF
GUNMETAL CASTING



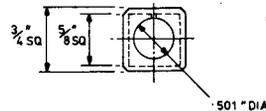
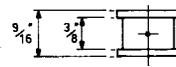
CRANKSHAFT.
M. STEEL



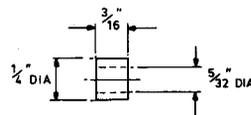
CONNECTING ROD
M. STL. - 2 OFF



JOY VALVE GEAR LAYOUT
(CRANK ON BACK DEAD CENTRE)



BIG END BRASSES
GUNMETAL - 2 PAIRS



JOY GEAR BUSH
PH. BR. - 2 OFF

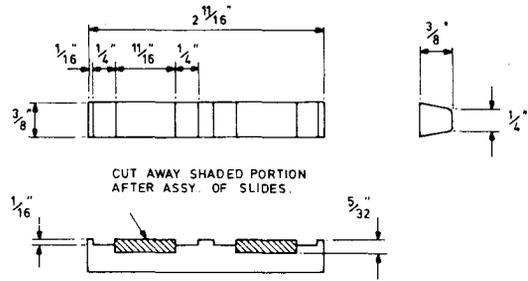
through. (A favourite phrase when I was an apprentice was *You could stand the other side of the shop and throw that through!*)

Slidshaft

In an article in *Model Engineer* a few years ago the late K. N. Harris stated that the difference in performance between Joy valve gear fitted with curved slides and the same gear fitted with straight slides was marginal. I drew out the valve gear four times full size with both types of slide and the difference in effect on the valve did appear to be slight. Because the straight slide is so much easier to make than the curved sort I have fitted the former to the Clayton.

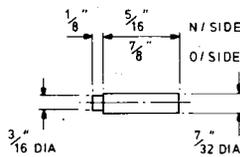
Make the slidshaft first, marking out the slots on a length of 3/8 in. square mild steel. Using the machine vice and vertical slide again with a 1/4 in. dia. slot drill held in the chuck mill the four slots 1/16 in. deep. (I find a slot drill gives a more accurate width than an end mill). The graduated dial on the crossslide handwheel can be used to set the job over for each slot.

The slides themselves come out of 1/2 in. x 1/4

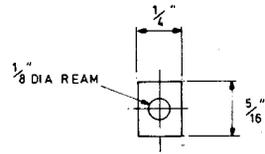


CUT AWAY SHADED PORTION AFTER ASSY OF SLIDES.

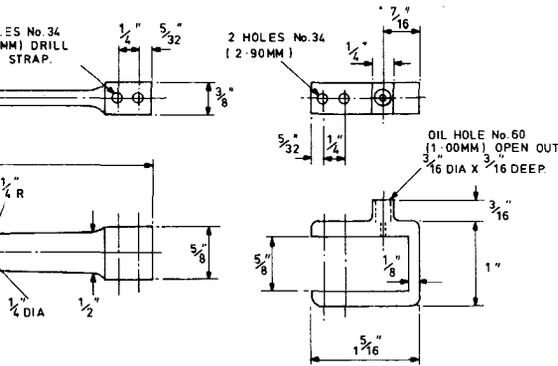
SLIDE SHAFT
M. STL.



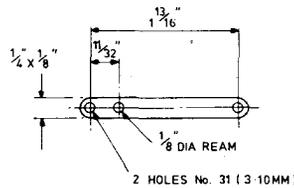
SLIDE FULCRUM PINS
SILVER STEEL



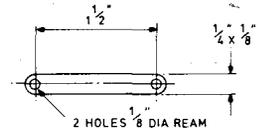
DIE BLOCK
GUNMETAL 4 OFF



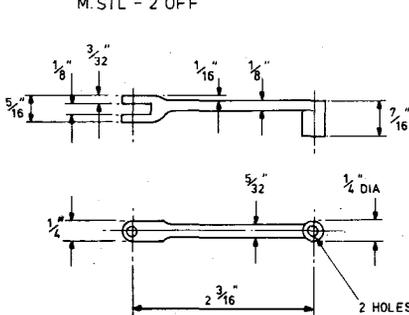
STRAP
M. STL - 2 OFF



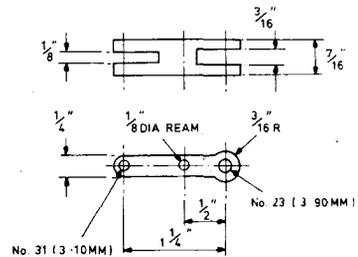
VIBRATING LEVER
M STL. CASEHARDEN
4 OFF.



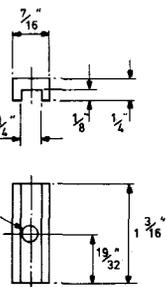
ANCHOR LINK
M STL. CASEHARDEN
2 OFF



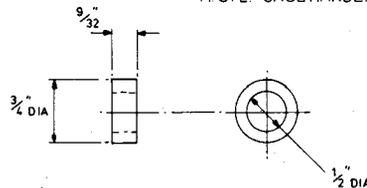
RADIUS ROD
M. STL. - 2 OFF



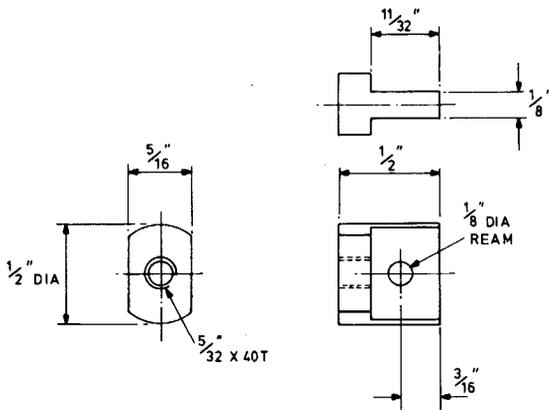
CORRECTING LINK
M STL. CASEHARDEN - 2 OFF



SLIDE - 4 OFF
M. STL.



CRANKSHAFT SPACER
M. STL.



VALVE SPINDLE CROSSHEAD
2 OFF - 2 FULL SIZE -- GUNMETAL

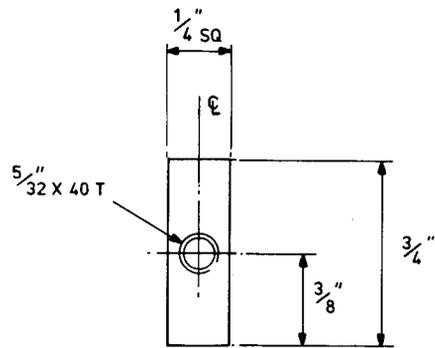
in. bright flat and are best made in two lengths, each making two slides, and they should be milled down to $7/16$ in. wide to start with. Machine the slot $1/4$ in. wide x $1/8$ in. deep and before removing from the vertical slide drill the fulcrum pin hole $3/16$ in. dia. Mark the slides then saw into two. Repeat with the other piece making four slides altogether, which can be held to the slideshaft with 10 BA screws for silver soldering.

Until all the valve gear is complete and working correctly it will pay to assemble the parts with temporary pins reduced in diameter to be an easy fit in all the holes. It is possible to assemble the crankshaft, connecting rods and valve gear into the crankcase as a sub-assembly, feeding the die blocks down the slides as the crankshaft is lowered into the bearing housings. A spare pair of hands would be an asset.

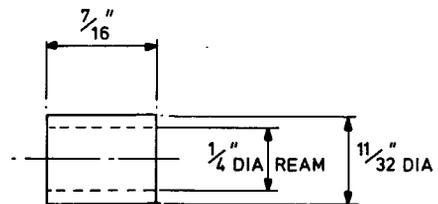
On with the remaining parts of the valve gear: the correcting link slots can be started with a hacksaw and finished with thin files to fit over the connecting rod at one end and the anchor link at the other. This latter part and the vibrating levers (four of these required) are very simple parts made from $1/4$ in. x $1/8$ in. bright flat. The radius rod is more complicated and is probably best made in three parts silver soldered together on a jig. The jig consists of a length of flat with two $1/8$ in. dia. pins pressed in on $2\ 3/16$ in. centres.

If you make your steam chest cover out of 10 s.w.g. brass the cast gunmetal cover provided with the cylinder set will yield ample material for the die blocks. Skim down to $1/8$ in. thick then mark out the four die blocks. Drill the $1/8$ in. dia. holes then cut out and file up the individual blocks. They will lead a hard life so make them a good fit in the slides.

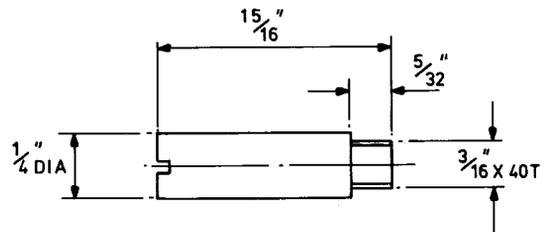
Final hint for the month; assemble and test each set of valve gear separately, rotating the crankshaft slowly to check that nothing jams. There is no need to assemble the valve spindle guides as yet so just let the radius rods poke out through the crankcase



VALVE BAR
2 OFF. BRASS



SMALL END BUSH
2 OFF. GUNMETAL



GUDGEON PIN
2 OFF - SILVER STEEL

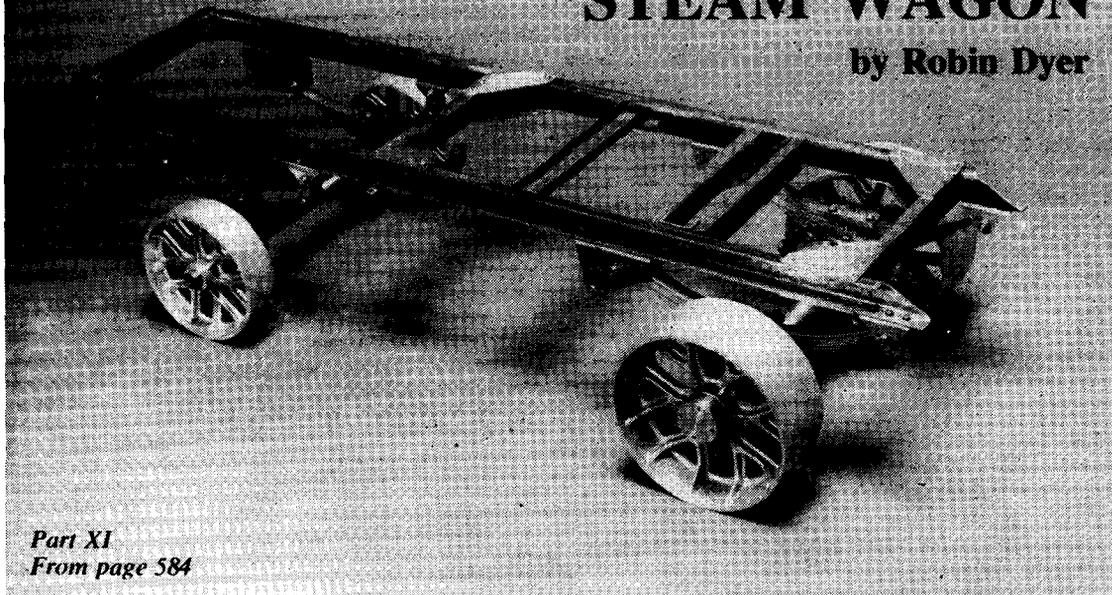
front. Points to watch are vibrating levers clouting the slideshaft — file a little metal away if necessary. It must be possible to tilt the slides 25 deg. forwards or backwards, these being the positions they occupy in full gear.

Two corrections to the boiler drawing to finish with, neither catastrophic fortunately. The centre-line of the clinker hole from the bottom of the boiler is $2\ 1/2$ in. (missing dimension) and the smokebox ring should be tapped $3/8$ in. x 32T, not $5/16$ in. x 40T as shown. The correct information for the latter was given in the text.

To be continued

A CLAYTON UNDERTYPE STEAM WAGON

by Robin Dyer



Part XI
From page 584

Robin Dyer describes the valve setting, the water pump and gives more drawings of boiler fittings

READERS MAY REMEMBER that the cylinder block is as yet without any stud holes for the valve chest. When the valve spindle crossheads have been completed this situation may be remedied. Screw the crossheads on to the spindles, push the spindles through the valve chest glands and position the valve chest on the cylinder block. If your model making is to drawing (!) it should be possible to poke the crossheads through the 1/2 in. dia. holes in the front of the crankcase thus lining everything up. Clamp the valve chest to the cylinder block and spot through some of the holes. Drill and tap the block, insert some studs and run some nuts down. The remainder of the holes can now be spotted through and finished off.

Re-assemble the valve chest, this time with the valve spindle guides. Clamp the latter to the crankcase and do as before with the holes, tapping those in the crankcase 8BA.

The operation just described will have to be carried out with the crankcase empty, so while it is in this state the water pump gears can be attended to. These are available from the casting suppliers as commercial spur gears in mild steel and are easily modified to suit our application in the Clayton. The water pump on the full size wagon was driven from

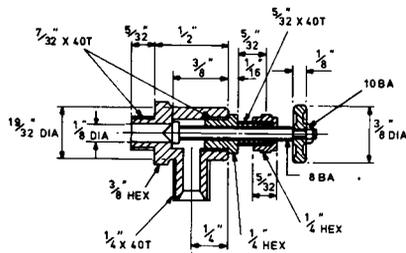
an eccentric on the end of the layshaft, this shaft carrying the valve gear eccentrics and itself being driven by a pair of spur gears of 1:1 ratio. The train of gears in the model brings the pump eccentric clear of the bearing housing and positions the pump in more or less the right place.

To modify the drive gear, chuck by the boss so that the teeth run true. Face to 5/32 in. thick then bore out to 1/2 in. dia. and form the recess. Reverse and chuck by the recess in order to face the boss to 5/32 in. wide. The idler should be chucked by its boss and the bore opened out to 5/16 in. dia.

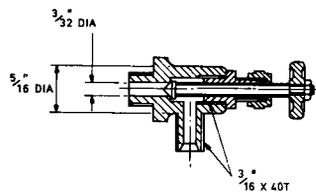
Face the tooth thickness down to 5/32 in. leaving a 1/2 in. dia. boss 1/16 in. wide. Remove from the lathe and saw off the original boss, returning to the lathe in order to skim this face flush. This gear requires a small bronze bush.

The final gear is even easier; saw off the boss and press or Loctite the gear on to its shaft. Grip the shaft in the chuck and skim to 5/32 in. wide. The crankshaft gear is driven by a 1/8 in. dia. peg pressed into the nearside crankweb. The other two gears are fitted into the crankcase before assembling the rest of the parts.

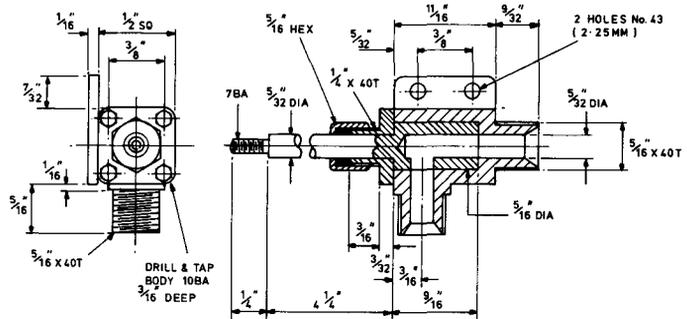
When everything is functioning as it should all the mechanism can be stripped out of the crankcase



INJECTOR STEAM VALVE
BRASS (ST STL SPINDLE)



BLOWER VALVE
BRASS (ST STL SPINDLE)



INJECTOR WATER VALVE
BRASS (ST STL VALVE)

port at each extreme of movement but the valve nut will almost certainly require adjustment on the spindle to achieve this. Put the lever into forward gear and check that the valves fully uncover the steam ports. Adjust the valves again, if necessary, to achieve an equal opening of the ports and note the position of the reversing lever which gives full opening, but only just. This is full forward gear and a notch should be filed in the quadrant for the latch.

Intermediate notches should be filed to allow adjustment of the cut-off position while running. A repeat of the above performance will establish full reverse gear position but it is not usual on a wagon to provide intermediate notches.

Water pump

This is cast in one piece with the gland so the first operation can make use of this as a chucking piece. If your four-jaw chuck is less than about 6 in. dia. it will be necessary to saw off the small boss opposite the barrel as it will be impossible to offset the pump sufficiently to get the boss running true.

So either turn and drill the boss, threading 1/4 in. x 40T, or face right across to clean up the pump body. A threaded nipple can then be silver soldered in position later. Saw off the gland and clean up the other flat surfaces. Chuck by the body with the barrel running true then drill and ream 5/16 in. or 3/8 in. dia.

The smaller bore will, theoretically, supply all the water needed but having experienced the frustration of running engines with inadequate pumps I am opting for the larger bore. The bypass valve is there to be used and is one of the adjustments which makes driving a steam engine so interesting.

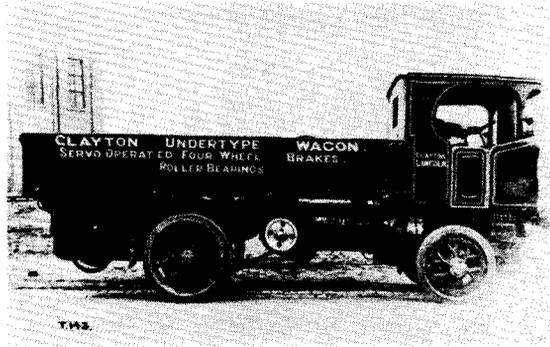
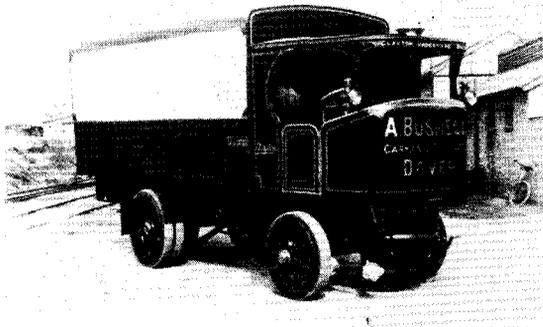
After the gland recess has been bored and the flange faced back, the casting should be set up with the lower 1/2 in. dia. boss running true. Drill 5/32 in. dia. only as far as the main bore then open out for tapping, face to length and turn the boss to 1/2 in. dia. Reverse in the chuck, gripping by the boss, and finish off the top half of the valve box. The rest of the work can be carried out on the drilling machine.

The remaining bits are quite straightforward; the 3/16 in. dia. balls should be allowed between 1/32 in. and 3/64 in. vertical movement. It then only remains to make up the bracket from 3 mm mild steel sheet and secure the pump to the crankcase. Note that the length of the pump bracket should be 1 3/4 in. in order to bring the air vessel forward clear of the chassis cross member, and the eccentric rod centres should be 2 3/16 in.

The ram centreline should be on the engine centreline, and the crankcase side can be tapped 6BA to take the bracket fixing screws — better than fiddling about with nuts inside. The G. A. drawing shows whereabouts these screws come. The pump should be installed first and the length of the eccentric rod checked from the job; push the ram right in, check the dimension and subtract 1/32 in. This will give minimum clearance volume although with a gravity fed pump like this cavitation should be no problem.

The air vessel was fitted to the full size wagon and experience with my Thornycroft has shown that it is a worthwhile gadget to have on a model since it materially reduces the amount of hammering given to the balls in the pump and clack.

To be continued



THE CLAYTON UNDERTYPE STEAM WAGON

by Robin Dyer

Part XII

from page 718

BEFORE PROCEEDING with the cab of our Clayton wagon, it is necessary to describe a modification to the rear axle boxes. These being made of gun-metal, it has come to light that if the spring retaining nuts are tightened with vigour the box can be distorted sufficiently to lock up the rear axle. The cure is to make up a pair of thin plates to drop over the studs, these plates supporting the ends of the bottom spring leaf and taking the clamping force.

Cab construction

With the engine of the model complete, the day of the first steam-up seems much closer. We can now turn our attention to the cab, the completion of which will make a dramatic improvement to the appearance of the wagon. I should explain at this point that I am about as skilled at carpentry as I am at brain surgery (*you can say that again—Mrs. D.*) and any builder who finds wood a sympathetic material with which to work will no doubt approach this job in a different way.

To make access easier the boiler should first of all be removed; while it is out it might as well be lagged, using balsa wood strips or felt, etc. covered with shim brass or cladding steel.

The front apron of the cab is made from 18 s.w.g. brass or steel sheet, and a full size template for this is provided with the cab drawing as available from the MAP plans service. Either cut out and stick on the metal or copy down on to card using carbon paper and use this as the template.

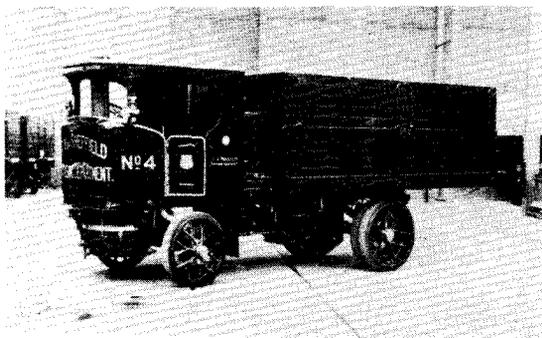
After the acquisition of a lathe and some sort of drilling machine, I would suggest that every model engineer attempts to obtain a bandsaw since cutting

out sheet metal on one of these machines is so ridiculously simple compared with other methods that it just isn't true. So, the lucky ones can go ahead and buzz round the apron outline while the others use the more traditional fretsaw and piercing saw blade. Alternatively one of the modern hand nibbling tools might do the job.

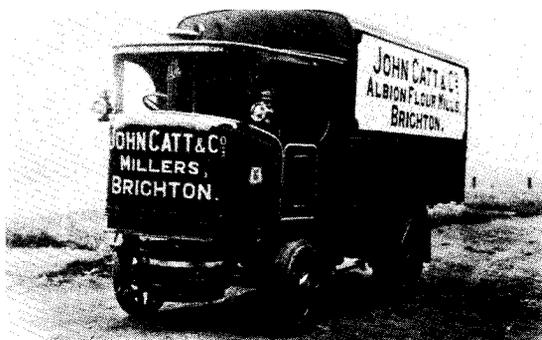
The next task is to carefully bend the apron to match the front radii of the cab floor; note that it sits snugly round the outside of the floor, not on top of it. Next grip the top edge in the vice together with a piece of bar or tube 1½ in. dia. and tweak round to produce the lip or curve which runs across the front of the apron. Strictly speaking, this is a compound curve as it should run into the sides, but a simple turning over of the top edge is almost as good and a lot easier.

Fit ¼ in. brass angles 1/16 in. up from the bottom edge, using rivets countersunk on the outside, and fit the apron to the cab floor making sure it sits tight up against the edge of the floor sheet. I used 8BA screws passing up through the cab floor into tapped holes in the angles. The front angle will have to be scalloped to clear the heads of the screws securing the floor sheet to the front chassis crossmember. The addition of a 1/8 in. wide half-round brass beading around the top and side edges of the apron (not the bottom edge) will complete the job.

The cab sides can be dealt with next, cutting the two together and filing down to the scribed lines. After separating and deburring, a length of ¼ in. brass angle should be riveted to the inside of each piece, 1/16 in. up from the lower edge and 9/16 in. from the back edge (to allow room for the cab back



Some photographs of the full-size Clayton.
 Far left. An example shown at the Royal Show, Chester, 1925, but never delivered.
 Left. A 1925 model used for demonstrations.
 Above. This wagon was owned by Sheffield Cleansing Dept.
 Right. Another example that was never delivered.



and corner post). It is a good idea to soft solder these angles for additional strength.

Next, a length of 1/8 in. wide flat brass strip (boiler band strip) should be soldered around the cab cutout and down the front edge. The corner posts are cut from 3/8 in. square hardwood and are held in place with No. 2 x 3/8 in. brass countersunk screws—four or five for each post. The posts should be set in from the rear edge by the thickness of the cab back. Finally the cab side “sub-assemblies” are secured to the cab floor in the same way as the apron; they will be a bit floppy until the back panel is fitted.

A 3/8 in. square stiffening piece is now required across the cab floor, set in by the same amount as the corner posts. The drawing implies the use of the hardwood strip again although square mild steel rod would make everything a lot stiffer. Use 4BA screws to clamp it to the cab floor.

The cab back panel is best made from 5 mm. ply and any coachbuilders who intend to plank their cabs can skip the next bit. Cut the sheet about 10 3/8 in. high and wide enough to be a snug fit between the

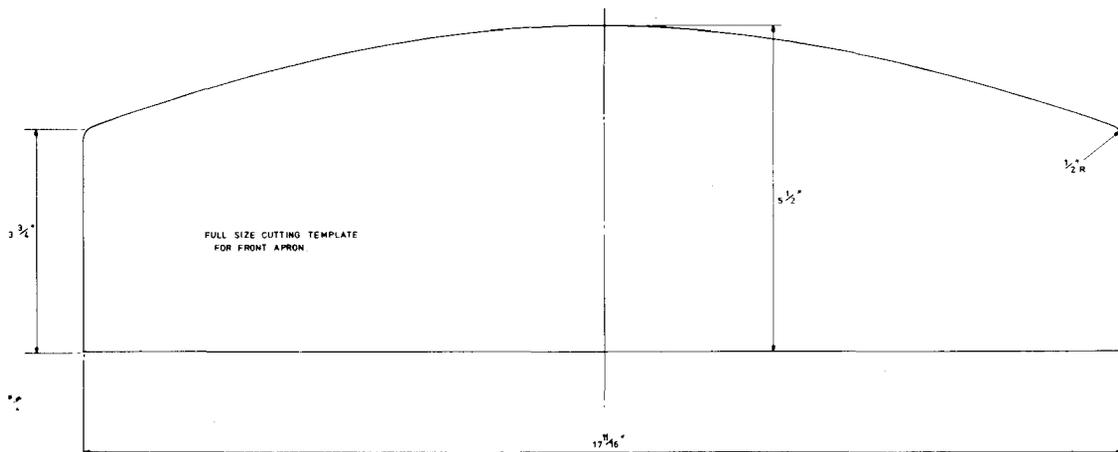
cab sides. Trace off the curvature of the roof from the drawing and trim to outline—each end should finish level with the top of the cab sides. A large cutout, 9 1/4 in. x 5 1/2 in. is now required for purely practical reasons as without it the model would be very difficult to drive.

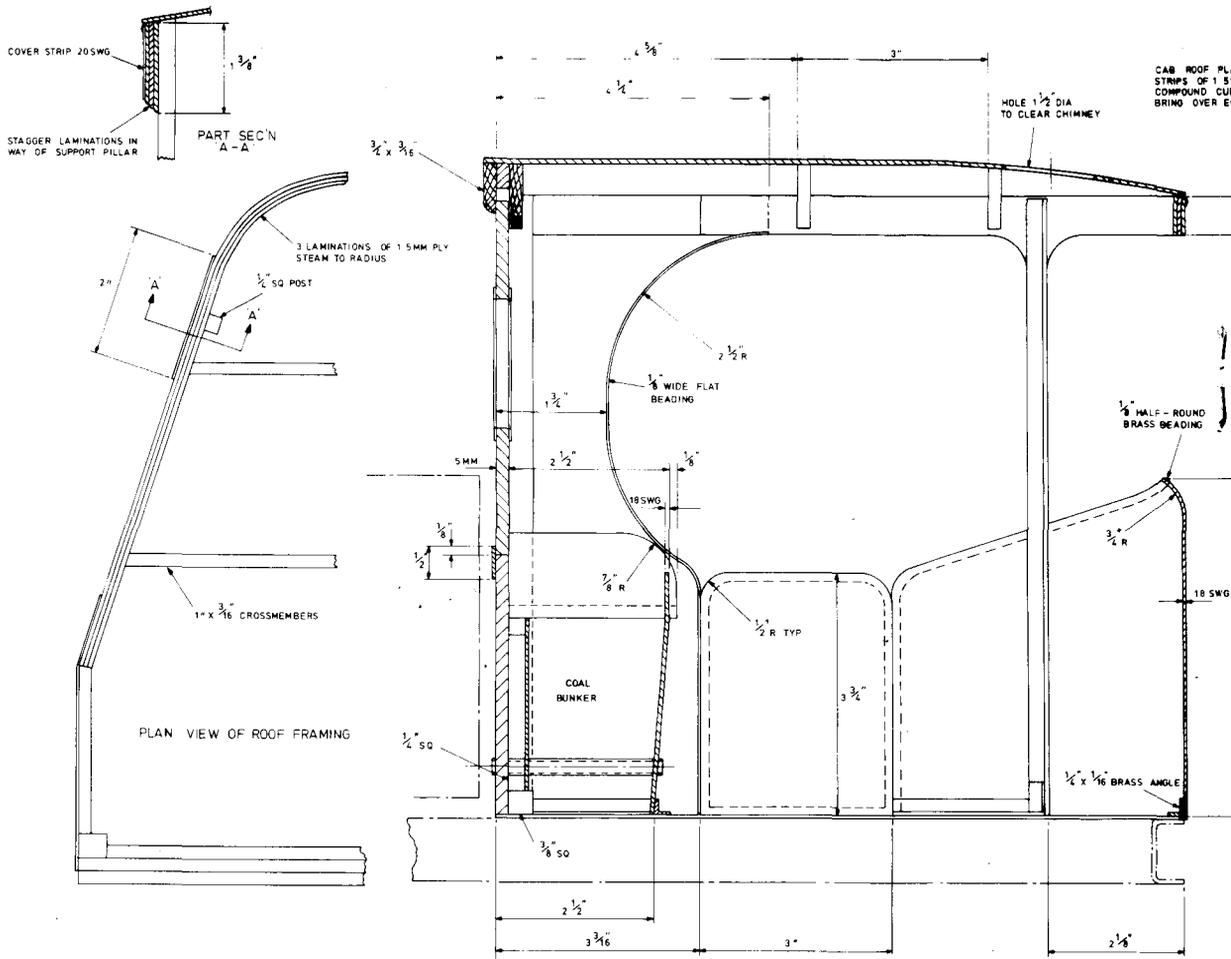
The drawing shows how the cutout can be filled with a removable panel when not being used; when being driven the panel can be lifted out and dropped down between the cab back and the water tank. The ply back panel can be scribed both sides to simulate planking and, after sanding and cleaning out the grooves looks very realistic. The panel is secured to the corner posts with No. 2 x 1/2 in. brass countersunk woodscrews or 6BA bolts.

The “real” cutout can be framed as shown, or with square section mitred and fitted into the hole. A sliding shutter with runners can also be made up and fitted to the inside of the cab back—I believe this was fitted although the photographs in my possession are not too clear.

Cab roof

The best way of tackling this is to cut a template out of timber or chipboard, at least 1/2 in. thick, to the outline of the cab floor less 3/16 in. on the front edge and two sides. The roof valance is cut from 1.5mm ply, obtainable from model aircraft and boat





shops, and is built up three layers thick around the template. Cut the first strip, not forgetting the downward projection which fits against the roof support pillar. Steam it to fit around the two front corners of the template and pin in position to dry. Repeat with the middle and outer layers and when all the layers are dry they should be glued together with a waterproof adhesive (all that steam swilling around the boiler would soon unstick PVA type glue). Pin through the layers into the template while the adhesive cures.

When all is dry the front two roof crossmembers can be cut to length, the ends being trimmed and angled to be a snug fit inside the valence at their respective positions. As was done for the cab back, the roof curvature should be traced on and each crossmember shaped to the outline. The Ramin hardwood strip available in do-it-yourself shops is suitable although the minimum available thickness may be 1/4 in. or 6 mm. Remove the valence from the template and secure the crossmembers in position.

The free ends of the cab side sheets above the cutout should be bent inwards to match the outline of the cab floor so that when the roof valence is offered up the rear ends will tuck inside the cab sides. These ends should be secured with 8BA screws and nuts and a temporary prop at the front end will prevent any droop.

Two lengths of 1/4 in. square timber or steel are now required for the roof support pillars, each pillar having a small angle piece fixed to the bottom end for securing to the cab floor. The roof valence can either be screwed directly to the pillars, or a "top hat" section made up and fitted to the valence which will wrap around the pillar making it easier to remove the roof.

The roof itself cannot, unfortunately, be covered in a single sheet owing to the compound curvature at the front. Therefore it must be planked, a job somewhat akin to making a model boat hull.

The 1/2 in. wide strips are cut from 1.5mm plywood long enough to overlap the roof at front and rear.

PLANKED FRONT TO REAR WITH 2 WIDE
1 5/8" PLY TRIM AT FRONT TO FORM
CURVE COVER WITH COTTON FABRIC DOPE ON
FRONT EDGE & TRAP BENEATH BEADING

1/2"

3/8" WIDE BEADING

SCRIBE AT 3/8" CTRS
FOR PLANKING

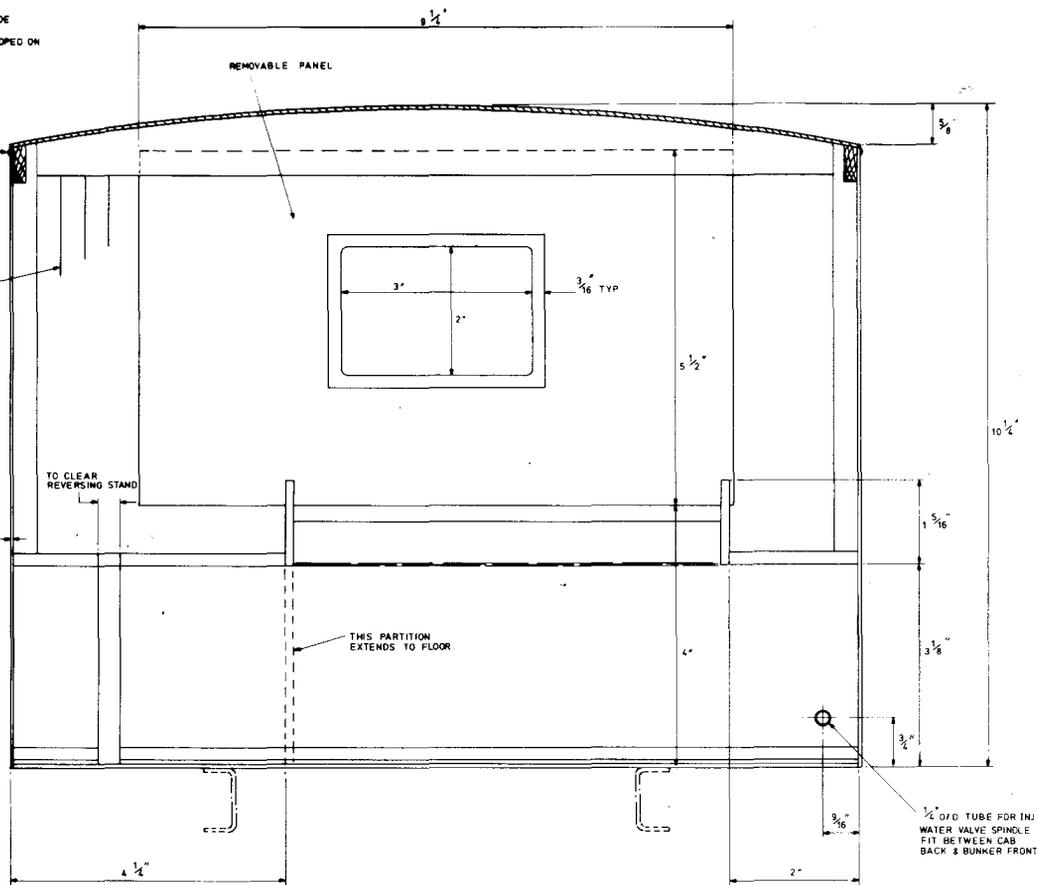
SWG

5 1/2"

18 SWG SIDES

TO CLEAR
REVERSING STAND

THIS PARTITION
EXTENDS TO FLOOR



1/2" O/D TUBE FOR INJ
WATER VALVE SPINDLE
FIT BETWEEN CAB
BACK & BUNKER FRONT

Before starting to plank the roof the two crossmembers which run across inside and outside the cab back panel should be fixed in position; the inside one can be glued to the top of the back panel, but the outer one should be screwed in position. When planking the roof, pin and glue the planks to this rear-most crossmember but not the top edge of the panel or the inside crossmember. That way it will be possible to lift off the roof quite easily.

Commence planking at the centre of the roof and work outwards both sides at the same time to reduce the risk of warping. The planks will need tapering slightly at the front end to allow them to sit tight against their neighbour while at the same time curving down to meet the valence. Use brass gimp pins to hold the planks to the crossmembers and the valence, together with waterproof adhesive in the joint between each plank. Pre-drill the holes before putting in the pins to avoid splitting the wood.

When all is dry and secure it should be possible to remove the roof from the vehicle for further work;

indeed, any boat builders making the Clayton may prefer to plank the roof on a jig. With a fretsaw, sharp craft knife or miniature modelling plane (to name but a few) trim the planks to the correct outline, finishing off with garnet paper to bring the planks flush with the valence and rear crossmember. Also sand over the top surface of the roof to smooth off any bumps and hollows. Cotton fabric may be used to simulate the canvas or felting of the prototype roof, brushed down with model aircraft dope.

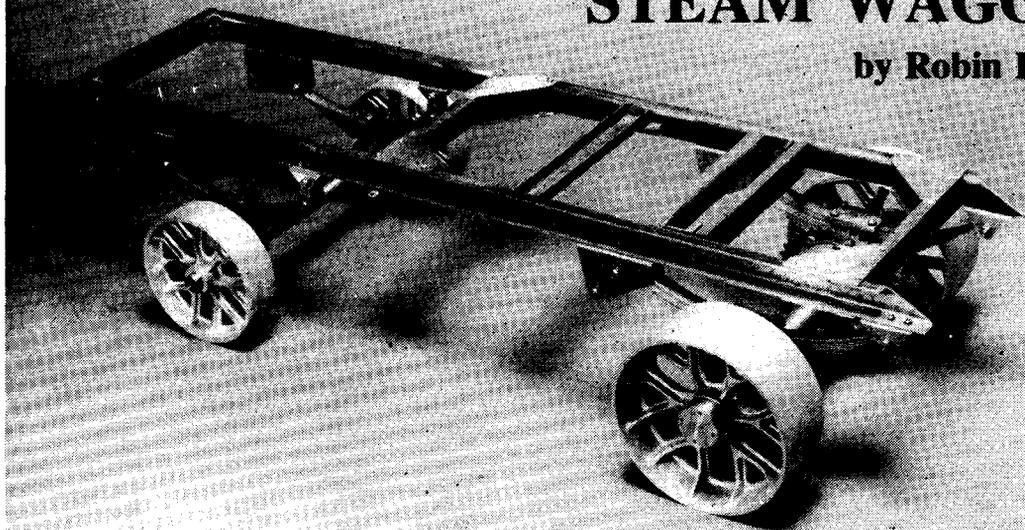
Narrow triangular pieces or "darts" will have to be cut out at the front end to avoid the formation of creases. Find the longitudinal centreline of the roof and carefully measure back to find the centre of the chimney. Scribe a circle 1 1/2 in. dia. and cut out a hole well inside this line.

Try the roof on the wagon to check that the hole is correct relative to the chimney (remove the brass cap for this exercise) and carry on opening up the hole accordingly, until the roof will drop on with an equal gap all round.

To be continued

A CLAYTON UNDERTYPE STEAM WAGON

by Robin Dyer



Part XIII
From page 839

Who describes the lubricator, and drive, the water tank, ashpan and mudguards

The Lubricator

THE GENERAL ARRANGEMENT drawing shows the lubricator driven from the offside valve spindle but having examined photographs of the full size wagon a little more closely (through a magnifying glass!) I discovered that the drive was taken from the end of the crankshaft. This is more satisfactory as it ensures a constant feed of oil unlike a drive from the valve spindle which varies with cut-off. The pencil drawing of the G.A. has now been altered and I hope the tracing will be amended in due course; the detail drawings will enable the parts to be made and fitted in any case.

The author confesses to having obtained his lubricator as a finished item since time was short, and he claims no credit for the design in the drawings as it is an adaption of that described by Martin Evans for his 'Greene King'. The oil is fed into the valve chest via a second non-return valve and appears to find its way very adequately upwards into the cylinders and thence to the chimney and the driver's spectacles!

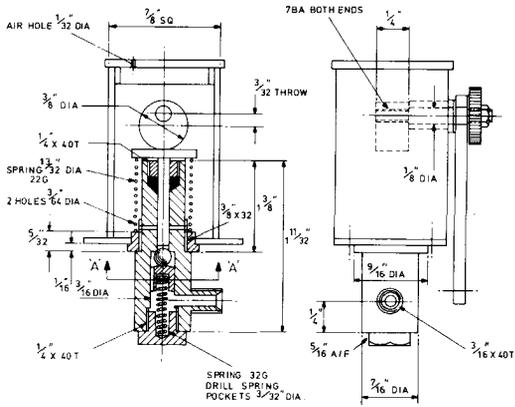
The lubricator arm is driven from a small crank fitted to the end of the crankshaft; the 5/8 in. stroke feeds the ratchet wheel two clicks at a time which appears to be adequate. The lid of the lubricator tank

would appear to be rather inaccessible under the water tank but in practice the oil level can be seen and the tank can be filled quite easily with a pressure feed oil can. Its position does at least keep it clear of the ash and cinders which settle on every exposed surface.

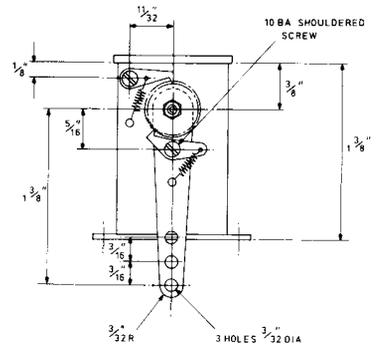
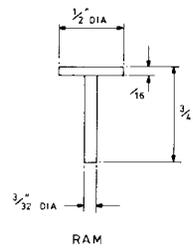
Water tank

This differs from that fitted to the full size articulated wagon by being made lower in height. This is compensated for by an increase in depth front to back, giving a water capacity of about 5½ litres — sufficient for about 45 minutes running as near as I can judge from experience so far. Changing the shape of the tank enables better access through the back of the cab.

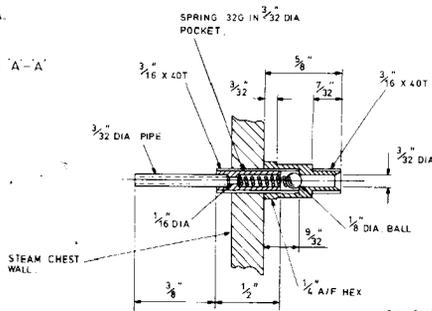
The drawing shows two methods of making the water tank; both methods were used by the wagon manufacturers. One method involves flanging the ends of the tank and riveting them into the main body, the other simulates a fully welded tank by being made of flat plates soldered together. The corners are reinforced on the model by brass angle riveted in position. A dummy inspection hatch is fitted to the top of the tank, being merely a drop on lid permitting access to the hand pump. Keep the lid on when running or cinders may drop into the water and end up under a valve ball (it happened to me). My pump is a



LUBRICATOR ASSEMBLY



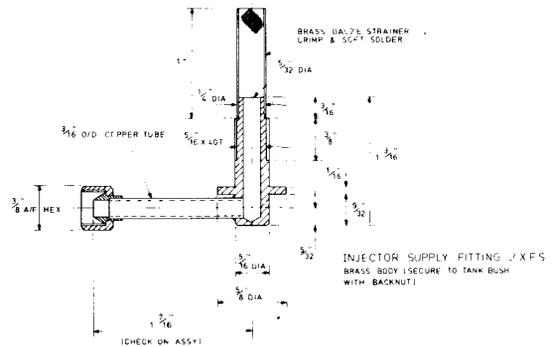
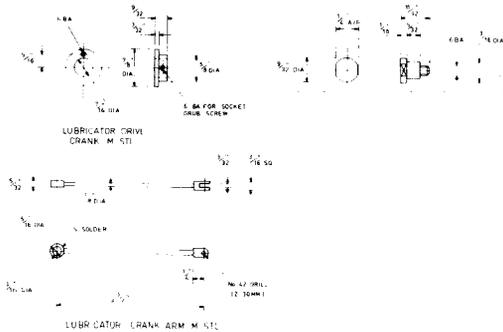
SECTION 'A-A'

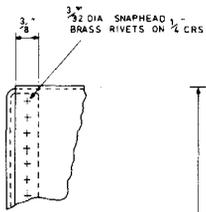
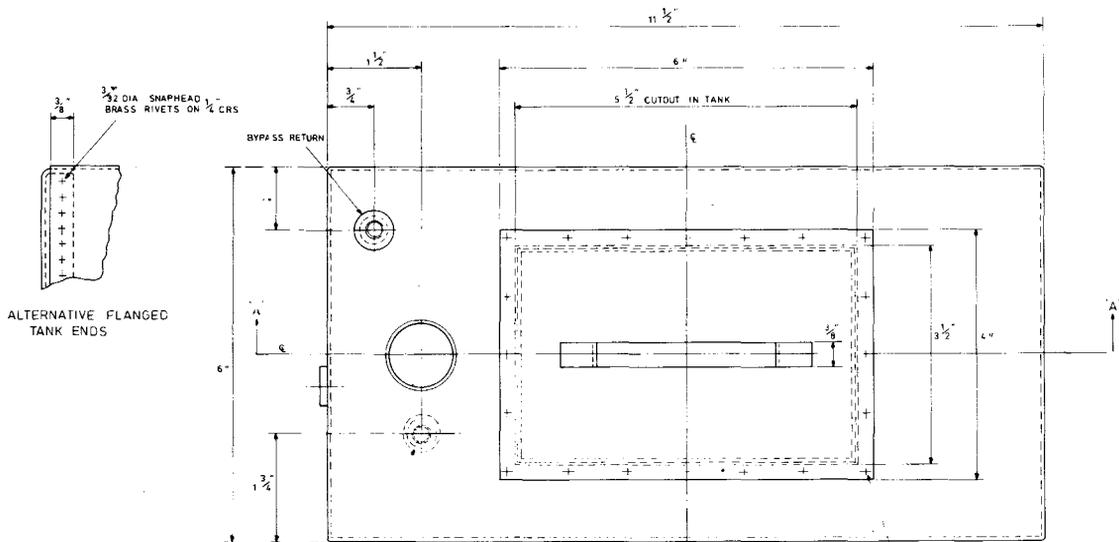


OIL CHECK VALVE



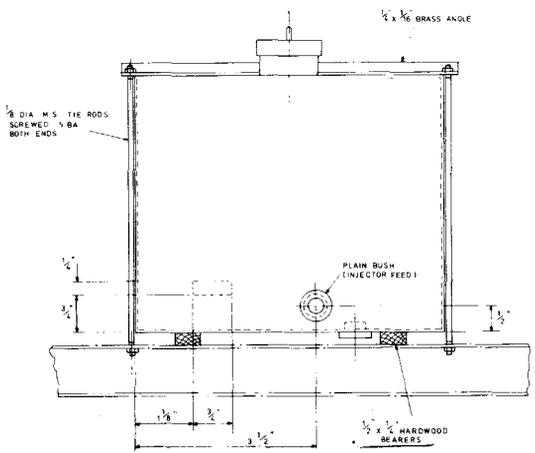
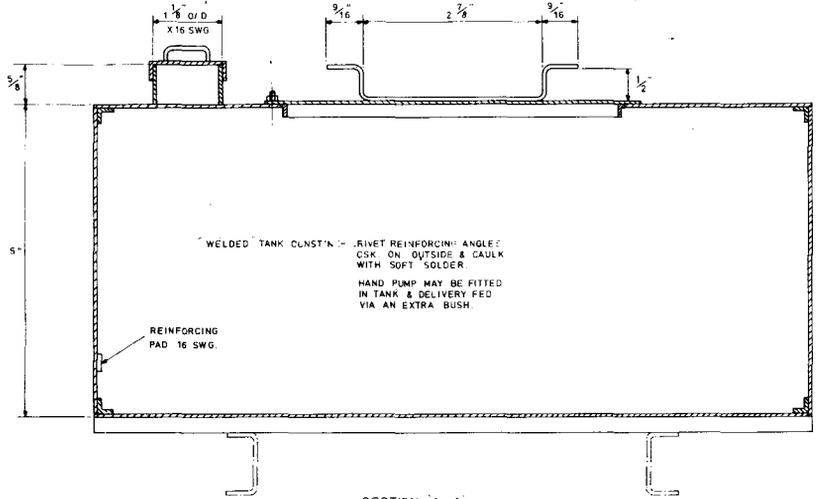
TANK BUSH - BRASS
2 OFF AS SHOWN
1 OFF DRILLED 1/16 DIA

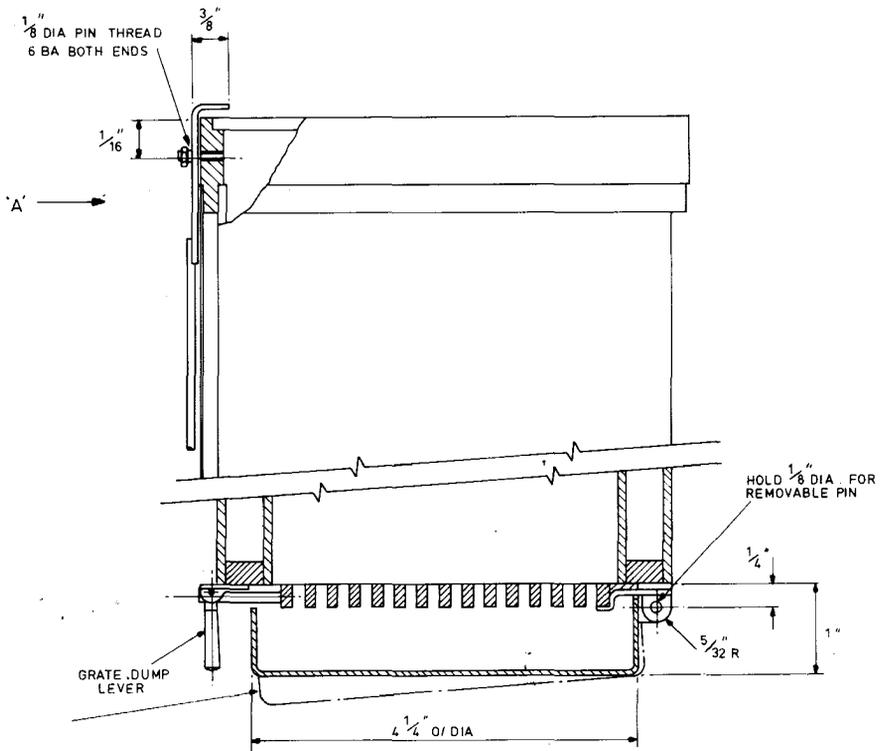




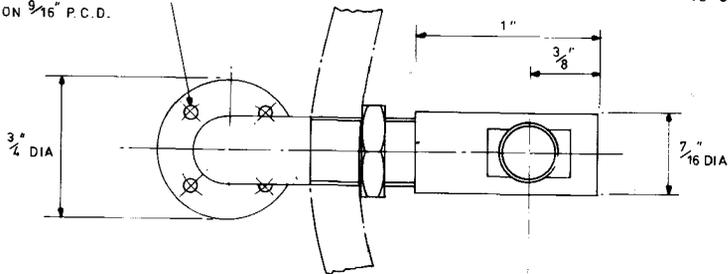
FEET TO MECH PUMP

20 DUMMY STUDS & NUTS 8BA

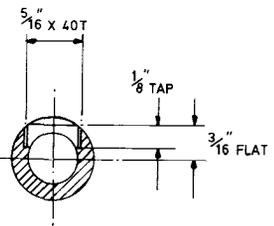
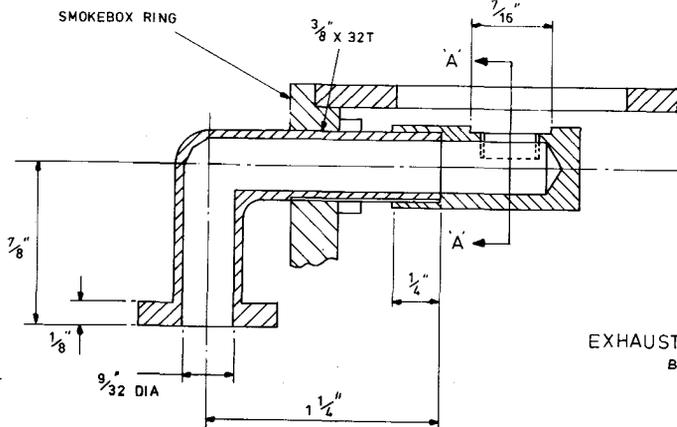
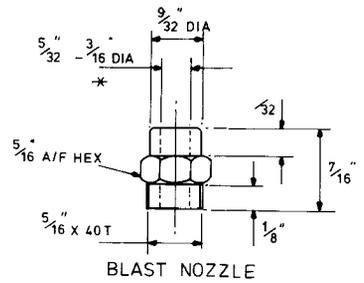




4 HOLES No. 43 (2.25MM)
ON $\frac{9}{16}$ " P.C.D.



* NOMINAL DIM. ONLY ADJUST
TO SUIT SPECIFIC CONDITIONS.



SECTION 'A-A'

EXHAUST ELBOW & BLAST NOZZLE
BRASS FABRICATION

commercial item with a 1/2 in. dia. nylon ram and it fills the boiler up quite briskly.

The filling spout and cover can be made from tube offcuts and the various bushes are turned from brass bar and sweated in position with soft solder. A water lifter was fitted to the top of the full size tank in the front nearside corner. This bush can be used on the model for the bypass return, a single ended union being screwed into the bush having a short length of copper pipe soldered in the inner end. With the union screwed in tight the pipe can be bent to appear under the filling spout where it will act as a "telltale" to check the working of the pump. The bypass return pipe is brought up behind the cab and bent over in a neat radius and screwed to the union thus following the route of the water lifter steam pipe. I found it necessary to fit a union in the pipe under the cab floor such is the length and route taken up to the bypass valve.

The injector water valve occupies the same position as a box-like structure on the full size wagon which could well have housed a filter for the injector water supply. Our water valve is based on the quick action type now popular on model locomotives and the spindle is brought through the coal space where it could theoretically be operated by a one sixth full size driver (Action Man?). The injector may be purchased from one of several advertisers in the magazine, or made according to the articles which appeared in

'M.E.' in 1975 and 1976 (Nos. 3511/7 & 3536/7).

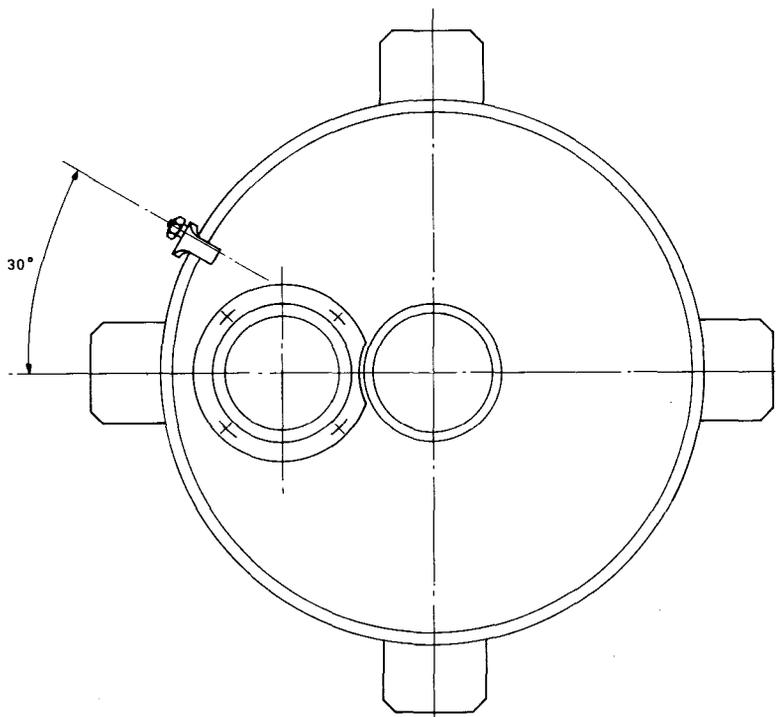
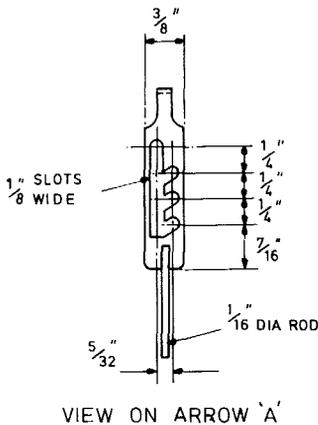
Boiler finals

The boiler still awaits the blast pipe and ashpan, the reason being that I wanted to try them out on my own model before drawing them up. Having made three blast nozzles with orifices of 5/32 in., 11/64 in. and 3/16 in. dia. I have found that the middle one is satisfactory when burning anthracite, pressure just being maintained with the engine well notched up and blowing off when in full gear. Astute readers may notice a resemblance between my exhaust arrangements and those of the Marshall portable engine.

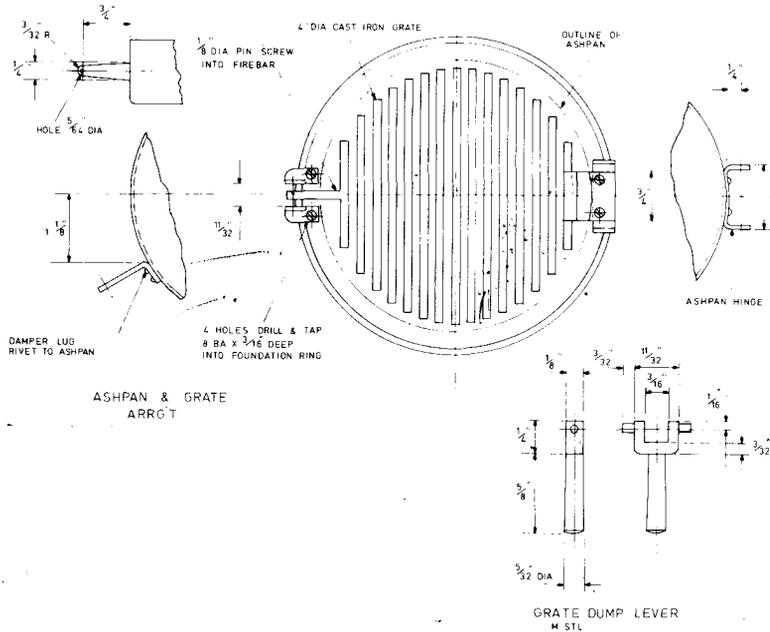
The blower pipe is led through a hole in the smoke box and finished off with a little nozzle arranged to sit alongside the blast nozzle. A No. 60 hole is quite big enough to raise steam on this boiler.

Ashpan

Turning to the other end of the boiler, the ashpan also forms the damper, being lowered to admit combustion air to the fire. Since this reduces ground clearance I have drilled 12 holes 3/16 in. dia. round the rear of the ashpan, enabling me to run with the ashpan closed or nearly so. The grate is a standard iron casting available from Reeves and is cast with three legs. These should be sawn off as on the Clayton the grate is held up by a clip at the back and a hinged lug at the front. Rotating this lug upwards will drop the front of the grate into the ashpan and enable the fire to be raked out.



NOTE - COMPLETE ASHPAN HINGES DOWN TO REGULATE AIR



Unless I have forgotten something the only job left on our Clayton wagon is to make the mudguards. The front ones are little more than shields behind the wheels but the rear ones are elegant curved affairs each with a pair of lugs riveted on, enabling them to be bolted to the chassis.

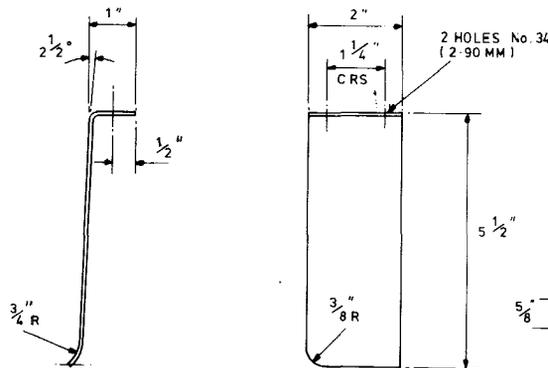
Finally, a word about the chain drive. Reeves can supply both the sprockets and the 8mm chain, the latter being a kit containing more than enough chain plus cranked links and a spring link. To shorten the chain grind the rivet flush with the sideplate and punch out. I did not have to use the cranked link on my own model, merely shortening the chain and fitting the spring link. Adjust the radius rods to give the bottom

run of the chain about 3/8 in. vertical play in the centre but make sure the axle stays square to the chassis!

I propose to use the next article to describe firing and driving the model, for the benefit of newcomers, and I hope before too long to describe a semi-scale trailer to go with the tractor unit which will be sturdy enough to use as a driving truck.

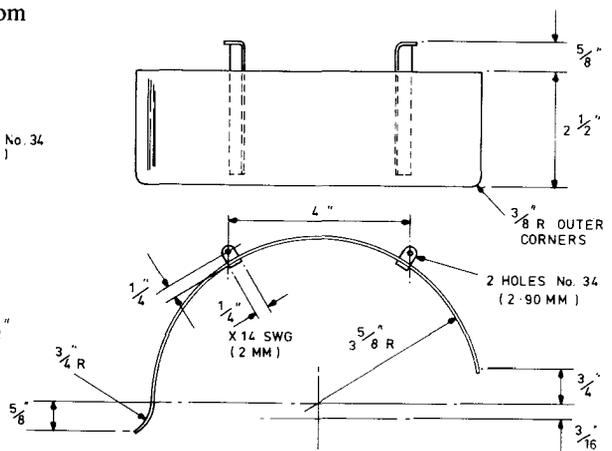
continued

LUBRICATOR CRANK PIN
SILVER STEEL



FRONT MUDGUARD

18 SWG. (1.2 MM) BRASS OR M.S.
1 OFF EACH L.H. & R.H.



REAR MUDGUARD

18 SWG (1.2MM) BRASS OR M.S. 1 OFF EACH L.H. & R.H.

THE CLAYTON UNDERTYPE STEAM WAGON IN 2 in. SCALE



Bob Webb's Clayton and trailer. Fig. 1.

by Robin Dyer

Part XIV

From Page 1083

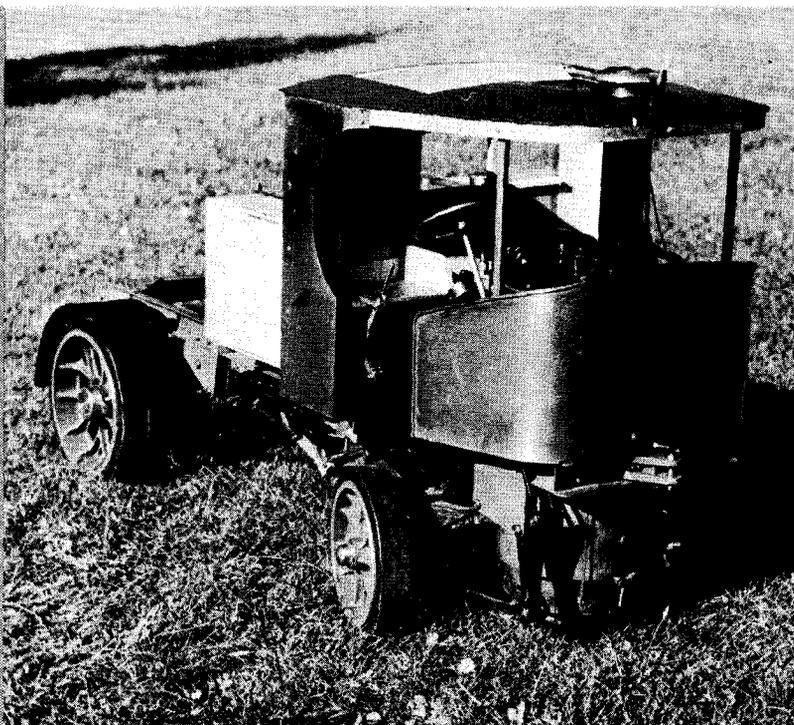
BY THE TIME this article is published, A. J. Reeves & Co., who are supplying castings and other materials for the Clayton, should have good stocks of moulded rubber tyres for the wheels. They are moulded as correctly profiled rings in a fairly hard black rubber and a set comprises four large and two small tyres (each rear wheel requires two tyres). Providing special items such as these tyres involves heavy tooling charges and these, of course, have to be taken account of when fixing a selling price. However, seeing these splendid tyres on the finished model makes the cost worthwhile and is a far quicker and more satisfactory job than cutting strips from sheet. The tyres are moulded slightly smaller than the outside diameter of the wheels and are best secured with Evostik Time-Bond or Dunlop Thixofix. Spread it on both surfaces and assemble while wet. Leave for 12 hours before driving and the adhesive will "grab" the tyre; the model race-car boys assemble their tyres this way.

Bringing it to life

Let it be said at the start that it will take several steaming sessions to achieve a satisfactory performance from the model; every new model is a bit of an unknown with respect to demands for coal and water. The engine will be stiff and demand more steam than at subsequent sessions, and fingers will be burned whilst groping for unfamiliar valves and firedoors!

Minimum tools will be a shovel and a pricker, the latter being a length of $3/32$ in. dia. or $1/8$ in. dia. steel rod sharpened at the end and bent over for $1/2$ in. Form the other end into a ring and make the tool long enough to reach down the stoking chute just in case the odd lump of coal gets stuck in its tumble on to the fire. However, having made the tools for coal firing, there is something to be said for firing with a Propane blowlamp while checks and safety valve adjustments are made. I did this by standing the wheels on four bricks and removing the ashpan and grate; there is a

Fig. 2. Robin Dyer's finished model before stripping down for painting.

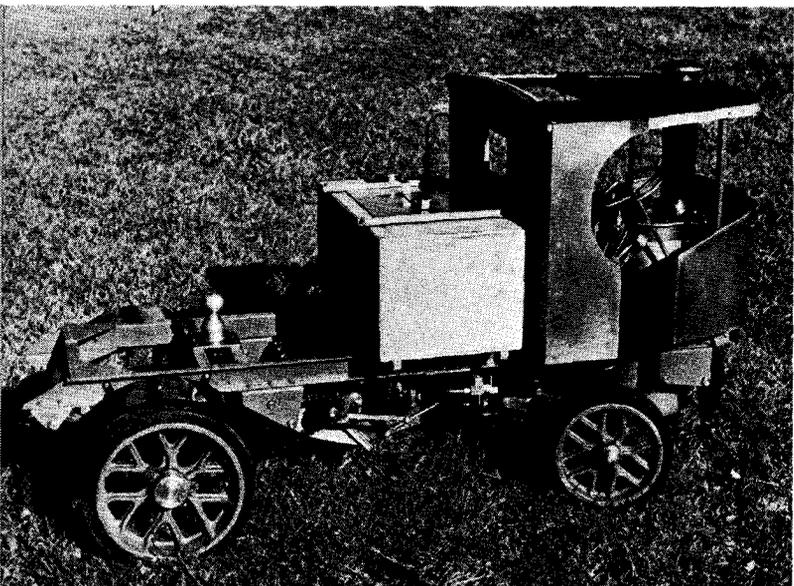


lot to be said for the ability to turn the fire on and off at will!

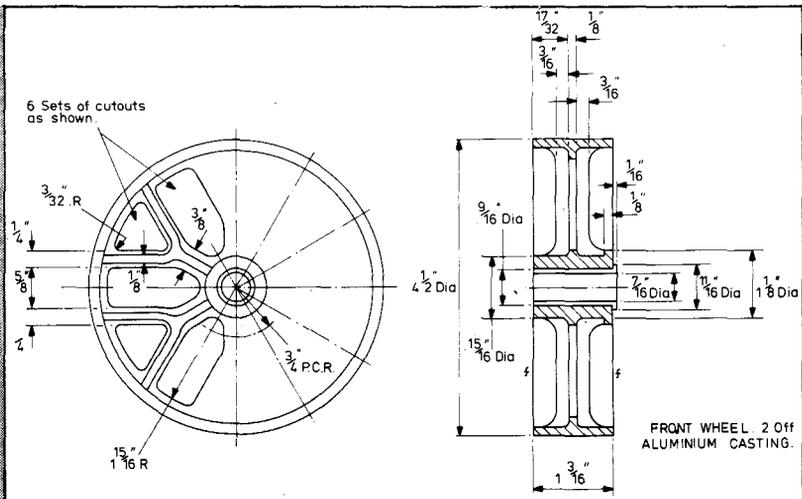
When the time arrives for coal firing a method of generating a draught through the fire before the wagon's own blower can take over is required and this is usually achieved by mounting a fan on the chimney driven by a low voltage electric motor (a sight which is a constant source of amazement to bystanders at

public rallies, as is the act of placing *coal* on a *real fire!*). A fan very suitable for the Clayton was described and drawn up by Mr. J. O. S. Miller in *Model Engineer* No. 3549 (19-30 Nov. 1976). The boiler should be filled to "half a glass" by means of the hand pump, and the engine sump requires just over half a pint of oil — Castrol GTX is a good sticky oil which will hang on to all the valve gear pivots.

Fig. 3. A second view of Robin Dyer's model.



Although some details of the front wheels were given we never published the full drawings. Most constructors have managed without them. But for those who do require them they are now published.



Experience shows that the oil is flung about very adequately while running and works its way out along the main bearing journals.

With the grate in position and the ashpan lowered insert a few pieces of kindling through the clinker hole. Switch on the fan, light a shovelful of paraffin soaked charcoal and drop it on the kindling. Carry on inserting charcoal until the grate is well covered and close the door. When everything is well alight the anthracite can be shovelled in and walnut sized pieces are best, dropped in down the firing chute. The anthracite "peas" which are sometimes available are too small and tend to get sucked up the tubes with the exhaust blast. Allow the last load to burn through before adding more and fill the firebox level with the bottom of the clinker hole. As soon as the pressure gauge shows 20 lb.s.i. the fan can be removed and the blower turned on. This really brings things to life and in no time the safety valves will be lifting, having been adjusted earlier whilst firing with gas; never steam a boiler with dodgy safety valves. Put some water in the

boiler to kill the safety valves and rake the fire through. Top up again with fresh coal and set the blower to a gentle draught and it will be time to refill the water tank and fill the lubricator with steam oil.

For the first run the back wheels could be lifted free of the ground to let the engine run light. Put the reverse lever in full forward gear and open the regulator slightly; in all probability nothing will happen so rotate the back wheels by hand — both wheels or the differential will absorb all the energy — and a shower of oily water will gush from the chimney. Keep turning and opening the regulator and all at once she should roar away. Check the speed with the regulator and bask in the flush of pleasure as you watch everything purring away!

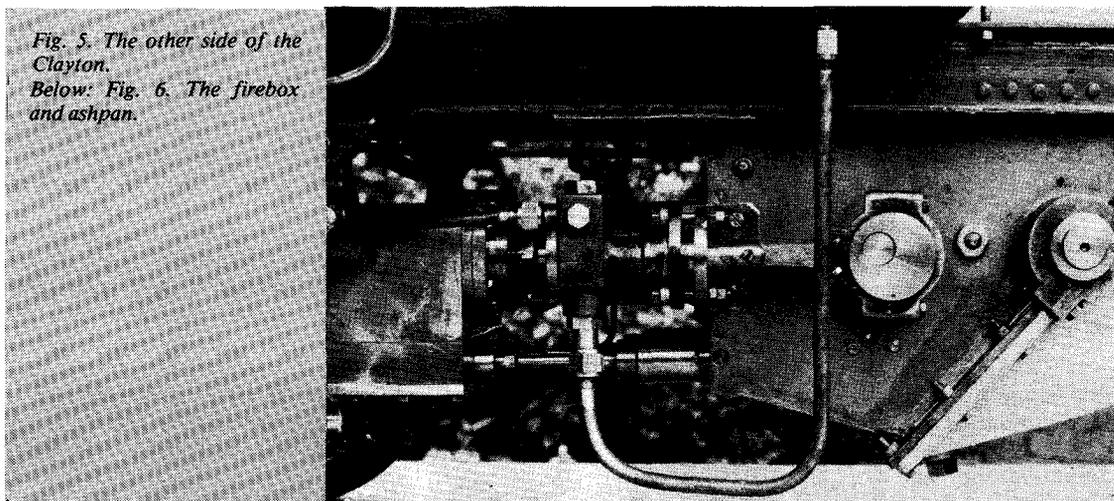
The small reserve of water in the boiler means that the level will soon drop and so the engine pump can be given a try. Close the by-pass valve and you will probably hear the clack valve working; the engine may also need more throttle because of the increased load. Try the effect of opening the regulator and pulling back



Fig. 4. A close-up view of Robin Dyer's Clayton.

Fig. 5. The other side of the Clayton.

Below: Fig. 6. The firebox and ashpan.



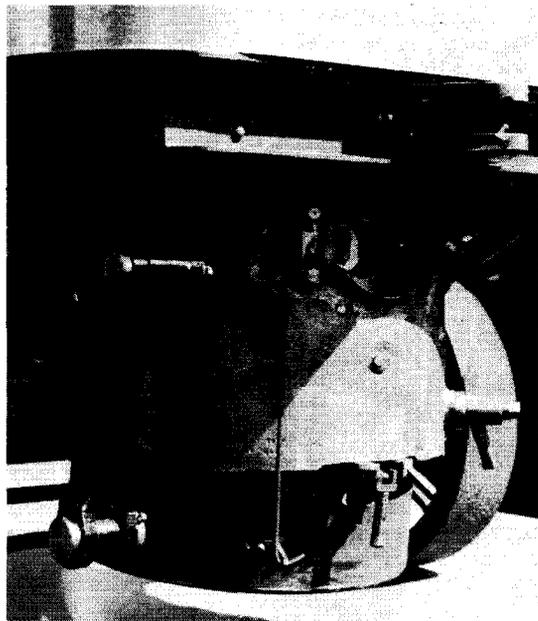
the reversing lever; the engine should run at the same speed but with a quieter chuff. If you come back too far the engine will cut — do this while on the road with a load and you can feel the engine start to knock. If you drop forward a notch it will smooth out and run with a soft exhaust sound.

To become fully operational a driving truck is required and many and varied are the designs which one sees at club gatherings and rallies. Bob Webb, a fellow member of the G.E.C. (Coventry) M.E.S. has built a lovely scale trailer for this Clayton, seating two adults and he has kindly agreed to let me “crib” his design for a future short series in *Model Engineer*. His model can be seen in one of the photographs. The appropriate driving style for the Clayton appears to be to insert the right hand through the cab back and twirl the steering wheel by inserting the forefinger in the spokes. The thumb is then in the right place for operating the regulator. The left hand can look after the by-pass and whistle.

One reader has asked me if I will say a word about colour. One advantage of building a wagon is that the livery can be anything the owner wishes. In general, greens, blues and browns seem to have predominated amongst full size wagons and a glance through old photographs will reveal that a good majority of wagons had no lining out and even hub caps were painted over. The chimney cap was usually kept polished as well as perhaps the pipework and panel beading. Although the paintwork was generally subdued the signwriting was sometimes quite extrovert and will probably tax the modellers ability more than lining out would!

And finally

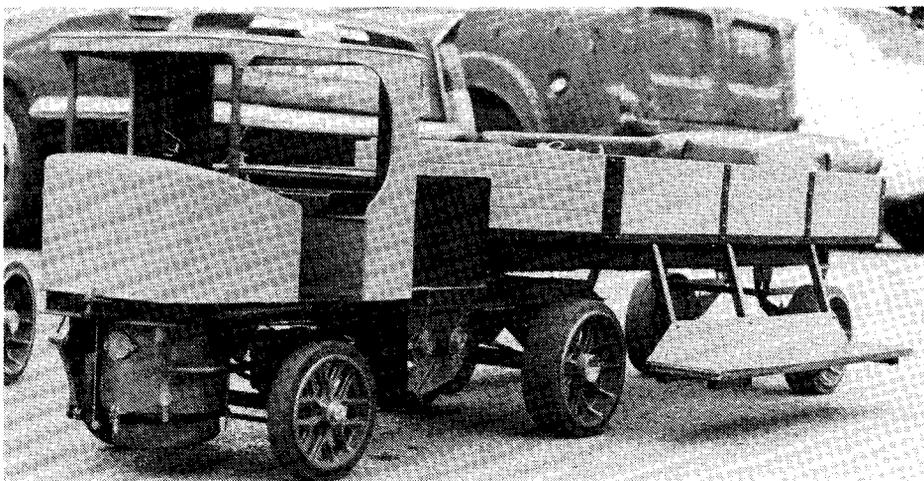
A word about the photographs. The heading photo shows the first two model claytons to be steamed! The occasion was a club day last August; the author's model on the left and Bob Webb's on



the right. He had copies of my pencil drawings and went on to finish his model ahead of mine! I think readers will agree that the trailer really sets the model off; a very handsome combination, but just try driving one in reverse!

Figures 1 and 2 show views of my model in its final state before stripping down for painting and finishing off. Figures 4 - 6 show close up details of each side of the engine.

During the course of this series I have received a large number of letters from readers. Some, indeed, have written more than once, giving me progress reports on their models. I have replied to letters where it seemed appropriate but I would like to thank everybody who has written and taken such an interest in this model. Happy driving!



A TRAILER FOR THE CLAYTON

by Robin Dyer

WHEN DESIGNING THE *Clayton* steam wagon, one decision which had to be made was whether to make it fixed wheelbase or articulated. Although a scale of 2 in. to the Foot is a good size for storing and transporting, and can be stood on the bench for working on, it is a little small for carrying its driver — the man rather dwarfs the machine. For this reason I decided to make the wagon the tractor unit for an articulated set, an added bonus being that the wagon is short enough to be picked up single handed. (Although at around 70 lbs. it is no lightweight). Having the driver seated on a separate trailer seems to show the model off to greater advantage.

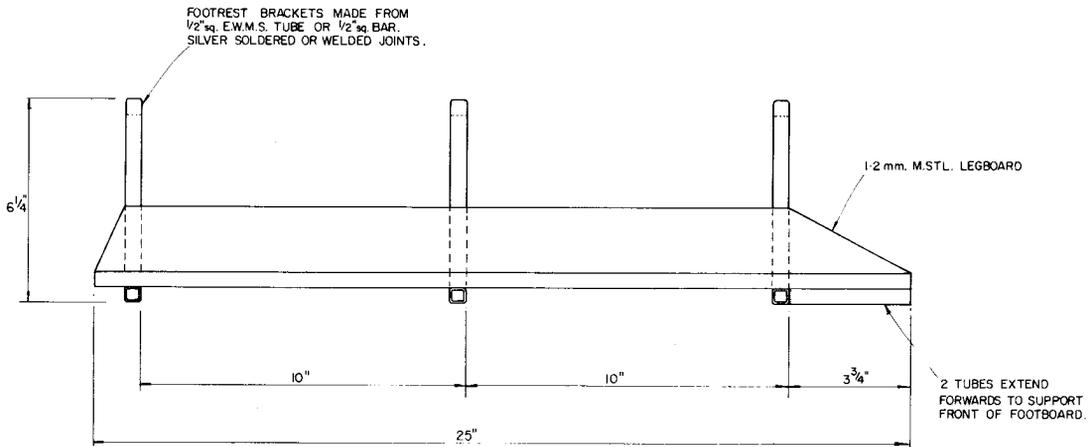
Many and varied are the trailers which I have seen, and the perches adopted thereon by their owners. In the main they have been hauled by traction engines and I have only seen two which were made up to look like a true trailer or living van. This is not intended as criticism as I know that many trailers are made to carry passengers; giving kiddies a ride is cruel hard work but tremendously rewarding. (As long as their parents realise that soot and sparks go hand-in-hand with the sight and smell of steam!). The biggest problem with model trailers is comfort; one's feet should be below or ahead of one's centre of gravity when leaning forward, otherwise one's weight has to be partly borne by a hand leaning on the model, usually on something sharp or hot, or both. Use two hands to drive the model and the back and leg muscles begin to protest. One trailer I know of requires that the driver sit cross-legged as if in meditation — the owner appears to be able to trundle around all day in this position, but when I tried it I soon siezed up and lost all feeling in the legs!

Clayton Wagons made one articulated unit in their batch of undertypes, this being delivered to John Penglaze, haulage contractor of Chipping Sodbury. By all accounts they were not very happy with it as they sent it back to the works after two years. The trailer of this unit was a massive affair with the chassis cranked upwards over the wagon chassis and with a tipping body. A beautifully detailed model of this rig was on show at the last *Model Engineer Exhibition* where it won the Bill Hughes award. Clayton's also produced a drawing of a simpler trailer with a high, straight chassis and fellow club member Bob Webb built this version for his own model *Clayton*. Thanks are due to Bob for letting me use his design, more or less unaltered, for the published version.

Construction

The chassis of our trailer is made from the same 1 in. \times $\frac{1}{2}$ in. channel section as the wagon and three lengths as sold by A. J. Reeves, of Marston Green, will be required. One length is sawn up to make the various cross-members, the other two lengths being used as is. The cross-members are strengthened with gusset plates riveted in position. Before securing cross-members 1 & 2 (numbered from the front) it would be as well to drill the holes for the release rod and coupling supports. Note that the frame spacing on the trailer is 6 $\frac{1}{8}$ in. whereas on the wagon it is 6 $\frac{1}{4}$ in. This is to enable all the cross-members to be cut from one length of channel.

The spring mounting brackets are folded up from 16SWG (1.6mm) mild steel and screwed to the chassis with 6BA fasteners. The trailer drawings refer to details on the wagon drawings where appropriate to



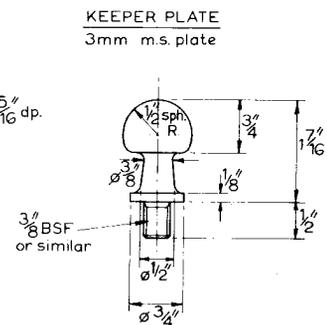
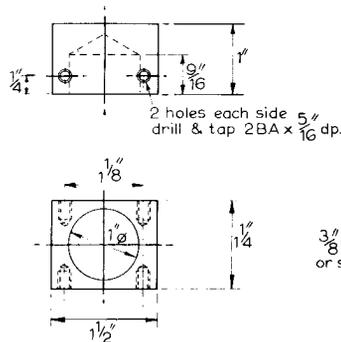
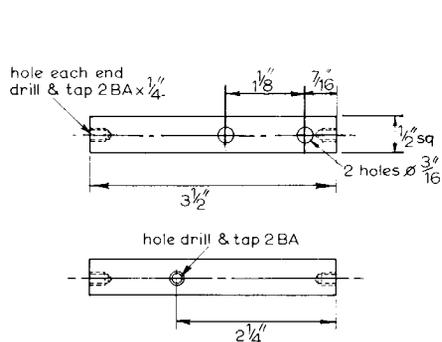
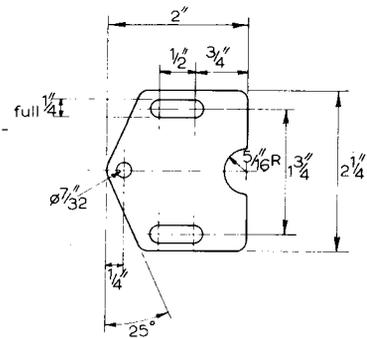
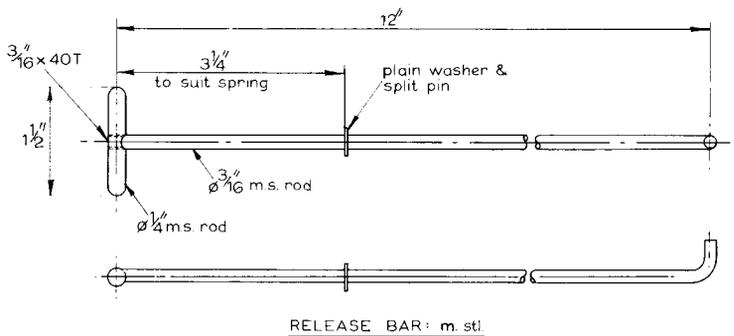
FOOTREST

1 OFF L.H. & 1 OFF R.H.

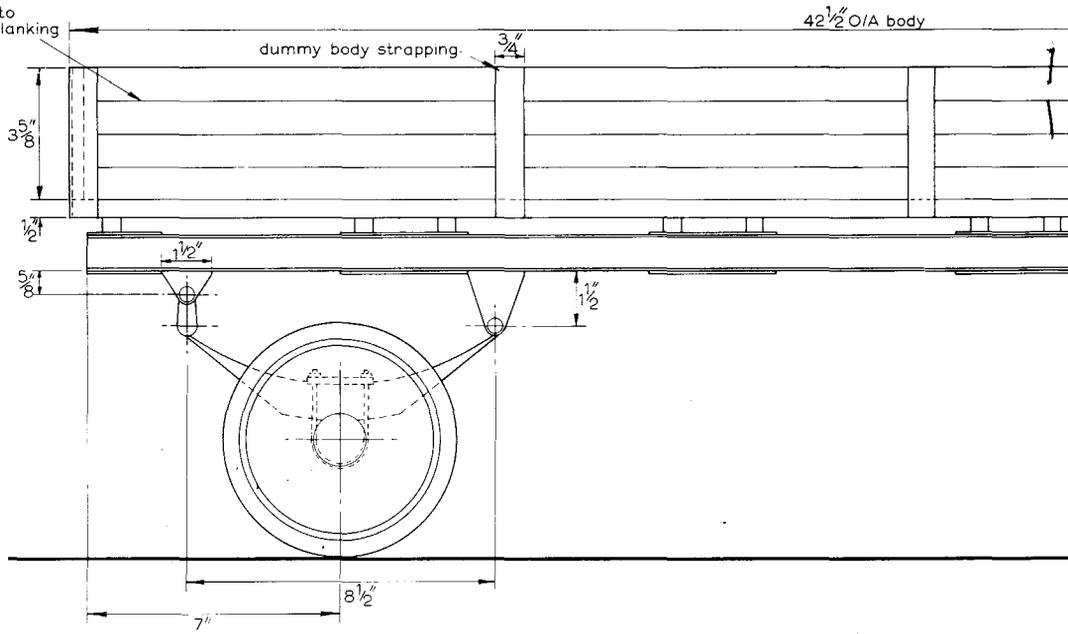
avoid duplication, and the first such items are the spring mounting pins and shackles. The springs themselves are similar to those fitted to the rear of the wagon except that the top three leaves, instead of being curved over at the ends, are cut back slightly, and the top leaves have eyes silver soldered on. The effectiveness of the springing will depend on the material used, all the springs on the wagon having

been designed empirically (engineer's term for trial and error). Those on the wagon itself appear satisfactory but if the trailer springs appear to complain at the weight of two adults, the suspension can be rendered rigid by fixing a bar between the front and rear spring pins on each side.

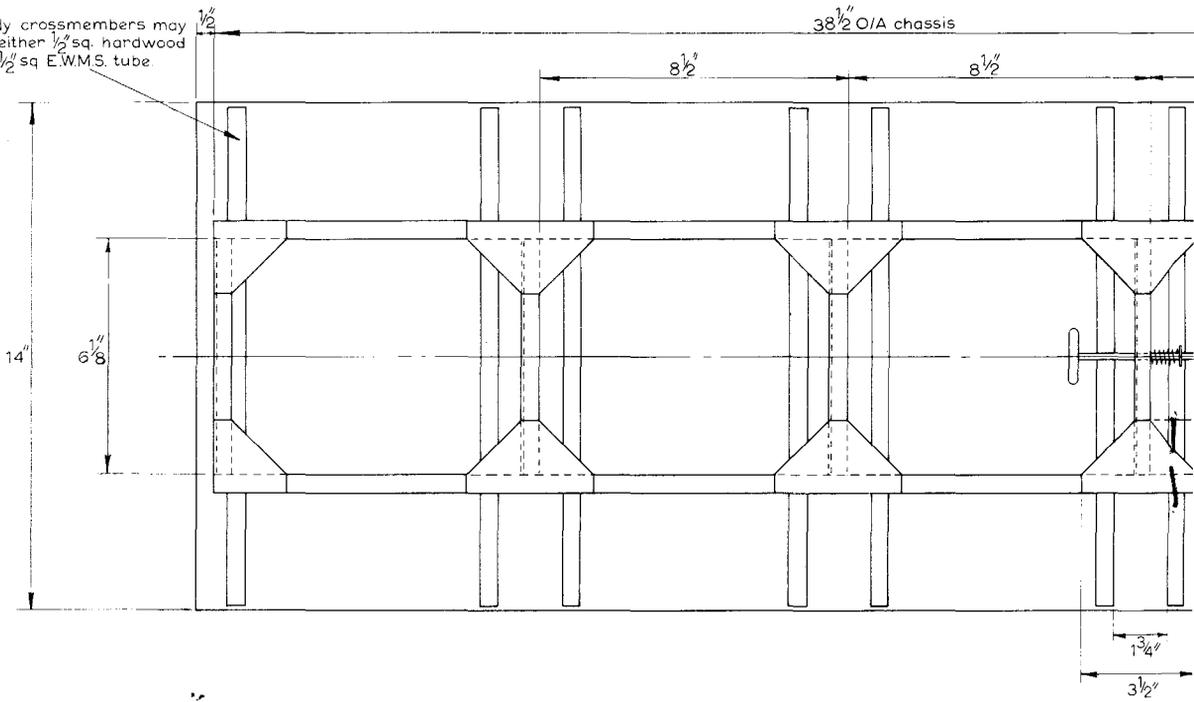
Turning our attention to the front end of the trailer, the coupling socket is mounted on the chassis via two

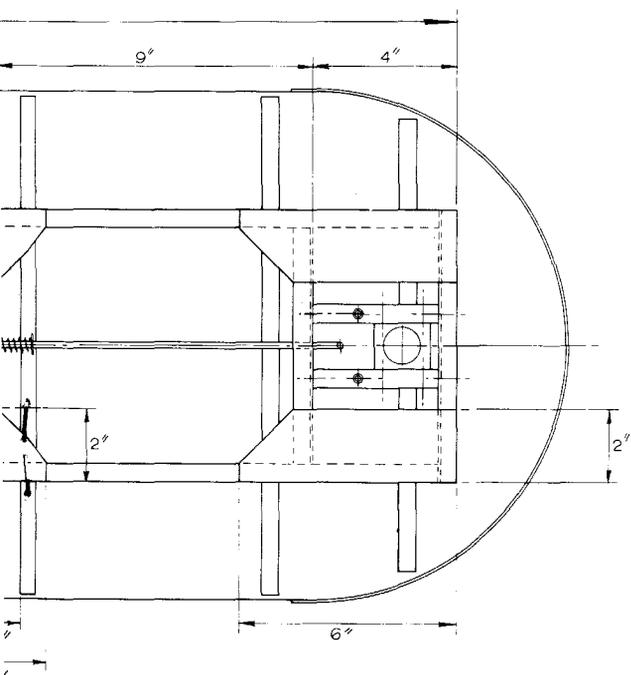
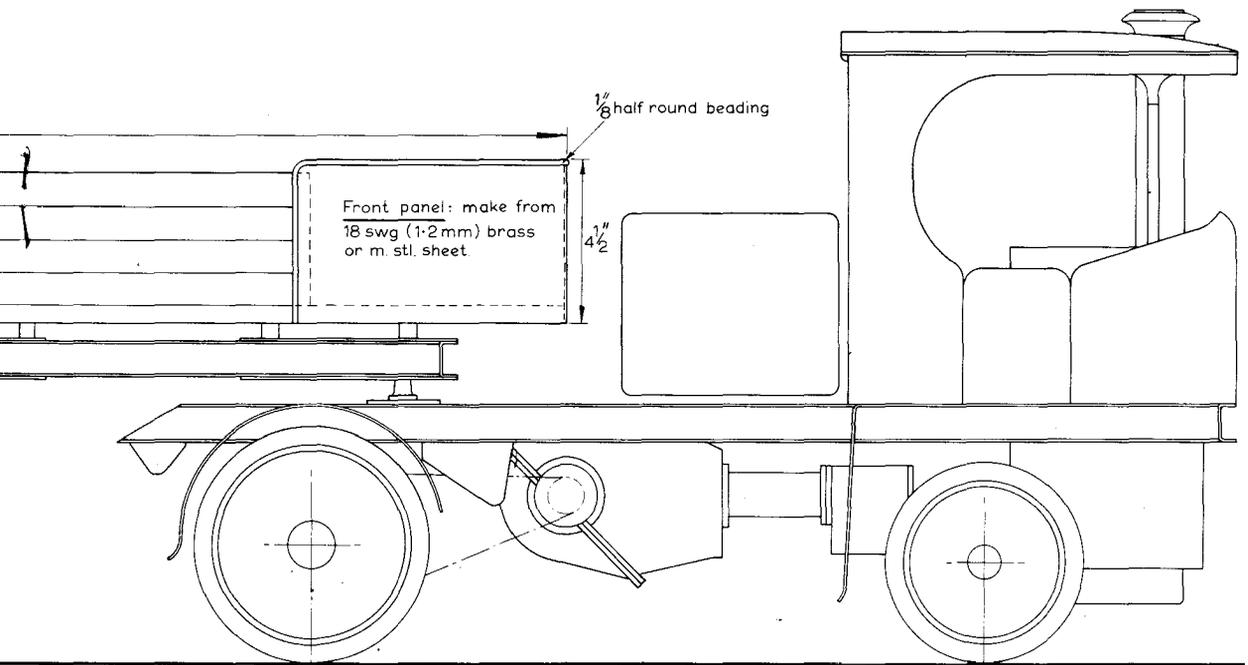


scribe lines to represent planking



Body crossmembers may be either $\frac{1}{2}$ " sq. hardwood or $\frac{1}{2}$ " sq E.W.M.S. tube

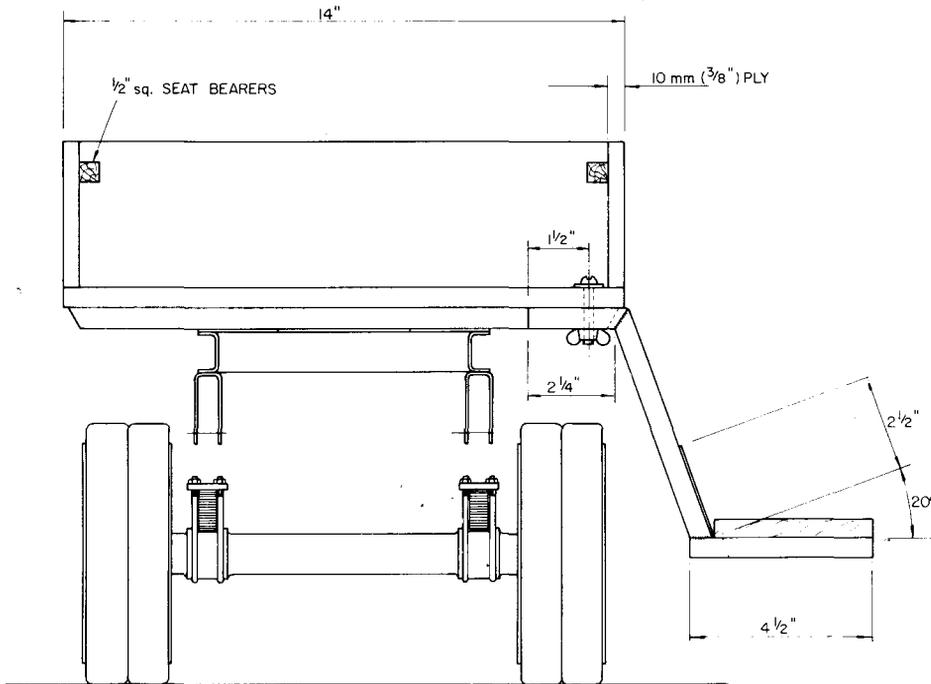




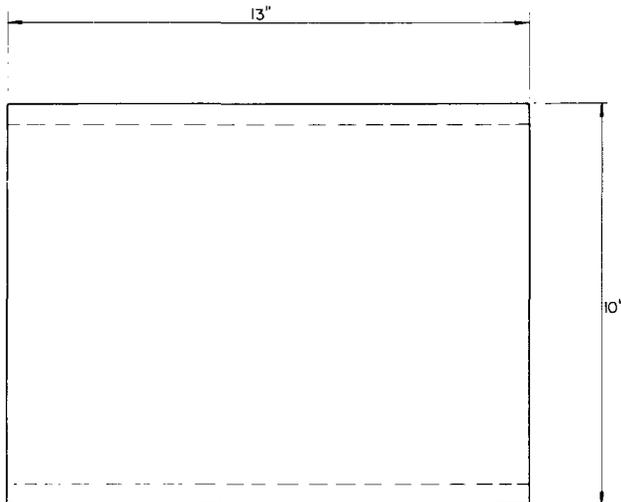
NOTE:- THE FOLLOWING CLAYTON WAGON CASTINGS
8 PARTS ARE REQ'D.:-

- 2 OFF REAR WHEEL
- 4 OFF REAR TYRE RING
- 2 OFF REAR HUBCAP
- 2 OFF AXLE COLLAR - NEAR SIDE
- 3 LENGTHS CHASSIS CHANNEL SECTION

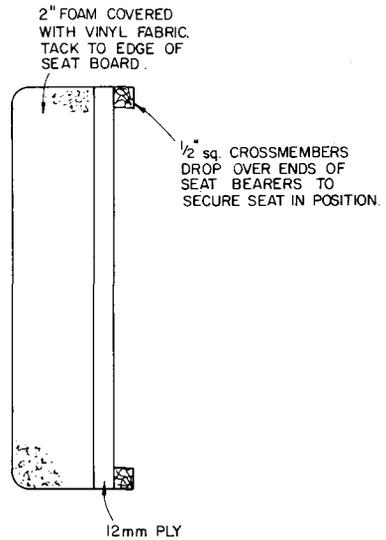
VIEW ON UNDERSIDE
with wheels etc. removed

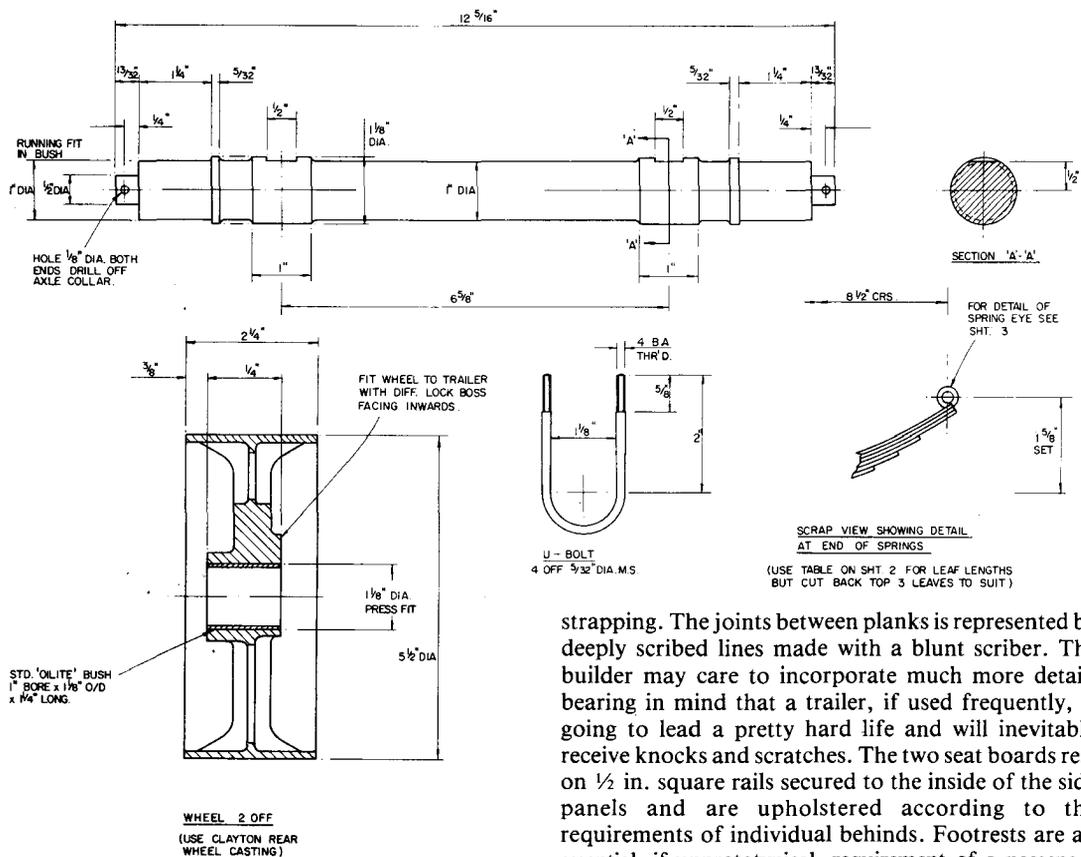


SECTION THRO' TRAILER
SHOWING ONE FOOTREST IN POS'N



SEAT 2 OFF





1/2 in. square support bars, these being tapped at the ends for securing to the first two cross-members. As to the coupling socket itself, this can be made from a piece of 1 1/4 in. square bar; it is not a very large piece and the Magpie habits of the average model engineer may come to the rescue here. It is surprising what forgotten treasures sometimes lurk in the darker recesses under the bench! A plain hole is shown for the ball hitch but a nylon pad in the bottom of the hole might make the pivoting action smoother. A keeper plate is required to prevent the trailer accidentally lifting off the ball hitch and this is kept engaged by a spring mounted on the pull rod. The end of the pull rod is bent through 90 degrees to engage a hole in the keeper plate, and the latter slides rearwards to release the coupling. The length of the shouldered screws should allow the plate to slide freely but without too much shake. The ball coupling itself — the part which is attached to the wagon — can be turned by manipulation of the cross slide and top slide handwheels, checking against a card or thin metal template, finishing off with files and abrasive cloth.

The bodywork of the trailer, as drawn, is pretty basic and is made from plywood with dummy

strapping. The joints between planks is represented by deeply scribed lines made with a blunt scriber. The builder may care to incorporate much more detail, bearing in mind that a trailer, if used frequently, is going to lead a pretty hard life and will inevitably receive knocks and scratches. The two seat boards rest on 1/2 in. square rails secured to the inside of the side panels and are upholstered according to the requirements of individual behnds. Footrests are an essential, if unprototypical, requirement of a passenger carrying trailer and are made from 1/2 in. square electrically welded steel tube or square rod and can be brazed or welded according to resources. The footrests are secured to the underside of the platform with wing nuts and are removed and stowed inside the trailer for transport. Care should be taken to see that the front end of the footboards clear the rear mudguards of the wagon when turning a corner.

The wheels of the trailer are made from the same castings as the rear wheels of the wagon; although made in aluminium they are quite capable of carrying human cargo. They are fitted to the axle "inside out" as the differential locking boss is not required. The machined dimensions of the wheel are the same as for the wagon except that the bore is made a press fit for a standard Oilite bush. These are stocked by Reeves, who advise that the bushes be soaked in oil overnight before being pressed into position.

The rear axle is a much simpler affair than that on the wagon, being stationary, and can be clamped to the springs with U-bolts. The springs sit on flats milled in the top of the axle, the U-bolts are positioned each side of the spring and the ends are passed through clamping plates identical to those on the wagon, being secured with nuts on top.

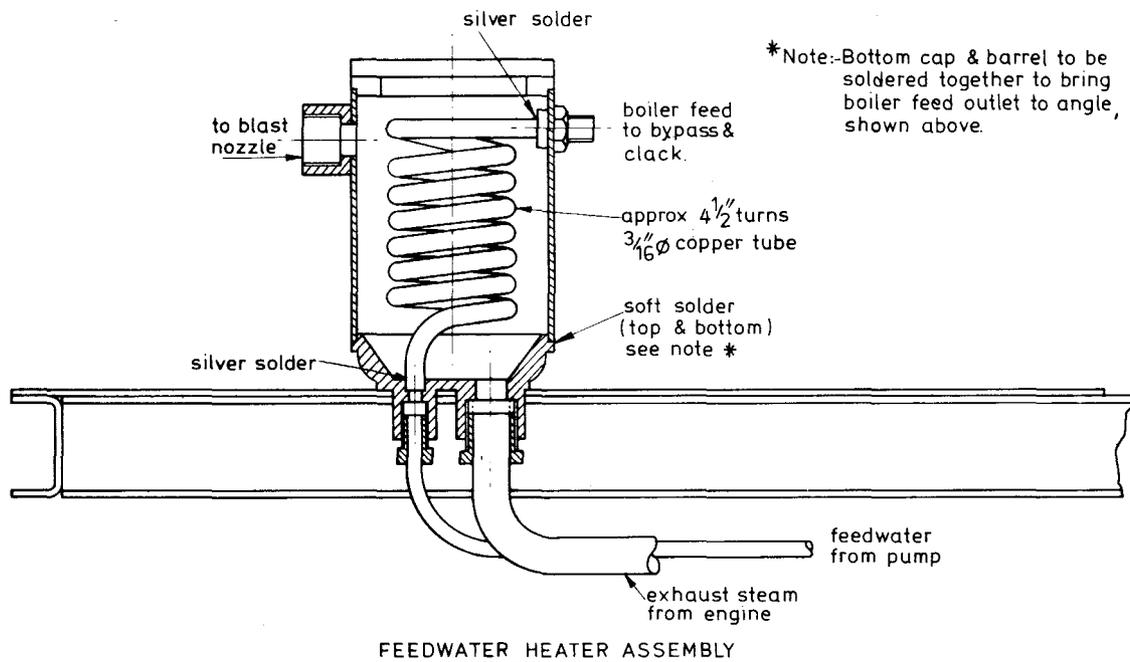
A MODEL FEEDWATER HEATER

an accessory for the Clayton steam wagon described by Robin Dyer

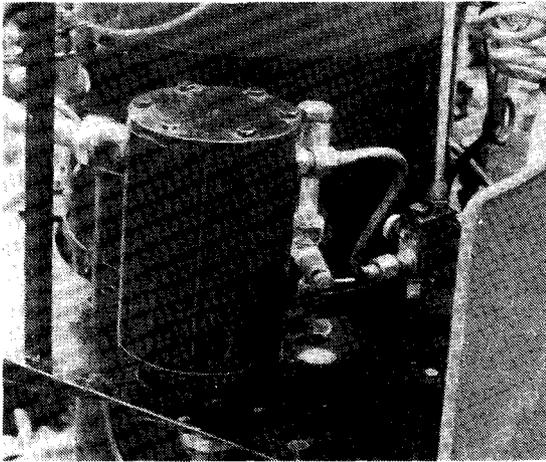
CLAYTON WAGONS LTD., along with many other wagon manufacturers, fitted their vehicles with feedwater heaters, these devices utilising the waste heat in the exhaust steam to pre-heat the cold boiler feed water. This resulted in a measure of economy in fuel consumption and thus a reduction in operating costs. Although fuel costs are hardly a significant factor in the operation of a coal fired model I was nevertheless interested to see if a miniature feedwater heater would bring about a noticeable reduction in coal consumption on my 2 in. scale Clayton wagon, and to observe any other effects. Accordingly I made up the heater about to be described and fitted it, as on the prototype, to the cab floor on the left of the boiler. Changes were of course required to the plumbing, the most difficult part being the modifications to the exhaust pipe between the engine and bottom of the heater. Eventually it all went together and the boiler was fired up with the propane torch. Results were spectacular for on opening the regulator and starting

the engine a solid column of water shot out of the chimney, struck the workshop roof and showered the model, tools and yours truly with an oily dew. Thinking that this was merely initial condensation I let things run. The fountain continued unabated until water found its way down the boiler tubes and put out the torch. It eventually dawned on me that I had created a condenser rather than a pre-heater; 10 turns of 3/16 in. copper tube inside the barrel were obviously too many, so I reduced the number to 4½ and tried again.

Results this time were much more satisfactory, with a plume of white steam from the chimney and scalding hot water being fed back to the water tank via the bypass. A number of steaming sessions, one of them for four hours continuously (nice bit of steam coal) have shown that there is, as hoped, a significant drop in coal consumption. Not only that but there also appears to be a drop in water consumption as well; whether this is due to the feedwater heater or not I



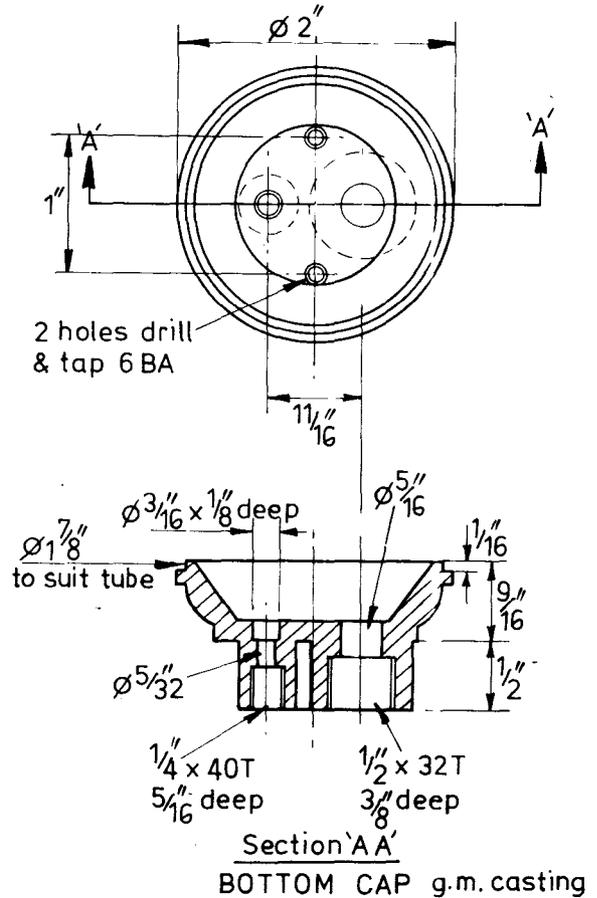
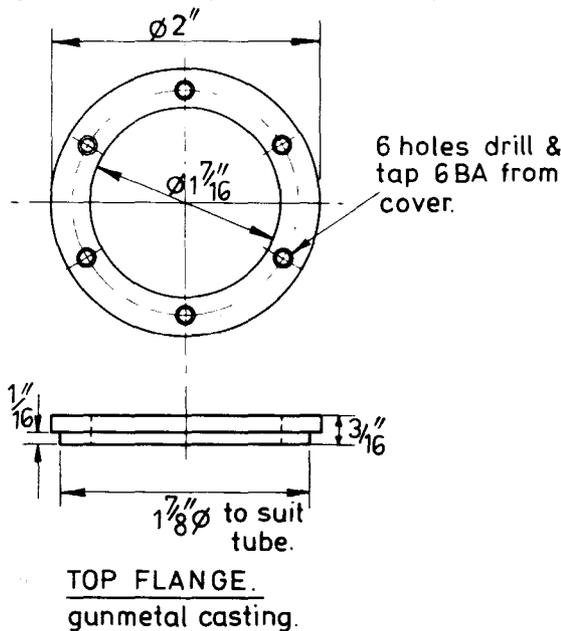
FEEDWATER HEATER ASSEMBLY



Completed installation of feedwater heater. Note modified bypass valve, necessary because of new route for feed water.

cannot say, but overall there does appear to be some advantage to fitting one. The only disadvantage arises from the position of the bypass, this coming after the heater and bleeding hot water back to the tank. The contents of the tank rapidly get very warm and render the injector inoperable. The answer is to move the bypass but my aim was to modify the original design as little as possible and make the heater an "optional extra".

Another side effect has been a reduction in the amount of "chuff" at the chimney due, I think, to the volume of the heater barrel acting as a pneumatic spring on the surges of steam coming from the



cylinders. It has been necessary to reduce the size of the blast orifice on my model to a No. 20 drill (0.16 dia.) in order to keep the fire bright.

Construction

Two castings are available for the heater from A. J. Reeves of Marston Green, Birmingham, these taking the form of a base casting and a combined bolting flange and top cap, these latter being divided after machining. Reeves can, of course, supply all the other materials as well. The barrel can be tackled first and is made from a piece of 2 in. outside diameter brass or copper tube. After skimming the ends to give a length of 2 1/2 in. the exhaust steam and water exit holes are drilled 1/2 in. from one end with a radial displacement of 110 degrees.

As mentioned above, the top cap and flange are cast as one with a chucking piece provided on the cap. This chucking piece should be skimmed to clean up and gripped in the three jaw chuck. The outside diameter can be finished and the short spigot turned to locate the flange in the barrel tube. Bore out to 1 7/16 in. dia. for a depth of at least 3/16 in. and carefully saw off the flange from the rest of the casting. The piece which is

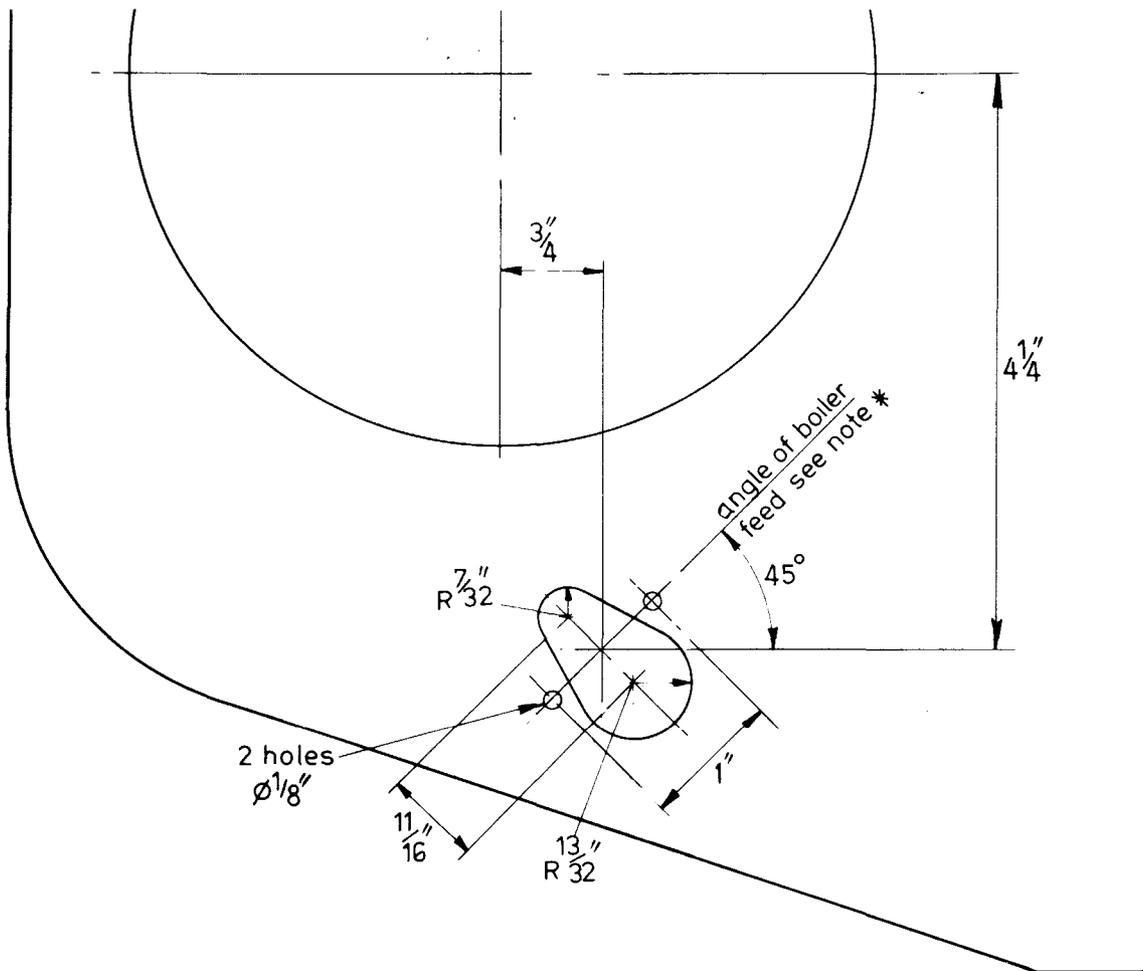
left can then be faced off to form the cap and then sawn off from the chucking piece. Both parts are then gripped by the outside jaws to complete the back faces. The cap should be marked off for the six fixing holes before being removed from the lathe.

There is relatively little machining to be carried out on the bottom cap; grip by the lower rim in the four jaw chuck and turn the outside diameter and spigot. Remove from the lathe and centre-pop the two bosses. Drill and tap the respective holes, then turn over and open up the 5/32 in. dia. hole to 3/16 in. dia., going in about 1/8 in. to form a pocket for the heater coil inlet end. The two fixing holes are next drilled and tapped 6BA, their centre line being at 90 degrees to the line of the bosses. The cap can be held by the spigot and a skim taken off the bosses to level them up; this operation would best be carried out before drilling the bosses.

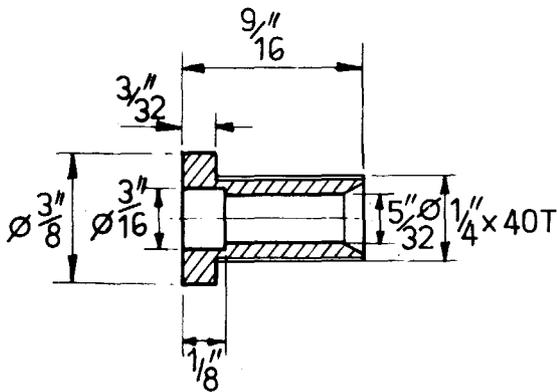
To those readers who wish to fabricate everything

themselves and who find that not every dimension is shown, I would say that it is perfectly acceptable to scale the drawing. Even the non-scale drawing in *Model Engineer* can be scaled by marking off the edge of a piece of paper against a known dimension — say 2 in. outside diameter — and dividing it up, then using the paper as a scale rule. This method is very useful when trying to use the works drawings which one finds published in books, printed to a much reduced scale.

To move back to construction, a boss is required to take the exhaust steam connection to the chimney, and this can be quickly turned up from an odd piece of brass; the internal arrangement is the same as the large boss on the bottom cap. A radius should be filed in the bottom end to enable it to fit snugly against the barrel, where it is silver soldered over the 5/16 in. dia. hole. Someone is going to write to me to ask why the exhaust steam pipes are fitted with screwed unions at the heater and flanges at the other ends. The only answer I



CAB FLOOR CUTOUT DETAILS

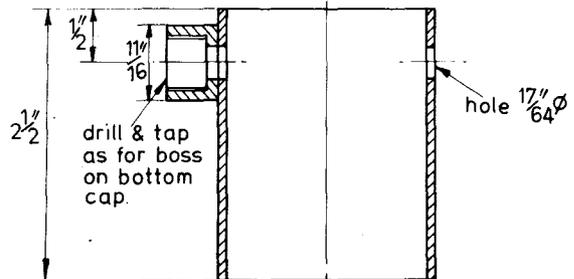
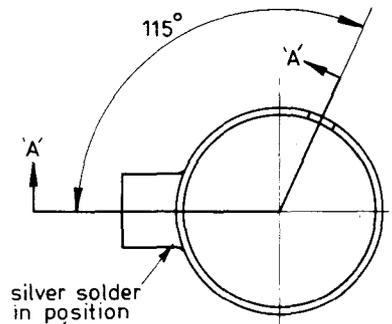


BOILER FEED CONNECTION
1 off brass

can give is that is how it was done on the prototype; it does at least make piping up much easier. The heater coil itself is made from 3/16 in. dia. copper tube and a minimum length of about 21 in. will be required. About 17 or 18 inches goes into the actual coil but some extra is required to make manipulation easier. The whole length should be annealed and, after cooling, wrap 4½ turns around a 7/8 in. dia. bar taking it gently to avoid kinking, and starting the first turn about 2 in. from one end. Slip the coils off the mandrel and re-anneal the straight bits at each end. The inlet end needs to be bent down at 90 degrees to fit in the counterbore drilled in the base cap. This is a tight bend and may need several annealings to complete. The top end (outlet end) likewise has to be bent sharply round so that it will line up with the hole in the barrel when the latter is finally secured to the base. When the coil has been finally tweaked to shape the ends can be sawn off to length and deburred.

Assembly

It will pay to have a dry run before finally soldering everything up, mainly to ensure that the heater coil ends are trimmed to the right length and point in the right direction. Having satisfied oneself that it will all go together, final assembly can begin. First, the exhaust outlet boss should be silver soldered to the barrel, and the top clamping ring soft soldered to the top of the barrel. Next the water outlet connection should be silver soldered to the top end of the heater coil, and the lower end of the latter silver soldered into the base cap, ensuring that the centreline of the cap and coil coincide. Slide the barrel over the coil — the outlet connection will need to be pushed inwards to achieve this — until it locates over the base cap spigot. Poke the outlet through the 17/64 in. dia. hole and secure it with a backnut. Mount the assembly temporarily on the footplate (assuming that the holes



Section 'AA'

BARREL

2" O.D. brass or copper tube

have already been prepared) and swivel the barrel until the feedwater outlet is positioned at 45 degrees to the wagon centreline; the exhaust pipe should then be able to sweep round the front of the boiler in front of the whistle valve. Mark the barrel and base cap in some way, unbolt from the footplate and secure the two with soft solder making sure the two marks stay together. Screw the lid on and the heater is complete.

Assuming the original exhaust pipe has been removed it may be sawn into two and modified, or two new lengths made up. It will pay, though, to make patterns out of heavy wire especially for the lower section. The copper tube will need plenty of annealing and gentle bending to avoid kinking. The lengths will also need careful checking to ensure that the union nuts can be tightened without straining the flanged connection at the other end. It will be necessary to remove the smokebox top as the blast pipe fitting will need to be re-aligned. Some of the foregoing assumes that the builder has made the wagon to the original drawings; new builders ignore the bits which do not apply.

The fitting of the feedwater heater simplifies the pump feed as the route to the bottom of the heater is more direct. However, it will be necessary to fit the bypass valve with an inlet nipple on the side rather than underneath. The pipe from the heater is then led across the top of the water gauge and down through two right angles to the bypass. The installation of the feedwater heater is then complete.