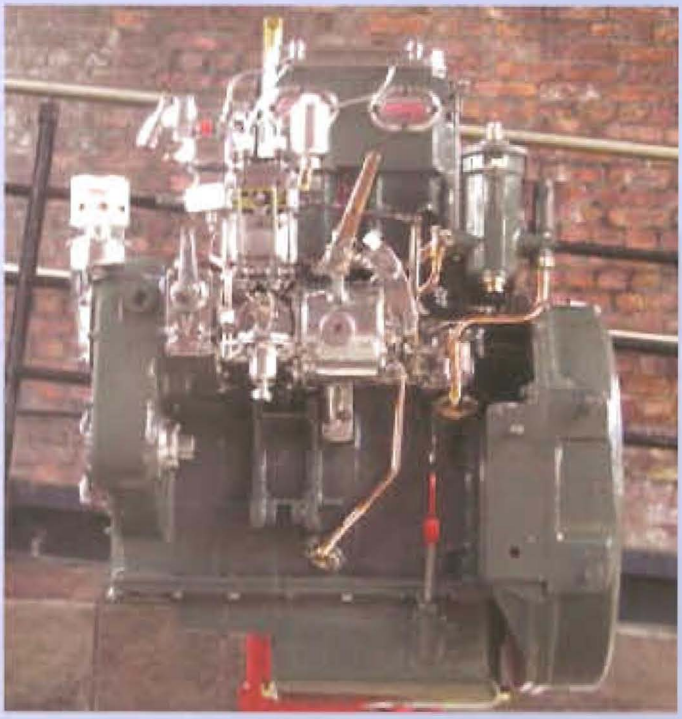
GARDNER

Engine Forum



Autumn 2005 Issue

No 9

Gardner Engine Forum Philosophy

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

Subscription

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Cover Picture

A 2LW - magnificently restored by employees of Gardner Parts - as displayed at the Gardner Engine Rally 2005.

Chairman's Jottings

Welcome to you all this autumn issue - where does the time go, it does not seem like 5 minutes since the last issue. In the interim we held our AGM at the Anson Engine Museum where our three committee members were re-elected to the committee for the next year. Our thanks go to Geoff Challinor, Proprietor of the Anson Museum for allowing us to use his facilities and for giving us a better insight into the work that goes on behind the scenes up at the museum. The AGM was very well attended and I must express my personal thanks to those that give me their full support. For all those who wish to get their diaries sorted for next year, the 2006 AGM will be held on 1st April at the same venue (not any April fool). More details will follow.

On 7th May I attended a presentation at the Anson Engine Museum given by the Institution of Mechanical Engineers to award the Gardner 4L2 for being the first consistently reliable, high speed direct injection diesel. The presentation was given by ImechE President William Edgar CBE. This award is not often made - examples so far include the Thames Barrier, Harrier Jump Jet, Rolls Royce RB211 engine and the invention of the float glass process at Pilkington Glass. The Gardner 4L2 on show at the museum was the first L2 to be built and was in service in the Gardner Engine House driving a Gen Set to help supply the works with electricity.

The Gardner Engine Rally held at Manchester in June this year was a big success and as in previous years we had a varied collection of engines. A very big thank you to all those who took the time to attend. (See centre pages for pictures). Unfortunately, the cost of road fuel is deterring the road vehicles and I suppose we must accept this. My personal favourite was Brian Partner's fully resorted ERF on its first public show. It looked good and sounded brand new. The last but one Gardner engine built, was fitted to this lorry. The cost of this year's rally was borne, by the Gardner Engine Forum with support Gardner Parts who has already said it will support the next rally in 2007 and it is looking like the GEF can bear the cost of a biannual rally. We are looking for a site somewhere in the Black Country for 2007 – does anyone have any suggestions?

I am working with a local IT guru to build and run a website and email address to encourage members to communicate with each other. This will hopefully build a strong network of "nutters" and provide world wide communication to foster the interest we have with Gardner Engines

Just a reminder that I hold a stock of engine spare parts Catalogues, workshop overhaul information books and operation manuals for the L3, 6HLX, LW, HLW and LK and L2 engines

Dion Houghton has suffered a minor stroke and we wish him a speedy recovery back to full health. Dion was a main board member at the works until his retirement and now runs the Gardner Vintage Engine Register.

Radio 2's DJ Steve Wright has an afternoon programme in which he has a section called "Ask Elvis" and supposedly Elvis Presley gives an answer to a question. A chap called Gary rang into the programme and told "Elvis" that he was having a new hull built and could he advise him whether to have a Russell Newbury or a Gardner. Elvis had done his home work as he gave a very accurate description on both engines and advised Gary to have a Gardner - being the better of the two. I wonder who gave him that advice.

We are always looking for new material and articles for our newsletter and would welcome any contributions you would like to share with our members.

Regards

Colin Paillin

Chairman - Gardner Engine Forum

Gardner Engine Rally 2005
From left – Paul Crisp of Gardner Parts with the winners,
Cliff Noble (Stationary – 1L2), David Dowler (Marine – 4LK),
Edwin Fasham (Overall – 1L2 / 4LK / 3LW), John Waynham (Road – 6LW)

Continuing our transcript of:
Diesel Maintenance
T. H. Parkinson, AMIAE

Injection Equipment
Part I : Routine Maintenance; Sequence of Adjustments; Filters; Sprayers

Vehicle operators did not always recognise how difficult the establishment and organisation of present-day fuel injection service stations was in view of the rapid expansion in the use of the oil engine; furthermore in view of the fine limits of manufacture in injection equipment it can be understood that manufacturers were somewhat reticent in releasing repair information, particularly during the early days of oil engine operation and users were not encouraged to undertake injection equipment maintenance. Certain manufacturers however, considered that the maintenance of injectors was a liability that they must accept, and by comparatively cheap rates for injector changes every effort and encouragement was given to operators to use the facilities they offered. This policy was sound, since fuel pumps were not expected to give trouble, whereas injectors called for periodic cleaning and adjustment. Attention to pumps being so rarely needed there was no difficulty in making service units readily available for use during overhauls by the makers.

In view of the rapid expansion in the use of the oil engine, the need for knowledge of maintenance and repair methods arose. Injection equipment manufacturers introduced instructional courses and by availing themselves of these facilities, the larger operators were enabled to commence their own specialists' sections.

Large-scale operation of a unit produces the necessary condition for the acquiring of service knowledge, and it was inevitable therefore that attempts to improve consumption would follow. As with carburettors, fuel pumps are delivered to meet average conditions, and the large passenger vehicle operators were not long in exploring the possibilities of curtailing pump outputs. It was soon apparent that the test plant available at the time would be a limiting factor in producing the desired results. Power-operated plants were a necessity, and a number of shop-built plants preceded the subsequent release of the CAV and Hartridge products.

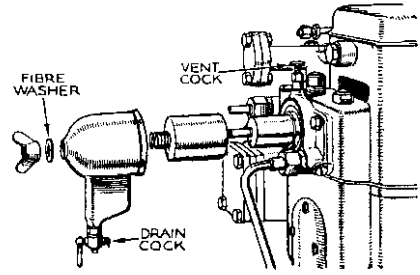
Fuel pump adjustment and overhaul is outlined in a later stage in this chapter, but it must be emphasised that pump tuning is only a part of injection equipment

maintenance. It should under no circumstances be assumed that calibration is the main adjustment, or a cure-all for every injection disorder. Treated as an essential operation in correct sequence, calibration is important, but if adopted as a separate and detached adjustment, final results will be disappointing.

The aim of a successful maintenance scheme is to produce the maximum economical operation for a minimum outlay on equipment renewals, and to achieve this it must be accepted that injection equipment as a whole requires regular inspection and attention. A carefully balanced pump will not produce the desired result if nozzle spray is incorrect due to low pressures or dirty nozzles, and correctly set injectors will not compensate for erratic governor operation which is a natural sequence of lubrication neglect.

Whilst methods of pump overhauls are a controversial subject there is complete agreement on the importance of fuel filter attention, pump lubrication and injector condition in relation to satisfactory engine operation. Filter elements are usually gauze, cloth or felt, and their cleansing or renewal requirements are outlined in the makers' instruction books by which the mechanic must be guided as to the intervals of attention, although there are many variables arising from such diverse factors as the design and type of filter, its location on the vehicle, the condition of operation, methods of storage of filter spares, and lastly, the nature of the fuel storage and issuing system. Weekly or fortnightly intervals for filter attention are general, or say, intervals of from 800 to 1,500 miles. Experience however, may indicate much longer periods, even up to 5,000 miles.

The second fuel filter on Gardner engines is mounted on the forward face of the cylinder head. Care must be taken not to overlook the fibre washer indicated when reassembling.



Filters of metallic gauze are probably easier to deal with that the other types, but they must be very carefully handed as the mesh is extremely fine. In the Gardner filters, for example, there are two layers of 140-mesh supported between layers of coarse mesh. Should this not be cleared by gentle washing in paraffin or the use of a not too powerful spray in the reverse direction to the normal flow, the fine gauze must be renewed and the makers' recognise this by carrying out the replacement at negligible cost. But on no account must the gauze be brushed or wiped with a cloth, nor must it be replaced by gauze of coarser mesh.

It will be noted on Gardner-engined vehicles that there are two filters, one being placed between the fuel lifting pump and the tank, and the other on the front of the cylinder block. Both filters are fitted with sumps and drain taps, and the latter also has a blow-off valve so that air can be expelled after it has been reassembled after cleaning. The position of this second filter will be noted. It is heated by its location on the cylinder block and even the first filter is placed under the bonnet and away from any cold air stream if the maker's advice has been followed in laying out the chassis. The reason for this is that fuel oil occasionally deposits a wax which chokes the fine mesh filters if the temperature drops too low, as it may well do in the winter. The delivery filter therefore is always fitted onto the cylinder block.

Where cloth or felt filters are used, the same reason dictates that they shall be mounted under the bonnet while the same applies to Autovac apparatus; indeed some of the latest chassis have bonnet sides without louvers in order that the under-bonnet temperature shall be sufficiently high to obviate any trouble from waxing of filters of Autovac in cold weather. Should this occur in existing vehicles, repositioning of filters, or if that is impossible, shielding them from the cold air blasts should be considered. In the same connection the fuel pipe from the tank to the lifting pump should not be unnecessarily exposed. It is often run in close proximity to the exhaust pipe and under certain conditions has actually been clipped to the exhaust pipe with beneficial results.

Felt filters cannot very well be cleaned and it is usual to run them for some long distance specified by the suppliers (say 10,000 miles) and then scrap them. But an economy may be affected in some cases where the filter elements are interchangeable with the lubricating oil external pressure filters that are sometimes used, by transferring them from the fuel to the lubricating oil system, possibly shortening the period of the first application somewhat and regaining it by a long spell of service as a lubrication filter.

In all cases of filter attention in the fuel line, special care must be devoted to jointing on reassembly as air-leaks are fatal to the satisfactory working of the injection equipment. Filter container domes or filter body caps may either have metal to metal contact faces or be provided with cork or fibre gaskets. Whatever the method the joint must be above suspicion, and in the case of metal face joints care must be observed in handling the dismantled parts, while when reassembling, the dome or cover should always be lightly oscillating on its seating to ensure that it has bedded down and that no grit is between the faces. Any fibre washers on retaining screws should also be cleaned and replaced

and the fixings should be done up firmly but without being forced. Both during removal and refitting, care must be taken to avoid distortion of the filter body.

Cloth filter elements require rather more careful handling than the other types and rubbing or brushing should be avoided. Where quantities are being dealt with, some method of submerging in paraffin and cleaning by air flow from the centre of the assembly through the cloth element is recommended. This method has the effect of removing dirt without chance of puncturing the fabric. Certain manufacturers place fuel filters on the suction side of the Autovac or fuel lifting pump and the importance of good joints with complete freedom from air leaks will be apparent. After re-assembly the need for bleeding, or eliminating, air is generally known, but, like other simple operations, care should be exercised to obviate the casual handling which this operation frequently receives. A tap or plug is fitted to CAV pumps at the opposite end to the feed pipe union for air release purposes.

Fuel pump lubrication is particularly important; as if it is neglected expensive replacements are inevitable. In recent years the method of arranging for governor lubrication on the CAV pump has been improved by the adoption of what is termed common-level lubrication. Particulars of this are given under the heading of pump overhaul, but as it is a comparatively recent development probably the majority of pumps in service have the original layout which embodies separate lubrication chambers for pump mechanism proper and for the governor. A dip stick is provided for checking the pump chamber level, but for the governor chamber the maker's recommendation is to maintain the quantity of oil at approximately a quarter of a pint; filling is carried out through a lubricator on the governor case and is checked by a plug in the housing, whereas the pump chamber is replenished through the dip stick orifice. Engine lubricating oil is used for both compartments.

Operating conditions must be the determining factor on the period of check, but as lubricant topping is a simple operation it is advisable to adopt a weekly interval until a safe cycle is established. There is always the possibility of fuel oil dilution of the pump chamber lubricant and while fuel oil does possess some lubricating properties prolonged running on diluted lubricant will lead to excessive wear. The pump cam and tappet gear and the governor of the Gardner injection equipment is lubricated from the crankcase lubricating system and it does not, therefore, call for any detail attention in this respect.

Injectors

Published details of manufacturers' and operators' recommendations for injector removal reveal the widest mileage interval variations of any component in the whole engine, and this is obviously due to the various running conditions and to some extent to the standard set by the parties concerned. In some cases smoke emission is accepted as the limiting factor, in others, judging by the exhaust emission of vehicles seen on the road, its relation to injector condition is apparently not recognised. It is generally accepted that the injectors of air cell engines will operate over great mileages than those of direct injection units. Excessive emission of black smoke at the exhaust is not always an indication of faulty injectors, although generally speaking it suggests the need for injector attention.

Black smoke is evidence of incomplete combustion and if it is due to faulty nozzles it usually means that the penetration of the fuel spray is reduced and that is it incomplete. This in turn is the result, in pintle type nozzles, of reduced injection pressures due either to dirt or to faulty seats.

CAV Nozzle Holders, Nozzles and Recommended Pressure Settings

Make & Mode	Nozzle Holder	Nozzle	Injection Pressure lbs.sq.in.
AEC			
A165, A170, A171 (Mark i)	BKB 35 SD51	BDN 20 S2	1500
A171 (Mark iii)	BKB 35 SD51	BDN 12 SD 12	1500
A173*, A173* (latest type)	BKBL 67 S503	BDLL 150 S523	2600
		BDLL 150 S559	2600
Albion			
EN234, 242*, 242B, 244*	BKBL 97 SD518	BDKK 120 S556	2550
Crossley			
VR6	BKB 35 S24	BDN 30 S2	1500
Leyland			
Cub H2	BKB 35 S24	BDN 40 S2	1600
8.6 litre*	BKB 80 S24	BDL 0 S288	2350
Perkins			
P4, P6	BKB 80 S508	BDL 110 S525	1750
Thornycroft			
DC 4/1, DC 6/1	BKB 50 S51	BDN 12 SD12	1470
DC 4/2*	BKBL 97 S528	BKBL 97 S528	2500
* = Direct injection engines			

Gardner and the latest AEC and Leyland direct injection engines are fitted with multi-hole nozzles and the orifices are very small, so that when they become fouled with carbon, the spray characteristics are seriously affected.

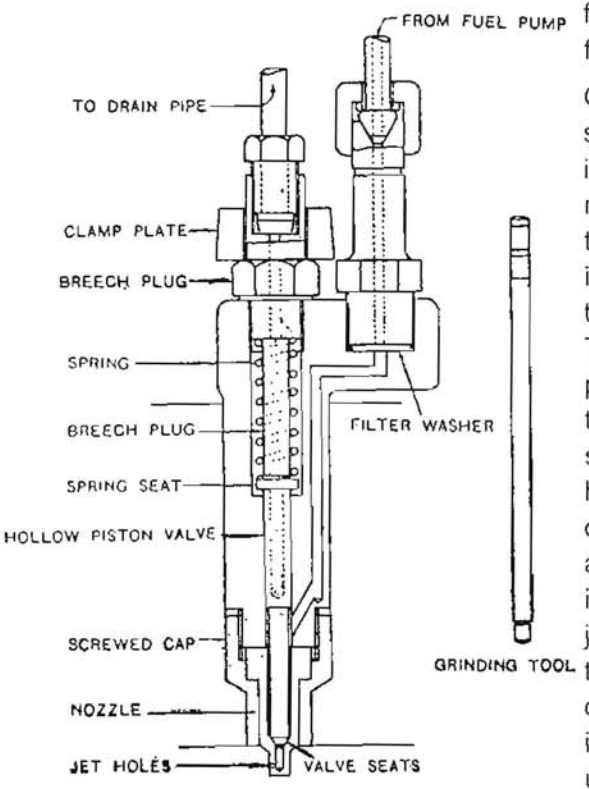
Detailed instructions on the individual designs are outlined later, but the following comments will probably assist in understanding the general procedure followed. Exact knowledge of nozzle types and recommended pressures is essential and is summarised in the accompanying table which relates to the engines in general use.

Successful injector maintenance cannot be achieved if adjustments are carried out on a dirty bench or by an operator with dirty hands. With regard to the latter it is imperative that when regularly undertaking sprayer cleaning and adjustments the mechanic should use on the special hand preparations or cleansers that are rubbed in before commencing work since prolonged contact with fuel oil is a suggested cause of certain skin diseases. Whether this is correct is best left to the medical profession, but preventative measures are at least advisable. From the health point of view, also, it is desirable to provide some form of cabinet to confine the fumes and thus avoid direct contact with the operator, where a large amount of sprayer testing is being done.

Careful handling of dismantled injector parts is important and the use of lino or zinc covered benches is recognised practice in this class of work. Contact with these materials offers little chance of damage to finely machined and ground components, apart from their being easily cleansed. Injector dismantling is primarily carried out for cleaning, removing carbon deposits, cleaning of spray holes in multi-hole nozzles, and the examination of nozzle valves and seats. Air cell engine sprayers and certain CAV nozzles fitted to AEC and Leyland direct injection units have provision for spring adjustment, while later type Leyland nozzles have spring adjusting washers in steps of 0.005in. Gardner nozzle design does not incorporate any method of spring adjustment.

Under normal conditions, when cleaning and spring adjustment failed to restore the correct functioning, many operators availed themselves of the manufacturers' injector service facilities. The CAV stations have always given admirable service on their own products, and in view of the difficulty in obtaining the correct lapping tools it is doubtful if anything was gained by the operator in attempting to carry out the work even with the flow of reconditioning of nozzles associated with large fleet operation. On the other hand the engine makers producing their own nozzles have outlined the procedure for limited

nozzle reconditioning, although with distinct warnings as to the delicacy of the procedure. For example, most explicit warnings are issued regarding the careful extraction of injectors fixed into position by carbon deposit and the avoidance of using excessive force for tightening down the fixing nuts when replacing. .



Gardner Injector showing its component parts

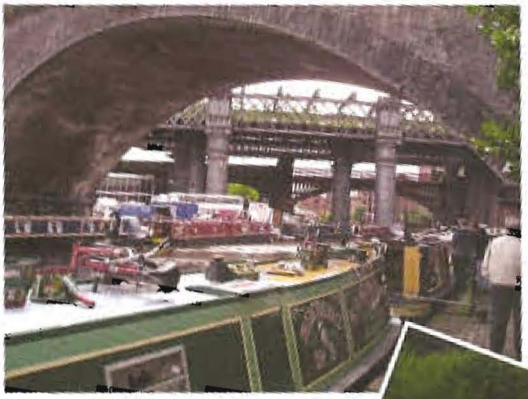
On Gardner engines facilities for sprayer check are incorporated in the engine pump design. The nozzle should be removed from the cylinder and reconnected to its pipe in such a position that the spray can be observed. The hand priming lever of the pump unit concerned should then be operated, when the spray emitted from all four holes of the nozzle should be of the same apparent volume and length. If there is any irregularity in the size of the jets, the sprayer should be taken to pieces, the large part of the body being gripped lightly in the vice while the nozzle is unscrewed. A special pricker is supplied by the makers and no other should be used for pricking through the nozzle holes, otherwise they may be enlarged and the functioning of the injector upset. After pricking the holes any carbon dislodged will have been pushed through into the interior of the nozzle and attempts to clear it out by flushing with paraffin (or by using a blow gun) from the inside will be so much waste of time, as the dirt will merely be forced back into the jet holes again. The flushing must be done from the outside, i.e., in the reverse direction to the normal fuel flow. An adapter to fit the nozzle to a special syringe is provided in the standard tool kit supplied with the engine, the syringe being first filled with paraffin which is forced through the jet holes after the nozzle is fitted into position.

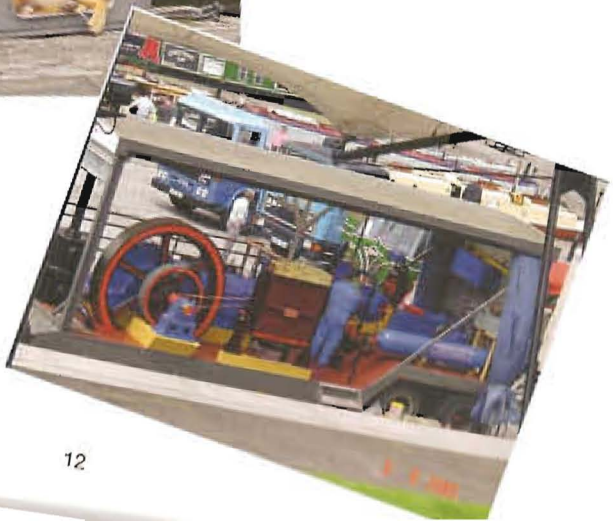
These nozzles should be tested not less than every 10,000 miles for valve leakage, the sprayer being coupled up externally as before mentioned, the pump lever being operated gently to get the "feel" of the force needed to lift the sprayer valve. Any oil is then wiped off the nozzle and as nearly as possible about half the necessary force is applied. There will be a slight leak of fuel, but if it is not more than two drops per minute the valve can be passed as in good order. A cross-check of valve condition can be made by operating the lever fully and quickly, where there will be a characteristic squeak or grunt from the injector. It does not follow that the sprayer making the most noise is best, or that one making no noise is leaky. But, in general, the injector with its valve in good condition makes a distinctive squeak and absence of the noise suggests that close examination is desirable; by removing he nozzle cap the valve seats on both nozzle and piston can be inspected by the help of a magnifying glass.

To remove the valve piston and spring, in order to check the latter, if leakage is persistent, the top breach plug must be unscrewed. No spring adjustment is provided and the springs should measure 1 5/16in when loaded with a weight of 50lbs in the case of the latest injectors (stamped "E" on the body) and with a 60lb weight for the earlier unmarked injectors.

Before reassembling the parts should be washed in paraffin (but not wiped), the nozzle should be placed in its cap and the cap partly engaged with the thread on the injector body. The valve grinding tool provided in the standard tool kit is inserted in the hollow body of the piston valve, which is then passed through the injector body and as the nozzle cap is screwed finger tight the piston valve is tapped gently on its set in the nozzle. This centralised the nozzle and if the alignment is correct the piston will slide freely, but it will resist withdrawal if the nozzle is out of centre. When it is free the nozzle cap should be tightened with the spanner and freedom again tested. Correct alignment is most important as faults in this matter are a frequent cause of leaking sprayer.

Mention is made above of this grinding tool, but it would be preferable to rename it the assembling tool, for although the maker's supply is under the name used, none but a specialist fitter should attempt the grinding-in of sprayer valves. The maker's issue instructions, but even so, only a man skilled in delicate work would be expected to carry them out with any hope of the injector being in better condition when he had finished with it than when he started.





Although the Gardner engine is the only one incorporating hand-operated sprayer test facilities, so that users of other makes require a bench test pump (which also incorporates a pressure gauge), very similar methods of servicing apply to the multi-hole CAV sprayers used on other engines such as AEC and Leyland. Those on the AEC however, have a detail that must be watched during reassembly. The jets from the four 0.25mm holes in the nozzle have a definite positional relation to the air-swirl in the cylinder at the moment of injection and accordingly the nozzle is located by two holes on its upper edge which register with dowel pegs on the face of the injector body. This applies also to the CAV nozzles used in Perkins engines, in which there are two holes in line with the passage to the air cell.

Carbon tends to collect on the tip of the nozzles and may choke the small holes. Consequently, on removing an injector, the first thing to do is to clean the tip with a brass wire brush. The injector can then be tested on the bench pump tester to observe that all four sprays are alike. Incidentally, uninitiated mechanics are warned to keep their hands away from the jets which can cause serious injury. An injector that shows even sprays and no after-dribbling (with the pressure gauge of the tester cut out) needs no further cleaning or dismantling. The valve should be set to open at 175 atmospheres (2,500lbs) and the injector spring is adjusted by a screw and lock nut in the spring cap nut under the top end cap.

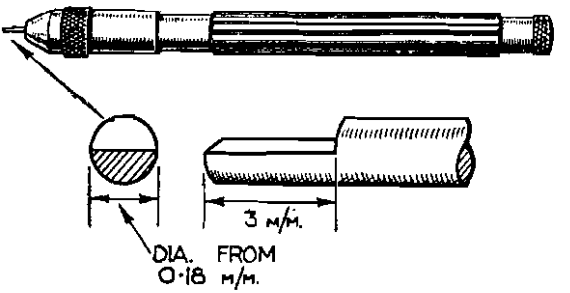
Should the spray be obstructed then the injector body must be held in the vice and the nozzle cap nut is unscrewed (only accurate ring spanners must be used on injector parts). A magnifying glass on a stand is also a necessity as the small holes are difficult to see, and for clearing them only the special tools provided are admissible. The clearing needle is in the form of a 0.25mm D drill, the flat only extends 3mm at one end and only this amount of the drill should project from the chuck of the holder, in the handle of which spares are carried. The drill must be rotated between finger and thumb into the hole and the greatest care taken not to break it off, otherwise the nozzle tip will have to be returned to the makers for removal of the broken piece.

If one hole is carboned up, all the holes should have the drill passed through as it is more than likely that carbon will have started to form in the others. When this has been done the nozzle must be flushed through from the outside by means of a special washing out fitment used in conjunction with the test pump to force fuel oil through the holes in the reverse direction. Any attempt to wash the nozzle from the inside will most probably block the holes permanently.

Dribbling of nozzles after injection may be due to dirt on the valve faces, or to actual damage. Rectification of the latter may be possible by the makers, but dirt can be removed by the use of special tools. First of all the brass brush should be used gently on the valve face, although if any hard carbon resists it there is a special tool for the job, rather like a pencil sharpener made of brass, but if this is not available, scraping with the finger nail may serve. For cleaning the inside of the nozzle tip a brass D reamer and a brass conical-ended reamer are available; failing these a piece of hardwood dowelling point with a 60 degree angle may be used to clean the valve seat.

Single hole and pintle type nozzles are easier to deal with, but here again, only the special brass brushes and reamers should be used. It might be noted that any blueing of the metal of nozzle valves indicated overheating and they should be returned to the makers for attention.

The Leyland single-hole nozzle is of similar general design to the other makes, and on the hand test pump it should give a well atomised spray no matter how slowly the pump lever is operated; there should also be a distinct grunt from the injector when it is working satisfactorily. Any divided or sideways inclination of the jet indicates a partially carboned orifice. The valve spring is non-adjustable, but it can be pre-set by means of suitable adjustment washers. The gauge reading at injection should be about 2,220-2,300lbs. and the spring should support a weight of 50lbs at compressed length of 1.355in. Adjusting washers in six thicknesses are available, rising in 0.005in steps and these are fitted under the lower end of the spring. Each increase gives a rise in pressure of four atmospheres. Should it be impossible, even with the thickest washer to show a pressure of 1,900lbs, a new spring is needed.



Prickers for CAV multi-hole nozzles are actually D section drills or reamers as small as 0.18mm; they must be definitely suited to the particular nozzles on which they are used.

A word of advice about fitting and removing injectors is desirable. The injector is easily damaged and it cannot be dealt with like a sparking plug. Should it be gummed in with carbon it must not be extracted by putting a lever under the projecting block at the top of the body. Very gentle taps and the use of paraffin or penetrating oil should loosen things if special withdrawing tools are not available. But with a reasonable system of engine maintenance, injectors should never become carboned in. During decarbonisation all deposits should be removed from the injector hole in the cylinder head, and where special reamers are provided for this purpose, they should be used.

Unlike sparking plugs, injectors are not screwed into the cylinder head but are held by a clamp or by studs and nuts. The joint between the injector and the cylinder also deviates from petrol engine sparking plug practice. Gardner injectors have a conical metal to metal joint on the seating in the cylinder and there is a slight difference in the angles of the two parts so that a line contact is established which effectively seals the joint with very little pressure on the holding-down nuts. These indeed, should only be run down finger tight onto the clamp and then given one complete turn with the small box key and short tommy bar provided. The leverage of a long spanner should not be applied.

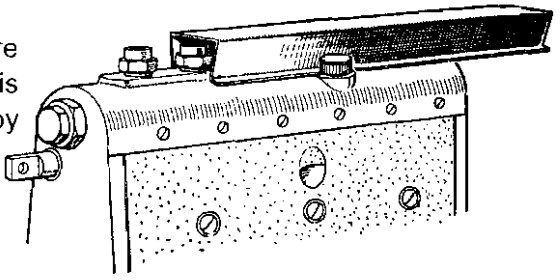
Solid copper or special copper and asbestos joints are used for CAV injectors at the seating in the cylinder and it is essential not to use ordinary copper and asbestos washers of the sparking plug type. The washers should be an easy but not loose fit on the injector body and all faces must be clean so that the injector sits down squarely into position. The clamp nuts must be tightened evenly, first one and then the other, a little at a time to avoid canting of the injector and possibly distortion.

The final warning to mechanics must be a reiteration that injectors cannot be treated like sparking plugs. They must never be dismantled except on a special bench where scrupulous cleanliness is observed, and they must never dealt with more than one at a time, because the clearance limits are so fine that the parts are not interchangeable. Two injectors dismantled at once and the parts mixed would probably mean two injectors put out of action altogether.

The fitting and replacement of fuel pipe connections to the injectors, whilst not calling for any particular skill, is an operation demanding reasonable care. It will be appreciated, particularly in the case of direct injection engines that pressures of 2,000 to 2,500lbs per square inch have to be dealt with. Steel piping of approximately 6mm outside diameter with a bore of 1.5mm is in general use. Nipples can be fitted and secured by silver soldering or, as is

general practice, swaged or rolled by a nipple forming tool procurable from CAV service stations. On replacement, either complete or after rolling new nipples, pipes must be thoroughly cleaned by high pressure air supply to remove any scale or foreign matter. If this is neglected injector life may be seriously jeopardised. In the early days, stress was laid on the importance of having injector pipes of equal length. Generally speaking in he light of increased knowledge of injector characteristics, this does not now apply.

When the unions and pipes are disconnected from a pump, dirt is kept out of the delivery valves by sliding on a sheet metal cover.



The mechanic, in handling the pipe removals and replacements which must be undertaken during injector changes, must appreciate the need for correct size (18mm) spanners if damage to union nuts is to be avoided. Further, excessive tightening is unnecessary and can in fact disturb the delivery valve holders on the pump; as far as possible, these must remain undisturbed and careless tightening or slackening of union nuts, without the support of a second spanner, must be avoided.

Keep plates are fitted to Gardner pumps, while some CAV pumps are fitted with knurled delivery valve holders secured in pairs by serrated locking plates. This latter device is not proof against careless spanner use, and the removal of injector pipes should always be carried out with a second spanner to steady the delivery valve holder. A further point, applying particularly to direct injection engines, is that certain makers use clips to support injector pipes, and they are not included in the layout merely to improve appearances. Appreciable vibration is present in injector pipes under working conditions and neglecting to replace the clips will probably result in fractures. Copper pipes are only used for feed connections, but the importance of annealing them must not be overlooked, after which, cleaning by air pressure is even more necessary. Modern flexible engine suspension also stresses feed pipes, and the need for replacing all clips and supports will be obvious.

In estimating the intervals at which injector removal is desirable, it is necessary to appreciate their definite relation to conditions of operation. If a high standard of engine efficiency is desired, and whether maximum power on maximum fuel economy is the target aimed at, a high standard of injector efficiency is required. This can only be achieved by regular attention for cleaning and the necessary adjustments. Experimenting with various injector pressures, however, is not likely to prove worthwhile; manufacturers are in a decidedly better position to determine correct injector settings than operators, and their recommendations should be followed. Any attempt to operate injectors at lower pressure is likely to be unsatisfactory even if performance appears to be passable. Low pressure due to poor nozzle valve condition is not conducive to attaining maximum engine life, for faulty spraying; with excessive exhaust smoke emission shortens the interval for engine valve attention and has some influence on cylinder wear. It has not yet been possible to produce figures showing the effect of faulty sprayers on pump life, but it is significant that where pump life of upwards of 250,000 miles without major replacements is being achieved, regular changing of injectors is an essential feature of the general maintenance scheme.

In reviewing methods of injector maintenance it is advisable to bear in mind that distortion of nozzles and nozzle holders is a major source of trouble. The relationship of distortion to any form of overheating as well as to careless handing in fitting to and removal from the engine must be appreciated if shortened injector life is to be avoided.

Before leaving the subject it may be pointed out that modifications have been made from time to time in nozzle detail, and it is possible that a group of identical engines may be operating with different types of nozzle design in similar nozzle or injector bodies. The value of a simple colour scheme for easy identification will be seen, otherwise there is no guarantee that eventually one or more engines will not be running with a mixed set of injectors of differing characteristics. Development and improvement in nozzles as a rule means extended life, therefore an agreed colour scheme for the appropriate type also prevents routine change sacrificing useful life by premature removal.

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

A Tale of Two Broomwades

Not much has been written on showmen's lighting sets, so I hope the reader finds what I have written interesting. This piece first appeared in The Fairground Society Platform of November 2003 and they and I have given permission for this to be reproduced in the Gardner Engine Forum Newsletter. **Tommy Green**

Diesel engined lighting sets transformed fairgrounds in the years immediately prior to the outbreak of World War Two. Rides went faster and were better illuminated. Tractor Engines, like old soldiers gradually faded away and there were very few being used by the end of hostilities. Better lorries were arriving on the fairground scene and they became the prime movers of rides. Pre-war, some Scammells an Armstrong Saurers lorries, fitted with dynamos, were also used as generators. From around 1937 John Fowler of Leeds produced excellent sets which had Fowler engines and Mather and Platt dynamos. Pelican Engineering also based in Leeds, produced Gardner engined lighting sets with various dynamos. Often the dynamo had been removed from a traction engine. If the Gardner engine was the L2 marine type, slow running engine, the traction type dynamo could be fitted without modification. If the engine was the faster LW type the dynamo had to be modified to run at the faster speed of 1000/1100 revs. There were of course other makes of diesel engined lighting sets and petrol engines ones that generally ran on TVO (tractor vapourising oil).

John Shaw Snr. had a set built by Pelicans in the late forties with a 6LW Gardner engine, a heavy flywheel and block governors. It handled a load of 400amp (44Kw) without boiling. Post war Isles Limited of Stanningley, Leeds, produced sets based on the Leyland tank engine. Lister built sets for the military. They used their JP4 engine and a Lister/Mawdsley dynamo. The engine found little favour with Showmen as it was a little thirsty, but Mawdsley dynamos were the most common type of ex. WD dynamo on fairgrounds.

I bought a Broom and Wade compressor with a 6LW engine from Walsh and Dearden around 1976. It had been rough handled but had a good engine. There were no side plates and it looked as though it had been roughly treated on site.

It however remained at Walsh and Dearden's yard off Bull Hill, Darwen. Whenever I passed I could see it from the road and was reassured that it was still there. It was three years before we called with a lorry to take it away in 1979, just after Blackburn Easter Fair. Brian Walsh had forgotten who had bought it but advised that it was now worth more than I had paid for it.

No storage was charged or harsh words uttered despite the overdue collection. Gardner engines were then being exported in large number to Hong Kong and the price paid by the exporters varied according to demand. I have seen these engines in Hong Kong whilst on holiday, in buses, junks and as auxiliary engines on the star Ferry. I noticed a pile of Gardner parts on a quayside in Singapore where they also had junks powered by Gardner engines.

The LW range of engines was introduced in 1931 and production of this type ceased in 1974. With its reliability, durability and low fuel consumption it was unsurpassed. The six cylinder version was 8.4 litre. The extensive use of aluminium parts made it a lighter engine than other diesel engines. The LW range was produced in 2,3,4,5,6 and 8 cylinder versions. I have seen a Robbie Coltrane TV programme extolling the merits of this combustion engine. Robbie pointed out how thin the cylinder head gasket was. This was proof of how well engineered the parts were. Because they were so over engineered Gardner were able to more than double the output when they redesigned the engine post war.

As they have constant speed governors, Gardner are good engines when used as generators. On this Broomwade, the compressed air was stored in an air receiver or tank at the back. There were connections for road drills (paddy's motor bikes). When the receiver was full, an air operated piston moved the accelerator and slowed the engine down. When the pressure dropped the piston opened the engine up again.

In due course I removed the compressor part and sold it to Walter Shaw for £25.00. The compressor had three upright pistons but Broomwade also produced versions with the pistons in V configuration. Walter wanted it for spares for the identical one he was using with his Maxwell "Hurricane Jets". The Broomwade was then taken to an engineer at Hyde who fitted a shaft and pulley to the flywheel. At the other end of the shaft was a bearing bolted to a cross member. A 350amp Rather dynamo was mounted above the shaft and this was belt driven. The dynamo had to be belt driven as its speed of 750 revs was too slow to be direct coupled. Although belt drives are not always popular with Showmen, they do, in my opinion produce a quieter drive than a direct coupled on. After I had run the set, the bearing end of the shaft was warm indicating it was slightly out of line. I solved the problem by fitting a thin piece of leather under the plummer block. This allowed slight movement and the shaft was still cool after hours of running. The new outfit proved a very good spare and got me out of trouble many times. Because it is a stationery engine the fan blows through the radiator which is the correct practice.

The chassis has a turntable lock that can only be turned to quarter lock because of the chassis. It was however a vast improvement on Ackerman steering in which the wheels turn by track rod, etc., as on a motor car. This type of steering was christened acrobat steering by a showman who had experienced a lot of trouble with his mobile generator.

I loaned it to Harry Hamer and it ran his Ark for two weekends at Farnworth September Fair. I then took it to Hull Fair to ensure I had adequate power for the Mont Blanc. These two double trips involved 400 miles but were worth the trouble. It was used on many occasions to run the Blanc. In 1981 the wheels were removed and the set had a season with the Twist being located down the driver's side of that machine's lorry. The following year it reverted to its wheels. When the Twist was on tight fairgrounds I sometimes used the set to power and light up the machine. It was also used with the ride in 1999 and 2001 because of problems with the regular set. This was one of two Ingosoll Rand compressors I bought and had modified into lighting sets. These had 5LW engines but this is of course a another story. Anthony Harris' lorry and lighting sets were badly damaged by fire at Hull Fair in 1989. He borrowed the Broomwade to run his Waltzer at Ilkeston and at his bonfire fairs. New blocks, piston rings, etc., were fitted around 1991.

On another occasion I loaned it to run five juveniles in the town centre of Bolton. It has of course run our Flying Coaster and our juveniles when they have been open on their own. The set proved so useful I resolved to buy another. An advert in the Manchester Evening News advised that a mobile Broom and Wade compressor was for sale. When I enquired on the phone I was assured it was a Gardner engined version. I raced across Manchester and discovered it had a Leyland engine. The vendor, an Irishman, said he would have sworn it had a Gardner engine! A number of goose chases followed and I still had not bought one. Around nine years ago, John Walter Shaw offered to sell me the Broomwade that had been used on his father's jets. It had been supplied new to Whites in Scotland around 1954, when they bought a new set of adult jets from George Maxwell. Shaws had not used it for many years and it was being used as a defence against ram raiders at Shaws' Denton yard. John offered to get the engine in running order again as the injection pump tops were missing. I rather forcibly told him to sell it as it was and that I would put it back to running order myself as I felt I could do the repairs myself. John would employ a mechanic to make the repairs which would prove expensive and add to the price I would have to pay. A deal was done and I became the owner of a second and rather bedraggled Broomwade. It had been better looked after than my original one and being stood had brought about its shabby appearance.

Close inspection revealed that the wheels and drawbar had rusted to such a degree that they were no longer useable. The tyres were perished and not fit for roadwork. Second hand wheels and tyres were bought, cleaned and painted. I borrowed the drawbar from the other set and fitted it to the No.2. The new wheels were fitted and a canvas sheet tightly fixed to hide the general state of the bonnet, side plates, etc. Shaws have a very high standard for their equipment and Marissa Shaw thought it a huge joke that I was messing with this scrap item. I was then able to take the set, by road, to Fitter's yard at Warrington for modification.

The compressor part was unbolted and removed as was the bonnet and covers. I recognised when dismantling that it was very well engineered. Broom and Wade were one of the major British manufacturers of Compressors. The two enamel badges on the bonnet had union jacks and proudly proclaimed "Broomwade British made".

I then fitted reconditioned pump tops and injectors. The original diesel supply was gravity fed so I obtained a lift pump mounting plate from Gardner and fitted it to the engine. One of our spare lift pumps was then bolted in place. Previously the engine had been hand started so a suitable starter bracket was obtained. This and a 24 volt starter were attached to the engine. The front fuel filter bowl was removed, cleaned and a new filter and washers fitted. Pipes were connected to a drum of diesel and the fuel was hand primed to the injectors. The engine oil and filter were changed. These engines are very easy to work on. The nuts and bolts are whitworth thread. This is a coarse pitch (twelve to the inch) and not easily cross threaded. The small bolts are B.A. a bolt type similar to model makers. Once the starter had been connected to batteries the engine was repeatedly turned.

Initially it was decompressed to get the lubricating oil to all the bearings, etc. With compression on, the engine was spun and spun. After what seemed a long time the engine began to smoke and show signs of life. Eventually it started with probably three or four cylinders firing. There was a lot of wheezing and banging until it settled down to a regular and even beat. In due course suitable brackets for the dynamo were welded in place and the dynamo bolted down by engineer, David Fitter. The four belts were put in place and tightened. The Mather and Platt dynamo had previously been overhauled and the small crack in the casing welded. This dynamo had a long history as it was originally on the Burrell "Violet Lily". Herbert Silcock Snr. had later used this dynamo on a lighting set after he finished with his traction engine.

I built a switchboard and this, together with supply cables from the dynamo, were fitted. The repaired bonnet and side plates were then put back in place. A fresh drawbar was fitted plus a battery box. To make it roadworthy, seven-core wire was fitted down the chassis so a back light board could be fastened to the rear. David then welded an air brake diaphragm to the back axle. This was connected to the levers and a plastic brake pipe was run down the chassis to a newly fitted brake coupling on the front cross member.

In August 1999 I collected the outfit from Fitter's works in Warrington and it was taken to Irlam where I was open with the Twist at this fair of John Silcock's. After further adjustments and the fitting of a silencer, it was used to run the Twist for an afternoon and proved reliable. I had a week off after Irlam and used the time to lick both Broomwades into shape. I wanted them to be recognised as twins. The next fair for me was Bury and both Broomwades were taken there. There was not room at this town centre site (car park) for our eight wheeler and lighting set. The two sets looked well and when Marissa saw the No.2, she was as generous with her praise as she had been with her laughter when I collected it from their yard. I used both sets alternately without any breakdowns. On the second Saturday I secured Charlie Wright's consent to light up and run his jets that previously belonged to Walter Shaw. The No.2 was back in its old spot but this time providing electric power instead of compressed air.

My circumstances had changed since buying the No.2 and I reluctantly put it up for sale. It is now owned by preservationists and has a good home. 110 volt DC is not now the norm on fairgrounds. Since the introduction of electric light on fairgrounds 100 volt DC reigned supreme for a generation. The standard voltage on Royal Navy ships was 220 volts DC until long after the 2nd World War.

When showmen's generators were being hired out in the 'winter of discontent' in 1973/74 almost all were 110 volt. Even showmen with arcades only had rotary converters or small alternators. Teddy Silcock's Tri-star was the first travelling roundabout that I can recall that relied exclusively on 3 phase and this made its debut in the early '70s. 3-phase 440 volt AC is now the accepted voltage and silent run lighting sets are a vast improvement. It is the bonnet and sides that absorb the noise. The enclosed nature of these covers makes good ventilation for the engine essential.

Travellers with rides that run on DC such as Waltzers and Dodgems often have 3-phase supplies transformed and rectified to 100 volt DC. However a

showman recently pointed out that it was pointless having "silent run" if the amplifiers on rides were too loud and created a nuisance. A modern 200 KVA set can easily run two machines and a 300 KVA can run three or more. Matty and Douglas Taylor had a huge lighting set at Hull fair. When it unexpectedly stopped, the amount of rides that blacked out was amazing.

Gardner engines are no longer seen in large numbers on fair grounds and have been replaced with recently designed engines such as Cummins, Volvo and Perkins which are more powerful. To produce AC current an engine speed of 1500rpm is needed. This is much higher than the 1100rpm which is normal for a DC lighting set. Running at the lower speed a Gardner will almost last forever. A Gardner that has been "sized up" whilst running at 1100revs can often be coaxed back into action without major surgery, but this is not the case if it has been running at 1500revs. In August 2001 I sold my Twist ride to Gary Gore. I loaned him the No.1 until the end of the season. It gave no trouble and was returned in late November.

I sold the original Broomwade in October of this year. The new owner may use it as it is or put a dynamo on his traction engine. I trust he will get the same service from it as I have. It has been a very faithful servant.

The "twins" at Bury September Fair

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