* A 15-c.c. FOUR-CYLINDER E.

By Edgar T. Westbury

WE come now to the final stages in the construction, including the minor items of fitting and assembly, which should present very little difficulty if the machining has been accurately carried out, but which have a far-reaching effect on the efficiency and reliability of the finished engine.

It has already been stated that practically all the joints between the various components can be made without the use of gaskets or other packing material, the joint surfaces being lapped perfectly flat, and a smear of varnish or other liquid jointing preparation being applied before assembly. There is, perhaps, at least one joint surface which cannot be lapped in this way, namely, the flange of the main bearing housing, but as this is a plain circular face with a register spigot, no difficulty should be encountered in machining it true enough, especially as it only has to hold tight against oil creepage.

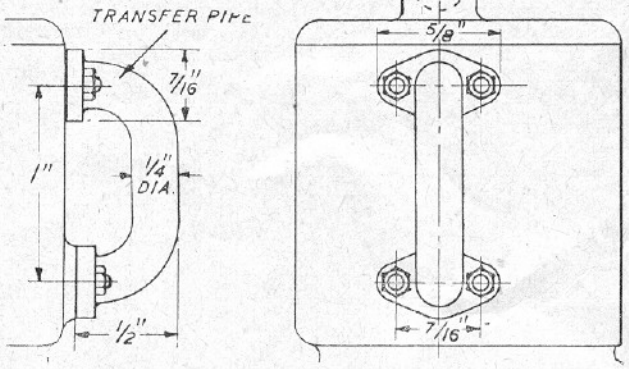


Fig. 46. Showing how a transfer pipe may be fitted to communicate between water jackets in main and cylinder-head blocks

My method of lapping flat joint surfaces is to use a piece of plate-glass, not less than ¼ in. thick, smeared with fine carborundum paste, and work the component evenly over its surface, taking care to avoid undue local pressure, by continually shifting one's hold on it. A circular motion of the work produces fairly good results if it is also rotated slowly on its own axis as well, but operators experienced in lapping generally adopt the characteristic "figure of eight" movement, which results in every point on the surface traversing the same linear distance, at the same mean speed. This treatment is continued until the surface of the work shows a perfectly even matt surface, after which it is thoroughly cleaned by washing in petrol or paraffin, particular care being taken to remove the abrasive from tapped holes and other interstices.

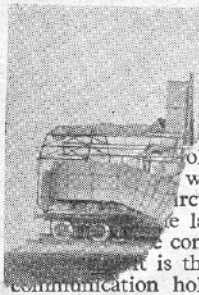
It may be remarked that the glass surface will not last indefinitely, as it is gradually worn inaccurate, but it is not expensive, somewhat large, most glaziers have a few small pieces of glass which they are only too glad to get rid of. Thin glass is not desirable for truing down because even if its surface is perfectly flat—often it is not—it is capable of distorting to a considerable extent under pressure.

The matt surface produced on the joint faces is better than a highly polished surface, as it holds the varnish film more effectively. Care should be taken to avoid subsequent damage to the surface by scratching or burring; when small studs are screwed home there is a tendency to throw up a burr around the tapped hole, which should be avoided by lightly countersinking with a small centre-drill. Persistent refusal of the joint to maintain tightness is generally due to "growing" or "seasoning" of the casting by the gradual release of internal stresses, and may call for some patience in getting it finally correct, but aluminium alloys are better than most other metals in settling down quickly.

Water Passages

The communication between the water passages in the body and cylinder-head blocks may be made in two ways; the first, which is the more common in motor car practice, is to form passages through the horizontal joint surfaces, in such location that they are clear of the combustion spaces and do not interfere with the gas-tightness of the joint. If, however, the constructor has any doubts about using the one joint surface to hold both water and gas pressure, an alternative method is to fit a bent pipe to the flange on the body casting, at the remote end from the water inlet, to carry the water up to a similar flange on the end face of the head. This method is sometimes used in marine engine practice, so it is by no means out of character with the model. No provision has been made on the head casting for fitting a flange joint on the head in this way, but there is sufficient metal on either end face to true up to an accurate

*Continued from page 103, "M.E.," July 24, 1947.



ap for the securing studs,

d to communicate directly
es, their location should be
47, and in cases where forced
oyed, three holes $\frac{3}{16}$ in. dia-
oles 5/32 in. diameter, in the
will be found sufficient. For
rculation, however, the passages
e largest possible area, so as to
convection flow to the minimum
t is thus desirable to open out the communication holes as shown by the dotted lines.

When the supply of circulating water is unlimited, as in the case of a marine installation, it is usually convenient to pass it once through the jackets and overboard, or into an exhaust cooler or water-injection silencer. But even in such cases, it may be an advantage to circulate the water in a closed-circuit system, incorporating a radiator or cooling tank, in order to avoid possible clogging of the passages with sand, mud, or weeds. Small radiators are usually of dubious efficiency, but effective re-cooling of the circulating water may be assured by running it through a keel pipe or similar form of cooler in contact with the water through which the boat is running.

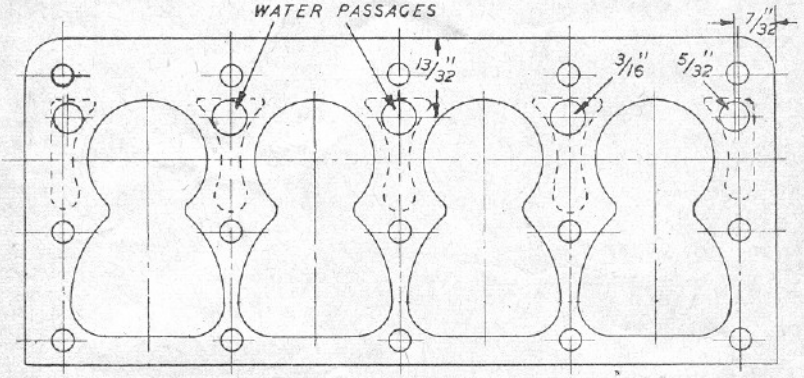


Fig. 47. Plan of cylinder-head joint surface, showing position of water communication holes. Dotted lines indicate how holes may be enlarged to suit thermo-syphon circulation

Mechanical Assembly

It is most essential that all working parts of the engine should work perfectly smoothly and freely. Particular attention should be paid to the alignment of the pistons and connecting-rods with the crankpins, as mentioned in the April 17th issue, and side binding must at all costs be avoided; but the big-end bearings should not be given appreciable end clearance, as it is desirable to maintain the maximum bearing area on these bearings. End play, if necessary, should be allowed at the little ends.

In view of the offset of the cylinders, it may be found that the connecting-rods tend to foul on the valve chamber side when at the position of maximum angularity. They must not be wider than shown on the drawing, and may be rounded on the edges to reduce this tendency, but even so, the usual expedient of filing notches in the lower edges of the liners, to give clearance at this point, may be necessary.

The detail drawing of the connecting-rod (Fig. 16, April 17th issue) indicates the use of 3/32-in. set-screws in the big ends, tapped into the upper half of the bearing and cross drilled through the tail ends to take a security wire. In view of the smallness of these screws, and to promote accessibility, I have now found it better to cross drill the screw heads, which may be a good deal deeper than as shown, and need not be hexagonal. Tough material is essential for these screws, commercial screws not being regarded as safe; I recommend turning them from a piece of motor-cycle spoke, which should be annealed before machining. Do not attempt to screw them up to the bursting point, but secure the heads by passing a steel wire through both of them, and bending round the ends, in such a way as to resist any tendency to unscrew, as shown in Fig. 48.

Accurate Timing

When fitting the camshaft, it is advisable to fix a disc to the flywheel, with the timing diagram marked on it, to suit the proper direction of rotation, and carefully set for top dead centre. This will enable the camshaft to be accurately timed (assuming that it is not positively keyed) and it will be found only necessary to check up on the valve vents for one cylinder, as the others will come right automatically if the cams are correctly machined. Insert the tappets and valves, and adjust them to the specified clearance in the closed position, holding the head with a screwdriver while manipulating and locking up the nuts. Check both the opening and closing points, by noting exactly when the tappet clearance is taken up. It is possible that the opening period may not agree precisely with that shown on the diagram, and if so, the difference should be split, so that the mid-open position is correct; exact opening and closing angles are of minor importance. When properly timed, tighten up the camshaft nut firmly.

All instructions for timing, so far, have been based on the assumption that the engine is

ssembled as shown in the drawings, that is, to n anti-clockwise at the timing end. If the body is reversed, for the other direction of running, it is simply necessary to reverse the order and sequence of all timing vents, as if the entire system were viewed in a mirror.

Coupling and Oil Retainer Sleeve

These items have been omitted from previous detail drawings, as they may be open to variation to suit the purpose for which the engine is to be used. It is, in a general way, desirable to take the main drive from the flywheel end, by any kind of coupling which may be considered suitable, such as a pin coupling or flexible disc ; but in many cases, the need for a main or auxiliary drive at the timing end is encountered ;

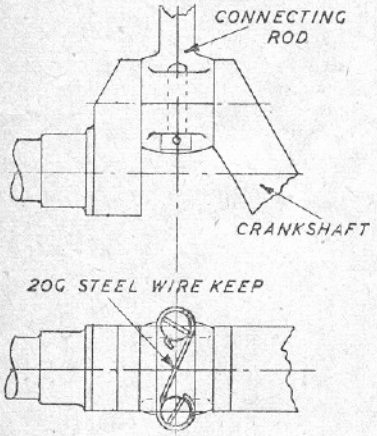


Fig. 48. *Use of steel wire keeps to secure crankpin bearing screws*

or it may be found desirable to fit a starter similar to that designed for "1831." If no coupling of any kind is required, a plain or castellated ¼-in. B.S.F. nut may be fitted.

The form of coupling shown in Fig. 49 may be modified as required, to suit a simple "ball and pin," Cardan, or die-block type of universal joint, dog clutch, or face ratchet. It may also be combined with the oil retaining sleeve, if desired, as shown in the alternative detail drawing.

The sleeve acts as a spacer between the shaft nut and the timing pinion, running round with the shaft in the clearance bore of the timing case. A right-hand spiral groove is incised in its outer surface, to retard the escape of oil from the casing, and it should finally be case-hardened and polished ; the coupling, also, may with advantage be hardened when its final form has been decided upon. For an engine of reversed rotation, it will be desirable either to screw the shaft and tap the coupl[illegible] thread, or to pin it in positi[illegible] sleeve must also have a left-l[illegible]

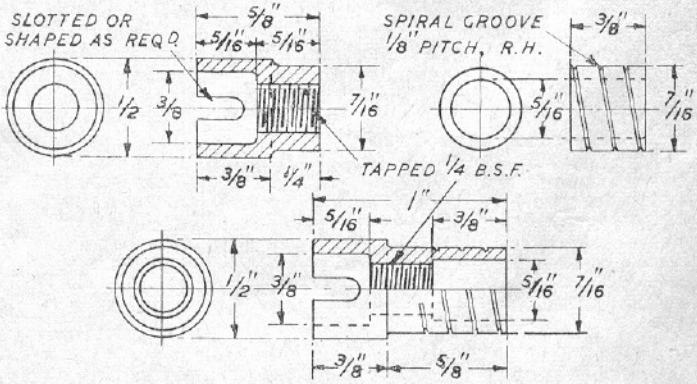


Fig. 49. *Coupling and oil retainer sleeve, showing (below) an alternative fitting combining both components*

Ignition Timing

General instructions on th[illegible] contact-breaker and distributo[illegible]ob. With bearing been given ; it remains now t[illegible]he bore of 13/16 in. individual h.t. leads to their res[illegible]omewhat large, The centre lead, of course, goes to shaft was not minal of the ignition coil, the [illegible]assembling it connected so that the lead from the stu[illegible]ning down adjacent to the distributor segment at the [illegible] goes to the plug of the cylinder which is in the firing position ; that is, at approximately top dead centre with neither valve open nor about to open. Mark the distributor cover with the numbers of the leads, to facilitate subsequent assembly, and fit spring clips or other neat terminals to the lead ends for making connection to the plugs.

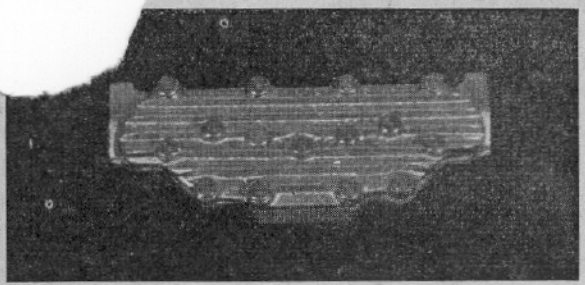
A Magneto for the "Seal" Engine

Several readers have asked whether I am going to provide magneto ignition for this engine. The answer is that, like quite a number of other features, it is an optional fitting, and provision for it has been by no means neglected in the scheme of design.

The simplest way to adapt the engine to magneto ignition is to do the same as I have done with the 50 c.c. four-cylinder engine constructed by Mr. Savage, as described some time ago ; namely, to utilise the existing contact-breaker and distributor, in conjunction with a magneto of substantially the same type as that used for a single-cylinder engine. While this does not represent prototype practice, where the orthodox form of multi-cylinder magneto is employed, the latter presents serious difficulties for modelling on a small scale, and from the practical point of view, offers no advantages beyond that of correct appearance.

A self-contained magneto such as the "Atomag" type, or the ready-made "M1." ma[illegible] be used, fitted with a double-break cam, and direct-coupled to the main engine shaft in any

ernatively, a built-in fly- e " Atomax " type may be in size to conform with the , is preferable in respect of neatness. I have in hand a neto well suited to this particular hope to be able to arrange for



Inlet-exhaust manifold for the " Seal " engine

supplies of essential parts for its construction in due course.

I must confess to being a little disappointed in the general attitude of readers to the small magneto ; while nearly all petrol engine users are very enthusiastic about it and ready enough to adopt it, few of them seem prepared to tackle the job of making one, though the directions which I have given should be sufficient to enable any model engineer of average ability to carry out this work successfully.

Final Adjustments

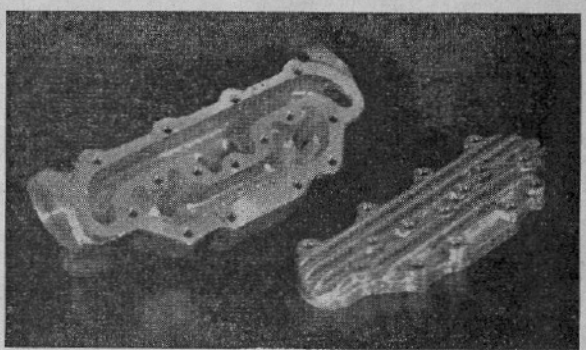
These are not in any essential way different from those of a single-cylinder engine, neither should it be any more difficult to get the engine working, or to maintain it in an efficient running condition. As with any small engine, it is most essential that the compression should be good, and the valves tight, also that jet adjustment and other details should be carefully attended to. The standard form of ignition coil, as used with single-cylinder engines and running at normal voltage, will suit a " multi " fairly well, so long as it is of good quality and capable of a high spark frequency. As the drain on the battery will be greater than that of a single, be sure that the capacity of the battery is ample, or disappointment will be the result. The bad reputation which small petrol engines have acquired in certain quarters is very largely due to ignition trouble caused by cutting the margin of battery capacity and coil efficiency too fine.

Water !

Do not, in the hurry to get the engine running, forget to fit up the water circulating system, or—even more important—to fill it with water ! I have known this happen many times, strange as it may seem. The fuel tank should be placed as near to the carburettor as conveniently possible, and within an inch or two below jet level. Filter all fuel meticulously before putting it in the tank. Oil level should be kept well on the high side during the running-in period ; it is much better to oil a plug than to score a bearing. Never succumb to the temptation to open the engine flat out without load, just to satisfy personal curiosity or show off to admiring friends ; remember that there are four split big ends in the engine, and what *might* happen if only one of them failed to stand the strain is better imagined than described.

The " Seal " Steps Out

In this first essay in the design of a small four-cylinder engine, I have attempted to live down, to some extent, the reproach that small petrol engines are not " true models " (whatever that may mean), but at the same time eliminate the major difficulties of near-scale petrol engine modelling, and bring it within the scope of the average model engineer.



The manifold with cover removed to show exhaust and inlet passages

The intention to produce four-cylinder engines of similar type, but in other sizes, has been referred to earlier, and I have had many letters asking for both larger and smaller versions. I do not propose to make exact scale copies of the engine in various sizes, though this is quite practicable if readers wish to do it for themselves. I prefer, however, to explore other paths of design, to tackle new problems, and if possible, to attain still further facility of construction and elimination of snags. Supplies of castings and other essential materials of construction are still a problem, but this is gradually being ironed out and I hope to make a definite announcement about it in the near future.

I have already made some progress in the design of a 30-c.c. four-cylinder engine, and a friend is co-operating with me in providing another of 10-c.c.—the smallest size I can contemplate with equanimity at present. But please don't write and ask for advance details of these designs yet—they will be made public when the time is ripe. For the present—Hush ! keep it dark—my lips are SEALED !