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# SALLY

## Running on Steam

Whilst you can safely run the engine for half an hour with no more than a little steam oil injected before you start, it is unwise to run for longer without proper lubrication, especially if you have built the engine with the plain, unpacked piston. The little Stuart type 155 lubricator is ideal, since it incorporates a steam stop valve in the design. (Fig.60) The inlet to the steam chest is threaded to fit this accessory and the union is the right size for the steam pipe too, being  $\frac{5}{16}$ in. outside diameter.

Running on steam is a very different matter to running on air. The engine *must be warmed through* before allowing it to run free. As soon as you have about 10 lbf/sq.in. in the boiler open the stop valve just a trifle and rotate the engine forwards *very slowly indeed*. Steam entering the cylinder will all condense and will lift the slide valve off its seat, passing into the exhaust. It will take quite a while to clear, the more so since the exhaust pipe on this model points upwards. As the spurts of water diminish you can open the stop valve just a little more, but you may still have to help the engine over the dead centres since the clearance spaces will still be full of water. After a while the engine will want to run and you can let her go at a small throttle opening and low speed. Thereafter all should be well, and you can apply some load. You will find that she runs far better on steam than on air and makes much less noise. However, you will be well advised to fit a fairly large exhaust pipe to lead the steam away to a safe place, or you will fill the workshop/kitchen/living room with steam - and oily steam at that!

You must, of course, attend to the lubricator from time to time. It will feed a considerable proportion of its contents during the warm-up period, but should last for quite a while after that - some 10 minutes or so. Shut down, undo the bottom screw about two turns to let out the condensed water then undo the top cap, close the bottom screw and refill to the bar with oil. With a hot engine it will last longer, but you must check from time to time so that, for future reference, you can make a note of how long a fill of oil lasts. When ringing down "Finished with engines" disconnect the steam pipe, empty the lubricator, refill with oil right to the top and then turn the engine over by hand to get a good film of oil on all the internal working surface. Wipe down and oil all external bright parts, too.

## Noises off

All engines make their characteristic noises, but there are some which are obviously wrong. These may be classified as "grunts, groans and squeaks" and "thumps and knocks". Either may be regular or intermittent. Regular noises are associated with the rotation of the engine, and we can look for a cause so associated, but intermittent ones, as a rule, are caused by some component which is loose. The latter should be fairly easy to find, but the former may need careful diagnosis. The main difficulty lies in establishing the source, since the noise travels through the structure of the engine. A

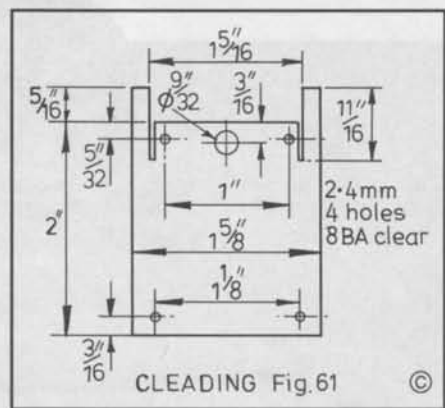
## Tubal Cain

Completes his notes on building this fine little Mill Engine with guidance on first running on steam, trouble-shooting, cylinder cleading, painting and final assembly.

● Part X (conclusion) from page 449 (16 April 1993)

useful tool for the amateur is a fairly long pencil. If the blunt end is set to the ear and the point on the various parts of the engine in turn, e.g. cylinder, bearing housing, crosshead guide, and so on, the source will usually become fairly evident.

Dealing first with its *grunts* and the like, these are symptoms of improper rubbing contact somewhere, but first check that all working parts are lubricated. Then look for the following:

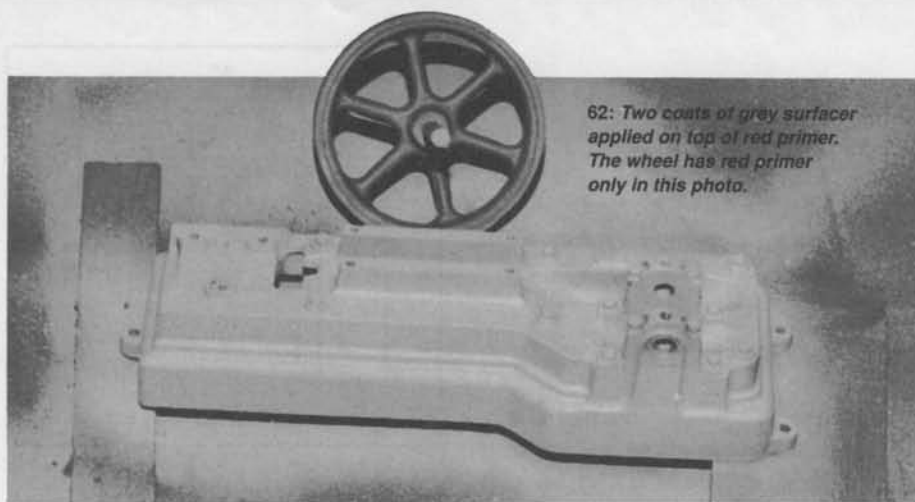


This list may appear formidable, but it is very unlikely that you will meet more than the odd case of such noises if you have taken reasonable care during machining and erection. One cause which I have not mentioned is *excessive lead*. This can cause a large end knock even when clearances are correct. However, this should have been dealt with when setting the valve, since the conditions causing knock also prevent slow-running.

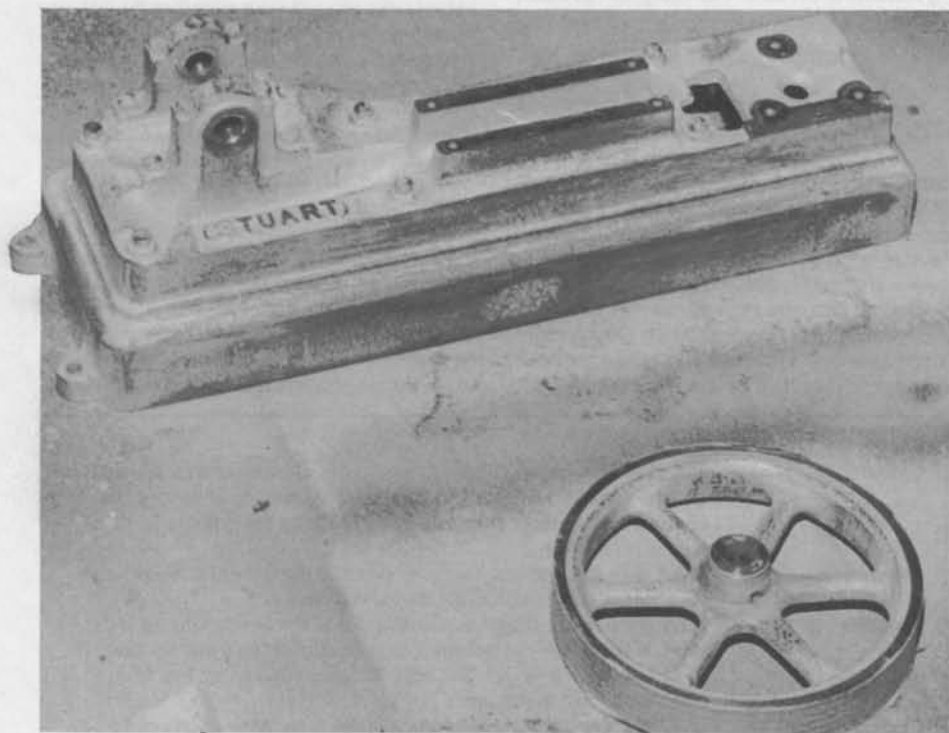
## Cylinder cleading

Part 1, Fig.61. Note that dimensions here may differ on some of the earlier Stuart drawings. If you also find that your piece of material is too small to suit Fig.61 it will still serve; all that is necessary is to shorten the two "ears" which, as shown in the exploded general arrangement drawing, Fig.61,

SOURCE	POSSIBLE CAUSE
Cylinder	Misalignment, causing piston to rub - check clearances at crosshead for vertical misalignment. Check lateral misalignment by observing travel of crosshead. In either case remedy by adjusting the cylinder fixing bolts and/or shims.
Valve chest	Valve nut askew causing excessive pressure on edges of valve or valve chest on upside down, leaving inadequate clearance.
Crosshead guides	Misalignment of cylinder as above or one of the distance pieces is too short. If OK check by slackening crosshead guide nuts one at a time. If this cures the noise check that ends of distance pieces are free from burrs and square to the axis.
Crankshaft etc.	(a) Check that large end of connecting rod is not rubbing on crankdisc - if so, relieve as shown in Fig.39D. (b) Eccentric - first check that the eccentric rod is not bearing on the sheave, then that the strap adjusting screw is not too tight and finally, that the eccentric rod is correctly aligned to the valve rod.
<i>Now for thumps or knocks, taking them in order.</i>	
Cylinder	When starting up on steam any such noises are most probably caused by condensed steam and will cease when all is warmed through. If not, check that there is the proper clearance at each end of the stroke. A piston loose on its rod is most unlikely, but check this if all else fails.
Valve chest	Valve nut too slack, either on the valve rod or between the valve "ears". In either case a new one must be made. An unlikely cause is that the guide hole in the far end of the chest is not deep enough, but this would show up during erection.
Crosshead and guides	(a) Excessive clearance on the crosshead pin - replace. (b) Small end of connecting rod moves sideways at each stroke, impacting sides of slot in the crosshead. This is almost certainly due to the crankpin being out of square to the crankdisc. Check for burrs on the shoulder or for a poorly formed thread - at worst, make a new one.
Valve/eccentric rod	Excessive clearance between pin and hole. Alter as indicated making new bolt - Fig.57.
Crankshaft, etc.	(a) Slack fit to crankpin. Make afresh, or ream out and fit a bush, if not already done, but check that crankpin is screwed tightly into crankdisc. (b) Excessive main bearing clearance - check by gently pressing shaft one way and the other (horizontally) with a finger on the free end whilst engine is running. If this reduces the noise then the cause is excess clearance. Either bush and re-ream the main bearings or make a new shaft to fit with minimum clearance. (c) Excess endfloat on the crankshaft - adjust flywheel to reduce this. (d) Crankpin fouling bedplate - unlikely, since this should have become apparent during previous work. Check for cause and either rectify or, if none, file out more from crankpin.



62: Two coats of grey surfacer applied on top of red primer. The wheel has red primer only in this photo.



run around the cylinder flanges. It is, of course, necessary to remove the cylinder assembly from the bed to fit the cleading, but this will be necessary when painting and you can deal with the fitting whilst waiting for paint to dry on other parts.

Although the drawing is quite clear, I always advise first making a trial piece from thin cardboard. The *exact* position of the hole for the exhaust connection can be established by this means. You can then mark out on the back of the sheet, keeping a piece of paper between the other side and any backing plate, essential when drilling since the material is very soft indeed. This backing must be metal, not wood. The small screw-holes (2.4mm) present no problem but if you try to drill a 1/16 in. or 6 mm hole, the sheet will cockle and distort. Mark out the circle, drill a ring of, say 1.5mm dia. holes inside this, carefully snip out the centre and then clean up with a small fine half-round file.

Offer the sheet to the cylinder and spot through for the two holes in the flat face opposite to the portface. Drill and tap these, secure the sheet with temporary screws, and then fold it over the cylinder flanges. The screws should not, of course, be fully home. Press down with a piece of wood to form the slight return bend in the sheet where the circular part meets the flat top of the portface. Don't bend the ears over the flanges yet. Spot through and drill and tap the holes. Fit the screws and tighten them all down. You may have to trim edges here and there with a fine file. The "ears"

may then be folded around the flanges. There is no need to remove the cleading again since there is no paintwork on the cylinder itself.

### Painting

The important factor here is not the top-coat, but what lies underneath it and the way in which the undercoats are treated. Unless the final finish on these coats is perfect it is almost impossible to obtain a fine finish with the final colour coat, no

matter what paint is used or how it is applied. I leave the choice of *type* of final coat and its colour to you, since this is a matter of personal preference. However, it is perhaps worth making the point that not all engines were painted "engine green"! Rich brown, deep red, grey and even black have been used. Pastel shades should be avoided, as should any garish tints and "locomotive" colours. The latter, however authentic, always seem to be out of place on a stationary engine.

There is no doubt that cellulose based material is the most convenient for priming and undercoats, whatever the top-coat may be - oil-based enamel can be used on top of cellulose, but not vice-versa. The Dupicolour aerosol cans sold by Halfords and similar motor accessory dealers are very convenient, since an airbrush will not, as a rule, handle the heavy primers and fillers. The stores you will need for this little engine are

- One tin of red primer, DS108
- One tin of grey filler-primer, DS113
- Cellulose thinners

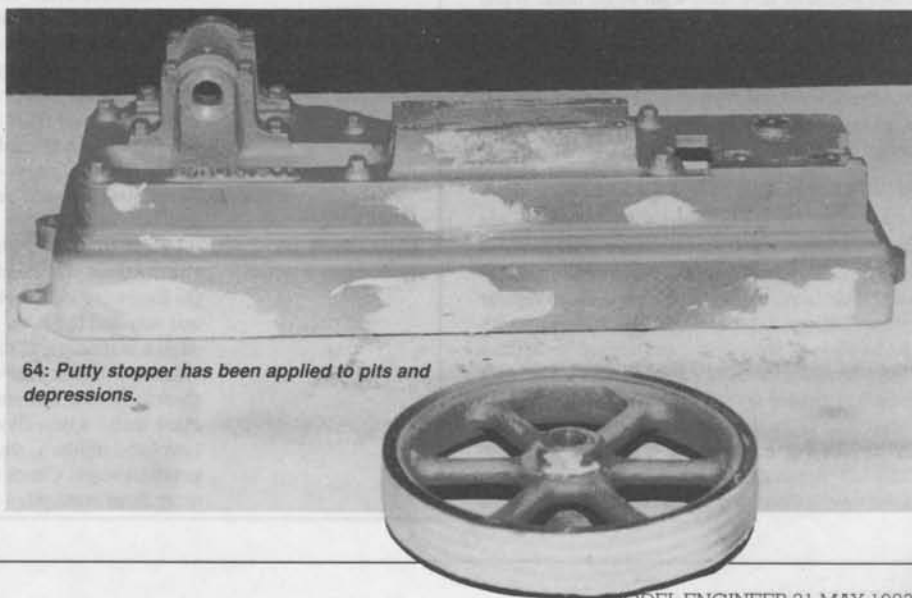
Small tin of paste stopper - this may be difficult to find, and if a small tin is not available you may be able to obtain a little from your local car body repair works. Many brands of aerosol spray are available. Take care that those used are compatible - try to buy the same brand name for all materials.

You will also need Wet-or-Dry silicon carbide rubbing down paper. This must be the very flexible back type, not the hardback often sold in D.I.Y. stores. You will need one sheet of grade 240, one or two of 320 and one of 400 grade.

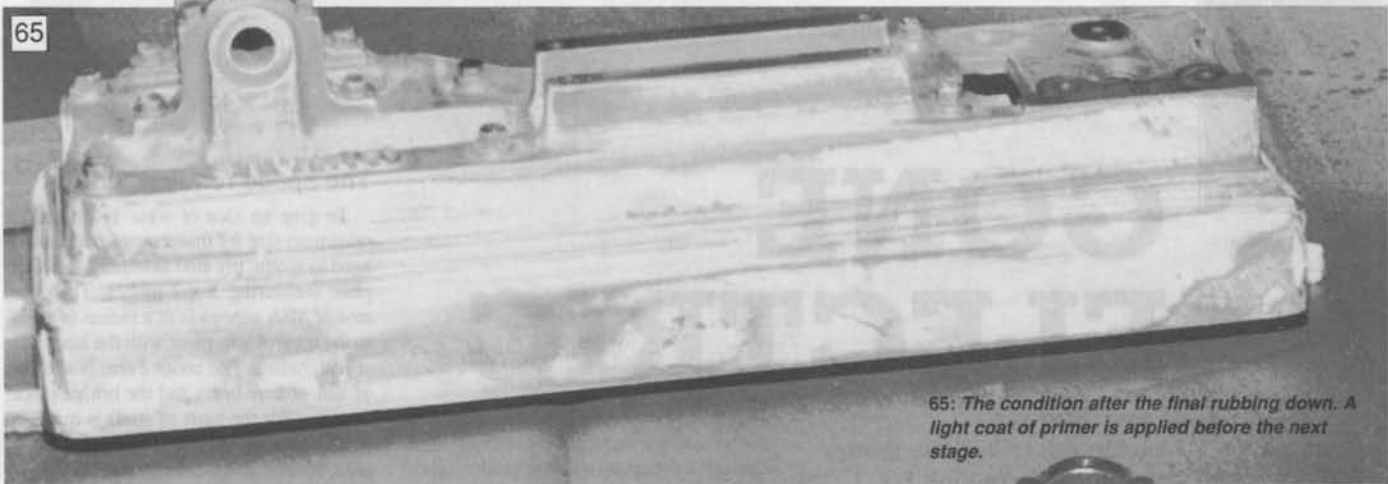
In addition, of course, you will need an aerosol of colour coat. When you get the cans, give each of them a very good shake and thereafter always store them on their sides.

Dismantle the engine, but there is no need to take the cylinder set apart. You will have to remove the steam chest if you intend to paint it, though, and you must form a *tiny* radius, not just a bevel, on the sharp corners, otherwise the paint will chip off there. The steam chest cover will need paint in the recesses, but this is best done with a brush, both for priming and for colour coat. This leaves only the flywheel and the bedplate to be dealt with.

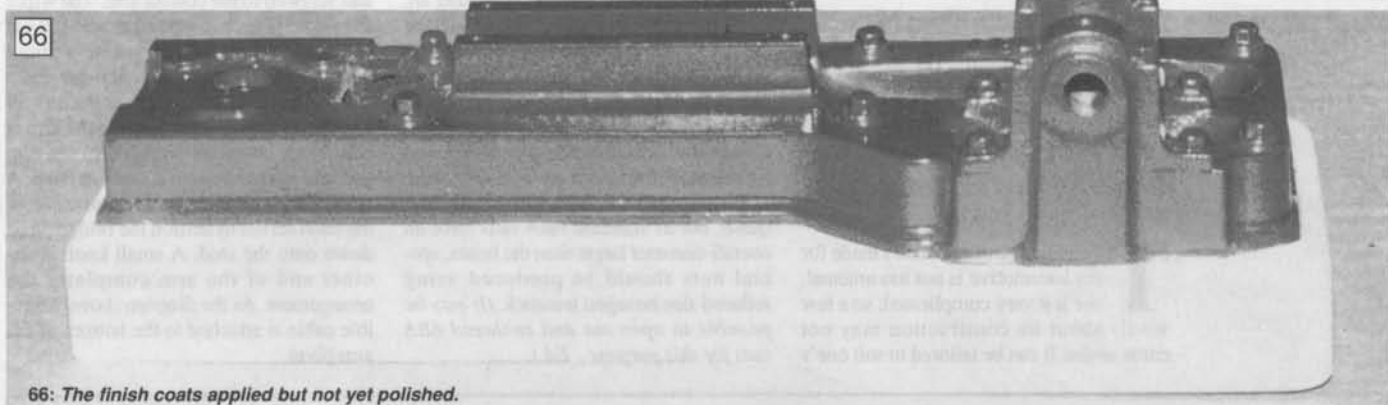
You will already have been over the castings removing lumpiness but check over once more to make sure that all is well. Then thoroughly degrease all over, and make sure that the painting



64: Putty stopper has been applied to pits and depressions.



65: The condition after the final rubbing down. A light coat of primer is applied before the next stage.



66: The finish coats applied but not yet polished.

bench area is absolutely free from loose dust etc. Plug the bearing oil holes and set old screws in any tapped holes. It will help in handling if you put an 8in. length of 1/4in. stock - dowel will do-through the flywheel boss to act as a handle. Short lengths should be set in the main bearings, too. *Except* for the grooved face of the flywheel it is not worth masking machined parts; paint is easily removed from spot-faces and suchlike if you remember to scrape off the primer as soon as it has set. Look out some blocks of wood on which to stand the bed, and consider carefully how you will hold or support the parts whilst you spray them.

Now, the object is to cover the painted areas with sufficient thickness of primer and filler so that, after rubbing down with the silicon carbide paper, the surface is dead smooth. Wipe all over with cellulose thinners, allow to dry and start with red primer. Shake the tin for *at least* two minutes, then give two coats, not too heavy, leaving about 10 minutes between each. Shake the can of filler-primer as before and apply two coats of this with an interval of about 15 minutes this time. Make quite sure in each case that you do not miss any areas. After about 20 minutes turn the bed over and apply two coats of red primer inside as well, there is no need for filler here. (Fig.62)

Leave the castings for at least 12 hours in a warm room, or for four hours if they can be put on a warm radiator. Then retire to the sink. Fold and tear half of the No.240 silicon carbide paper into four pieces and use one of these, with plenty of water, to rub down the bed all over until you reach bare metal over most of the castings. You will find patches of red and grey as well. Repeat for the flywheel - this is more difficult, but you must persevere. Dry off well and then examine closely.

The grey areas will be depressions. (Fig.63) If these are quite unmarked by the paper they need stopping. Apply a full coat of red primer then apply paste stopper, not too thickly, with a knife, pressing it down as you would putty. Treat any lit-

tle pits as well with just a tiny nib of stopper pressed well down. This must be allowed to set for at least 24 hours at room temperature or eight on a heater. (Fig.64) Then repeat the rubbing down process. You may have to do it all over again, to get a properly levelled surface, so find something else to do whilst waiting - on no account try to rush the job.

Once past this stage apply two fine coats of red primer and two of primer surfacer. Allow to harden off as before and repeat the rubbing down procedure, this time with No.320 paper. You should get a reasonable surface when the red starts to show through, but with little or no metal showing. Dry off well once more, then apply one coat of primer and two of surfacer - light coats again. When set, rub down *very lightly* with the No.400 paper with just a trace of Stergene or washing-up liquid added to the water. You must rub down all over, but with almost zero pressure. (Fig.65)

Dry off again and apply one fine coat of primer. Let this harden for an hour and examine your work very carefully indeed. Any pit or defect means that you must re-treat that area. If all is well, then you can apply the colour coat. Two light coats with an aerosol, but probably half a dozen if using an airbrush. Take the greatest care not to over-apply the spray - keep it moving and don't dwell at any one point. Don't touch for an hour, then leave on a warm radiator overnight or in a warm room for at least 48 hours. The longer it can be left the better, but there is little point in waiting more than a week. You can then give the paint a gentle rub over with a very soft cloth and a touch of Brasso to get a final polish. If you decide to use a two colour finish as shown in Fig.66 you must, of course, apply low tack masking tape over one section as you spray the other. Make quite sure that the paint has set hard before applying this tape!

A few minor points - to save work later use a scraper on spot-facings or other machined surfaces to remove primer and primer-surfacer about half

an hour after each application. You will then have no difficulty later in removing any colour coat. Again, the bed casting shows a number of dummy nuts. These should not be clattered up with paint, so remove primer from them also, until the final stage. The last coat of primer and the colour can be left there. There is no real need to paint the inside of the bed but, if you wish to, give it a coat after the first priming session; there is, of course, little need for any rubbing down here.

Finally, accidents; there is always the risk of scratch or chip damage on any paintwork. Correct this using a very fine pointed brush. If the damage is deep you may need first to fill with primer. If so, obtain a sheet of No.600 paper and rub down very gently around the area after priming, with a tiny piece, then spray a little colour into a tin and use this to charge the brush. Small chips or scratches can safely be disguised by using colour coat only.

### Final Assembly

You will have taken advantage of the intervals in the painting process to rectify any defects which may have previously appeared, such as shortening of over-long studs, replacing slack pins, and so on. The valve must be retimed, of course, and the brass setscrew replaced by a proper grub screw. You may then be thinking of a plinth or baseplate. This depends on the driven machinery. You may perhaps, be thinking of a boiler as well. In this connection, our engine will run quite happily from a simple pot boiler, provided it is fired by a 3-wick burner, but the Stuart No.501 "Babcock" type boiler will provide steam against full load and, moreover, in appearance is about the right proportion for the engine - a matter which does need some consideration, for she is a very nice looking engine indeed. She may have taken a long time to build, but I enjoyed every minute of it - I hope that you have too and will agree that she has been well worth it. 