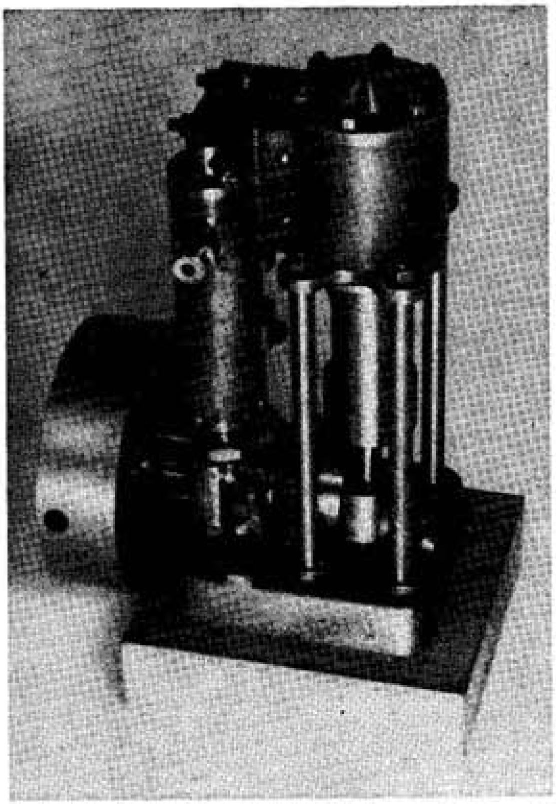
TROJAN MARK II

by J. P. Bertinat

Part VI *from page 1024*



Crankshaft. Fig. 39.22

In the present engine the shaft and disc are assembled by press fitting, but many alternatives are possible e.g. machining from solid, brazing followed by machining all over or assembly with Loctite. The press fit method will be described, and although I have dimensioned the shoulder on the shaft as 1/4 in. dia., I actuallly made mine 9/32 in. since a reamer of that size was available.

The disc is made from a 9/32 in. thick slice of 1 in. dia. b.m.s. Chuck the disc in the three-jaw, face and slightly chamfer the back face and drill and ream the hole for the shaft; reverse in the chuck and face the front. I used a small four-jaw chuck for this second facing operation since it was possible to locate the back face on the step of the jaws which were used in the 'lathe' position. This is not possible with the larger lathe chucks and parallel packing will be needed to get the two faces of the disc parallel. It is important to ensure that the crankpin hole is square with the disc and I again held the work in the small four-jaw chuck from which the back plate had been removed so that it would sit flat on the table of the drilling machine. Since I was making more than one crank, I bolted the chuck to the table of the miller and drilled using the sliding vertical head; this required only one marking out for three discs. Fig. 40 shows the set up.

The shaft can be made from ground b.m.s. if available, or a straight true piece of b.d.m.s. can be used if the diameter is correct. I actually used silver steel which in theory has too high a carbon content for use as a crankshaft, but in the present case stresses are so low that it will be quite satisfactory. This silver steel is straight, round, usually true to size and of good surface finish, which attributes make it an ideal bearing material. The shaft is gripped in the three-jaw chuck and the end turned down to a force fit in the disc. My method was to turn the shaft to about .01 in. oversize for a length of about 9/32 in. and then carefully reduce the first 1/16 in. to a push fit in the reamed hole in the crank disc. The remainder of the shouldered length is then carefully turned to a diameter of .0005-.001 in. greater than this, aiming at a good surface finish and a clean shoulder. The shaft is then removed from the chuck, cut to length and the flywheel end faced. For press fitting, the chamfered side of the disc is offered up to the shaft while the latter is held in the chuck and the parts are gently eased together over the initial push fit section by means of the tailstock chuck. This will ensure a square start to the operation and the push fit section will serve as a guide to the following press fit which is performed in the vice (I use a hefty machine vice for this job), placing a brass pad on the end of the shaft and a washer against the disc to allow the press fit end to come right through. To complete the job, the shaft is returned to the chuck and the projecting end of the shaft machined off flush with the disc.

Crankpin. Fig. 39.23

This is a plain turning job which needs little description, and it may be made from 1/2 in. dia. b.m.s. since the outer diameter of the head is not critical. Aim at a good surface finish on the big end bearing and an accurate and well fitting thread; it may be worth screwcutting the latter. If there is any

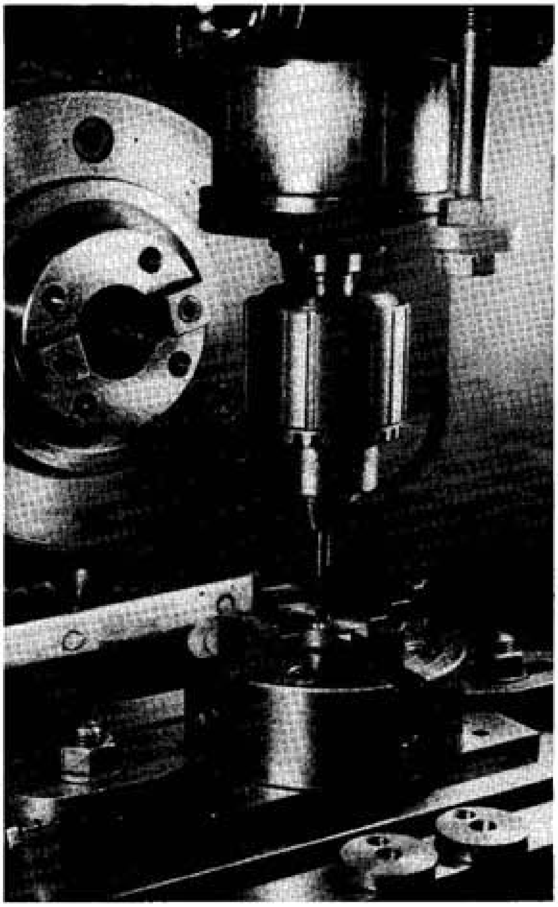


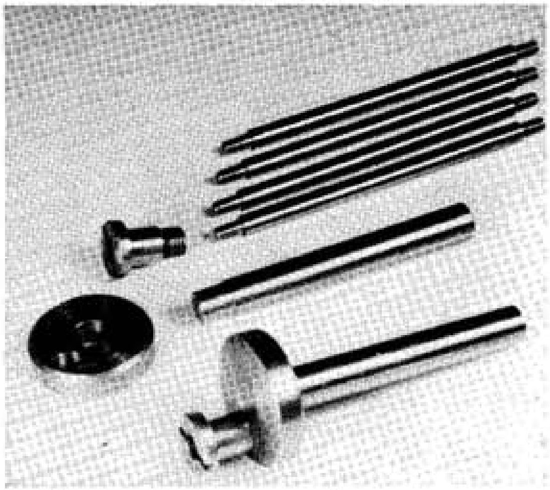
Fig. 40: Machining three crank discs.

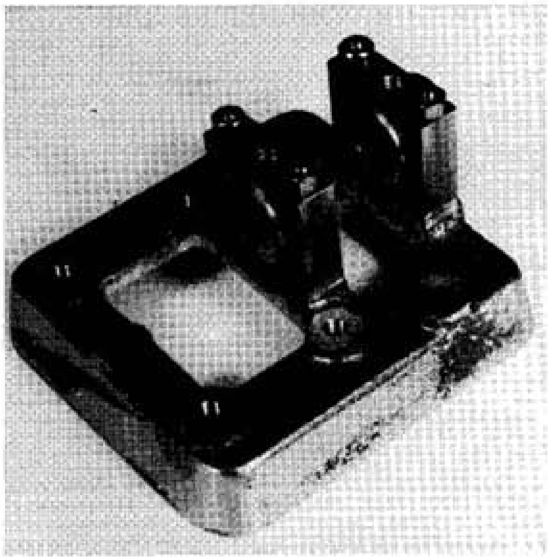
doubt about the size of the hole produced by your 5/16 in. reamer, it might be advisable to delay making the crankpin until the connecting rod has been completed, so that the pin may be turned to fit the big end bore. I used a small slitting cutter mounted on a stub arbor in the milling machine for cutting the slot in the head. If desired, the pin may be lightly case-hardened and if this is to be done I suggest that the operation is deferred until the crosshead pin (Part 26) and the eccentric rod pin (Part 29) have been completed so that the three parts may be treated simultaneously.

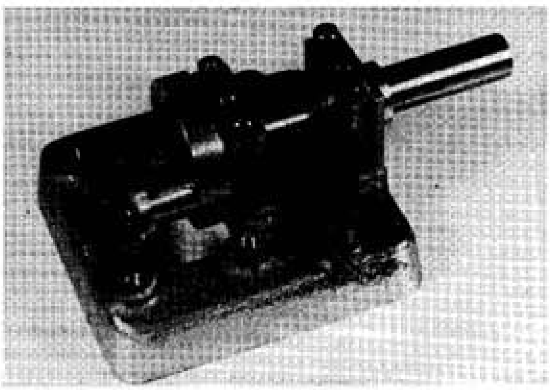
Crankshaft components and the columns are shown in Fig. 41 and the bedplate/bearing/ crankshaft assembly is shown in Figs. 42 and 43.

Connecting Rod. Fig. 39.24

This may be machined from 5/8 in. dia. b.m.s. and I found it convenient to start with a piece of bar at least 3½ in. long in order to provide ample material for holding the work during machining. A gunmetal casting was provided for the Mark I engine







Top, Fig. 41: Crankshaft components and columns. Centre, Fig. 42, Bottom, Fig. 43: Bedplate/bearing/ crankshaft assembly.

but, apart from the fact that a gunmetal rod looks wrong, much time is spent in trying to hold these small castings for machining, and I find it much quicker to work from a bar which is rigid enough to support the machining operations. These are carried out in the following order: i) drilling all cross holes; ii) milling all flat surfaces; iii) turning. For constructors with a milling machine having dividing equipment, the first two operations can be carried out at a single setting but more care and lighter cuts are necessary when using the lathe/vertical slide set up.

For purposes of illustration I used the vertical slide set up for drilling and reaming the cross-holes (big end and small end bores and holes to commence fork end). The big end should overhang the edge of the vertical slide in order to allow the 13/32 in. reamer to pass right through (if no reamer of this size is available, use 3/8 in. and modify the bush to suit). The set up is shown in Fig. 44, the spacing of the holes being obtained using the cross slide index, and the work being previously centred as described for the crosshead. N.B. Before drilling for the big end it will be advisable to erect temporarily the components of the engine so far made to check that the required length of the connecting rod between centres of bearings is 1¼ in. as given on the drawing; mine was O.K., but slight errors in components have a nasty habit of adding! In order to rotate the rod through 90 deg. without moving it axially, I clamped a 5/8 in. bore collar on its projecting end, the collar resting against the edge of the vertical slide.

For forming the flat surfaces at the big and little ends of the rod, the bar was transferred to the milling machine, the work being held in the chuck on the dividing head and supported at the big end by means of the tailstock. Fig. 45 shows the set up in which the cutting is done by means of a 1/2 in. dia. end mill (long series) in the horizontal spindle; a vertical spindle would serve equally well. The vertical position of the table is first adjusted until the cutter just touches the 5/8 in. dia. of the work, and the index is then set to zero, after which it is a simple matter to remove the correct amount from each face to bring the big end to 5/16 in. thick, the small end to 7/16 in. thick and the lower part of the side of the small end to 7/32 in. thick. The extent of this latter face is gauged by inserting a plug having a 5/16 in. dia. head in the small end bearing and feeding the end mill until it barely clears the plug. Having completed one side, the work is indexed through 180 deg. and the opposite edge machined to the same table settings; using this method, one is sure that all the flat surfaces are symmetrical with respect to the rod centre. The appearance of the rod after the completion of this operation is shown in the upper part of Fig. 46

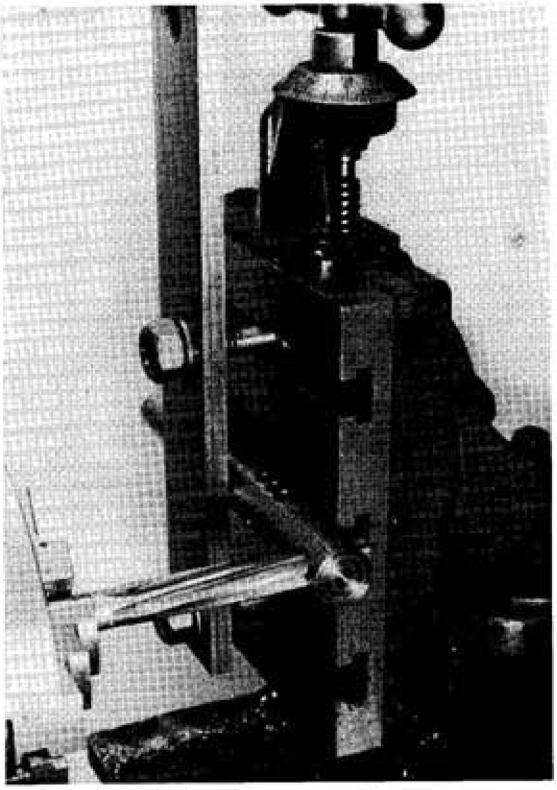
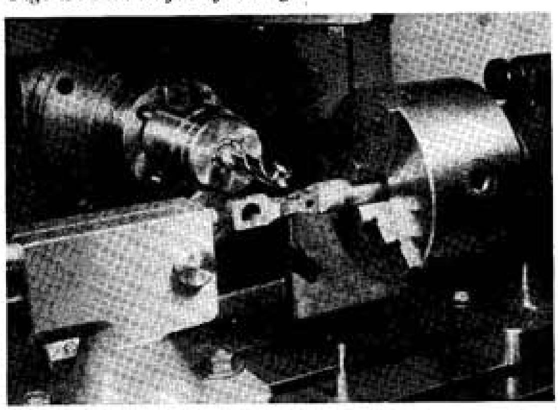


Fig. 44: Drilling and reaming cross-holes.

which incidentally shows a pair of blanks on opposite ends of a length of rod. The final cutting of the fork in rods of this type often presents a problem as there is normally so little material to hold and one often has to resort to the saw and file technique. On this occasion I tried with complete success removing the centre part of the fork with a 1/4 in. dia. slot drill while the work was still set up in the miller. The work of the slot drill was eased by drilling two 7/32 in. holes adjacent to the 1/4 in.

Fig. 45: Flat surface forming.



hole already drilled at the base of the fork. The slot drill was centred on the 1/4 in. hole and in three cuts (two would have probably sufficed) the slot was neatly and accurately formed, so that when the rod was eventually separated from its chucking piece the fork end would be formed. Fig. 47 shows the operation in progress and the finished result of the slot drilling is shown in Fig. 46.

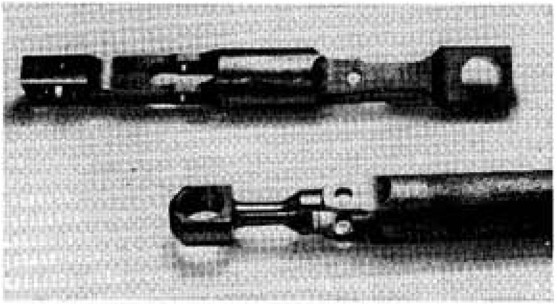


Fig. 46: Various stages on the rod.

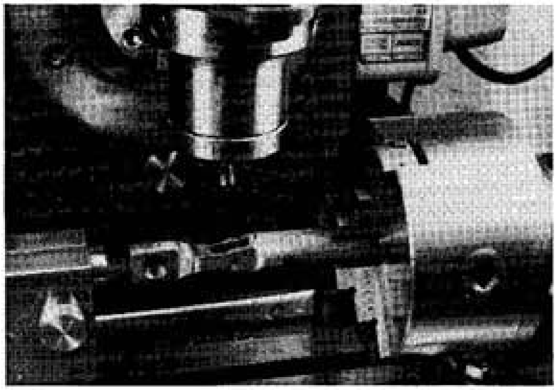


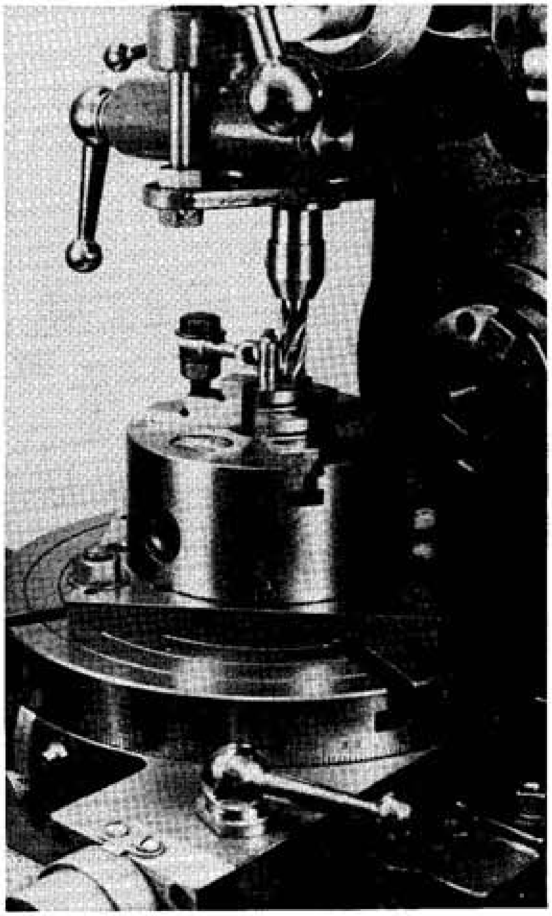
Fig. 47: The slot drill in action.

Having cleared the heavy operations, the work is transferred to the lathe, gripping the chucking piece in the three-jaw chuck and supporting the big end by the tailstock centre. The large diameters are finished to size first and then the shank of the rod is turned, using the top slide to obtain the necessary taper. The lower part of Fig. 46 shows the work after completion of this stage.

The rod can now be carefully sawn from its chucking piece and all that remains to be done is to form the 5/32 in. radius around the small end bearing. If some form of rotary table is available, this can be carried out on either the miller or the lathe. We are sometimes told to mount the work on a pin (5/32 in. dia. in this case) and pull it round against the rotation of an end mill, but I cannot recommend this as a safe operation especially with such a short rod. From the point of view of hand injury the milling cutter is one of our most dangerous tools and in our model work industrial type guards are not always practical; I always try to keep my hands on the machine controls so that they cannot stray near the cutters. Even the application of suds by brush can be dangerous unless it takes place on the outcoming side of the cutter. To return to our rod, my set up is shown in Fig. 48. The work is held by a mandrel in a chuck on the circular table, and is secured by a nut to this mandrel, a well fitting distance piece being placed between the forks. Note the bolt through the big end, wedged against the chuck jaws to prevent uncontrolled rotation of the work.

If desired the radius on the fork may be formed by filing, and this work is simplified if a simple filing jig is applied to the work. This jig takes the form of a pair of 5/16 in. dia. washers and a bolt having a 5/16 in. dia. head as shown in Fig. 49. The work is filed down until the file just makes contact with the 5/16 in. diameters. On balance it is preferable not to harden the jig parts as they are cheaper to replace than a file!

Fig. 48: Forming the radius at the small end.



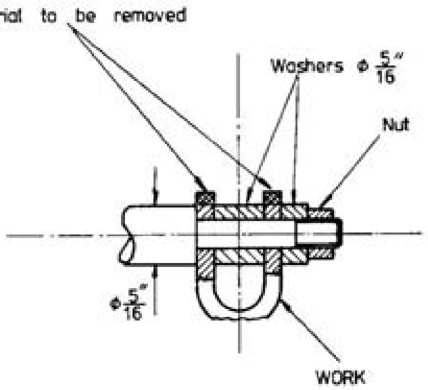


Fig. 49. FILING JIG

Big End Bush. Fig. 39.25

This can be made from 7/16 in. dia. drawn gunmetal rod, but it will be found that hard brass bar serves almost as well if lubrication is adequate, and produces less crankpin wear. Material sufficient for bush and chucking piece is gripped in the three-jaw chuck, faced, centred and drilled about 3/16 in. dia. and the bore opened up with a 7.8 mm. drill and reamed 5/16 in. (this is one case where a letter drill will not provide the ideal reaming allowance). The outside is turned to a press fit in the big end of the connecting rod, and for this an interference of .001 in. should be adequate. The bush will need further application of the reamer after the pressing in process and if the latter is satisfactory, there should be no fear of the bush moving during this final reaming process.

Crosshead Pin. Fig. 39.26

This is turned from 5/16 in. diameter b.m.s. and is prevented from rotating by means of a small pin or 'snug', the hole for which is drilled when the connecting rod and pin are temporarily assembled. In order to ensure ease of assembly the inner portion of the snug is reduced to a clearance fit in the hole and its end is fully radiused, while that section of the snug which enters the head of the bolt is made a press fit in the latter. Erection is also simplified if a very slight chamfer is formed on the leading end of the 5/32 in. dia. of the pin. If it is intended to case harden the crosshead pin, the snug should not be fitted until after hardening, and also the pin should first be temporarily assembled with the connecting rod, crosshead and guide to check that it does not foul the latter since clearances are small.

To be continued

TROJAN MARK II

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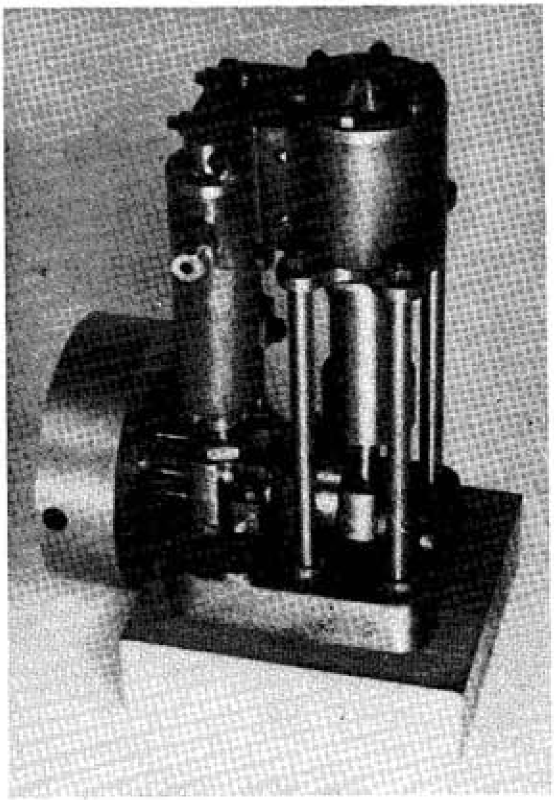
Part VII *from page 1074*

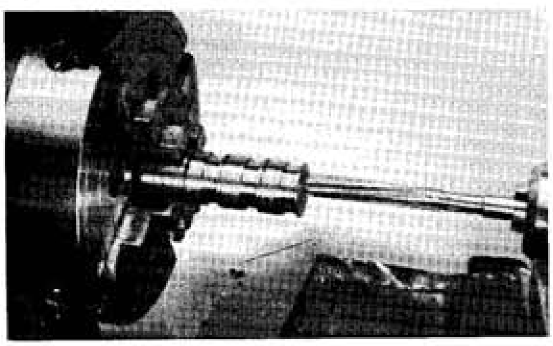


Eccentric Sheave. Fig. 50.30

This part is most easily turned up on a length of 3/4 in. dia. b.m.s. The material is first gripped in the three-jaw chuck, its end faced and the bar turned to 23/32 in. dia. With a parting tool, preferably held in the rear tool post, the groove for the strap is formed by a series of plunge cuts followed by a light cut of about .002 in. during which the tool is traversed axially along the width of the groove (n.b. it is important that the front edge of the tool is truly parallel to the lathe axis in order that a true surface may be obtained on the sheave; I usually hone the tool with a long oilstone which is easy to sight parallel to the lathe bed).

Direct measurement of the 5/8 in. diameter is difficult since the spindle of a normal micrometer will not enter the groove; I first gauged the size by noting the cross slide reading when the tool just touched the 23/32 in. diameter and then feeding in within .001 in. of the amount to bring the groove diameter to 5/8 in. Final measuring was done with a vernier caliper. With a narrow parting tool, a groove no greater than .10 in. deep is now turned in the work at the position in which it will later be separated from its chucking piece.

Fig. 51.



If for any reason more than one sheave is required, it is a simple matter to turn a series of grooves on a bar of appropriate length. In this case it will be advisable to support the outer end of the work by the tailstock centre, and if this is to be done, make sure that the centre hole occurs in an extension of the bar which can be faced off before the shaft hole is drilled, otherwise difficulty will be experienced in centring the latter accurately.

The shaft centre (3/32 in. from the sheave centre) is marked out and lightly centre punched on the faced end of the sheave(s) and the work remounted in the four jaw chuck with this centre running truly. I use a simple "wobbler" for this process; it consists of a steel knitting needle, one end of which is ground to a 60° point, to fit the centre punch mark, the other end being gripped in the tailstock chuck. A d.t.i. applied to the centred end clearly indicates any eccentricity. After setting up, the work is carefully drilled and reamed 5/16 in. diameter for the shaft and the sheave is then sawn off from the stub. Fig. 51 shows a set of three sheaves ready for separation.

The sheaves are now mounted boss end outwards on a stub mandrel held in the three-jaw chuck for finish turning the boss. I have shown the tapped hole for the grub screw, by which the sheave is

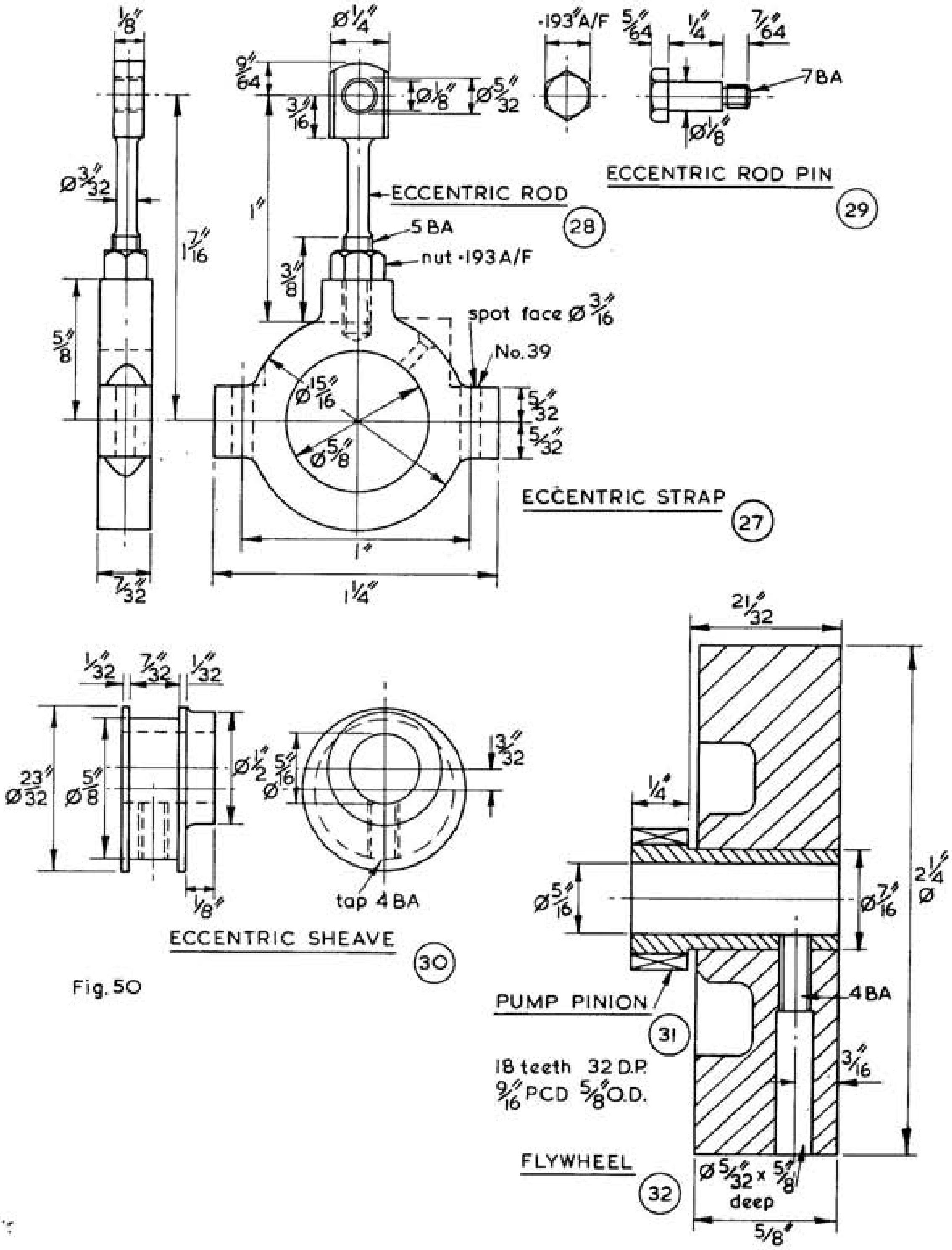

ECCENTRIC ROD
28
5 BA
nut ·193 A/F
spot face Ø 3/16″
No. 39
ECCENTRIC STRAP
27
Ø 15/16″
Ø 5/8″
1″
1 1/4″
7/32″
1 7/16″
5/8″
3/8″
9/64″
3/16″
Ø 1/4″
Ø 1/8″
Ø 5/32″
Ø 3/32″
1/8″
5/32″
·193″A/F
5/64″
1/4″
7/64″
7BA
Ø 1/8″
ECCENTRIC ROD PIN
29
1/32″
7/32″
Ø 23/32″
Ø 5/8″
Ø 1/2″
Ø 5/16″
3/32″
tap 4 BA
ECCENTRIC SHEAVE
30
21/32″
1/4″
Ø 5/16″
Ø 7/16″
2 1/4″ Ø
4BA
PUMP PINION
31
18 teeth 32 D.P.
9/16″ PCD 5/8″ O.D.
3/16″
FLYWHEEL
32
Ø 5/32″ x 5/8″ deep
5/8″

Fig. 50

secured to the shaft, within the sheave rather than in the limited thickness of the boss. This permits the use of a 4BA socket grub screw (the smallest I normally keep in stock), but I note that Reeves list smaller sizes, and 5 or 6 BA would be adequate here. The smaller grub screw could be located in the boss, thus simplifying valve setting.

Eccentric Strap. Fig. 50.27

This differs considerably from that supplied for the Mark I version of the engine and can either be cut from 1/4 in. brass plate or machined from a gunmetal casting. I used the latter since I found a pair of straps among my miscellaneous castings obtained from Reeves many years ago; incidentally I have checked that Reeves still have the appropriate pattern, so that supplies should present no difficulty.

After removing any pronounced roughness from the faces of the casting, I usually drill the two holes securing the two halves of the strap. This operation is most conveniently carried out using the vertical slide and vice in the lathe, or in the vertical miller; I used the latter. The vice is set with its jaws parallel to the cross slide, or to the table feed in the case of the miller, and the holes positioned by using the feed screw without any marking out; the holes for the eccentric rod and for the oil cup may be drilled at the same setting. Fig. 52 shows the work set up in the miller.

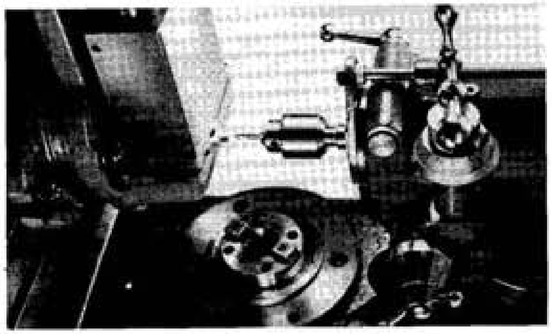


Fig. 52.

While the work is thus held, the drill may be replaced by a sharp end mill and much of the profiling of the strap carried out; by rotating the casting through 90° stages in the vice all flat edges of the strap may be thus dealt with. Fig. 53 shows this operation in progress and I would emphasise the necessity for using a really sharp cutter otherwise the poor surface finish and the excessive burr produced make the operation hardly worth while.

Much fitting time is saved if the strap can be divided with a slitting saw; the main difficulty is holding the work securely and at the same time leaving room for the cutter and its spindle. I am fortunate in having an angle plate which is machined

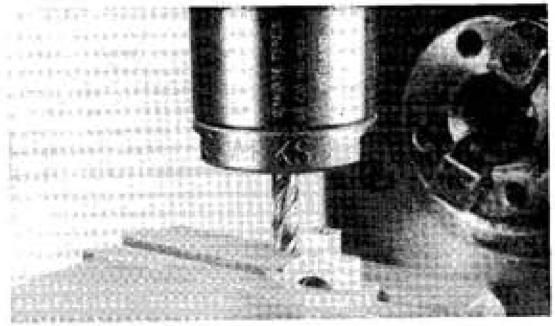


Fig. 53.

inside and out, and this is used in conjunction with a conventional angle plate to make a partial box plate. The strap is then clamped to the top of this assembly and divided by a thin slitting saw held in a stub mandrel. Fig. 54 shows my set up; a similar result could be achieved by using a single angle plate with a vertical spindle or on the vertical slide on the lathe.

The two halves of the strap are now bolted together and set up in the four-jaw chuck for facing and boring. After machining the outer face to a distance of 7/64 in. from the bolt centres, the hole is bored for the sheave. We cannot "turn to fit" here and accurate measurement is the only sure answer.

I set my vernier caliper to an easy fit over the sheave, and not trusting my ability to be sure of the vernier to the last .001 in., I set a telescopic gauge or internal caliper to the vernier jaws and measured the result with a micrometer. The strap was bored to this setting plus .001 in., and the entry to the bore very slightly chamfered. The remaining face of the strap is machined by mounting the work on a suitable stub mandrel.

The remaining curved portions of the strap profile are completed by careful filing. On the drawing I have indicated spot facing for the bolt seatings, but found this unnecessary on the castings I used.

Eccentric Rod and Pin. Fig. 50.28 and 50.29

The rod is turned from a length of 1/4 in. dia. b.m.s. Start by drilling and reaming the 5/32 in. dia. diametral hole for the cross-pin at a shade over 1 in. from the end of the bar, mount the work in the three-jaw chuck, face the end to 1 in. from the centre of the hole and centre with a small centre drill. The rod is then turned to .126 in. dia. and its end threaded 5 BA and the shank is then reduced to 3/32 in. dia.

After separating from its chucking piece, the flats on the top end of the rod can be formed by mounting the work on a 5/32 in. dia. stub mandrel held in the chuck, and facing 1/16 in. from each side. The part is completed by rounding the top end with a file and squeezing in a 1/8 in. bore bush made from a scrap of brass or bronze bar. For appearance sake, the 5 BA lock nut is turned from hexagon bar normally used for 6 BA nuts.

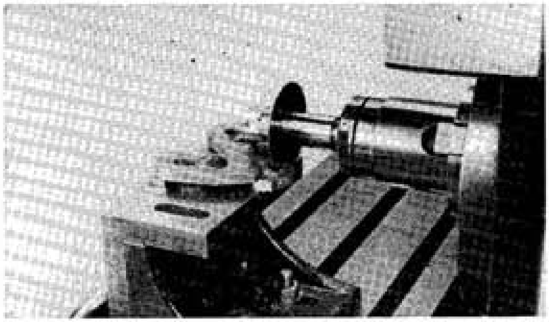
The pin (Part 29) is a simple turning job and needs no detailing; it may be casehardened if desired.

Finally Fig. 55 shows the completed eccentric components.

Pump Pinion. Fig. 50.31

If no boiler feed pump is to be fitted, this item is omitted and the flywheel is bored to fit the crankshaft directly. The pinion detailed was made in mild steel and is a press fit in the flywheel bore. The first two I made some years ago on my ML7, using the Myford Dividing Head and a commercially made cutter; I would now carry out the operation on the Senior miller.

Fig. 54.



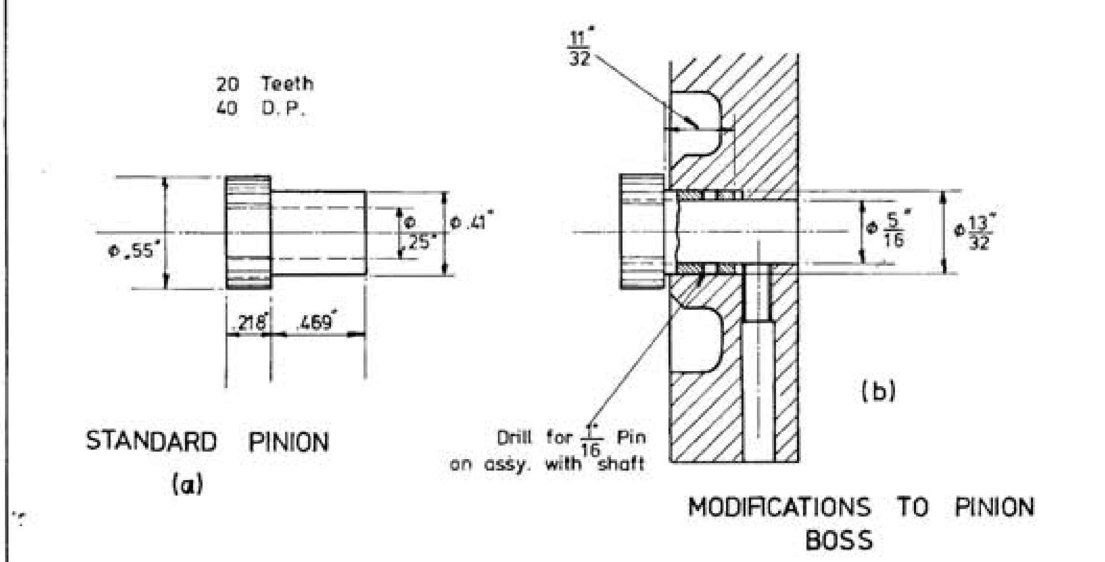
Since constructors who have gear cutting facilities will carry out the work in a manner dictated by their equipment, it is pointless to give detailed descriptions applicable to my own or similar equipment; I will give instead a method of incorporating commercially available gears. For this latter purpose I am basing my recommendations on gears supplied by S. H. Muffett Ltd. who used to advertise regularly in the *M.E.*

The gears recommended are of 40 DP and the appropriate reference numbers are A6-20 for the 20 tooth pinion and A6-60 for the 60 tooth gear (if a brass gear is required the reference is C6-60, the price difference being negligible).

For the commercial gears, some slight change in the method of attachment of the pinion to the shaft will be necessary since the boss on the pinion is only .469 in. long. Fig. 56a shows the pinion as supplied, while Fig. 56b shows the pinion as modified, together with the modified flywheel boss.

The modifications include opening out the bore from 1/4 in. to 5/16 in., shortening the boss and, if necessary, skimming its outside surface. For these operations it is safest to use the initial bore as datum, and the pinion is first mounted on a truly running stub mandrel and the outside of the boss turned if necessary; do not shorten the boss at this stage. A piece of 5/8 in. dia. brass or steel about 5/8 in. long is now firmly mounted in the chuck and faced and bored to receive the pinion boss as a tight push fit.

FIG. 56



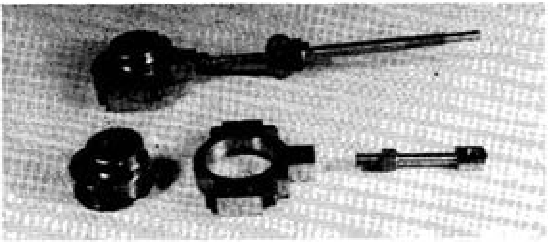


Fig. 55.

Thus set up, the pinion can be bored out and finally reamed 5/16 in. dia. with reasonable assurance that it will still run truly. After shortening the boss (a 5/16 in. stub mandrel is needed here, but one which has been previously used may be employed since concentricity does not affect this operation), the pinion is secured to the crankshaft by means of a small cross pin whose ends should finish slightly below the outside of the pinion boss in order that the flywheel may fit over the latter.

Flywheel Fig. 50.32

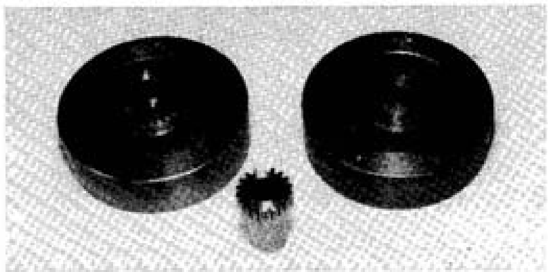
The wheel used is larger than that originally specified for the Mark I Trojan and is one of several castings obtained from Reeves in the old A.J.R. days; reference to the *M.E.* of 10.3.49 suggests that it may have been intended for the *Warrior* engine. A smaller wheel will do, but I found this one convenient for mounting the pinion and the shaft coupling.

The casting is first mounted in the four-jaw chuck boss side out and set so that the boss and inner edge of the rim run truly. At this setting the boss and rim can be faced, part of the outer surface turned and the hole bored for the shaft and/or pinion (press fit if you are making your own pinion with elongated boss, or push fit for commercial pinion). The work is now reversed in the chuck, taking care that the already machined face beds firmly on the chuck jaws, and by means of a d.t.i. in the bore or on the part of the periphery already machined, the work is set to run truly. The remaining face of the wheel and the rest of the periphery are now machined.

Unless you are very lucky with your setting up and machining, the two parts of the outer surface of the wheel will not blend perfectly, and this may be corrected by giving the wheel a final skim on a truly running mandrel. If the wheel is to be grooved for a driving belt, this is best done while the casting is still gripped in the chuck. The wheel is secured to the shaft by a 4 BA socket head grub screw, the hole for which is drilled radially (after pressing in the pinion) as shown on the drawing. Fig. 57 shows the flywheel and "home made" pinion.

Fig. 57.

To be continued



TROJAN MARK II

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Part VII *From page 1074*

Having completed the machining of the engine components, thoughts may now be turned to their erection. The principal fastenings used are 7 BA studs and nuts and although it may be argued that 8 BA would have been adequate, I preferred 7 BA since an acceptable thread can be formed on 3/32 in. b.m.s. I have not been very successful in obtaining steel rod in BA diameters and have on occasions spent considerable machine time in turning BA stud material.

When making up the Tangye Mill Engine, I made up what seemed to be yards of 6 BA studding, and for this work the travelling steady and feed cut-out on my Drummond lathe proved most valuable since I was able to set the lathe going on a fairly long length of material and get on with another job, knowing that the feed would cut out before the tool hit the chuck! I appreciate that "all thread" studding is available but I do not favour this as a stud should lock in the work on its end thread and not on the bottom of the hole.

Standard 7 BA nuts look a trifle large on an engine of this size, and for the present series I have made up all the nuts using 8 BA hexagon steel (.15 in. across flats). Older model engineers (like myself) may remember the pre-BA days when Whitworth threads were used and the engine illustrated in Figs. 1 and 2 of this series is actually assembled with 3/32 in. Whitworth studs and nuts in an attempt to use up my remaining 3/32 in. nuts which, incidentally, have the smaller hexagon size. Fig. 58 shows all the 7 BA studs required for the engine and they are also scheduled below:

Item	Location	No. off
a)	Main Bearings	4
b)	Valve Chest	4
c)	Bottom Cylinder Cover and Guide	4
d)	Top Cylinder Cover	6

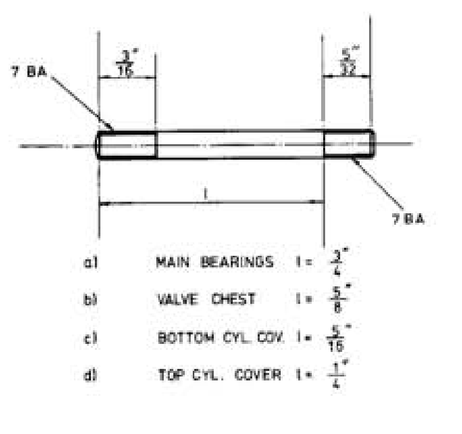
Lagging

Before permanently assembling the cylinder components it is advisable to fit the lagging. In our small engines the lagging serves little useful purpose but if fitted carefully it greatly enhances the appearance of the finished engine. I have in the past tried various materials for this purpose, and have found the blue steel strip now supplied by Reeves to be the easiest to apply neatly. This strip is of spring temper but it can be cut in the normal manner and drilled with sharp drills; on account of its springy nature I found it necessary to roll it round a 1/2 in. dia. mandrel in order to make it fit neatly round the cylinder.

Some of the softer blued steel sometimes used tends to bend in a series of flats rather than in a continuous curve unless carefully rolled. The lagging is secured to the cylinder block by four 9 BA roundhead brass screws, positioned 1/8 in. in from the port face and 7/32 in. in from the ends of the cylinder block.

Cylinder Assembly

If not already done, it is advisable to lap lightly the port face of the cylinder block and the faces of the valve and valve chest; I normally employ an unworn fine India or Aloxite oilstone (not carborundum — this is too coarse and loses its flatness too readily) for this purpose. The parts are then cleaned in paraffin, making sure that no swarf is lodged in the ports, and the fourteen studs screwed into the cylinder block.



TROJAN II. 7BA STUDS

FIG. 58.

For this latter purpose I use a stud driver consisting of about a 3/8 in. length of 7 BA hexagon steel rod (i.e. .17 in. across flats) which is drilled and tapped 7 BA to form a long nut; a 7 BA set screw is screwed into one end of this nut to just over the halfway position and the nut is then applied to the stud which can be tightened readily; slight slackening of the set screw will enable the driver nut to be unscrewed leaving the stud in position.

When all studs are home, check that all components slide over the studs and seat snugly into place. Thin paper jointings may now be cut for the cylinder covers and for the valve chest. The bottom cover and trunk guide may now be permanently assembled to the cylinder with the piston and crosshead in position, the piston and gland being packed with graphited asbestos yarn. Follow with the valve chest and top cover, but note that the valve chest cover will need to be removed for valve setting.

Assembly of Motion Work on Bedplate

Any painting work should be carried out prior to this stage, the only components needing this treatment being the bedplate, the unmachined part of the flywheel and possibly the bearing housings. Commence erection with the crankshaft bearings and the eccentric sheave; unless the setscrew securing the latter to the shaft has been transferred to the boss, it will be necessary to leave the strap off until valve setting time.

Follow with the flywheel (a small flat should be filed on the shaft to receive the point of the grub screw, otherwise subsequent removal of the flywheel will be difficult due to the burr raised by the screw point), and after checking for free rotation the four columns are added. Four 5 BA nuts will be required for the tops of the columns and these will look better if made from 6 BA hexagon rod and will be less likely to foul the cylinder lagging than standard 5 BA nuts.

The cylinder unit and connecting rod should now drop naturally into place. The top half of the eccentric strap and the valve rod are now coupled up and the valve adjusted on its spindle until equal port openings are obtained at both ends of the valve travel. Unless some positive locking device is fitted to the crankpin, the engine is only suitable for clockwise rotation viewed from the flywheel end, and the eccentric must be set for this direction of rotation.

With the crank on top dead centre, the eccentric sheave is set to lead the crank by an amount which will cause the valve to be just opening (i.e. giving a slight lead). With this setting, the crank is turned 180 deg. and the eccentric strap pressed firmly into contact with the sheave, when the valve should be just opening on the upward stroke of the piston. With the given valve dimensions and setting, cut-off should occur at approximately 60 per cent of the stroke.

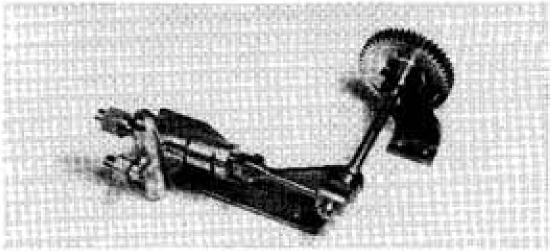


Fig. 59. Trojan's water pump — to be described soon.

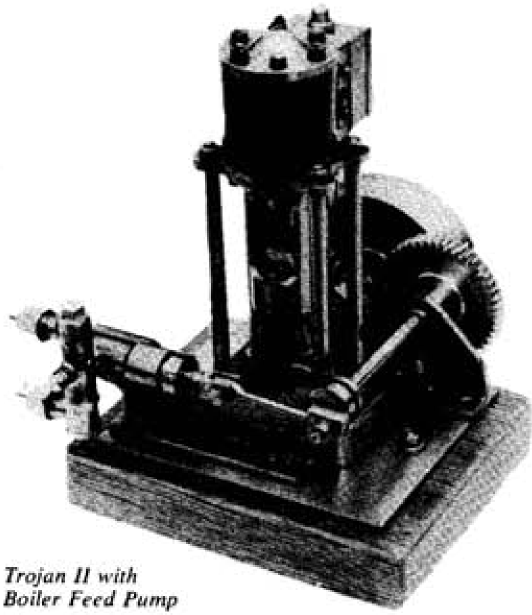
If the engine is required to do much running at low steam pressures or to run smoothly on compressed air, a somewhat later cut-off will be preferable and this can be obtained by removing, say, .02 in. from each end of the valve, making sure that the cavity remains central. This reduced steam lap (accompanied of course by re-setting the eccentric to put the lead right) will give about 75 per cent cut-off and much less compression at the end of the exhaust stroke.

After completion of the valve setting operation, the sheave setscrew is fully tightened, the lower half of the strap bolted up and the valve chest cover secured. The engine will probably be a bit stiff, if for no other reason than tight piston and gland packing, and I usually run mine in for a short while by gripping the flywheel in the lathe chuck and supporting the engine by hand against rotation while applying copious lubrication. If a compressed air test is required prior to steaming, a bicycle pump will serve to check that the valve is seating correctly and should produce a few rotations at each stroke. I keep one or two cycle valve stems, the inner ends of which are threaded 3/16 in. x 40 and these are very useful for preliminary test purposes.

Before much steam running is done, a cylinder lubricator is a "must" and this can be either a do-it-yourself affair or one of the Stuart Turner range. Their No. 155 combined lubricator and stop valve would be ideal and is correctly threaded for screwing directly into the valve chest. The engine illustrated at the commencement of this series is fitted with a larger version of this type of lubricator and it and the stop valve were made as separate units.

For constructors who do not wish to fit the boiler feed pump, this is the end of my story, but for those who do I will follow with details of a suitable pump which I consider a necessity on a marine engine intended for long runs, especially if used with a fast steaming boiler of limited water capacity. Fig. 59 shows the water pump unit designed and made for the Trojan Mark II engine.

To be continued



Trojan II with Boiler Feed Pump

TROJAN MARK II

by J. P. Bertinat

Part IX *From page 1355*

The Boiler Feed Pump

REFERENCE HAS ALREADY been made to the boiler feed pump and it was illustrated in Fig. 59 on page 1355 of the final instalment on the engine. The general arrangement of the pump and its driving mechanism will be shown in the next part. It will be seen that the pump unit and engine are mounted on a sub-base made from plate 1/8 in. thick, and that the pump is driven from the engine crankshaft via reduction gearing. Note that the pump and the main bearing for the auxiliary crankshaft driving it are mounted on the same bracket, thus enabling the pump thrust and bearing load to balance out in the same component, rather than be transmitted through separate brackets with consequent loss of rigidity. The construction of the pump is slightly unconventional in that the valve box is placed at the side of the plunger rather than in line with it; this permits the pump bore to be reamed through, one end being subsequently plugged, and also lends itself to simple built up construction. It will be noted that a banjo fitting has been used on the suction pipe; this allows the angular position of the pipe to be set as required, and a similar treatment could be given to the delivery valve if required.

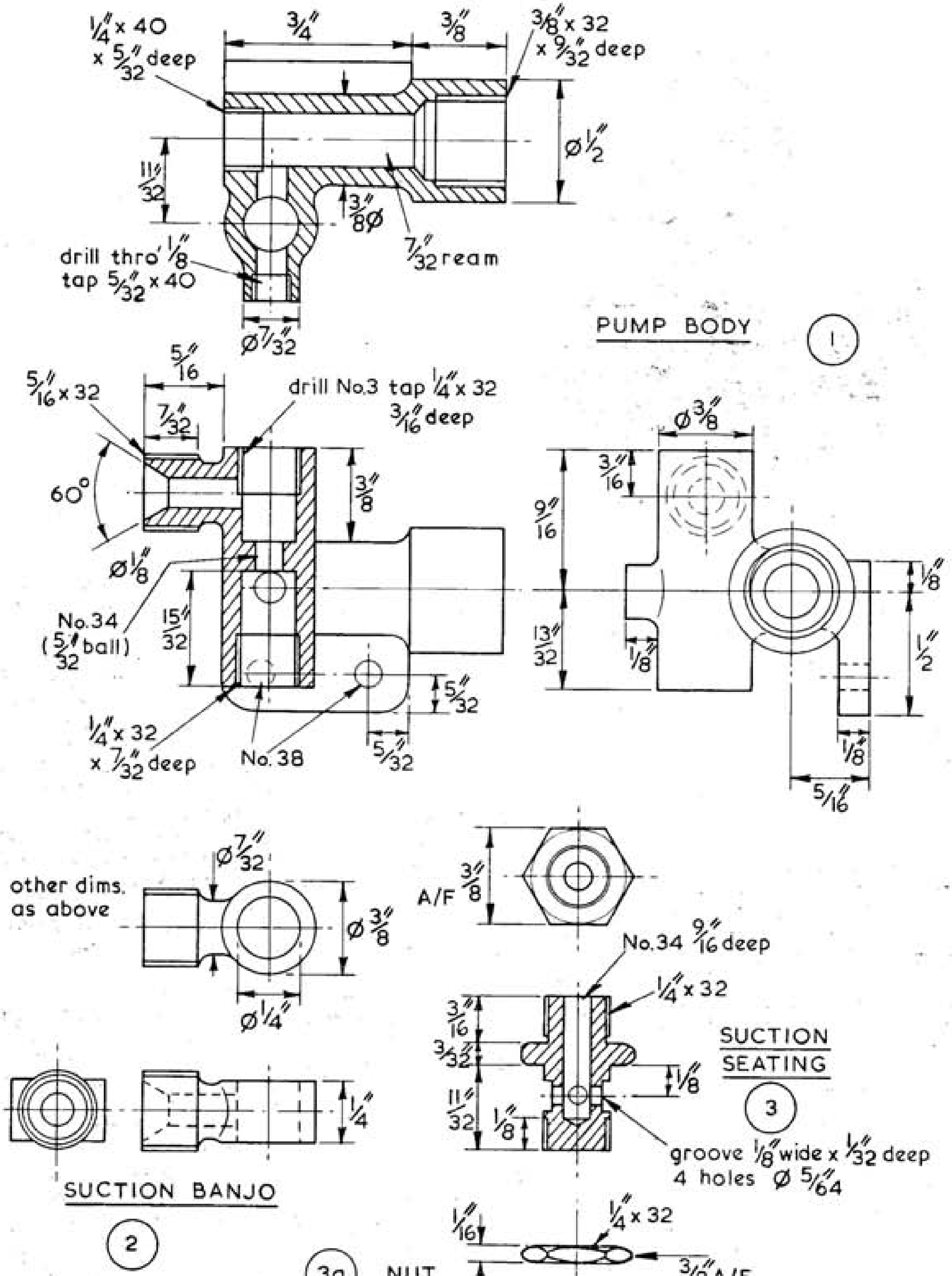
Pump Body and Suction Banjo. Figs. 61.1 and 61.2.

I find that for small items such as pump bodies, fabrication by silver soldering is quicker than machining a casting, and a good external finish is easier to obtain. All machining of the appropriate bar or plate material is carried out before silver soldering; I used brass throughout. Fig. 62 shows the component parts of the pump body and suction banjo before silver soldering together; it will be noted that the parts are "saddled" by milling or filing at the appropriate places. For securing the parts while silver soldering I use steel nuts and studs tapped into an appropriate part of the assembly; this is shown in Fig. 63 and it will be noted that a single long stud tapped into the back mounting plate serves to secure the lift restrictor boss, the valve box, the pump barrel and the mounting plate. After silver soldering and removal of studs the holes are opened out or plugged as appropriate. I sometimes blacklead the threads of the studs to discourage the silver solder from making them a permanent fixture, and over the years I have made up a large number of fittings by this method without trouble. Fig. 64 shows the pump body and suction banjo after silver soldering and pickling.

There may be some prospective constructors who prefer to use a gunmetal casting for the pump body, and to this end an alternative and more easily moulded design is suggested. This is detailed in Fig. 65 which also includes an appropriately modified plunger. This appears in the next part.

Pump Details Fig. 61.3 and Fig. 66

These are simple machining jobs and call for little comment. I have shown plugs made from circular bar, the hexagons being milled, but hexagon bar can be used if desired. Similarly the gland nut (Part 66.8) can be machined from hexagon bar if no dividing equipment is available. The plunger should be made from bronze or ground stainless steel and its fork end from 1/4 in. sq. BMS; all other pump components may be made from brass bar. The length of the pip on the delivery valve plug (66.6), and the diameter of the lift restrictor screw should be adjusted if necessary to restrict the lift of the ball valves to about 1/32 in. These latter are 5/32 in. dia. phosphor bronze or stainless steel, and if machining



1/4" x 40
x 5/32" deep
3/4"
3/8"
3/8" x 32
x 9/32" deep
Ø 1/2"
11/32"
3/8" Ø
7/32" ream
drill thro' 1/8"
tap 5/32" x 40
Ø 7/32"
PUMP BODY
1
5/16"
5/16" x 32
7/32"
drill No.3 tap 1/4" x 32
3/16" deep
60°
3/8"
Ø 1/8"
No.34
(5/32" ball)
15/32"
5/32"
1/4" x 32
x 7/32" deep
No. 38
5/32"
Ø 3/8"
3/16"
9/16"
13/32"
1/8"
1/8"
1/2"
1/8"
5/16"
other dims.
as above
Ø 7/32"
Ø 3/8"
Ø 1/4"
1/4"
SUCTION BANJO
2
A/F 3/8"
No.34 9/16" deep
1/4" x 32
3/16"
3/32"
11/32"
1/8"
1/8"
SUCTION
SEATING
3
groove 1/8" wide x 1/32" deep
4 holes Ø 5/64"
1/16"
1/4" x 32
3/8" A/F
3a
NUT

Fig. 61

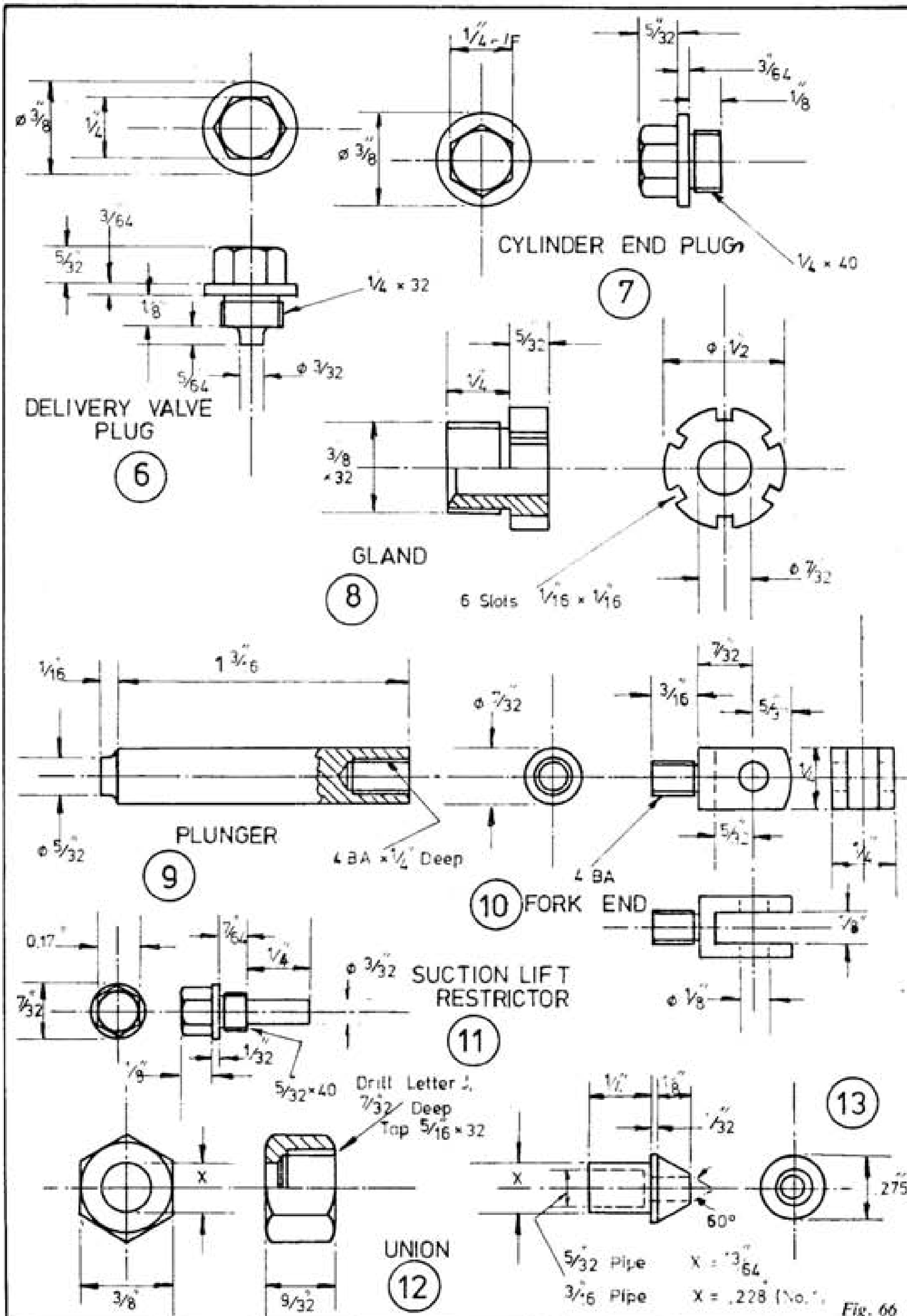

DELIVERY VALVE PLUG
6
CYLINDER END PLUG
7
GLAND
8
6 Slots 1/16 × 1/16
PLUNGER
9
4 BA × 1/4" Deep
10 FORK END
4 BA
SUCTION LIFT RESTRICTOR
11
UNION
12
13
Drill Letter
7/32" Deep
Tap 5/16 × 32
5/32 Pipe
3/16 Pipe
60°

Fig. 66

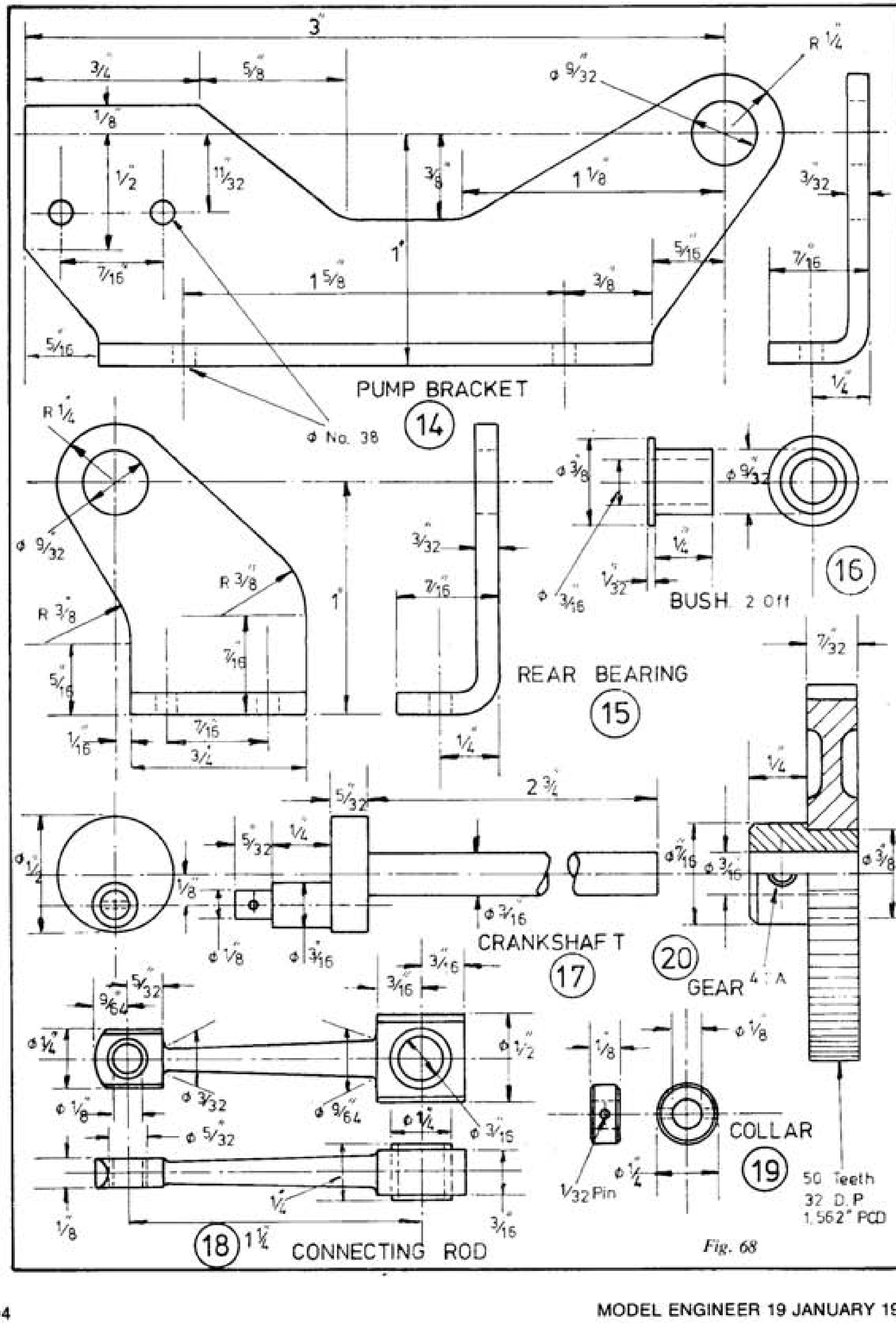

PUMP BRACKET
14
ø No. 38
REAR BEARING
15
BUSH 2 Off
16
CRANKSHAFT
17
CONNECTING ROD
18
COLLAR
19
GEAR
20
1/32 Pin
50 Teeth
32 D.P
1.562" PCD

Fig. 68

has been carried out accurately, the ball can be seated by tapping it lightly on the seating using a suitably recessed brass or copper punch between the ball and the hammer. Note that if phosphor bronze balls are used, the seating operation *must* be carried out using a *new* steel ball (not stainless) of the same diameter, since the phosphor bronze ball would itself become deformed. This precaution is sometimes advised when stainless balls are used since the non stainless balls are considerably harder than the stainless variety. Ideally the punch should slide in a guide bush in the body of the pump to make sure that the ball is hit squarely on to the seating, but with reasonable care this precaution is not essential.

For making the joints at plugs and banjo, I usually cut washers from cartridge paper or some similar material. Fig. 67 shows the assembled pump.

Pump Bracket and Rear Bearing. Figs. 68.14 & 68.15

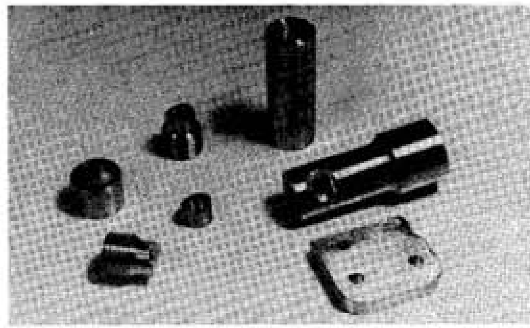
These items are bent up from *soft* BMS sheet, the flanges being carefully hammered over a suitably radiused block of steel before the shaping of the brackets is commenced. To obtain a clean bend it is essential that the material is in the fully softened condition, and that the part below the bend is held extremely firmly. A hardwood punch is used and the flat end of this punch is kept in contact with the whole surface of the flange during the bending operation, i.e. the punch starts in a horizontal plane and is gradually raised as the metal is turned over. In this way the metal will follow the contour of the block over which it is being bent and a clean unbruised flange will result. In my aircraft fitting days, a pair of bending bars was an essential part of a fitter's tool kit. Mine consist of two 9 in. lengths of 1 in. x 1/2 in. BMS held together at their ends by 1/4 in. BSF bolts, the edge of the bar over which metal is to be bent being suitably radiused. In use, the work to be bent is clamped between the bars by the end bolts and set carefully in position, and the assembly then placed in the vice.

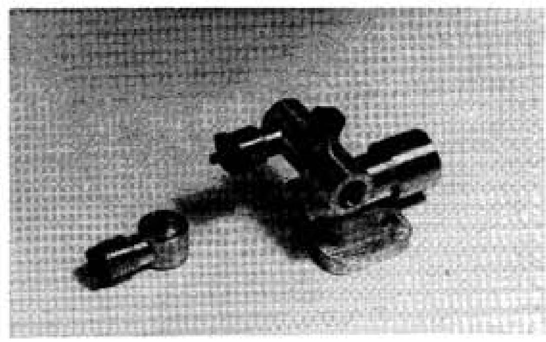
After bending, the bases of the flanges may be cleaned up with a file if necessary to bring the faces to exact right angles. The profiles of the brackets are now marked out and the parts sawn and filed to their finished dimensions. The 9/32 in. dia. holes for the bearing bushes should be reamed to provide a good finish for the press fitting of the bearing bushes.

Bearing Bushes. Fig. 68.16

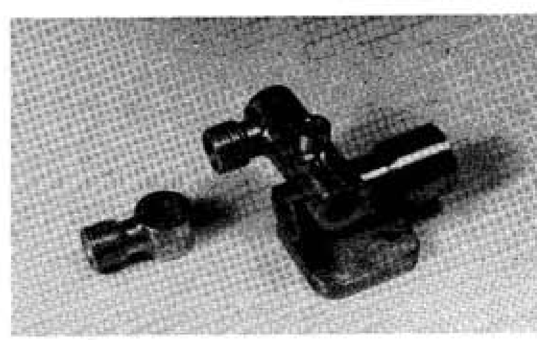
These are turned from 3/8 in. diam. brass or GM bar. If press fitting is to be adopted, the first 1/8 in. of the 9/32 in. diameter can be relieved by about .002 in. so that only the part adjacent to the flange is a press fit.

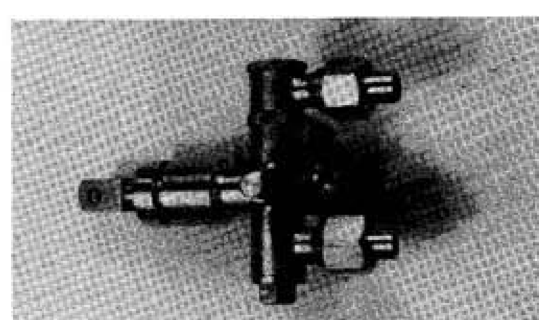
To be continued



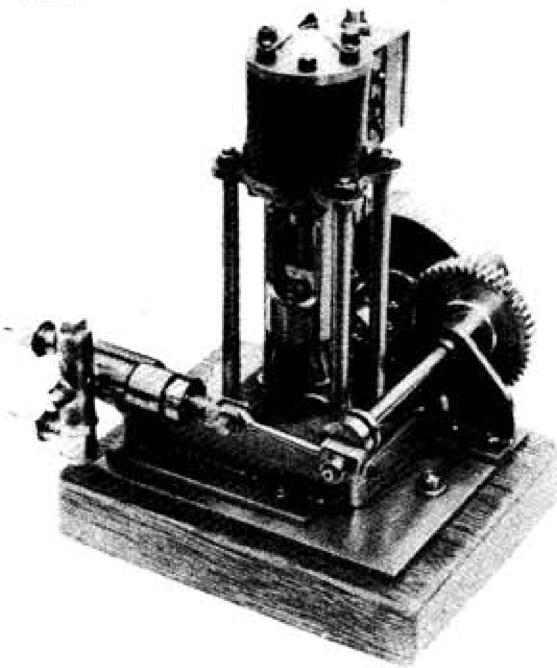


Top. Fig. 62. The pump body components.
Above. Fig. 63. Securing the assembly.
Below. Fig. 64. The pump body and suction banjo.
Bottom. Fig. 67. The assembled pump.





Trojan II with boiler feed pump.



TROJAN MARK II

by J. P. Bertinat

Part X *From page 95*

The last article in the series completes the description of the boiler feed pump

Pump Crankshaft. 68.17

Since the shaft and pin are so close here, it is most satisfactory to machine this component from a single piece of 1/2 in. dia. b.m.s. Whichever end is machined first, the second will be found awkward to hold unless one is prepared to make up a special jig.

My "jig" for this type of work consists of a 3 in. 4-jaw chuck mounted on a flat steel base; this can be mounted on the face plate and set at any desired eccentricity, whereas only a limited offset of small diameter components can be obtained with a four-jaw chuck rotating on its own axis. Assuming this equipment is not available, I would proceed thus; A piece of 1/2 in. dia. b.m.s. is first faced on both ends to a length of 3⅜ in. and a centre pop made on one end at 1/8 in. from the shaft axis; this is now set up in the 4-jaw chuck so that the offset centre pop runs truly; and the crankpin is finish turned. The work is now transferred to the 3-jaw chuck, the other end centred, and re-set so that the shaft is only gripped by 1/8 in. of what will be the crank disc, the outer end being supported by the tailstock centre. This set up will enable the 3/16 in. dia. shaft to be turned for its full length, after which the work is gripped by the 3/16 in. shaft and the periphery of the crank disc is lightly skimmed to remove any chuck jaw marks. With my face plate mounted 4-jaw chuck available, I would machine the shaft first (and have a greater length to hold in the 3-jaw chuck since the crankpin is not yet formed), subsequently transferring to the special 4-jaw chuck for machining the pin.

Pump Connecting Rod. 66.18

This is of mild steel with bronze bushes and is cut from 3/16 in. x 1/2 in. bar or the nearest available; leave at least 3/8 in. extra on the length to form a chucking piece at the small end. First drill and ream the holes for the two bearing bushes (5/32 in. and 1/4 in. respectively). The profile is turned with the chucking extension at the small end held in the 4-jaw chuck while the big end is supported by the tailstock centre. The bushes at either end are either press fits or Loctited into position (I employ the former). The connecting rod on the crank pin by a small collar (Part 19), this in turn being retained by a small cross pin; the direction of rotation is wrong for a normal threaded retaining nut.

The small end pin has not been detailed since it is identical with the eccentric rod pin, see engine part 29.

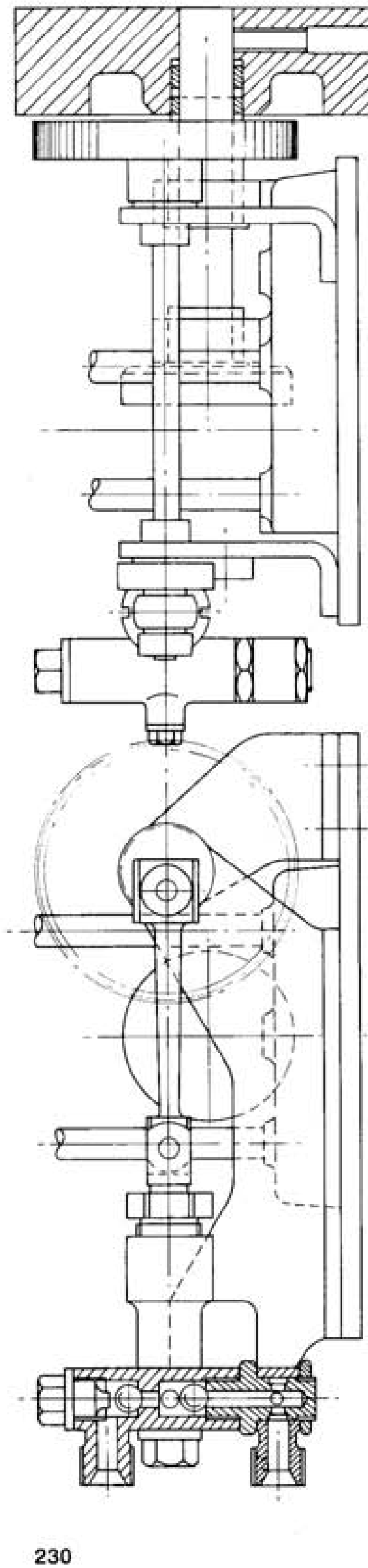
Pump Gear. 68.20

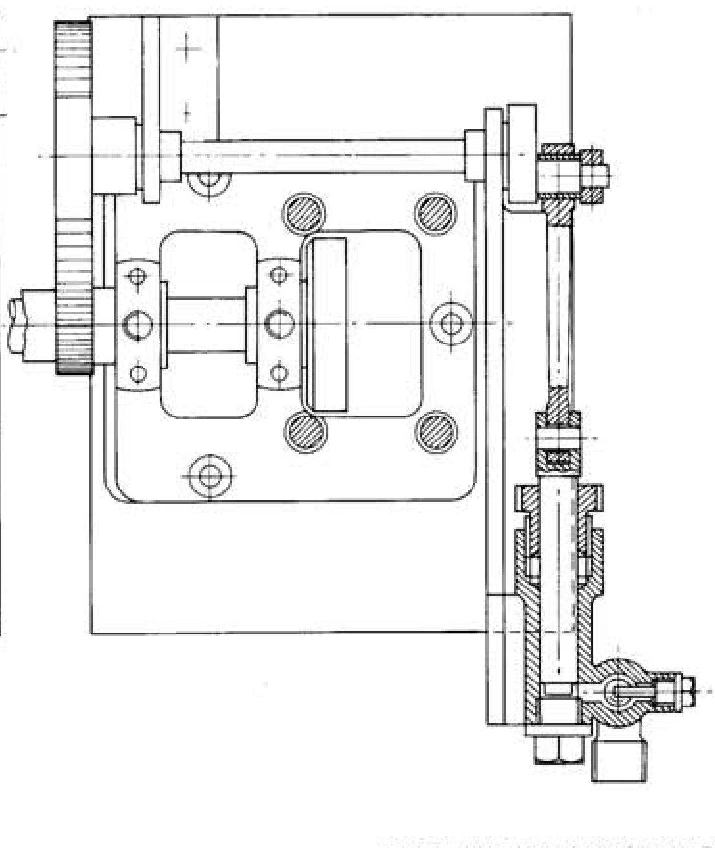
Reference to the pump gearing has been previously made (Pump Pinion, Fig. 50.32 p. 1197). If a commercial gear is used, the boss length will need reducing to 1/4 in. and the boss diameter to something approaching 1/2 in.; the bore of the gear will also need to be reduced from 1/4 in. to 3/16 in.

I made my gear(s) from blanks cut from 1/4 in. thick dural plate. The use of a separate boss permitted this to be done and also enabled a batch of 3 blanks to be mounted on a 3/8 in. diameter mandrel for the gear cutting operation. Fig. 70 shows this in progress; I am using the Myford Dividing Head on the Senior Miller, the dividing head being mounted on the short ML7 cross slide which became redundant when the long slide was obtained. The steel boss for the gear is a simple turning job and is a press fit in the gear; the sides of the latter are relieved as shown for appearance sake.

Mounting and Erection

In Fig. 60 I have shown the engine and pump mounted on a base made from 1/8 in. thick b.m.s., but aluminium alloy would serve equally well. The exact size of the base plate is not critical and slight variations in the minimum size will arise according to the size of gears used, but a plate 3¾ in. wide x 3 in. long should accommodate all reasonable variation. The engine should first be fixed to the base plate on its longitudinal centre line and leaving 9/16 in. of base protruding at the front end of the engine. For fixing, I used 5 BA studs tapped into the base.





Trojan mk.II

Arrangement of boiler feed pump

Fig. 60.

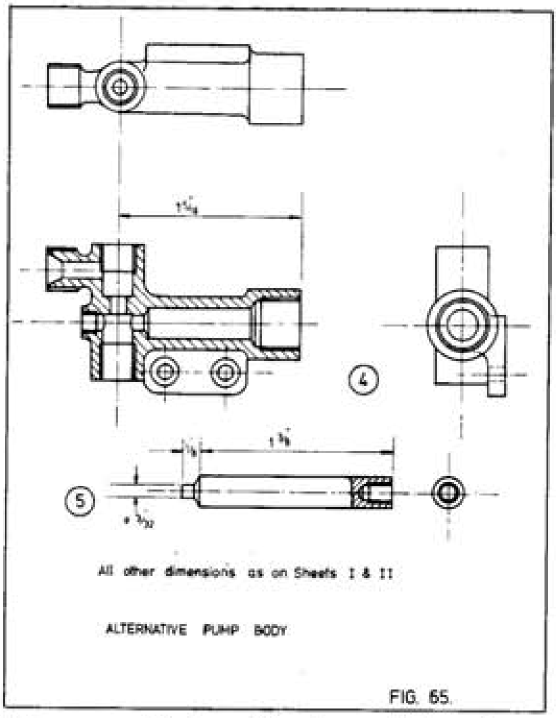


FIG. 65.

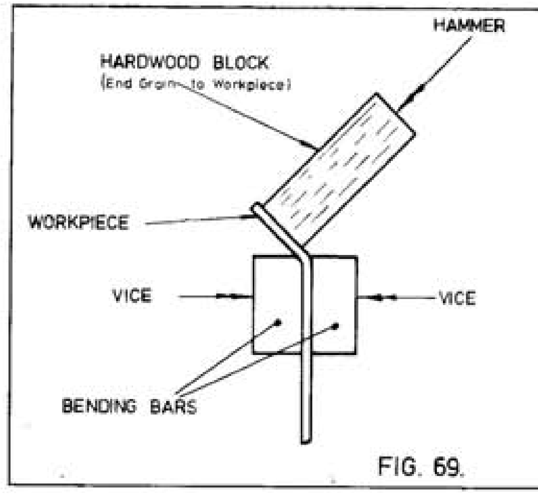


FIG. 69.

The pump unit is then offered up and clamped temporarily in position while the fixing holes are spotted or scribed through. Final fixing is by 7 BA bolts or nuts and studs; I used the latter.

Finally the heading photo shows the engine and pump unit assembled.

POSTSCRIPT

In my opening remarks I referred rather nostalgically to the now defunct Stuart Turner Simplex Engine, and to the set of castings and drawing for this engine which have recently been retrieved from New Zealand. This engine has now been built up by Stuart apprentices, and in July last on the occasion of the SIMEC Open Day at Stuarts works, I was privileged to see and to photograph this 'historic' engine. The result is shown in Fig. 71 and its strong resemblance to the Trojan II is readily apparent. The Simplex was of the same bore and stroke as the Trojan and was available with either iron or gunmetal cylinder parts. (The example shown is in iron).

Fig. 70. Gear cutting in progress.

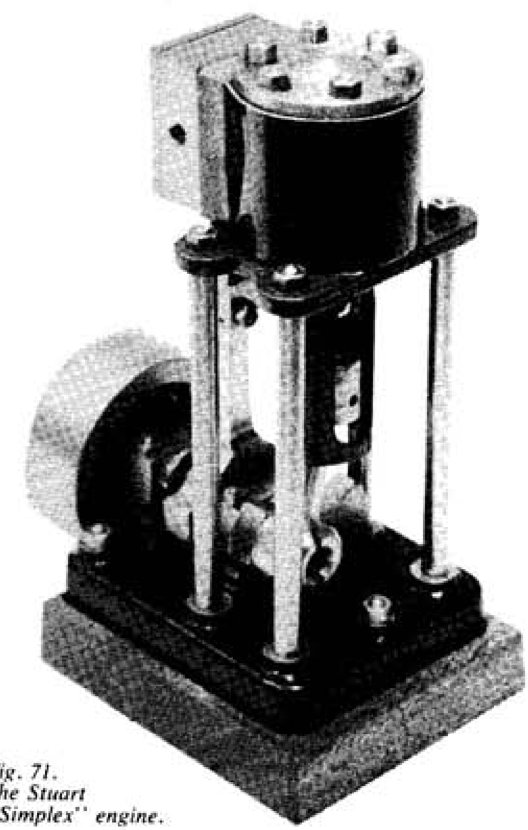


Fig. 71. The Stuart "Simplex" engine.