

ARMIG

the other way round



Design by Dick Moger

CAD by Bob Gamble

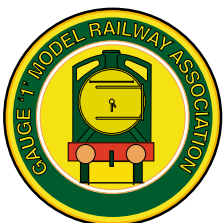
Book by Martin Hulse

A twin inside cylinder, butane gas fired

0-4-4 tank locomotive

at 10mm = 1ft scale

to run on Gauge '1' tracks



Published By The Gauge '1' Model Railway Association

Acknowledgements

In the end, this has proven to be one of the most difficult tasks I have undertaken. This is not from the standpoint of technical complexity because it is a very simple design, but in order to make the end product simpler, much more has to go into the overall design and presentation than is usual.

This could never have happened without a major input of skills and enthusiasm from others and I apologise in advance if I have managed to miss anyone off this list.

First and foremost, the efforts put in by Bob Gamble and Martin Hulse have been prodigious. Translating my Autosketch drawings and text into something more useable was a hard enough task in itself, but to raise the game with the layering and colour and to make them so readable required a level of skill and dedication quite out of the ordinary. This is not the limit of their involvement as I was the beneficiary of an endless stream of suggestions and enhancements.

I would also like to thank the large numbers of both the members of G1MRA as well as the officers of both the G1MRA administrations concerned with this book. Ideas and helpful comments have come from many, including Barry Applegate, Roger Marsh and late John Van Riemsdijk. Without their support, this would never have happened.

I need to particularly thank Alan Coombe, Andrew Pullen and Gordon Watson for supplying me with bits at the appropriate time in order that this venture could meet a few deadlines.

A special thank you has to go to the G1MRA Yahoo forum for provoking the idea in the first place. This is what it does best!

My final thanks must go to both the ARMIG Trial Group and those manufacturers brave enough to commit time and resource to something that truly represents a huge leap of faith. Let us hope that the results over the coming years justify their decision.

Dick Moger

Dick Moger provided the cover picture which shows the original ARMIG HD1 prototype, and many of the construction pictures inside. The remainder have come from the trial builders.

ARMIG is published by the Gauge '1' Model Railway Association Limited [G1MRA], London, England. Information on G1MRA can be obtained from their web site at www.gaugeone.org or by writing to the Membership Secretary at PO Box 581, Earls Barton, Northampton, NN6 0YW, England.

Other books published by G1MRA include:-

The Project - how to construct a single cylinder 0-6-0 Gauge 1 tender locomotive

The DEE - how to construct a two cylinder 4-4-0 Gauge 1 tender locomotive

A series on Modelling in Gauge 1 containing extracts from over 60 years of the G1MRA Newsletter

A Photographic history of 60 years of G1MRA

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Organisations and individuals who wish to supply components and assemblies to builders of ARMIG should contact Dick Moger.

Editor's note

This book is being created as G1MRA celebrates 40 years of the Project design, so a little reflection on G1MRA designs seems appropriate.

The Project book documented a single cylinder design for an 0-6-0 tender locomotive based on the ubiquitous Fowler 4F. Ron Poulter (one of the two authors) said it answered the perennial comment at exhibitions "I'd like to build a Gauge 1 engine but I just don't know where to start". Bob Hines (the other author) added that the only purchased components would be wheel castings and a pressure gauge, every thing else could be made with a lathe and a good set of workshop tools.

Many thousands of Project books have been sold, and the engines built from the Project design must number hundreds, with many variations on the 0-6-0 chassis, including an 0-6-0 + 0-6-0 Garrett, and derivatives in other configurations.

The Project book is still very much alive and well and provides a starting point for those who want to construct their first Gauge 1 locomotive using the traditional workshop approach.

Discussion on the limitations of the Project design have been many and continue today. The single cylinder approach can make for some problems both in running and fitting everything inside the frames.

In April 1993 the idea of round chambers for slide valves was raised at the G1MRA forum on twin inside cylinders. In 2001 the DEE book by Dick Moger & Barry Applegate was published. DEE is a twin inside cylinder design, using the round valve chambers idea, which gives a small cylinder block allowing successful Gauge 1 models of many 4-4-0 configurations, such as the Wainwright 'D' class on which DEE was based. DEE again assumes only wheel castings and pressure gauge need to be bought.

Many thousands of the DEE book have been sold and Dee has been built in quite some numbers around the world, but the preponderance of commercial models on our tracks gives the impression that model engineering as such is now in a minority. Nowadays it is possible to buy a Gauge 1 engine ready to run or a kit that requires simple assembly, whereas in the past you had to wait for a model to be available on the second hand market or learn to build your own from scratch.

In recent years the model trade has made available components for Project, DEE and other published designs that allow the builder to make only what they are equipped and skilled to create, and buy the rest. So it is possible to buy laser-cut frames, wheel and axles sets, coupling and connecting rods, bushes, gland nuts, cylinder blocks, boilers, platework, etc., which means the lathe and mill in the workshop might not be needed by everyone who would like to build their own Gauge 1 locomotive.

ARMIG aims to build on these changes by providing a design that is intended to be assembled from components you can buy. It is written with the details that show how the components can be made, but it assumes that many will want to take the short-cut of buying some or all of what is needed. Which is why ARMIG is the other way round to build a Gauge 1 locomotive.

As Dick Moger keeps reminding me - **Despite the many pages devoted to them, this is not a starter design for model engineers who intend to make every component! If this is their intention, then it is assumed that they have the relevant skills and equipment to cope. If they buy in the more complex items, then a starter loco it most certainly is.**

WELCOME TO ARMIG!

Martin Hulse

P.S. We are at the beginning of another design that should be as popular as the Project and DEE. We would like to develop the book as more ARMIGs are built. We know there will be areas that need clarification and correction in this book. If you build an ARMIG you might have notes, comments and pictures that will be useful to improve this book. Please look at the G1MRA website at <http://www.gaugeone.org/> for details of how to contribute your material.

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CHAPTER 1 - INTRODUCTION

The title of this book is ARMIG, or G1MRA the other way round. It is an attempt in these leaner times to enable newcomers to the hobby to build a scale working live steam model in Gauge 1 that involves little engineering and is very simple to run. Up to now our traditional approach has been from the angle of the model engineer and, although this has been included, the primary aim of ARMIG is to encourage the 'starter' with limited facilities and time. So this is G1MRA the other way round.

Just what a difference this makes can be seen by the considerable space occupied in this book by Construction (for the model engineers) and the relatively small space for Assembly, for those building from bought in components. The emphasis here is on accurate construction to a standard plan, by computer numerical control (CNC) if done commercially, so that parts go together with the minimum of 'fitting' being required. Naturally this puts more onus on the engineering in order to ease the path of assembly. A typical example of this is the use of squared axles. It complicates the construction of the crank axle, but it does wonders for the ease of assembly and subsequent maintenance.

In practice it is likely that a mix of both the model engineering and assembly approaches will take place and that some items such as crank axles, frames and cylinders will be very popular purchases from the G1MRA trade. It is also hoped that the model engineering aspects will ultimately prove of interest to all who use this book and, in my view, anything that encourages and maintains these declining skills is of value.

Ideally for the starter ARMIG would be presented in a shiny cardboard box with plastic wrapped bits, all neatly painted, labelled and arranged. Perhaps one day this may happen, but right now we have to make do with a more modest approach. The good news is that at least it goes down a well trodden path in G1MRA with popular designs being backed up by components from the traders, a process that has been evolving over the last decade. There is also the strong possibility that assemblers will be able to single source their requirements

Gas has been chosen as the primary fuel, although there is absolutely no reason why methylated spirits (meths) can't be used. Yes,

meths is a little more complex, involving sealed smoke-boxes, a blower and occupying space below the footplate.

Many newcomers to Gauge 1 are likely to have experience with gas and it makes the locomotive very much easier to run. It also opens up the possibility of adding remote control since the space normally occupied by a firebox and ash-pan is now vacant.

From the model engineering perspective, quite a lot has happened in the last decade. It is worth looking back to the introduction in the Dee book to see phrases like: "We think we have lessened the need for milling." Even then access to milling machines was not readily available for most, but an influx of cheap, rugged mills from the Far East has changed that scenario and with the simple addition of digital readout (DRO) to the long axis, precision milling is now within the grasp of most of us.

You will also note that we have slowly migrated from pure fractional Imperial measurements to mostly metric. There is still a residue of some Imperial dimensions due to the fact that most workshops are equipped for its use and most suppliers still provide the basic materials in Imperial sizes. But even if the lathe measures in thousands of an inch, digital callipers or readouts allow a very easy migration from one to the other.

However, even though the majority are happy to use metric drills, most round stock comes in Imperial and our workshops are set up with Imperial size reamers, taps and dies. A compromise has been adopted on the drawings which quote all linear measures in metric, but assume Imperial sizes for round stock.

Now this legacy of Imperial measures and stock leaves us with a problem that at first sight seems to make marking out a piece in the absence of a DRO equipped mill pretty nigh impossible. However, when you examine the drawings closely, you will find that the vast majority of dimensions involving parts of a millimetre are nothing more than a direct translation of an Imperial size and you can simply use the other side of the ruler - for example 6.35mm is 1/4".

This does not apply to 0.5 mm dimensions which are available on the same ruler or to those cases where an awkward value is inevitable such

Parts lists

No.	ITEM	Qty	Drawing	No.	ITEM	Qty	Drawing
CHASSIS							
c/1	Main frames	1 Pair	2_1	m/6	Xhead	2	3_3
c/2	Wheels Driver	2 axles	None	m/7	Xhead pins	2	3_3
c/3	Wheels bogie	2 axles	None	m/8	Valve rod	2	3_3
c/4	Crank Axle	1	4_1	m/9	Valve knuckle	2	4_3
c/5	Bearings driver	4	2_1	m/9a	Fork	2	4_3
c/6	Bearings bogie	4	2_2	m/9b	Pin	2	4_3
c/7	Coupling rods	1 Pair	2_1	m/9c	Knuckle	2	4_3
c/8	Mid stretcher	1	2_3	m/10	Gland nuts p	2	3_1
c/9	Bogie stretcher	1	2_3	m/11	Gland nuts v	2	3_1
c/10a	Lubricator	1	2_4	m/12	Valve	2	3_1
2c/10a	tank body	1	2_4	m/13	Main steam con	1	2_4
2c/10e	drain plug	1	2_4	m/13a	Steam dryer coil	1	2_4
2c/10f	oil feed pipe	1	2_4	m/13b	Lock nut	1	2_4
2c/10g	drain pipe	1	2_4	m/13c	Banjo nut	1	2_4
2c/10h	union nut	1	2_4	m/14	Eccentric	2	4_3
2c/10i	nipple	1	2_4	m/15	Strap	2	4_3
2c/10j	oil filler	1	2_4	m/16	Conn rod	2	4_2
2c/10k	end disks	2	2_4	m/17	S/chest pin	1	3_2
c/10c	Lubricator piping	1	2_4	m/18	Valve drive rod	2	4_3
2c/10m	pipe	1	2_4	m/19	Motion Bracket	1	4_2
2c/10n	cylinder banjo	1	2_4	2m/20	Steam banjo screw	1	5_1
2c/10o	feed connector	1	2_4	5m/21	Plug	2	3_2
c/10d	Lube filler plug	1	2_4	BOILER/BURNER			
2c/10d	Body	1	2_4	b/1	Smokebox	1	5_3
2c/10b	Sealing washer	1	2_4	b/2	Manif/ring	1	5_5
c/10e	Locating nut	1 or 2	2_4	b/3	Chimney	1	5_3
c/11	Buffer beam	1	2_2	b/4	Dome	1	5_3
c/11a	Front stretcher	1	2_3	b/5	Boiler	1	5_1 & 5_2
c/12	Drag beam	1	2_2	b/5a	Shell and flue	1	5_1
c/12a	Rear stretcher	1	2_3	b/5b	Take off bush	1	5_1
c/13	Buffers	4	None	b/5c	Dome retainer	1	5_1
c/14	Bogie frame	1	2_2	b/5d	Front tubeplate	1	5_2
c/16	Bogie pivot	1	2_2	b/5e	Rear tubeplate	1	5_2
c/17	Coupling hooks	1 pair	None	b/5f	Standard bush	4	5_2
c/18	Bogie pivot spring	1	None	b/5g	Steam manifold	1	5_2
c/19	Buffers	4	None	b/6	P gauge	1	None
MOTION							
m/1	Cylinder block	1	3_2	b/7	P G siphon	1	5_6
m/2	Front cover	1	3_1	b/8	Rbtm sv cover	1	5_4
m/3	Rear cover	1	3_1	b/9	Burner	1	6_1
m/3a	Plate	1	3_1	b/9a	Tube & adapter	1	6_1
m/3b	Cylinder boss	2	3_1	b/9b	Jet holder	1	6_1
m/3c	Valve boss	1	3_1	2b/9c	Holder	1	6_1
m/4	Trunk guides	2	4_2	2b/9d	Jet	1	6_1
m/5	Piston	2	3_3	b/10	Gas tank	1	6_2
m/5a	Head	2	3_3	b/11	Safety valve	1	5_4
m/5b	Rod	2	3_3	b/12	Enots/Rectus	1	None

No.	ITEM	Qty	Drawing
b/13	Gas valve (Control)	1	6_2
b/13a	Needle valve	1	6_2
b/13b	Gland nut	1	6_2
b/13c	Valve body	1	6_2
b/13d	Pipe & nut	1	5_6
b/14	Regulator	1	5_2
b/15	Gland nut	1	5_2
b/16	Clack valve	1	5_4
b/17	Rear boiler Support	1	5_5
b/17a	Ring	1	5_5
b/17b	Support	1	5_5
b/18	EWG Probe	1	App F
b/19	Water pipe	1	5_6

PLATEWORK

p/0	ETCH	1	None
p/1	Footplate	1	None
p/2	Side tanks	2	None
p/3	Rear tank	1	None
p/4	Cab	1	None
p/5	Steam reverser	1	None
p/6	Ash pan	1	None

See GA & elevation drawings for overall views that help towards platework. App B deals with modifying one commercial etch.

FIXINGS

f/1	10BA 1/4 csk screws	20 approx
f/2	9BA 1/4 csk screws	4
f/3	8BA 1/4 csk screws	12
f/4	8BA 1/4 chs screws	12
f/5	10BA 1/4 chs screws	2

csk = countersunk
chs = cheesehead

Parts are numbered, for example m/5. To make an ARMIG you will need to buy or make these items.

Some parts are built from a number of subparts, for example m/5 from m5/a & m5/b. This information is of more interest to constructors, and the text describes what to make and how to join the subparts to make the parts. If you buy the main part it would be prudent to check it includes the sub parts listed where these are detachable. In the parts list such parts have indented descriptions and are shown in italics.

Parts in Edition 1 of this ARMIG book had no numeric prefix. Parts introduced in subsequent Editions have a numeric prefix to show which Edition they first appeared in. For example 2c/10a. Mostly these correct errors of omission in documentation.

Drawings which have been revised have a new drawing number ending in V2, or V3, etc. and a new date plus some comments to describe the changes.

Both parts and their constituent subparts are shown on the relevant drawings, except:-

1. Those marked 'None' are items that will be probably be bought, not made.
2. Appendix B describes how to proceed from the W&C etch for parts p/n
3. Fixings are standard screws & nuts.

Eccentrics and straps

Since we have no need to split these eccentrics, my favourite material can be used: cast iron. This comes in sticks and is a delight to machine and handle. When used with brass or gunmetal for the straps, it is also very durable.

The conventional method works well here, even though they are smaller than used on Dee, due to the distance between the cylinder and valve centre lines.

Turn the outside to $\frac{5}{8}$ " (15.87 mm), and then fit a sharp scribe under the tool-post and mark out a ring 3mm from the centre. Set up the piece in a four jaw and use any part of the scribed ring to find and drill the axle hole. Drill undersize and finish with a $\frac{1}{4}$ " reamer. Part off the eccentrics at 4.8mm wide each.

Next I made the straps, this time using a very easy method employing hex brass or gunmetal.

Again chuck a short length of 1" across the flats hex bar in the 3 jaw. Centre, drill and ream to a finished $\frac{5}{8}$ " (15.87 mm). Next set up the hex bar in the mill vice and machine down the sides with a $\frac{3}{16}$ " end-mill as so that the cutter just reaches the corner. You can now spot and drill the 2.4m ($\frac{3}{32}$ ") holes that take the valve drive rod and lower bolt, making sure that you leave enough space between them so that parting off can follow.. Turn up the other way and mill the same recesses. On completion, put back in the three jaw and part off the individual straps.



Photo 4.9

In fact this hex bar is a peculiar size just under 1" AF and probably gunmetal, The blanks were already made, hence the need for the $\frac{5}{8}$ " tube up the middle to keep them together. This is a very easy exercise.

I decided not to fully split the strap as I am confident that in the unlikely occurrence of having to take it all apart, the crank axle will divide easily

enough. (Removing the pin and heating will destroy the Loctite grip). In the event, I cut through the bottom section only, so that the strap can be tightened to take up any wear.

I then put the valve drive rod into the lower hole (where the split is), fitted an eccentric and tightened up the strap. I have a dividing head from a Unimat 3 marked in degrees which I employed for milling the 130 Degree slot. Once you have drilled or milled the far ends of the slot accurately you can then use the strap to guide the eccentric while the rest of the slot is cut.



Photo 4.10 Milling the slot

Connecting rods

Again, simple enough to make, but be aware that there is a small offset of 1.5mm between the centre of the cylinder and the the centre of the crank.



Photo 4.11 Connecting rods

Some builders have chosen to put a slight crank in the rod to adjust for this, but since the angle is only 1.6 deg, it is probably within the manufacturing tolerances of a built up item like this anyway and simply selecting the component for fit should be enough. Drawing 4_2 has been revised to show this offset.

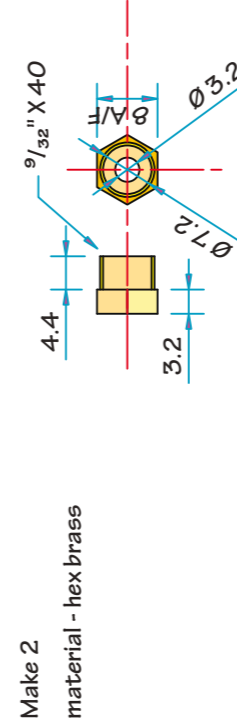
If in doubt, the gentlest of tweaking in a smooth jawed vice will align the big and small ends with respect to the crank and the crosshead pin.

You will see from the drawing that the small end is a bronze ring with a flat filed on one surface and the big end is $\frac{1}{2}$ " AF brass hex filed or milled to suit.

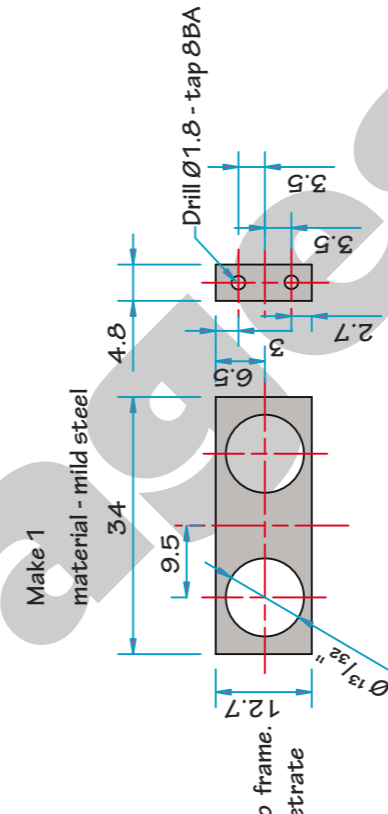
Changes from 4_2 V1 dated 7 March 2011

1. Trunk guide m/4 dia. corrected to $\frac{13}{32}$ " in V2
2. Hole in motion bracket m/19 corrected to $\frac{13}{32}$ " dia in V2
3. Cranked view of connecting rod added in V4
4. Added 8 BA screws for motion bracket in V5

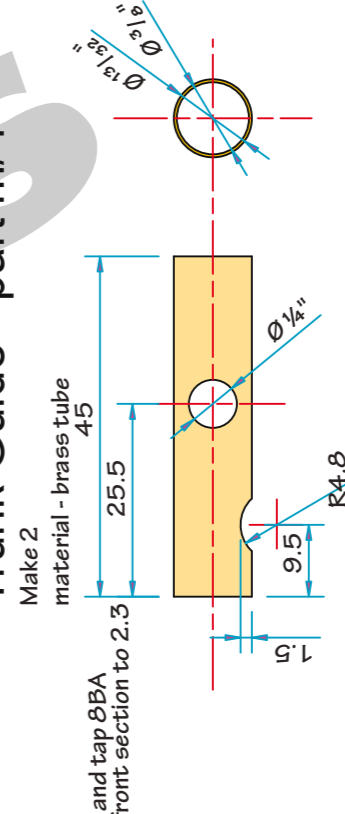
Piston Rod Gland Nut - part m/10



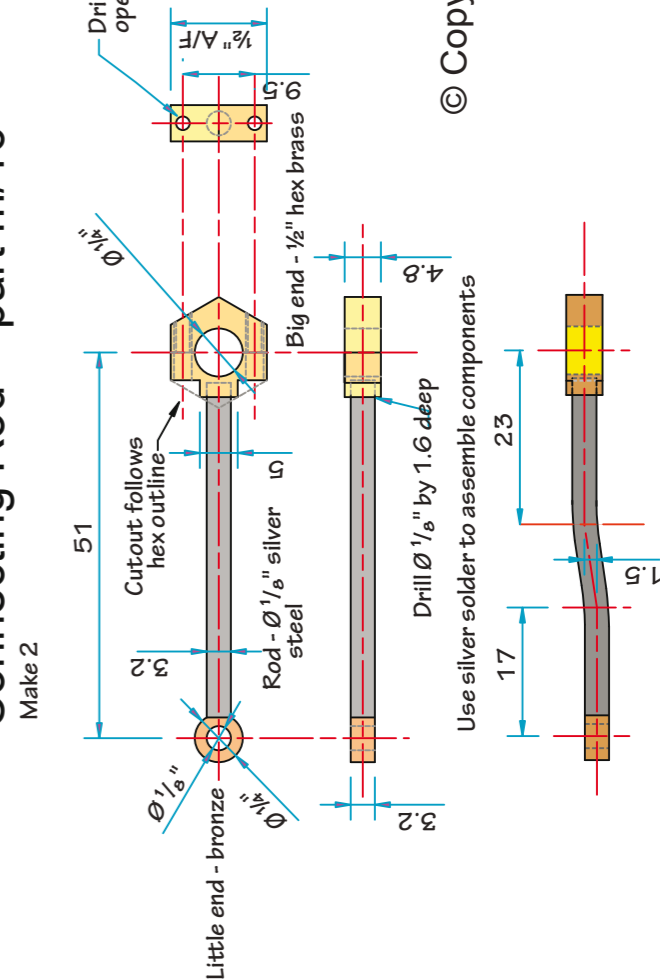
Motion Bracket - part m/19



Trunk Guide - part m/4

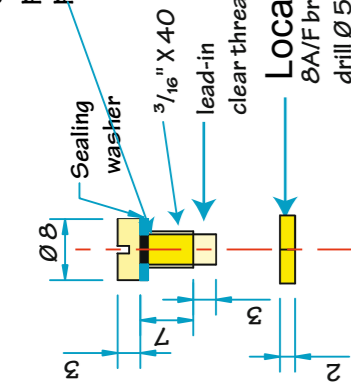


Connecting Rod - part m/16



Lubricator Filler Plug - part c/10d

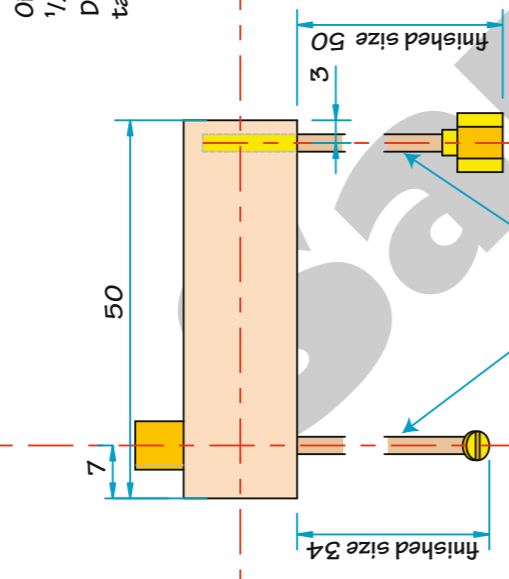
Comprises
part 2c/10d
part 2c/10b



Locating Nut - part c/10e

8A/F brass
drill \varnothing 5.6
tap $1/4$ " X 40

Note: Lubricator held into LH side tank by this nut
make two if height needs adjusting



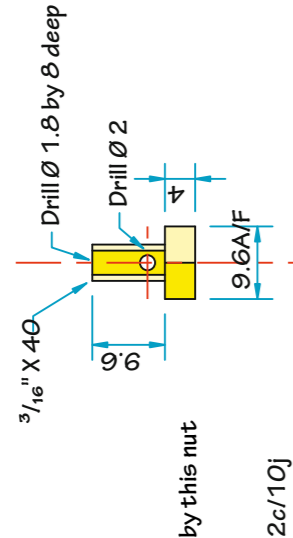
Drain pipe - part 2c/10g
 $3/32$ " copper pipe
Oil feed pipe - part 2c/10f
 $3/32$ " copper pipe

Lubricator Tank - part c/10a

comprises 2c/10a tank body - copper ex water pipe
2c/10g drain pipe, 2c/10f oil feed pipe - both copper pipes
2c/10e drain plug, 2c/10i union nut, 2c/10j nipple, 2c/10k end disks - brass

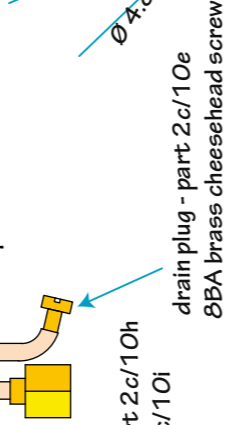
Lubricator Banjo Screw - part c/10b

Body make 1 from brass
Sealing washer - red fibre or PTFE or 'O' ring
material - brass



Lubricator end discs
part 2c/10k
make 2 from brass
1mm thick
to fit i.d. of pipe
set in 1mm from ends

Note: Oil feed inlet 10mm
above outer base of tank.
Suggest cut pipe away at
top to act as a depth
stop.



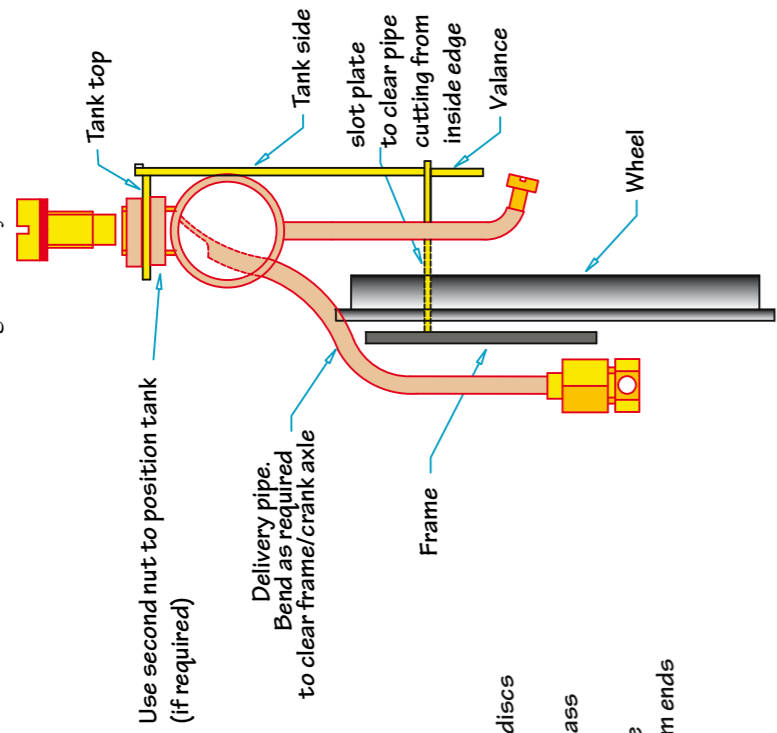
Lubricator Tank - part c/10a

Oil filler - part 2c/10j
 $1/4$ " X 40
Drill \varnothing 4 through
tap $3/16$ " X 40

© Copyright G1MRA 2010 Drawing 2_4 V4 dated 22 August 2011

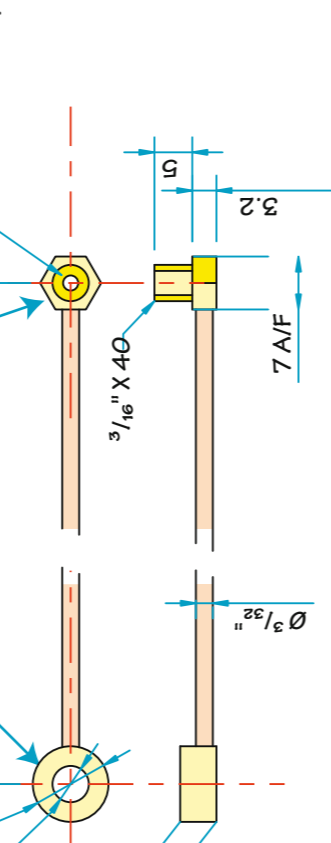
Changes from V1

1. Steam connection moved to 5_1
2. Subparts shown on all items
3. Oil feed inlet cut away to 10mm above tank base
4. Sketch below showing assembly added



Lubricator piping - part c/10c

Lubricator piping - ends brass, pipe copper comprises
2c/10m pipe, 2c/10n cylinder banjo, 2c/10o feed connector
Full Length 130
Drill \varnothing 2 by 7 deep



CHAPTER 8 - PAINTING AND LINING

This chapter could take up most of the book given a certain Harry S Wainwright's predilection for elaborate liveries. However, we are going to have to restrict ourselves to what is available, which mercifully cuts down on some of the complexity.

History

To give you a quick flavour, Harry S Wainwright was an artist more than he was an engineer and he would get his staff to take up an entire wall with a side view mock up of the proposed locomotive. He would then proceed to test and experiment with various styles of livery until he was satisfied.

The resulting style for the 'D' class and subsequent locomotives was extraordinary by any standard and a recent trip to the Bluebell Railway has demonstrated to me just how much of this was actually applied to a humble suburban tank such as the H class.

If you want the 'Full Monty', you will have to take a trip down there and see for yourself, but in the meantime, I will give you a guide as to how to use existing transfers and come up with an approximation of the real thing. Only a purist will know the difference.

The full Wainwright livery lasted for nearly a decade before the board of directors started asking awkward questions as to the cost of painting that was affecting their profits.

Wainwright replied that the paint itself was not the problem and would be required whatever the colour, but a simplified form of lining out could be used. This consisted of the same base colours as before, but a thin yellow line was used to pick out the shapes, with a double yellow line on the boiler bands. They also painted over the brass-work to stop reflection of sunlight affecting the driver's visibility.

This was applied somewhat haphazardly to all classes until 1913 at which point it became the standard livery. The J and L classes only appeared in this livery, but the H class could have been in either. During the first World War, a dull olive colour with large yellow lettering was applied, but this was quickly supplanted by a dreadful battleship grey austerity livery which lasted up until the grouping.

Mercifully a Maunsell Green was applied followed by all the usual variations, finally ending with BR black.

Full Wainwright livery



Photo 8.1 No 263 undergoing restoration - and this is just a wheel!

Proper tailored transfers for the H class are probably out of the question as the cost is absurd, even if you could find someone to do it. Fortunately, the water slide transfers I devised and developed for "DEE" can be adapted, provided that you buy an extra tender sheet.

The base colours of Dark Red and Brunswick green can be very closely approximated by Rover Brooklands Green and Opel (Vauxhall) Henna Red. These come in the usual handy aerosol cans, which are quick to use and give a good finish, but are prone to damage in the live steam environment. A better longer lasting result is achieved by epoxy two-part paints such as Hardnutt. These are more difficult to apply, but justify their use by outlasting any other sort of finish.

Simplified Wainwright

The simplified livery can be done, again using the same base colours, but DJB (Tawney Transfers) will do rub on lining for the fine yellow lines that are admirably suitable despite DJB's warning that the method is not suitable for live steam. I have to say that I have not found this to be the case, probably because the only lining on the boiler is actually on the bands themselves which are spared the worst of the heat..

In both cases, some form of varnish has to



above ARMIG HD2 at speed

below ARMIG HD2 prototype - steam galore

