GARDNER

Engine Forum

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Gardner Engine Forum Philosophy

"The aims of the Forum are to promote and foster interest in all Gardner engines"

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Cover Picture

Gardner Engine Rally 2005
Castlefield, Manchester

Chairman's Jottings

First of all, a big thank you to those of you who attended the AGM at the Anson Museum in Higher Poynton on 14th April 2007 We had an attendance of 25 with some members coming from as far afield as Hull and Bristol. It is really nice to meet up with our members and we thank you for your support.

The existing committee were elected en block to continue with the work of the forum. At long last our calls for new committee members have been answered and we have now been joined by Steven Gray who has almost single handedly taken the organisation of the rally under his belt for which we are all most grateful.

We have some 30 engines booked in so far for our 2007 Rally in Dudley and hopefully as time goes by we will have a lot more entrants to add to this. We are enclosing a flyer with this newsletter which gives precise details of how to get to the Rally and we would be really pleased to see you there with or without your engines.

At the Rally we have the opportunity to take a trip through Dudley Canal tunnel and limestone workings on board one of Dudley Canal Trusts trip boats This would take place on the Saturday evening. It would be accompanied by a fish & chip supper returning to the rally site by bus. Cost would be around £10 per head. A minimum number of bookings are required to book this trip so if you are interested please contact Steve by telephone on 0138475171 or email to putnalfield@blueyonder.co.uk. For more information about Dudley Tunnel visit www.dudleycanaltrust.org.

Gardner Parts will again support the Rally this year and have very kindly agreed to judge the engines. Their support also comes by way of supplying the trophies for the winner of the three categories - marine, road, stationary

At the AGM I expressed my personal wish to stand down as Chairman of the Gardner Engine Forum. This decision is for no other reason than I believe that a new Chairman would bring new input to the Forum and perhaps be able to drive it forward. I would still like to remain on the Committee, but have the time to pursue other interests. If you would like to discuss this, please give me a call.

On a final note, I would like to welcome our newest members.

Jeffrey Barley	Michael Zair	Iain Crosbie	Chris Burton
David Talbot	Cyril Parkinson	Mike Hodgkinson & Val Lipworth	

Colin Paillin

Chairman - Gardner Engine Forum

GARDNER

Engine Rally

9th & 10th June 2007

Between Parkhead Locks
& Dudley Tunnel
Road access from Holly Hall Road
Dudley
West Midlands

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Showcasing fine examples of GARDNER engines of all sizes in boats, buses, commercial vehicles and stationary exhibits

For application form and all other enquires Contact :

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ADJUSTMENT AND ALIGNMENT OF ENGINE AUXILIARIES

Auxiliary Drives and Couplings; Lubrication Pumps; Water Pumps and Cooling Systems; Exhausters; Control Assemblies; Engine Mountings

In examining components likely to be affected under this heading it will be seen that on layouts such as the Gardner engine, the auxiliary driven components are definitely located and no adjustment for alignment is involved. Most of the other well-known engines, however, employ tandem drive for exhauster and fuel pump and this, calls for knowledge relating to alignment when the components are being replaced after removal for attention.

During initial assembly the manufacturers provide for accurate alignment of the auxiliaries, but in the course of time, and particularly if interchanges are made, disturbances can be expected. Usually this is reflected in exhauster and fuel pump coupling wear. Where a number of units of identical make and type are operated, it is a simple matter to construct suitable mandrels to check this alignment; the procedure is outlined in the illustration, which is self-explanatory. Extensive running will result in a certain amount of wear which will be noticed in the fuel pump couplings. The condition of the coupling insert and the abutment points of the metal half couplings should be periodically checked; any backlash or lost motion will affect the injection timing. On an average layout approximately 0.025in wear is equivalent to 1o pump timing. In replacing an insert or coupling some idea of alignment can be obtained by feeling the insert when the engine is slowly rotated by hand. Misalignment will be revealed if the insert tends to float towards either coupling plate during rotation, since the coupling insert is trying to function as a universal joint. Incidentally, there should be from 0.005 to 0.010in on one side of the fibre block in the coupling between the pump and the exhauster to obviate any end loading on the rotor bearings of the latter.

A detail that possibly comes more within the scope of the previous Chapter on pump maintenance may be touched upon here because it is so intimately connected with alignment. It concerns the wear that makes itself evident on the tips of the radiused pump base where they rest upon the brackets. These tips become worn and indented if there is any loosening of the holding down straps and correct alignment cannot be obtained until the trouble is rectified. Suggestions are made from time to time, and may possibly be attempted, that the tips should be built up by welding. This is a thoroughly unsound proposition. Fuel pumps are pieces of precision equipment and the heat of welding the light alloy may lead to damage and distortion far more serious than the defect to be cured.

The method developed by the author involves removing metal from the tips by filing, afterwards fitting prepared steel tips which are then contoured to the correct radius of the base. This repair is permanent and gives a far great "life" than the original material. A ground mandrel is passed through the bearing housing of the dismantled pump body and a jig with a projecting tongue is slid on to the bar. Flats are filed on the pump tips until the tongue goes on tightly, and it then becomes a drilling jig for two holes which are tapped to receive countersunk screws which secure prepared tips of strip steel. The jig is then reversed on the mandrel and the tips are filed until the segmental part of the jig, the radius of which (56mm) corresponds with the pump base, will side over them with a close fit. Either one or both ends are treated as necessary and final alignment of the tips at both ends is adjusted by the use of a half cylinder of the same 56mm internal curvature. This is used as a surface plate with blue "marking" to check the final fine filing and scraping.

The pump platform on some engines is adjustable horizontally and vertically and this is the first alignment point, and the positioning of the exhauster is the second operation. Obviously the success of the final results is determined by the condition of the platform and pump base.

The recent trend towards removing dynamos from under-bonnet positions has introduced remote auxiliary drives, and as a general rule little trouble is experienced with these although the following incident shows how faulty driving may result in mechanical trouble in a direction that might not be anticipated from the general power unit characteristics. Coupling shaft failure occurred on a remote generator layout, the symptoms indicating excessive whip, which was difficult to reconcile with a governed engine and detail design well within the recognised safe limits. The vehicles, however, were operating on a route which included a gradient of I in 9, this being a compulsory second gear descent. The maximum road speed under load in second gear at the particular governed engine speed is approximately 12mph. Careless driving on over-run down this hill was raising the road speed to 18-20mph with consequent over-stressing of the shaft.

LUBRICATING OIL PUMPS

Excessive wear in working parts of lubricating oil pumps is rarely met today unless mileages are considerable. Nevertheless it is desirable to have some knowledge of accepted wear standards to enable an assessment of condition to be made. Particulars of the type of oil pump on modern oil engines are generally illustrated in the makers' instruction book and while detail design may vary, the principle followed is common to practically all makes. Wear, when present is found in (I) the pinion and shaft bearings in either the cover and body or both (2) increased peripheral clearance between the pinion teeth and the body, (3) excessive end-play of the pinions in the body allowing leakage across the side faces of the pinions between the body and cover faces.

Checks for wear under (I) present little difficulty while (2) is measured by feeler gauge and in general practice the maximum permissible wear is from 0.0004 to 0.0006in Measurement of (3) is again by feeler gauge, or by calibrated shims if a normal feeler cannot be applied, the permissible wear tolerance being

0.003in – 0.0004in. Methods of repair under normal conditions are usually met by replacement, since rectification may mean the fitting of oversize spindles and special bushes to correct for spindle or bearing wear. Under present conditions this course may be unavoidable (2) Pinion replacement to restore excessive tooth clearances to accepted tolerances is the only easy method, but if spares cannot be obtained then the building up of worn parts with bronze and re-machining, must be undertaken, while too much end float of the gears (3) will necessitate machining of the body and cover faces to reduce clearance to normal.

COOLING SYSTEMS

Water pump leakage has practically disappeared since the adoption of carbon glands, while damage due to frost is only likely to occur on haulage vehicles which are more subject to the possibility of frost damage than buses since they are often standing in the open for long periods, sometimes at night. Drainage of the cooling system in the event of frost should ensure that the water pump is also clear of water, otherwise it may be frozen solid and when the radiator is re-filled serious damage may occur if the engine is started. On Gardner engines not only is there a special tap for draining the pump but its impellor spindle has a reduced neck designed to shear if the engine is started while the pump is frozen.

In the replacement of pump glands special care is necessary as it is a comparatively delicate operation, and it is particularly important to avoid any attempt to chip out the old seating. The gland housings should be heated in oil until the seal can be easily removed and the new seal should be pressed in while the housing is still hot. In their instructions for a refitting the new seating AEC advise heating the sleeve over a gas ring to pale straw colour before fitting the new seal. Any lapping of seal to seating can be done with pumice, powder and water. Removal and replacement of carbon seals in Gardner water pumps does not differ from the foregoing, but it should be noted that impellors and spindles are not supplied as separate units as they require a special tool for their separation.

Generally speaking carbon seals are standard practice on water pumps fitted to modern oil engines. The water pumps fitted prior to their introduction were, as a rule, provided with an adjustable gland nut to compress a graphite impregnated asbestos packing or cork washers. The primary replacement in these types was the packing, although as wear increased the impellor spindle itself needed renewal although certain designs embodied a removable and replaceable impellor sleeve of special metal.

Lubrication of the early type pumps was probably more important that it is in present-day design largely owing to a certain amount of over-tightening of glands. On certain modern designs water pump lubrication is covered in the engine layout, but when lubricators are provided they should receive their fair share of attention.

Thermostats are standard equipment in oil engine specifications and major repairs are generally a specialist operation. At times, particularly under hot weather conditions, it may seem desirable to remove the thermostat altogether from air cell engines. This type of engine does not operate at such low temperatures as the direct injection unit, but careful tests have not indicated any improved results by removing thermostats, and in view of the important part they play in relation to cylinder wear, they should be retained and kept in efficient working condition. There is a danger that the importance of the oil engine cooling system has to some extent been obscured by the general opinion that oil engines run much cooler than petrol units. This is true when applied to direct injection engines but air cell engines work at temperatures which approximate closely to those prevailing in petrol units. There has been a trend in recent years on the part of manufacturers to reduce radiator capacities and in some cases dispense with cooling fans on chassis powered by direct injection engines and this is probably a result of the fact that many of the early application of oil engines in road vehicles, being conversion installations, were tied up with petrol unit cooling capacities, which led to extensive use by operators of radiator blanking plates. Under long-distance haulage conditions this method was successful, but where arduous conditions of operation exist, the correct amount of fixed masking is not easy to define. There is undoubtedly need for some improvement in certain aspects of modern cooling systems. A few minutes observation at a congested traffic point will leave no doubt in an operator's mind on this score when observing the amount of water lost through radiator overflow pipes.

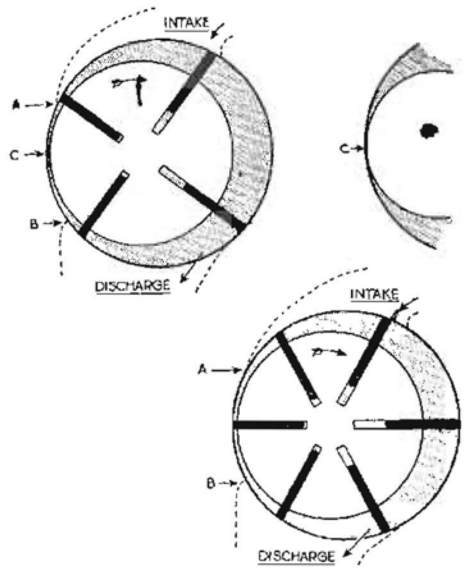
In reviewing the care of cooling systems every effort should be made to keep temperatures comparatively high, i.e. 70oC and the use of radiator blanking plates may be necessary to ensure this, although a thermostatic valve in the top water connection is better and is now the standard fitment. At the same time overheating should be avoided and during major repairs or overhauls special steps should be taken to remove any accumulation of road dirt from the outside of radiator tubes. Regular flushing of cooling systems cannot do any harm and should be part of the regular maintenance schedule. Any tendency to operate under conditions approaching boiling should be avoided, for if shortage of water occurs it results in serious overheating which is responsible for more cylinder head gasket failures than is generally recognised. It is admitted that actual shortage of water is not so common as to make gasket troubles prevalent under average conditions but avoidance of even minor overheating is essential if maximum injector life is to be attained.

EXHAUSTERS

The improvement in the life of the rotary exhausters used for vacuum brake operation has been considerable during the past few years. Compared with the early examples, three of four times the life is obtained with little attention other than flushing with paraffin and lubricant to ease gummed blades. Routine attention is covered in the makers' instruction books and with some knowledge of test standards, extensive component life can be expected.

The rotary exhauster is an auxiliary peculiar to oil engined vehicles and the mechanic whose training has been entirely associated with petrol engines is liable to be unfamiliar with it. It is advisable, therefore, to explain at some length the principles and main features of typical design.

In a four-blade exhauster the running clearance (c) between rotor and bore is a critical sealing point, as shown in the details on the right. There may be ample rotor clearance with six-blade machines however, since there is always one blade between intake and discharge ports (a-b).



Apart from the Gardner engine which embodies a reciprocating exhauster pump, all British oil engines have rotary vanetype exhausters which comprise a cylindrical barrel inside which is an eccentrically mounted rotor having radial slots. Loose vanes in the slots are extended centrifugally into contact with the bore and their sweeping action combined with the eccentricity of the rotor forces the air in the internal space towards the outlet port. More air flows in from the inlet port which is coupled to the brake actuating system, which is thus exhausted of air, hence the term "vacuum braking".

Now it will be clear that the efficiency of the exhauster depends upon several very critical clearances. In the first case the bore of the cylinder must be truly parallel and smooth throughout its length, the end cover faces must be truly flat and at right angles to the bore axis and the vanes must be truly rectangular with their ends and outer edges mathematically "straight". Furthermore the axis of the eccentric rotor must be absolutely parallel with axis of the bore while its length must be exactly the length of the vanes (which must all be equal) so that there is the minimum running end-clearance between the vane-rotor assembly and the end covers. Finally the vanes must be free in the rotor slots but must not have sufficient clearance to permit them to rock therein, while in certain types of exhausters not only must the rotor be absolutely parallel to the bore, but there must, at the point of closest approach to the bore, be running clearance but no more. It will be evident that the exhauster is a precision job and that its reconditioning is for the hands of the specialist fitter only. Efficiency depends upon freedom from leakage across the end faces of the vanes and rotor, between the rotor and the barrel (where that is a sealing point), and through the blade slots. That, of course, is assuming in the first case that the bore is parallel and true, that the blade edges are straight and that the driving shaft seals are in good order.

Too much play of blades in the rotor slots results in rocking and bending, causing jamming and excessive wear at the points indicated.

Certain difficulties confronting the designer should be appreciated by the maintenance engineer in approaching the exhauster problem, especially if certain complaints are brought forward by drivers; in particular, the common grumble that "there is no braking until the engine has been running a quarter of an hour".

The vanes are thrown out centrifugally to meet the bore and it is essential for efficiency that there shall be the minimum clearance in the rotor slots.

Since the blades are light and their surface area is considerable the cold lubricating oil effectively prevents their outward movement at low rpm, and even though the engine may be idled for some time for warming up purposes the vanes may still stick until the whole unit is hot; meanwhile the gauge will show "no vacuum". Then again the clearance between the rotor-vane assembly and the end covers must be at a minimum, but obviously that minimum must be fixed in relation to the dimensions existent under conditions of maximum working temperature; obviously under cold conditions the clearance will be excessive – another cause of "no vacuum" gauge readings when starting up. The mechanic should realise that from a driving point of view a high vacuum at high rpm is of little value if there is negligible vacuum at low speeds; indeed a reading of 15ins of vacuum if it is there all the time is of far more use than a reading fluctuating between 0 and 27ins, the readings being taken direct and without a vacuum reservoir tank in the circuit.

Exhausters with four blades, such as the AEC and Reavell are also liable to leakage between the rotor body and the bore at the point where they are almost in contact. The reason for this is that at certain vane positions the seal at this point is the only separation between the intake and discharge ports and by its nature it can only be an oil seal, hence any wear in the rotor bearings, or wear in the bore of the machine may increase beyond the 0.002in running clearance at more than which the oil seal may break down. In the Clayton Dewandre exhauster there are six blades, so that there is always one blade between the inlet and outlet ports, consequently the clearance between rotor and bore may be considerable, as sealing at this point is not a feature of the design. This machine also involves other important features. For instance the vanes are always maintained in the fully extended position by means of loose rings under steps cut in their ends. Leaving only about 0.0002in of free movement to be taken up by centrifugal force to make the blade to bore seal. This arrangement contributes largely to effective exhausting immediately the machine starts since the blades even if gummed in their slots, are not too far from the bore wall to be completely ineffective. End sealing, also, is fully operative, whether the machine is cold or warm, because of the spring loaded end sealing discs which, in effect, are slidable end covers which lengthen the bore as the rotor-vane assembly expands as it reaches running temperature.

It will be realised that four-bladed exhausters without automatically adjustable end-sealing devices are an extremely delicate fitting proposition both in initial assembly and in re-assembly after reconditioning. The blades are usually individually fitted to their own slots and appropriately numbered, and they must not be interchanged. The clearance between rotor-vane assembly and fixed end covers is critical and cannot be checked by ordinary methods as the machine must be completely assembled before it can be measured, or perhaps, to be more accurate, before it can be "felt" by the experienced specialist fitter, since he is dealing with an inaccessible cold clearance which will eventually be reduced to the correct running clearance by the expansion of parts under the influence of running temperatures. The six-blade exhauster with automatic end-seal compensation for temperature expansion, however, is amenable to more familiar procedure in that assembly, although calling for great care, is not dependent on the individual fitting of parts. Spare vanes, end seals, and the like are standardised and interchangeable.

In any sliding vane exhauster, however, it should be realised that excessive vane clearance in the slots will result in local wear on slots and vanes due to the rocking of the latter, while corrugations in the bore are liable to develop from various causes which are mainly due to the design and which therefore cannot be eliminated. Radiusing the port edges is sometimes effective and provision for the release of trapped air in the bottom of the vane slots is also important, but it is not suggested that chronic corrugating of the bore can be cured by the operator following out any trial and error methods of design modification; this trouble is definitely one for the makers' attention.

However, ordinary wear and tear will eventually necessitate reconditioning of even the most efficient and reliable mechanism and it is necessary to know just what can be done either by normal methods or in a specialist department.

The reciprocating exhauster may be mentioned in passing. It is true that it has not had a very wide following, but the adherence of the makers of Gardner engines (on which it is the standard fitment) has made it a common type especially on goods vehicles. As applied to the Gardner engine it is very similar to a small single cylinder air-cooled engine and renewals or reconditioning will be mainly confined to valves and piston. Naturally the cylinder bore condition is also a controlling factor and its case is therefore parallel with power unit maintenance. Earlier Gardner reciprocating exhausters had separate inlet and exhaust flap valves but in 1939 a modification was introduced whereby the exhaust valve was replaced by a method of using the top piston ring for the same purpose. On the up stroke the ring is in contact with the lower edge of its rather wide groove; in this position it uncovers a number of holes drilled through the bottom of the groove to the inside of the piston, so that the air drawn from the vacuum braking system into the cylinder, passing down the sides of the top gear case of the engine from which the exhauster crank is driven. This rather unusual feature is mentioned because the mechanic unfamiliar with it might not realise that the normal width ring in an exceedingly wide piston ring groove (0.13in vertical slack) is in order, and any attempt to obtain a wide ring, or to make one, to fill up the space, would, however well meaning, completely put the reciprocator out of action as a pump and might result in mechanical damage also.

The chamfered edge of the ring must be fitted downward.

The reconditioning of rotary exhausters usually means blade replacements and renewing the barrel bore surface although a feature of this type of machine is its ability to function when the bore has begun to show pronounced evidence of corrugation. However, the requirements of vehicle brake efficiency leave no doubt as to the necessity of ensuring the utmost exhauster efficiency if maximum braking power is to be obtained and a means of testing and a knowledge of the results required are an essential part of the garage equipment where oil-engined vehicles are maintained. The vacuum gauge on the dash and a watch with a seconds hand (preferably a stop watch) are all the apparatus called for.

In outlining exhauster test figures the importance of low speed efficiency and the time taken in building up to a maximum of about 25 inches of vacuum, must be considered.

Under passenger vehicle conditions it is usual to consider engine idling speed as the point to judge low speed efficiency. Assuming an engine idling speed of 350-400rpm, a minimum of 12.5 inches of vacuum from zero should be registered in one minute with an efficient unit. Maximum readings are judged under road conditions by producing 22-25 inches of vacuum at approximately 75% throttle openings. It is obvious that individual figures can be easily built up by taking a machine with efficient components and establishing test figures on the lines indicated. If the test results conform to requirements on the low speed test only when the engine is thoroughly warm but are not achieved from cold the difficulty is probably inherent to the design and little can be done, except possibly to use a lighter oil if there is a separate lubrication system for the exhauster.

Where extensive reconditioning of components is undertaken the transposition of road speeds to component rpm is a simple operation and a test rig providing motoring power, a rev. counter, and a vacuum tank with its associated piping and gauge, represent the necessary equipment. Incidentally, a rotary exhauster should never be run with the inlet open to free air; it should always be coupled to a vacuum tank. The following table taken from a Lockheed equipped chassis illustrates the relation of vacuum value to pipe line pressures.

The efficiency characteristics required will control the nature of reconditioning that may be attempted. Bore corrugation can only be dealt with by sleeving in the case of four-blade exhausters as regrinding is not advisable owing to the increased rotor clearance that results, while difficulties are introduced in connection with sealing the altered registers of end plates which are spigotted into the bore. Apart from this a ported barrel is a grinding problem probably beyond the skill and equipment of the average repair garage, no matter how well provided with plant. Blade contact in the barrel bore and the limited end play of blades involves fitting accuracy of the highest order. Where the flow of work is available, jigs for barrel and end face alignment are an advantage. A short running-in period with ample lubrication is necessary.

Inches Vacuum	Line Pressure in lbs. per sq. in.
27	1,075
23	1,025
20	925
16	850
13	800
9	700

Satisfactory test procedure must be designed to provide conditions for vacuum production. Light running is not sufficient, in view of the limited tolerances, to provide the required standards of reliability on reconditioned units. Where engine bench test procedure is followed, vacuum production while the engine is under test is advisable even when exhausters have passed through the checks outlined above.

CONTROL ASSEMBLIES

The importance of correct adjustment of controls is sufficiently well known to require little additional emphasis, but one or two points might be noted, however. The positive operation of the Gardner stopping device, for example, is unlikely to call for adjustment, and, in view of its layout any engines fitted with component pumps requires periodic attention. The slow running stop is fitted with a spring loaded plunger against which the control ever abuts during slow running.

Reverse motion of the control lever by lifting the accelerator pedal depresses the spring-loaded stop and allows the control lever to move to "no fuel" position. Apart from lost motion in controls, it is necessary to balance the loaded stop spring pressure against the accelerator release spring. If the latter is stronger than the stop spring, slow running will be disturbed owing to its tendency to move to the "no fuel" position.

It is not always recognised that fuel pump controls can be unduly stressed if care is not taken in the setting of the limiting stop screw for the accelerator pedal. Manufacturers provide an adjustable abutment stop to take care of the pedal load and correct adjustment will reduce control wear and tear.

Regular check and adjustment of the stopping device on the fuel pump, which cannot be expected to function efficiently where excessive lost motion is present, will obviate the wear associated with the crude method of stopping the engine by clutch and gear. Controls worn or out of adjustment to the extent of limiting control rod opening for cold starting allowance would be fairly obvious on examination, but the association with bad starting is worth noting. Compression release devices are rarely operated by drivers on vehicles with efficient electrical starting systems, but they are, when available and functioning, useful to the maintenance staff. Their use on lorries is more common, since hand starting is still used to some extent on vehicles fitted with direct injection engines.

ENGINE MOUNTINGS

It is not possible to detail much that is not obvious in the matter of engine mountings, although some of the later designs embody flexible couplings of various types. Suspension systems embodying what is termed a banjo pressing clamped between the faces of the flywheel and clutch housings should be inspected frequently on vehicles operating under arduous conditions as a certain amount of flexing is present and the neglect of loose bolts and nuts will result in the possibility of expensive replacements.

Rubber or other flexible mounting points are not items on which precise information can be given. It is usual to check locating bolts periodically and to define actual mounting conditions by known individual measurement. An initial check of standard clearances on a new chassis provides the necessary knowledge to detect settled or perished rubber and broken springs. In the case of combinations of coil springs and rubber buffers the former usually carry the weight and insulate the chassis from high frequency vibrations while the latter check the positive movement of the power unit under torque reaction and idling "kick". Under static conditions the rubber discs in this type of suspension must be unloaded, although there must be no excessive free movement. This form of engine suspension is common on goods vehicles fitted with Gardner engines.

BENCH AND ROAD TESTING

Bench Testing; Motoring-in and Power Tests; Variables Dependent on Fleet Size; Road Test Characteristics and Procedure; Training of Test Personnel.

It is sometimes claimed that the ability to test a unit before or after repair is more important than the actual repair. Strictly speaking this can hardly be a true statement, but the implication contains a good deal of common sense. The ability to distinguish between a bearing and a combustion knock or to recognise the roughness associated with over-advanced injection timing, are but two of the special factors associated with oil-engine testing. The possession of these test qualifications is an obvious advantage to any fleet, small or large, where rapid and accurate diagnosis can save a considerable amount of unnecessary dismantling.

In the matter of bench tests, the small fleet operator is, of course, always at a disadvantage. Overhauls in situ are the rule rather than the exception in his case, and in consequence testing is limited to the completed vehicle. Equally, in situ overhauls have other disadvantages, and they do not always effect that saving in time which at first appears to be the attraction of this class of work. There are certain difficulties associated with running-in a "top overhaul" in the vehicle. Top overhauls, if they include piston or ring renewals, are necessarily accompanied by a certain amount of bearing work, and the time spent in removing a unit from the chassis is often more than saved if a simple engine-test rig is available.

In what appears now to be the dim and distant past, running-in an overhauled unit under external power in order to ease off tight bearings was an absolute necessity, and in certain cases was an essential preliminary to effecting an engine start.

Fortunately, bearing replacement methods have advanced beyond what might be termed "barbaric practices." The need for motoring-in under modern conditions might thus be questioned. Motoring-in, however, can be justified if it be taken into account that facilities for liberal lubrication without combustion temperatures, an easy check of oil leaks, and examination of auxiliaries such as water pump, exhauster, etc. are provided.

Simple layouts for motoring-in, embodying a petrol unit and gear-box, an electric motor, or even a line shaft belt drive, are methods the cost of which will be more than repaid in the quality of the finished job. Without an expensive plant, accurate power characteristics and data cannot be obtained. This is, however, not a serious disadvantage on routine tests. The provision of a medium for the operation of the engine under test at quarter to half load conditions is sufficient to settle down a reasonably well reconditioned unit, using a short road test for final adjustments.

The average scrap heap can generally produce the essential material for a simple stand possessing some degree of universality. By utilising a flat-bedded fan as the power absorbing medium, a suitable test layout is easily contrived and the load characteristics and dimensions can be worked out readily. So far as road testing is concerned the small fleet owner may not consider it worth while to indulge in such items as a stop-watch or a Tapley meter. He may decide, possibly with some justification, that his more intimate knowledge of the performance of his own vehicle enables him to assess whether it is up to, or below standard.

Intimate contact with manufacturers' road tests, however, soon shows that if consistent and reliable test information is required, the "run round the houses" leaves much to be desired. Joint tests of performance and fuel economy do not allow any margin of error, and impressions of performance which can be influenced by how a tester feels do not form a suitable basis for accurate comparisons. A graded route and knowledge of distance is an essential for routine tests in large fleet maintenance and its importance to the small fleet owner will be apparent when consumption checks are undertaken.

A test route of this class should be eight to ten miles in length and it should include one or two gradients of about 5% (1 in 20). If possible it should be planned to include a timed climb in top gear and at least two standing starts should be arranged in order to check the performance on intermediate gears. In addition it is desirable to have a gradient demanding full power in third and top gears. This can be used for final setting of the pump control rod stop. If the length of this test is 400-800 yards it will provide a suitable check for fuel supply defects.

The controversial matter of laden or unladen tests is governed largely by local conditions. General experience indicates that in either small or large fleet road tests the unladen test is the more satisfactory. On maintenance work the road test is intended as a comparison against a standardised requirement and not as a measure of absolute maximum performance of the vehicle concerned, and when the man/hours element, not to mention the possible variations due to load distribution and so on, are considered, the loaded test is scarcely worth while. By taking an empty vehicle of known performance over a known route, and being able at any time to reproduce these conditions, might be classed as "rule of thumb" procedure but, at the same time, it cannot be denied that its simplicity makes it reasonably foolproof.

In carrying out fuel consumption tests certain vehicles require test tanks, although when Autovacs are fitted they can be made to serve the same purpose equally well by detaching and taping the suction pipe. Starting the test with a full Autovac and measuring the amount required to top up on completion is then the essence of simplicity.

In previous chapters emphasis has been laid upon the importance of knowing conditions of operation and building up a progressive system of prevention followed by correction. This principle is also to some extent applicable to road test procedure. It is not suggested that any manual can educate or teach a tester, but it is submitted that if the rule of "simple things first" can be thoroughly learnt, satisfactory results follow. Faults occasionally develop in such a way that they produce symptoms of the most baffling kind and testers should have a sound knowledge of the fleet maintenance procedure, particularly on such details as filter attention, sprayer or injection changes, tappet adjustments, etc. It must be recognised that they are often expected to report on a vehicle concerning which the only information available regarding the alleged defect is the driver's signing-off sheet. There are certainly many drivers capable of roughly diagnosing a defect correctly, but there are also many signing-off sheets that record complaints bearing little relation to the actual defect. This emphasises the importance of testers working to a sound system that must have as its basis an accurate knowledge of what is most likely to cause a given defect.

Briefly, on routine test or fault diagnosis on oil engines, the most likely troubles to be met are closely related to the various stages of maintenance, and to some extent are progressive. Any attempt to classify defects in the order in which they might appear would obviously commence with supply troubles. A restriction of supply, running out of fuel, or fuel tap turned off, causes a defect which is familiar enough to oil engine operators, i.e., air lock. At the same time, a dirty filter or even a carelessly assembled filter can product the same result. Autovac failures occur, but this is most likely to advertise itself by an empty container. A successful tester must know supply layouts, and particularly filter dispositions. This latter is by no means a standard followed slavishly by all manufacturers. Filters are placed in the feed side or suction side, and the importance of small points like this must be appreciated even in so simple an operation as bleeding the fuel lines or pump.

Tappet adjustment and injector changes are in the ordinary way covered by regular maintenance schedules, but these are possible defects likely to be met with by the tester. In the majority of cases defects of this type are invariably associated with some report loss of power or "pulling bad", the latter being a common term in passenger work. Without any attempt at compiling a list of defects and remedies the following illustrates a possible defect, and its probably cause in the order in which they might occur. Emphasis is again laid on the possibility of simple things resulting in major defects.

Defect	Seat of trouble	Symptoms
Reduced fuel delivery	Choked filter, leaking unions, etc., deranged pump control, broken sprayer spring.	} Loss of power or } "pulling bad"
Injection timing retarded or erratic	Worn pump coupling, timing chain slack	}

As an illustration of an "outside" cause of supply failure, which in the ordinary way is due to defects in the supply lines, filter of Autovac, a broken spring or some other injector failure, will allow "blow-back pressure" to build-up in the fuel pump and so prevent fuel flow. Faulty injectors, however, produce an effect similar to misfiring on petrol units, and the tester should spot this by revving-up and listening to the exhaust note as the first stage of diagnosis to be followed by final tracings by cutting-out fuel feeds to appropriate cylinders to isolate the faulty sprayer.

All manufacturers' instruction manuals agree that injection timing must not be over-advanced. At the same time the recognised timing marks do not always guarantee accuracy. An experienced road tester on routine test work is capable of "feeling" advance and where such skilled knowledge is available, air-cell engines, as well as certain direct injection engines, can be checked by the tester noting if the so-called "diesel-knock" disappears at half to three quarters load, this being indicative of a correctly timed injection advance. However, unless the feel of a unit has been acquired it is better to rely on the timing marks, as too much advance will probably have expensive results. Retarded timing due to worn couplings or timing chain stretch insufficient for the automatic tensioner to take up is usually accompanies by excessive emission of blue smoke.

Diagnosis of mechanical noises is analogous to petrol test procedure, and the same rules apply. Of course, it takes a man some time to dissociate normal oil engine noises on this type of work, but experience has not revealed that difficulty is encountered in diagnosing knocks.

In examining the possibilities of bench test procedure in large fleet operation, the field is much wider. These operators have for some years been approaching manufacturers' methods in unit overhaul; completely reconditioned engines are in these circumstances comparable with new ones. Test methods, if regular outputs are to be maintained, must follow manufacturers' test procedure. Some qualification of this statement is desirable. Maintenance test methods should be as simple and foolproof as possible. Any attempt at reproducing laboratory testing procedure should be discouraged, otherwise a hold-up or bottle-neck in overhauled units may occur. Repair garage testing does not call for time to be spent in fine tuning nor are detailed records of power and consumption curves necessary.

Operators recognise that maximum power on reconditioned units is not available unless some period of running-in is undertaken. Individual "engine nursing" by drivers sounds good, but is not likely to be achieved. Bench test under these circumstances must be planned to ensure that units are up to the standard of performance required in the particular fleet concerned. In addition, the test must be of sufficient duration to enable the engine, immediately it enters service, to stand up to the hardest work it is likely to get.

In planning to meet these conditions the value of some method of motoring-in is obvious. At the same time motoring-in and the subsequent power test cannot be expected to rectify bad alignment or faulty unit assembly. But treated as the final phase of an ordered and efficient reconditioning system they will assure with some degree of certainty that the component will function satisfactorily.

Test plants embodying motoring-in characteristics are in regular use, but where these facilities are not available, serious thought should be given to providing an equipment capable of motoring units at 400-600 rpm for approximately 90 minutes per test. Incidentally, where a good deal of the motoring time is utilised in fitting manifolds, controls, etc., the work is carried out by the test fitter, who still has ample time for routine checks. The latter includes periodic checks on local heating, water temperature, oil circulation and where provision is embodied in the plant, readings of friction loads, rpm, etc. The question of motoring-in with or without the injection equipment fitted is purely a matter of choice. Fuel pumps and their controls in the "no load" position cannot deliver fuel and final bleeding of the injector system prior to power test is a simple operation under the conditions outlined.

The actual power test must to some extent be governed by operating conditions, type of engine, and the standards observed in certain classes of repair, particularly cylinder and piston clearance tolerances. Experience indicates the following as a satisfactory basis for the combined tests:- After 90 minutes motoring, power test is taken for 60 minutes at quarter to half load, followed by 30 minutes three-quarters load. During this latter period prolonged full load running is not undertaken although periodic checks up to the maximum governed speed are carried out, varying with the different types of engines; prior to the final run cylinder head nuts are checked. Thus the total test procedure includes 90 minutes motoring and 90 minutes power test. After the bench tests, sumps are dropped for final filter and sump cleaning; no additional dismantling for inspection has been found necessary.

When the unit is installed in the chassis, a road test of approximately 20 miles completes the operation. The road test is used as a final check, and as mentioned in the chapter on injection equipment, allows for final adjustment of control rod stops.

Without the above motoring-in period, it would be necessary to observe a certain amount of "nursing" on the first half of the road test, but under the procedure described this is unnecessary and the first portion of the road test can be used for general chassis checks.

Road Test Sequence

(Outward)

A – A Flying start climb (1 in 47). Top gear, Tapley pull and time.

B – B Standing start climb (1 in 18). Third gear, Tapley pull in 3rd gear and time.

C – C Top gear accelerator, Tapley (1 in 80 decent) ¼ mill speedometer test.

D – D Top gear pull (1 in 24) Tapley.

E – E Top gear climb (1 in 19) Timed.

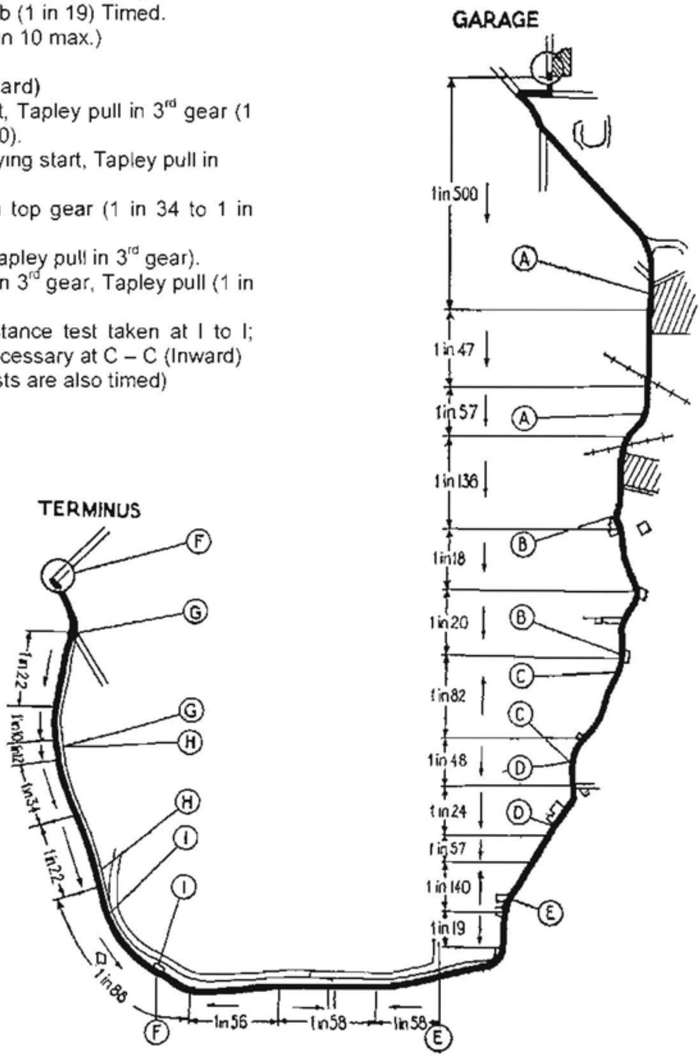
F – F Brake test (1 in 10 max.)

(Inward)

G – G Standing start, Tapley pull in 3rd gear (1 in 22 to 1 in 10).
(Alternative flying start, Tapley pull in top gear)

H – H Tapley pull in top gear (1 in 34 to 1 in 22).
(Alternative Tapley pull in 3rd gear).

I – I Acceleration in 3rd gear, Tapley pull (1 in 88).
Tractive resistance test taken at I to I; repeated if necessary at C – C (Inward)
(All inward tests are also timed)



Test route used by the Leeds City Transport Dept. The length is 5.1 miles : tests are taken on both outward and inward runs.

It will be appreciated that engine unit changes are in the majority of cases, associated with other chassis repairs such as brakes, or transmission unit replacements, and a single test suffices to correct or check the complete vehicle. The following brief summary is standard practice on road test after fitting reconditioned units:-

1) With engine stationary, the control rod opening in relation to accelerator movement is verified to assure full power injection and also the stopping arrangement.
2) Prior to starting-up from cold, where heater plugs are fitted, the period of the heater plug switch operation is checked; the standard period is 30 seconds and counting mentally is sufficiently accurate.
3) When started from cold the average oil engine is full of strange knocks and noises and little is to be gained by studying these varied sounds.
4) It is still considered good practice to move off as soon as even firing is evident. When moving on the road the period at which blue smoke disappears is noted. Routine tests will form a useful basis on which to gauge this, but in the ordinary way smoke emission will have ceased between a quarter and half a mile.
5) Brief contact with the test route will have enabled a rough estimate of performance to be made and at the first stop, power capabilities up to or below standard will be assessed.
6) In a carefully plotted test route the first stop is usually at the summit of a fairly easy climb and some idea of any tendency to overheat can be gathered. This stage of the test with the engine idling is a suitable point at which to make a final setting of the slow-running adjustment and to re-set the stopping device if necessary. Slow-running adjustment is usually called for on the road as the bench test does not as a rule embrace snap accelerator openings' the analogy with petrol slow-running adjustments will be recognised.
7) After these minor adjustments serious testing can begin. The tester is aware that the unit has received a power test and that he need not hesitate to open out to check performance. At this stage speedometer readings in relation to high speed governor cut-off are checked. This is not used as a final check on pump setting, but is part of test routine, and its value as a general guide to performance is obvious.
8) Final power test takes the form of a top gear climb, and extends the engine to full power. If standard performance is near the smoke limit as is the case in many fleets today, control stop settings are carried out at this stage of the test. The setting is usually just under the smoke limit and it can again be slightly reduced after approximately 1,000 miles of road work. Finally, if further adjustments are not required, a last check for control security and examination of all pipe unions is carried out. Adjustments do naturally arise after unit reconditioning, but a close analysis of these usually indicates little that cannot be detected on bench test. Bench test must be used as a test, leaving road test to act as final check.

Under normal conditions little difficulty is experienced in finding suitable testers, but present difficulties in this respect are not easily solved and it is not out of place to review certain aspects of training available personnel. Obviously driving capabilities are essential, but fitter qualifications are an almost equal definite advantage. Apart from a knowledge of repairs procedure on the part of the tester, the effect on the fitters in the shops of knowing that their work is being passed or checked by one who understands their craft is a point of greatest importance.

Given petrol test qualifications little difficulty is experienced in attaining the necessary standard of efficiency with oil engines. Time is well spent in discussing with a trainee such points as the need for providing an exhauster to operate Autovacs and brakes while on the petrol engine the induction system eliminates this auxiliary. Access to the injector maintenance shop should be allowed and encouraged, for while it is unlikely that the tester will ever be called upon to carry out this class of work, the added confidence of knowing how will be of definite value.

Practical demonstrations on an efficient standard vehicle to illustrate the effect of adjustment disarrangement invariably breeds confidence and opportunity to familiarise himself with the performance of a standard machine over the test route should be given. Instruction should then embrace air locks resulting from a reduction of fuel supply (they can be induced artificially by operation of the fuel tap) and the correct methods of clearing them. This should be followed by the detection of faulty injectors, which is easily demonstrated. Certain types of engines fitted with air cleaners can be maladjusted to restrict the air supply, while it is a simple matter to demonstrate the peculiar knock associated with faulty tappet adjustment. The trainee's fitting experience has probably given him the necessary knowledge of pump timing, but he should be encouraged to extend his knowledge by observing pump phasing in the fuel pump section of the shop. Finally, he must be trained and schooled to the importance of detail. One split pin missing from a control can cause the same service stoppage as a major mechanical fault.

Editor's Note – This extract has been taken directly from the book printed in 1942 and the written word, grammar and punctuation has changed quite significantly over the past 60 years.

From the Editor

My thanks go to John Dickson and Roger Millin, who very kindly replied to my "Cover Story" question in Newsletter No. 11. Both Gentlemen wrote to me saying that they had spotted an article in Old Glory about the 1931 Scammel tractor 'Supreme' coming up for auction in October 2006. Evidently it was purchased by a Mr. Kevin Gamlin in Somerset, but no history other than it 'worked for well-known amusement caterers George Rogers and Sons' was included in the article. If anyone knows of the wherabouts of Mr. Gamlin, perhaps they could ask him to contact us – he may be willing to let us have a potted history about the vehicle.

GARDNER SNIPPETS

PGE Services – Paul Gardner and Eddie Rayner of Gardner specialists "Paul Gardner Engineering" which ceased trading late 2006, now provide a Gardner parts and fuel injection service at Vine Street, Eccles, Manchester, trading as PGE Services and can be contacted on 0161 787 7357.

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Classic Maritime Diesels – (CMD Engineering) – will be moving from their Lord Vernon's Wharf location to a site adjacent to the Anson Engine Museum – only a short walk away from their previous canalside address. The new workshop will provide increased capacity and customer service. It will also benefit the close ties that exist between CMD and the museum on Gardner based projects. The move will take place in the Summer of 2007 with a dyno engine test facility planned for 2008 in collaboration with the Anson Engine Museum.

Readers Letter

Can any members help to locate some parts that I require for a 4LK No. 114416. The engine came from a scrap Bristol SC bus in 1985. I have been restoring it with a view to putting it into a narrowboat when time and money permit. In order to check the crankshaft, I need a copy of the workshop tools book No.55 which gives details of the crankshaft main bearing clearances and the tool for extracting the main bearing caps. I have an original 4LK manual which states maximum clearance as 6 thou. Mine are around this figure. As the crankcase uses thick-wall bearings, is it permissible to scrape down the caps to reduce the clearance? If I have the crank reground are bearings available? If new bearings are fitted are they pre-finished or do they need line-boring to size?

I have a marine gearbox that I wish to marry up to the engine. I think it is the correct one for the engine – it's of the same vintage. It is an SCG MRF112B and I have no information on it. Does anyone have any information on this box? What oil do I put in it?
I have the backplate but no flywheel housing on my engine. Can anyone help locate the correct flywheel housing for this box or maybe a vehicle type of housing with a suitable adaptor ring will do the job? At the moment the engine has a large 24v dynamo and as I don't have the control gear for it I wish to replace it with an alternator. Can anyone recommend an alternator that will fit the circular cradle on the crankcase? It need not be too powerful as I don't wish to strain the timing chain and cause wear to the sprockets, etc.

Many thanks.
Mike Duffy , 53 Cherry Tree Lane, Great Moor, Stockport, Cheshire. SK2 7PR
Tel : 0161 456 5862

Marine Engine Workshop
By Charles of CMD Engineering

Red -vs- White

If the price of gas oil (red diesel) ever approaches the cost of derv (white diesel) it will be worth paying the remaining price differential for the white stuff.

It is a common misconception that the red fuel is actually white diesel with the addition of red dye to discriminate it from road vehicle fuel.

Derv is in fact a superior fuel to gas oil and is controlled by a superior standard BSEN590 Minimum cetane value of derv is higher, whilst sulphur content, filter plugging temperature, clouding temperature and water content of derv are all lower. Also, bunkerage of derv (i.e., at filling stations) has to confirm to minimum standards, where as storage of gas oil at marine locations is often far from ideal with tanks never being inspected internally for corrosion. Fuel not being sampled for water, no dirt/water traps installed, etc., etc.

By the way, heating oil, also red like gas oil and cheaper in price, should not be used in diesel engines. Heating oil will result in smoke emission, inferior cold start performance and reduced power output. Injection system components will suffer from long term use of heating oil and valves, valve seats, exhaust ports and piston crowns will suffer heavy combustion by-product deposition and acidic attack.

Torque -vs- Horsepower

People often brag about engine power in terms of BHP (brake horsepower) but unless you are throwing a racing car round a track or piloting a 'planing' powerboat, horsepower is of little more than academic interest.

Engine output torque and engine RPM are both factors of horsepower for a given torque value - if the engine RPM is doubled, the horsepower figure is doubled.

Always remember that torque turns a propeller, not horsepower. Small displacement engines exhibiting a large BHP output due to their inflated RPM capabilities may only produce negligible torque and this being in the form of a severe spike, which drops rapidly away either side of a limited RPM band.

Of particular interest to those who operate 'displacement' vessels; tugs; trawlers; workboats (and yes, narrowboats and dutch barges) are the torque characteristics of an engine. This includes not only the peak torque value and the engine RPM at which this occurs, but also the shape of the curve - the flatter the torque curve the more 'useable' the engine over its RPM range.

It should be noted that an engine operating at its torque peak is also operating at its maximum volumetric efficiency, as the torque curve is in fact identical to the BMEP curve (brake mean effective pressure). Also fuel consumption per horsepower produced is also lowest at this point (the fuel consumption curve is in fact an inversion of the torque and BMEP curves).

Keep Her Cool!

With more inland craft venturing out into river, estuarial and even coastal waters, the inadequacies of previously trouble free cooling systems can come to the fore and can prove dangerous if an engine has to be shut down in tidal waters.

Cooling demands of an engine are directly relative to the horsepower produced by the engine. Whilst conducting some fuel consumption tests on a dutch sailing Skutse I had re-engined with a 4LW, I observed the engine rated at 56bhp/1300rpm only produced 16bhp under the demands of the Leeds-Liverpool canal, whilst the next day undergoing sea trials between Gut buoy (9 miles out of Preston in the Ribble Estuary) and Lune Deep buoy (at the north end of the Fylde coast), the engine was operating at rated load.

The Gardner engine needs to lose approximately 25BTu/bhp/min. to its cooling system. If the system, be it heat exchanger, skin tank or keel pipes, cannot transfer this amount of heat at the engines rated output, then the power plant will overheat when it is required to work for its living.

Some hints for an efficient cooling system:

1. Never reduce pipe sizes from those on the engine and recommended by Gardner.

2. For skin tank and bilge keel coolers, allow 1 sq.ft. of efficient cooling area per 3bhp engine output.

3. For keel pipes allow 1 sq.ft. per 6bhp.

4. On heat exchanger systems, the raw water pump should be rated at 1.5 gallons/min. per 10 bhp engine output.

5. Skin tanks must be baffled to utilise the full tank area.

6. Skin tanks work by convection which is a vertical process. Narrow tanks located on the hull side therefore work best.

All the best
Charles.

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