

The PROJECT Book



By Ron Poulter & Bob Hines

**How to construct a simple single cylinder, high pressure
0-6-0 steam locomotive and tender in Gauge "1"**

Published by the Gauge 1 Model Railway Association

Edition 5

The PROJECT Book

by Ron Poulter & Bob Hines

Published by The Gauge "1" Model Railway Association [G1MRA].

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First published 1970 type-written text and hand drawn sketches, printed on a stencil-type Roneo duplicator

2nd Edition 1971 reprints of the original printed on a small offset-litho machine

3rd Edition 1982 improved drawings, giving a more readable copy, printed on a small offset-litho machine

4th Edition 1996 new drawings, computer typeset, professionally printed.

5th Edition 2013 new drawings, computer typeset, printed using publishing on demand

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Edition 5 Designed & Edited by Martin Hulse

Drawings by Roger Thornber

Find out more about G1MRA at

www.G1MRA.com

including details of how to apply for membership

The cover picture showing Bob Hines' original Project was taken in 2013 after the overhaul described in G1MRA News Letter & Journal 238 when it was 45 years old.

The picture on the right shows Bob Hines standing by a display of engines built using the Project design at the G1MRA AGM in 2010 with the then G1MRA Chairman Michael Wrottesley. The display was staged to celebrate 40+ years of the Project design



INTRODUCTION

PREFACE TO 1ST EDITION

During our various exhibitions quite a number of visiting members have said - "I'd like to build a Gauge 1 engine but I just don't know where to start". Now it occurs to us that a constructional article on the subject would be a useful exercise, so - after mulling it over with Bob - we decided to have a go; we shall, in fact, be doing an "LBSC"; we shall build a loco and describe each step as we go along. So pick up your files, all you "Don't know where to starters", and get cracking.

The engine we have chosen for a prototype is the ubiquitous Fowler 4F, an 0-6-0 tender job. No bogies, no ponies, simple outline, and a tender because we felt it would be easier than a tank engine. It will be a single cylinder animal, again for simplicity - getting two 'pots' in starts to get a bit like watchmaking. Another reason for the 0-6-0 outline is that it can be adapted to a vast variety of prototypes: the principles are the same, only dimensions differ.

So - are you sitting comfortably? Yes? Then we'll begin

Ron Poulter 1968

Just before you start I would like to put a word in here:-

The only purchased components will be wheel castings and a pressure gauge. The rest will come from raw materials. Because of this a fair amount of equipment will be required, and therefore this series is aimed at those of you who are equipped reasonably well for live steam production but have been thwarted by lack of information or expertise. The minimum equipment we shall require is, of course, a lathe with a simple range of tools, and a means of keeping them sharp; a set of number drills; B.A. taps and dies (or their metric equivalent) and the popular 40 T.P.I. sized taps and dies. A bench vice, hacksaw, files and a hand brace are obvious requirements. A small tool-maker's clamp and marking out instruments will also be needed. For silver soldering, including the boiler, we recommend the Calor Gas (Primus Sievert) 2000 propane equipment, with jets Nos. 8720, 8719, and 8725. When it comes to drilling the steam ways in the cylinder block, access to a small bench drill with machine vice will be a great asset.

Bob Hines 1968

PREFACE TO 5TH EDITION

Some 45 years have passed since the first Project book arrived on the scene. Much steam has passed under the bridge since then and the scene today for the newcomer to the gauge one hobby is vastly different to how it was 45 years ago. When the Project was conceived the membership of G1MRA had just about reached 200 and the support from the trade was very limited. To get started then there was no alternative but to build your own, that is if you had the know how and some suitable tools. The book was designed to provide the know how.

Back in those days I could never have guessed that I would be invited 45 years later to provide the preface for a 5th edition. It gives me great

satisfaction that I was part of something that has not only resulted in the production of very many successful steam models but also the successful introduction of many newcomers to our hobby. Today's builder has a lot more help in that pre-cut metal parts are available. Use them by all means but do remember that there is no substitute for that wonderful feeling you experience when your work turns the wheels for the first time under its own steam and you can say 'I made that'.

Long live the Project.

Bob Hines 2013

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EDITOR'S NOTES ON 5TH EDITION

As you seen from the inside cover and read in the two prefaces, this book has already been in print for many years. The fourth Edition aimed to create a base for further corrections. Unfortunately the computer files were lost, which has meant that for some time copies were reproduced from aging paper masters, and corrections were not practical. I decided to revisit this aim, and have recreated this fifth edition of the Project book using today's technology.

A fresh approach to the layout has been taken with:-

- Words from the fourth edition, revised where necessary.
- The drawings redrawn by Roger Thornber, with some design changes.
- Exploded views and parts lists have been added for each section. The table of contents shows where part numbers can be found. The exploded views show how parts come together. Parts are referred to with their part numbers, for example [35].
- Some of the photographs have been replaced by 3D views where these provided more clarity.
- Colour has been added to the drawings, especially to distinguish dimensions from outlines.
- The modifications suggested by Ron Poulter to the lubricator steam feed and boiler manufacture have been used to modify these sections .
- A new cover picture.
- General arrangement drawings have been added.

This fifth edition aims to keep to the original design, except where a change is useful. The most obvious visible change is moving the lubricator to the right side, to give a neater backhead. The changes from previous editions are:-

- Slide valve rod and nut instead of filed rod. Easier to construct, get dimensions right, and adjust.
- Lubricator now on right. Tidier backhead
- Tender has axle bushes. Means they wear, not holes in frames.
- Alternative way of setting valve gear included.
- Sheet metal in metric thicknesses or fractions instead of SWG because that is what can be bought today.

We now have an edition that preserves the original work whilst adding those modifications that have proved themselves. We also have a base which can be built on to incorporate future changes and corrections as these are identified.

Equally important, the printing technology that is best for G1MRA can be used each time more copies are needed, and we can start to consider other ways of using this asset, such as electronic copies.

If readers find errors then let me know please so we can correct them. If builders explore variations then please write these up for the G1MRA Newsletter & Journal - we can build up a library of variations to consider via the G1MRA website.

Gauge 1 has changed since the original Project book was written. We used to assume the builder would make everything except the pressure gauge and wheel castings. As the membership of G1MRA has grown to over 2500 members commercial suppliers have provided many more choices to the builder of this Project design. If you join G1MRA you will find details in the G1MRA suppliers list. So if you would like to buy some of the Project parts rather than make them you will find laser cut frames, ready made boilers, pretuned wheels, complete buffer sets, etc are all available from suppliers. But do make sure they will work together - it is difficult for example to fit wheels with round holes to axles with square end shafts!

Many hands have worked on the Project book over the years, too many to name them all. We have Ron Poulter & Bob Hines to thank for the original design; Barry Applegate for technical advice and the axle pump; and new drawings for this edition from Roger Thornber that make it come alive. To everyone else who is not mentioned by name we apologise, but rest assured that we are very grateful for all your help.

As Editor I hope to have kept the Project design tradition whilst improving the layout and readability. The changes and additions are my decisions, as are any mistakes. Enjoy this 21st century Edition 5 of what is already a G1MRA classic book

Martin Hulse
G1MRA Vice President
2015

FOWLER CLASS 4F LOCOMOTIVES

PROTOTYPE INFORMATION

The 4F class was the last and largest development in a long line of 0-6-0 tender engines developed by the Midland Railway under a number of designers including William Kirtley and Samuel Johnson. The 4F's were designed by Sir Henry Fowler and first appeared in 1911. The Midland Railway built 192 at Derby works before the grouping in 1923, after which a further 580 engines were constructed by the LMS up to 1940 to the same design, giving a total of 772 engines of this type.

The Midland Railway built locos were numbered from 3835 to 4026 and the LMS built examples from 4027 to 4606. On nationalisation of the railways in 1948 all LMS engines were renumbered by the addition of 40000 to the LMS number, the 4F's then appearing in the 43835 to 44606 range. On the Midland Railway the engines were known as class 4's, the 'F' not being added until in LMS days to denote freight (or goods) engines.

Five engines were built in 1922 for the Somerset and Dorset Joint Railway and ran as Nos. 57 - 61 on the SDJR. When the engines were taken back into LMS stock in 1930 they took up their intended LMS numbers 4557 - 4561.

The Class 4 (or 4F) 0-6-0 tender engines were used mainly on freight and secondary services throughout the Midland and LMS network and did sterling service throughout their working lives.

PROTOTYPE LIVERIES

The livery of the 4F's stayed very much the same throughout the life of the class, the main differences being the style of lettering and numbering used. The locomotives were painted all-over black, with vermilion buffer beams and the inside of the main frames.

Midland Railway

Some engines were originally equipped with tenders from withdrawn locomotives and, as a result, these tenders were much smaller than the Fowler design. All locomotives were later fitted with the Fowler design tender. Midland engines carried the number on the tender sides in 18" high numerals. The power classification '4' was carried on the cab sides midway between the cut-out and the cab front. The numerals were gold leaf with black shading. A cast number plate was mounted centrally on the smokebox door. The Midland coat of arms was carried on the cab sides. Full details of the style of numerals can be found in "Midland Locomotives

-Volume 1" by R. J. Essery and D. Jenkinson, Wild Swan Publications Ltd., ISBN 0 906867 274.

LMS - 1923 to 1927

The first LMS style closely followed the Midland Railway practice with the engine number on the tender. The numerals were gold leaf with black shading until 1927 when a blended red shading was introduced. "L M S" was carried on the cab sides -at first just the letters but later outlined in a frame.

LMS -1927 to 1946

The second LMS style had the engine number on the cab sides and "LMS" on the tender sides. The numeral style was similar to that used by the Midland but the variety of letter colour and shading ranged through plain gold, gold shaded red, yellow shaded red or plain yellow! The power classification was carried in the same position on the cab sides (4F after 1928).

British Railways

The British Railways livery was similar to the second LMS style with the engine number on the cab side and the British Railways emblem on the tender side. There were two styles of emblem, the first being used up to 1956. The numerals were either 8" or 10" Gill Sans and coloured cream. In the early 1960's electrification warning flashes were added.

Further details of LMS and BR liveries:-

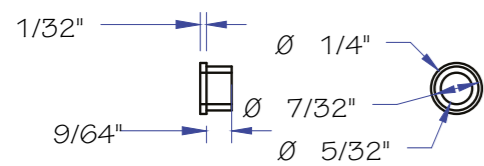
"LMS Locomotives, Volume 1", by R. J. Essery & D Jenkinson, Oxford Publishing Co., ISBN 86093 087 4

"Railway Liveries - BR steam 1948-1968", by Brian Haresnape, Ian Allan, ISBN 0 7110 1856 1 Preserved Locomotives

There are four 4F's preserved as follows:- No.3924 - Keighley and Worth Valley Railway.

No.4027 - part of the National Collection - based at the Midland Railway Centre, Butterley.

No.4123 - on the Avon Valley Railway. No.4422 - on the North Staffordshire Railway, Cheddleton.

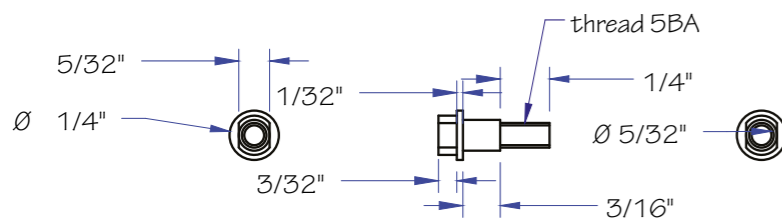


Coupling rod bushes - 13

COUPLING ROD BUSHES - 13

The bushes for the coupling rods can be made of brass or bronze, and are the same shape as the axle bushes, and made in the same way. Use 1/4" dia. rod, turn a shoulder 7/32" dia. x 9/64" long, centre and drill up to No. 21, part off leaving a 1/32" thick flange; make the 7/32" shoulder about a thou oversize so as to be a good press fit in the rod.

CRANKPINS - 14



Crankpins - 14

Make the coupling rod crankpins from 1/4" dia. mild steel rod. Chuck in the 3 jaw, face off, turn down to 1/8" dia. for a 1/4" length, turn down a further 3/16" length to 5/32" dia.,

die 1/8" dia. with 5BA thread, cut off leaving at least 1/8" of 1/4" dia. rod; make six off; now chuck one of the pins, gripping on the 5/32" dia. (1/4" dia. shoulder up to the jaws), face off to 1/8", turn down to 190 thou. by 3/32" deep, switch off lathe and set No.1 jaw at 'top dead centre', and file a flat on the 3/32" section about 1/8" long; rotate chuck 180 degrees, and file a flat on the other side. These flats should just fit an 8BA spanner. Repeat the performance with the other five, and that's the pins done.

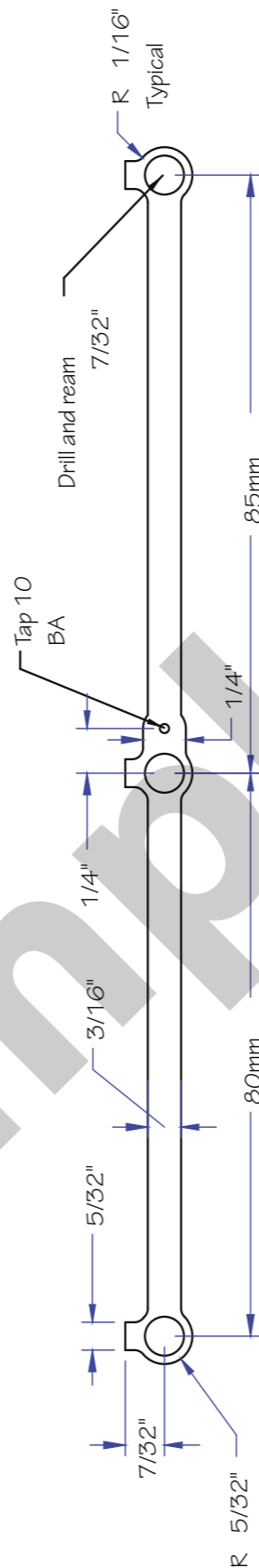
Special pin for marking coupling rods

We shall require one more special pin to assist in marking out the coupling rods; for this use a piece of 3/16" diameter silver steel. As before, chuck, face off, turn down to 1/8" dia. by 1/4" deep and thread 5BA, cut off leaving about 1/4" of 3/16" rod; now reverse in chuck, and grip on the 3/16" dia. about 1/8" in the jaws, set the top slide over to 45 degrees, and turn down the pin to a point. You will probably find that you are running into the jaws before you get to a point, but don't worry, just leave a shoulder on the pin by cutting in to a point just short of the jaws each cut. When you've got to a point, put it in the vice and file the spanner flats; put this pin in a safe place until we come to the coupling rods.

COUPLING RODS - 12

The coupling rods are made from mild steel 3/8" x 1/8". Mark out and cut and file them to shape, or if you prefer, set them up in the lathe and mill them, drill and ream the centre hole only at this stage, and press in a bush. We shall require two dummy axles made from brass with the shouldered part slightly shorter than the width of the wheel, say 6.5 mm, drill and tap the ends of these axles 6BA, and set the lot up in the frames in the front and centre axle positions, with the wheels held on by countersunk screws and washers. Note: the wheels need not be a press fit on these axles, hence the screws and washers. Put the special pointed crankpin in the front wheel, and the coupling rod plus its proper pin in the centre wheel, with a washer between the rod and the wheel to act as a spacer. Set both wheels with the crankpins forward and in line with the axles, and gently rub the rod on the point of the pin in front of the wheel; rotate the wheels 180 degrees and again mark the rod on the pin. The two marks thus made should be coincident, but if there is any discrepancy, centre-pop between the lines, drill, ream and press in a bush. Repeat this for all four wheels and make a note of which wheel goes where.

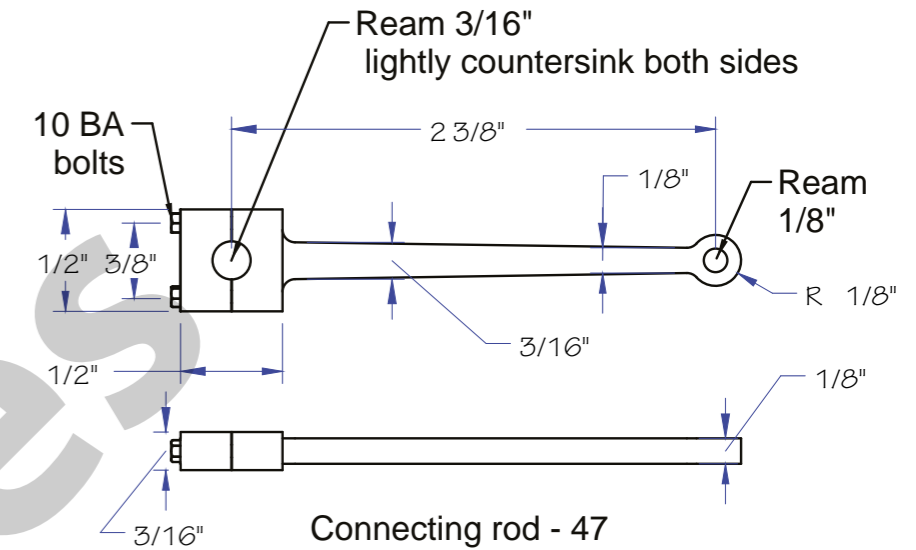
The 10BA hole marks the pivot point if the rods are to be split into two parts. Only necessary if axles are sprung and not described further here.



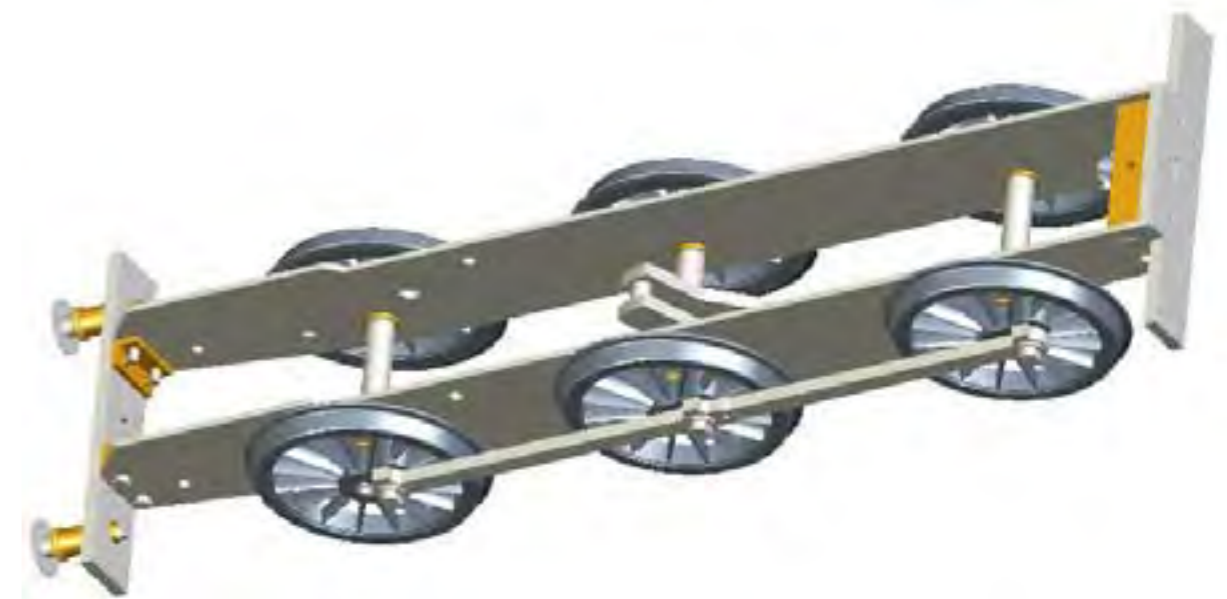
CONNECTING ROD - 47

The connecting rod is made from brass strip 3/16" by 1/2". Square off one end and drill two holes for the big end screws No. 55, about 5/8" deep, scribe a line across at a 1/4" from the end you've just drilled and cut it off dead square; this is best done in the lathe with a slitting saw, which will leave a true square face for the joint. Mark the two pieces so that they can always be assembled the same way round. The rest of the connecting rod can now be marked out, the small-end hole drilled, and the rest of the connecting rod can be filed down to size quite quickly, finishing up with a strip of emery cloth laid on a file to obtain a fine finish. Drill out the top section of the big end 10BA clearance - No. 50 drill - and tap the lower half; assemble with two 10BA screws. Now make a light centre pop half-way across the joint, drill No. 50, open up to 1/8", then by gentle stages open up further to No. 13 and then ream 3/16" diameter - a light countersink on either side will allow for any silver solder round the crankpin/web joint

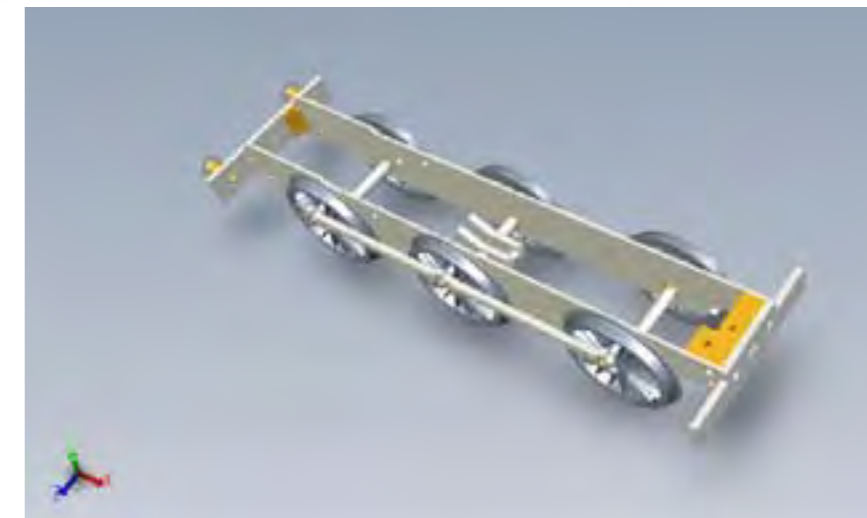
When you put it all together the chassis, without axle pump, looks like this. But don't fix the wheels on the valve eccentric side until you have made the eccentrics(s) and stop collar(s), put them on the middle axle, and sorted the valve timing.- otherwise you'll have to take one wheel off the middle axle to make changes.



Connecting rod - 47

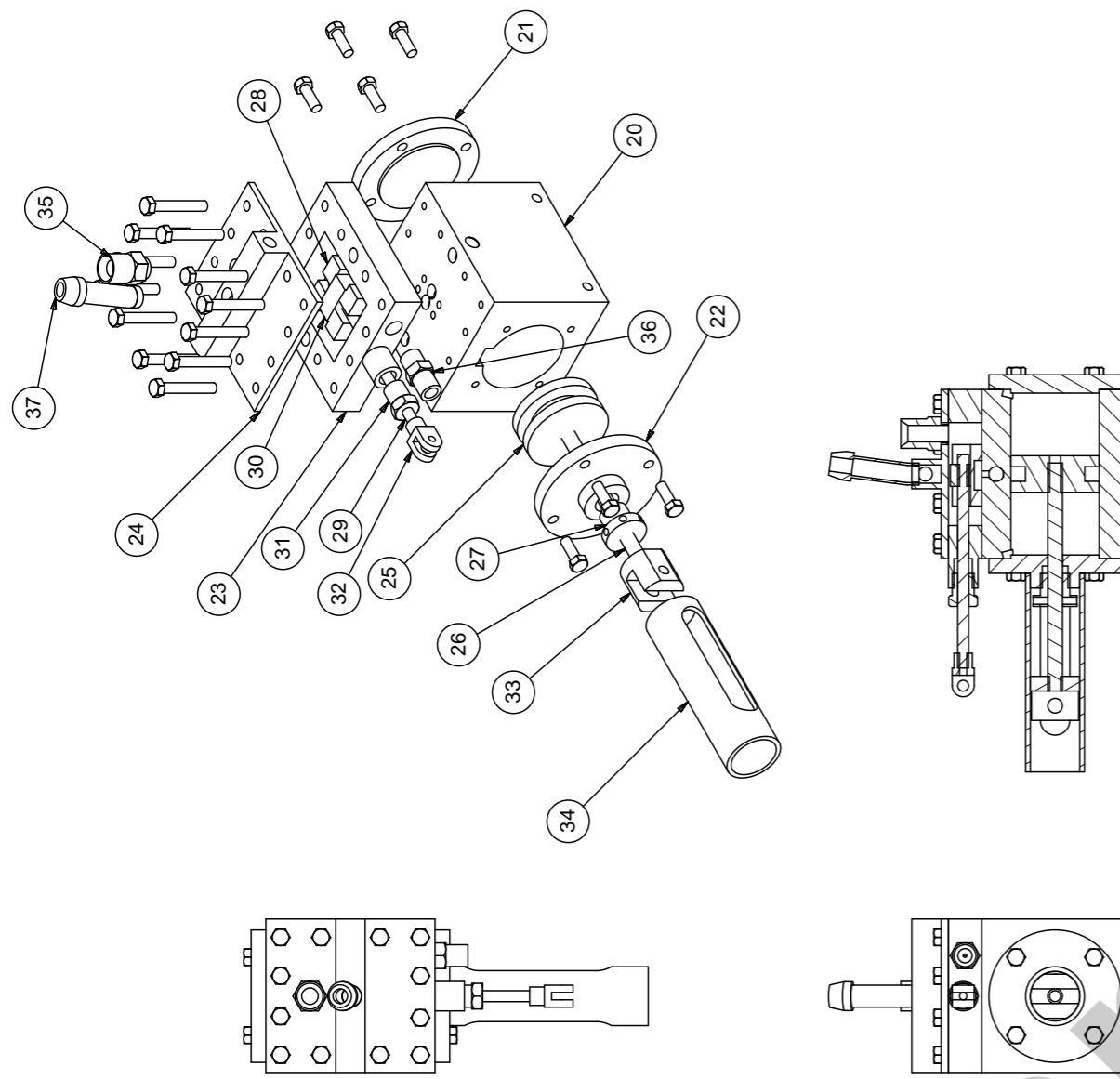


If you plan to fit an axle pump then look in Appendix C at back and use part 306 instead of part 6 as the inner block on the drag beam. See this graphic for difference



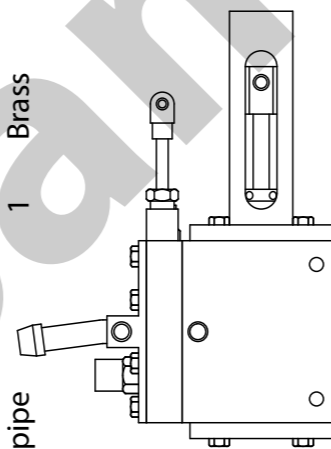
CYLINDER AND MOTION SECTION

PARTS LIST AND EXPLOSION



Cylinder assembly

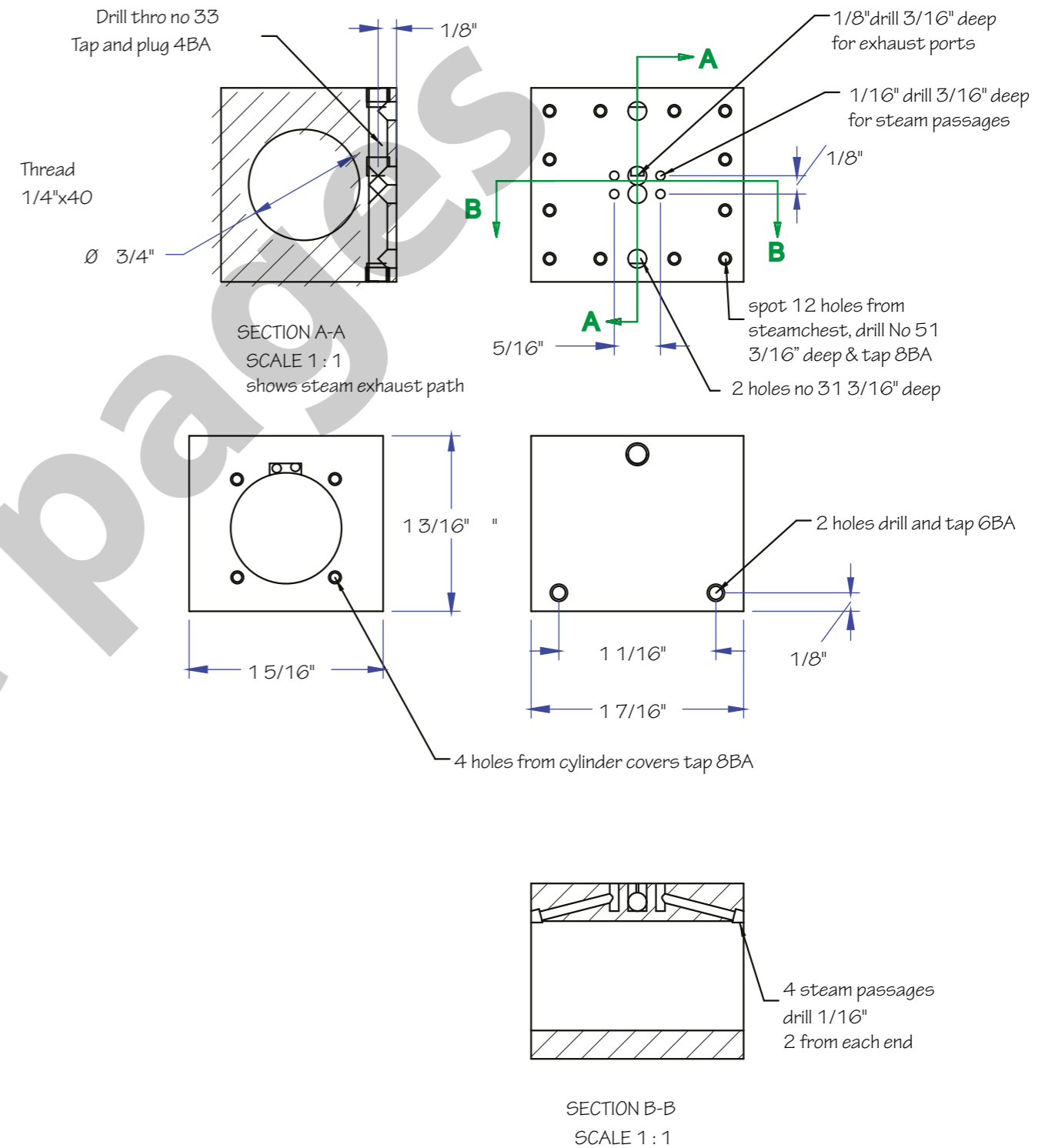
20	Cylinder block	1	Gunmetal or brass
21	Front cylinder cover	1	Brass
22	Rear cylinder cover	1	Brass
23	Steamchest	1	Gunmetal or brass
24	Steamchest cover	1	Brass
25	Piston	1	Brass
26	Piston rod	1	Stainless steel
27	Piston rod gland	1	Brass
28	Valve	1	Brass
29	Valve rod	1	Stainless steel
30	Valve nut	1	Brass
31	Valve rod gland	1	Brass
32	Valve clevis	1	Steel
33	Crosshead	1	Steel
34	Trunk guide	1	Brass tube
	8 BA bolts (short)	8	
	8 BA bolts (long)	12	
35	Steam inlet adaptor	1	Brass
36	Lubricator adaptor	1	Brass
37	Blast pipe	1	Brass



CYLINDER BLOCK - 20

This can be machined from ordinary free cutting brass, or gunmetal if you happen to have some. Avoid the harder bronzes as this material will be a nightmare to drill for the steam passages.

MACHINING CYLINDER BLOCK 20

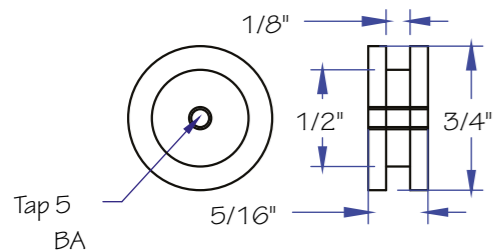


Chuck in the four jaw, and face one of the frame facing sides. Remove and mark off from this face 1 5/16" on all four sides. A useful tool for this operation is the "oddleg" callipers, and a spot of marking blue painted on before scribing is a great help. Replace in the four jaw with the one machined face against the body of the chuck and now face the opposite face until you nearly reach the scribed marks. Turn the lathe over by hand and observe whether your facing line is parallel on all four edges with the scribed lines. If not, slightly-slacken chuck jaws and tap to try and correct the error. Take a light cut and check again. When you are satisfied that all is well, complete the facing until the scribed lines are reached. Check with a rule that the block now measures 1 .5/16" and then remove.

PISTON AND DRIVE

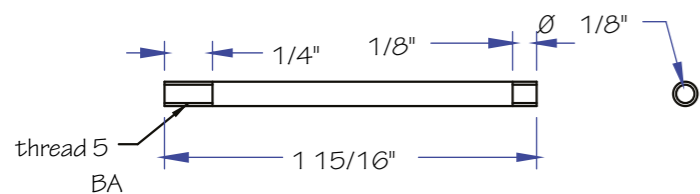
PISTON - 25

Note that groove is drawn for traditional packing. If an O ring or PTFE ring is used then different dimensions will be needed.



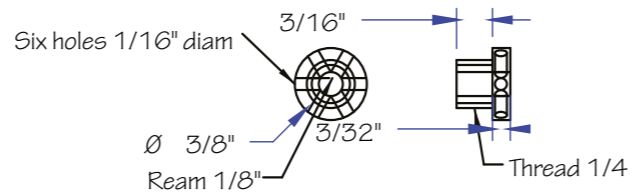
Chuck a piece of phosphor bronze or gunmetal rod in the 3-jaw, and face and turn down a length of about 7/16" until it is about 5 - 10 thou bigger than the cylinder bore. With a parting tool, partially part off a length of 5/16" plus and, with the same tool, turn a groove about 1/8" wide and a similar depth, for the packing. Note the word partial - the parting off is completed later. This operation is usually quite brutal, and this is why I suggest getting it done early, because if the material should shift in the chuck, we have not defined the bore or o.d. at this stage. Centre drill and open out with a No. 38 and, by holding a 5 BA (or 1/8" x 40 if you prefer) tap in the tail stock chuck, tap this hole for the piston rod. Now finish turning the o.d. until it just enters the cylinder bore; remove any burrs and finish parting off.

PISTON ROD - 26



The piston rod is a length of 1/8" dia. stainless steel rod, threaded both ends 5 BA (or 1/8" x 40 if you prefer). These threads should be cut using a tailstock die holder, or holding the tailstock against the back of the die in a hand stock to ensure that the threads are true. The piston can now be fitted to the piston rod and, with a fine file or emery paper - with the piston rod gripped in the 3-jaw - reduce the piston size until it becomes a good sliding fit in the cylinder bore without shake. This is the most important fitting job of the whole engine.

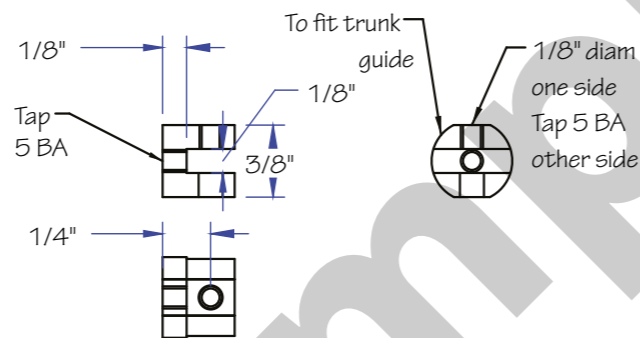
GLAND BUSH FOR PISTON ROD - 27



For the piston rod bush, use a piece of 3/8" o.d. bronze rod. Chuck this in the three jaw, face the end, and turn down a length of 3/16" to 1/4" dia and thread 1/4" x 40 using the die in a tailstock die holder to ensure that the thread is true. Make a deep centre with the Slocombe centre drill, and then drill with a No. 31 drill to a depth of not less than 3/8". Follow this with a 1/8" reamer as far as it will go. Using the chuck jaws as a crude indexing device, mark off six marks on the 3/8" dia, using the turning tool as a scriber. These can then be centre popped whilst still in the three jaw. You can now part off, leaving the flange 3/32" thick.

Take a piece of brass hexagon, centre, drill and tap one end 1/4" x 40. Screw the gland bush in to this so that the 6 centre pops align one each with the flats on the hexagon. Using the hexagon as a support, drill six No. 55 holes into the flange. Try and avoid breaking through to the centre hole, but if you do, it won't matter. Finish by hand, reaming the bore with the 1/8" reamer.

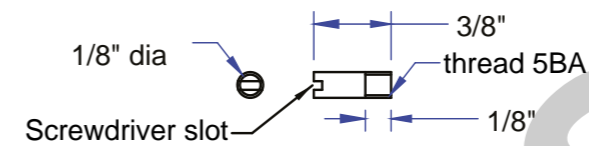
CROSS HEAD - 33



Take a length of 1/2" dia mild steel and file a pair of parallel flats on one end a good 3/8" across the flats. Place the bar in the 3-jaw chuck and turn down the end with the flats for 1/2" long until it is a good sliding fit in the trunk guide. Centre and drill No. 38 for about 5/8" deep and tap 5 BA also as deep as possible. Remove from the 3-jaw, and centre pop on one flat 1/8" in from the end and on the centre line the other way. Drill this centre pop No. 38 being careful to drill square with the axis of the rod. With the bar upended in the vice, flats uppermost, saw and file a slot, parallel to the flats, 1/8" wide and 1/4" deep. Open out the No. 38 in one limb to 1/8" and tap the other limb 5BA. Cut off from the bar a good 3/8" long and clean up, to result in overall length of 3/8".

GUDGEON PIN - 38

The gudgeon pin is a short length of silver steel rod to fit the 1/8" hole in the cross head, and threaded 5 BA for a length of 1/16" plus. Cut off at 3/8" long



and saw a screw driver slot in the unthreaded end. A test assembly of cross head, gudgeon pin and connecting rod can now be carried out. The connecting rod must have sufficient angular movement to allow the big end to follow the crank around. When you put the cylinder parts together it should look like this.

