GARDNER

Engine Forum

Spring 2016

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GARDNER Engine Forum

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Year of Manufacture			
Name Vehicle /Vessel			
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Mr J McCool
Membership Secretary G.E.F
Artasooley,
Benburb
Dungannon
N Ireland
BTB71 7LN

Tele 07802 57441
Email:-tangent.gardner@gmail.com

Gardner Engine Forum Philosophy

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

Forum Officers

Chairman:Colin Paillin
Red Hill Marina
Notts
Tele 07801 384898

Secretary. Linda Kemp
See below for contact details

Treasurer: Judith Gray 29 Verity Walk
Wordsley Stourbridge West Midlands DY8 4XS
Tele 01384 827745

Membership Secretary: Joe McCool, Artasooley, Bendurb, Co Tyrone, Northern Ireland BT1 7LN
Tele 07802 572441

Editor-Webmaster:Steven Gray 29 Verity Walk, Wordsley, Stourbridge, West Midlands. DY8 4XS
Tele 01384 827745

Andrew & Linda Kemp
Korna Cottage
Works Lane
Barnstone
Notts
NG13 9JJ
Tele 01949 860867

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Chairmans Notes

This newsletter landing on your doorstep has the most important issues, at the forthcoming A.G.M which will take place at the Anson Engine Museum we DO need a new chairman , it's not a difficult or testing role as we have a positive and hard working committee but without a chairman the forum cannot continue ,
I stepped in at the last minute to keep us going after the loss of previous chairman Mike Johnson but for personal reasons I cannot carry on after the A.G.M

So please if you feel that you can or will volunteer please get in touch with me , or our secretary.

I would hate to see the forum fold up

Collin Paillin

NOTICE

The Annual General Meeting of the

Gardner Engine Forum will be held At The
Anson Engine Museum
Anson Road
Poynton
Cheshire
SK12 1TD
on
Saturday 23rd April 2016 at 2 pm.
Items for the agenda should be sent to the secretary

Mrs L Kemp
Korna Cottage, Works Lane, Barnstone, Notts
NG13 9JJ
By April 9th 2016

Happy Memories

I enclose a photograph of one of my father's E.R.F commercial vehicles (cover photo) My father was a one wagon owner driver and this picture was taken in the mid 1970's. This vehicle was powered by a 6LW which seemed to be the rarer option as most LV models in this weight range had 5LW's fitted. It was coupled to a David Brown 5 speed gearbox and Eaton 2 Speed axle.

I always enjoyed driving this vehicle on my days off, at that time I drove an LV tractor unit shunting tanker trailers for my own employer, this had a 6LXB with the David Brown 6 speed gearbox (which was a 4th to 5th round the corner with 5th to 6th being forward) plus Eaton 2 sped axle. Sadly I didn't photograph this one.

In the eighties dads loads increased in size and he replaced the LV with a B series artic with a 6LXB coupled to an David Brown 6 speed gearbox and Eaton two speed axle, I must admit that I much preferred the LV A series models as I found the gear change more positive, I think that this was due to the linkage required to accommodate the tilt cab. Interestingly I've driven a couple of B's with Fuller Roadranger transmissions which seemed to be better, but maybe it was just me.

When the load sizes returned to 10 tons the artic was traded for another 4 wheeler,also a B series with the 6LXB-DB-6 speed-Eaton 2 Speed combination. The original owners specified the bigger engine as it was a rather heavy insulated van body which we replaced with a curtain side body

I cant imagine that my father wouldn't have photographed the last 2 vehicles and if I find any photographs I will send them along.

There was nothing on the road to compare with a Gardner engined ERF in my dads opinion, I've had the same photograph in the (ERF) REVs magazine, which would have made him very proud. If you include it in the Forum magazine as well he would be immensely proud believe you me

Stephen Brocklehurst

Information Request

Can any member help Tony in his quest to obtain information about his 2LW

In a conversation at the Whaley Bridge rally it was said that there's was a cancelled order of several 2LW pumps (in 1994 ?) and these engines were then returned to and marinised at Patricroft and sold to the narrow boat trade, 251630 being bought by S Goldborough and fitted in the Doug Moore boat Slender Delta which I now own.

What is unclear is who was the original customer and where were these engines/ pumps during 1994 / 5 ? Any Information gratefully received. Thank you, Tony Mann.

If you can help please send information gardnerengineforum@blueyonder.co.uk or telephone the editor on the number listed on page 1

In amongst some manuals and brochures that was passes to me for keeping was a cover less copy of the Gas and Oil Power magazine, from which I have extracted the following articles, I hope you find of interest. One of the benefits of fitting an A4 publication into an A5 one is it easily fills the latter,as a result there was more than could be fitted into one edition so it will run into the next edition with articles about the early days of Rudolph Diesel and his experiments and a look back by his son at his achievements.
Starting on page 11 is an account of the development of the Jerk type of fuel injection pump, Gardner's utilised this type of pump along with its own cambox and governor design on the L2 which was introduced in 1929.

Gas & Oil power

FOUNDED 1905

May, 1955 GOLDEN JUBILEE NUMBER VOL. L—No. 600

FIFTY YEARS . . .

Fifty years of service to internal-combustion engine specialists on the manufacturing and using sides can fairly be regarded as a long and proud record. Such is the position today of Gas and Oil Power. It is the oldest internal-combustion engine journal in the world by a comfortable margin; it has grown up alongside a great world wide industry. It has made many friends and kept most of them. It has done a straightforward, honest job of reporting development and progress in its field. In its early days it did a lot of vigorous propaganda for the gas engine; and if the accent then was on enthusiastic advocacy and "the case for the other side cannot possibly be as good as ours," we must plead for our predecessors of 1905-10 that they clearly believed in their cause and were for most of that time the lone and much needed champions of the industrial internal-combustion engine.

If half a century seems a long time when viewed through bound volumes of this journal and the immense amount of work they represent, it is a swift fifty years when viewed as a story of progress in gas and oil engine development and usage. When this journal had its modest but enthusiastic beginning the gas engine was in the ascendant. The oil engine then generally meant the light-oil vaporising engine. Dr. Diesel and those who believed in him to the extent of buying licences to build the promising new motor had made a sound start but it could not be described as anything more. In Britain, for example, the Mirrlees built engines were being turned out steadily in relatively small sizes and the Continental builders had advanced little further. No ocean-going ship with diesel engines had then been ordered; no diesel locomotive or railcar had been contemplated seriously; and the the road transport compression-ignition engine was barely a visionary's dream. In less than ten years the world was plunged into a major war but not before the heavy-oil engine had thoroughly established itself in every industrial country. A single decade had seen cylinder powers advance from a modest 50 or so to 1,000 and even 2.000 b.h.p. Crankshaft speeds had risen cautiously, reliability had increased, total enclosure with forced lubrication was coming along, the first steps with pressure-charging had been taken, and number of progressive designers had started work on the development of the airless-injection "diesel" engine. The ocean-going motor ship was properly established if still something of an operator's problem in 1914-15, and the oil engined submarine was generally accepted and, in fact, played a big part in the world conflict of 1914-18. The diesel locomotive and railcar had arrived at that time but their progress was delayed by the war.

At that interesting stage, when this journal had ten years experience behind it, the gas engine as we had known it in our early years was, in the modern idiom, on the way out. It is true that a number of firms still did important business with such engines and some new and interesting designs were still to make their appearance in the years ahead. The trend of progress was clearly in favour of the newer high-compression oil engine—whether of Akroyd Stuart or Diesel genre is only of technical interest and its flexibility and adaptability of application were undoubtedly bringing orders for the newer prime mover which the faithful gas engine could never have attracted.

The high-speed engine and the jerk pump

Let us jump another few years. The year 1925 saw the high-speed diesel engine established as a technically sound development. The diesel's field of application was, even then wide, and the number of firms making such engines was much greater than it had been at the end of the first world war. One of the most significant developments then proceeding cautiously was the proprietary "jerk" pump, a piece of precision engineering over which the technical highbrows were inclined to shake their heads. Its influence upon the establishment and rapid development of a new side of the oil engine industry—the high-speed engine market was tremendous. It would not be unfair to the designers and makers of these engines to say that it made possible the phenomenal and even spectacular growth of the high-speed diesel engine, the road transport "oiler," the diesel tractor and many other developments where the economy of the small and light compression-ignition engine has been such a factor .If the coming of the high-speed oil engine was the most significant thing of the early years of the period beginning around 1925, the tremendous development of motorshipping was, in our view, the other great landmark. True the courageous early experimental large two-stroke engines of 1,000/2,000 b.h.p. per cylinder had not come ahead for marine work as Dr. Diesel and others thought would be the logical line of development but the large fairly high-powered motorship was an actuality—and a success—thirty years ago. This is not a motorshipping journal and the chronicling of the development of the marine diesel engine and of the motorship has been well covered in other periodicals as well as in the proceedings of certain technical societies. The full story is splendidly told, incidentally, in a book which one of its best known chroniclers has written after a professional lifetime's close association with the subject. We are proud to be associated with this important book, as its publishers, and can promise those who buy it that they will not be disappointed. It is a well-told story, particularly carefully illustrated. The book* tells, as no other has ever attempted, a glorious chapter some think the most important in the history of the internal-combustion engine.

The next decade, beginning with 1935 and taking in the second war period, opened with airless fuel injection virtually universal. If some mourned the passing of blast injection because the change brought problems of fuel injection and combustion where none had existed, on practical grounds the advance was notable and welcome. Turbocharging by means of the exhaust gas turbo blower had forged ahead after a slow start around 1923-24 and was ultimately to become, and remain, a dominant factor in the trend of oil engine progress. Looking back it has been one of the most important of all developments in the industrial and marine engine fields.The high-speed oil engine had reached the status of being a separate industry by 1935, as many of us had believed would come to pass. It is doubtful, however, whether many keen enthusiasts at that time thought we should see millions of horse power of automotive and other high-speed oil engines turned out annually inside twenty years. For most duties save that of private cars and motor cycles and certain types of aircraft, the spark-ignition petrol and light-oil engine has been replaced today by the compression-ignition engine. That is a tremendous achievement, bearing in mind the higher cost of the latter.

Two great developments

Just before the second war began two important developments were recorded in our pages. The industrial gas turbine of practical type emerged—we saw it running on load in 1938—and in 1939 the high-compression gas and dual fuel engine technique as we know it today was consolidated successfully by the British National firm. Both are established as worldwide commercial prime movers today. The gas turbine has been developed cautiously and not without some growing pains. It is well that it should be so. Sound building, when such a bright future is in sight, is essential at this stage. The marine gas turbine has been slow in its advance but that too is not a bad thing. We have yet to describe the first sea-going gas turbine installation of significant power but progress is at an increasing rate.The modern gas engine has revived interest in what many readers, including engine builders, assured us was a dead field: they expressed concern at our stubborn holding on to an out of date title for this journal. Today it truly expresses the field of our editorial scope as aptly. if differently, as it did fifty years ago! So does the wheel turn.

The future

The rest of the story is virtually of the present—and the future. It is not the policy of the technical press to prophesy. Perhaps this is a privileged occasion when a little rash speculation will be forgiven—and maybe not thrown up in the years ahead. As we see the position in 1955, the oil and gas engine industry is set fair for the future. Pressure-charging (Turbo) will become almost universal for stationary, marine and railway oil, gas and dual fuel engines of both cycles. Only the small engine for farmers, industrial users, etc., will in the future use natural aspiration. The fuel injection equipment for quantity-produced engines will be simplified and cheapened. In this connection it is said that the single-plunger distributor-type pump costs about one-third the price of the conventional multi-plunger pump for the same duty. Air cooling will extend. Many believe that the days of the large oil engine are numbered. In the marine sphere there is no indication that the large direct-drive moderate-speed engine is losing ground to the quicker-running geared installation. On the contrary, turbocharging seems to have given the big slow-speed two-stroke engine a new future; one firm alone has over 170 such engines built or on order. In the stationary world firms who specialise in large engines are doing good business. At the same time the claims of the gas turbine cannot be ignored where high powers and intermittent duties (peak load and stand-by purposes, for instance) are under consideration. Here the future seems to be with the new prime mover. Given better fuel consumption's, the gas turbine should gain a place on the railways of the world. The diesel engine is very much in the ascendant here at the moment and it has far from reached its limit in respect of power and weight from a given set of limiting dimensions; it also has an advantage in respect of fuel economy which is not likely to be narrowed in the next few years. In short, the next fifty years are certain to be busy ones for this journal. There is no foreseeable lack of progress or stagnation of design, development and applications of gas and oil power.

* "The History of Motorshipping," by A. C. Hardy, B.Sc M.1.N.A., A.M.i.Mar.E. Shortly to be published by Whitehall Technical Press Ltd.

OIL AND GAS ENGINE MILESTONES — 1905 — 1950

Over the next twenty-eight pages we briefly set out, in chronological order, some of the main, events in internal combustion engineering during the major part of the life of this journal: we carry the story to 1950, happenings after that date being sufficiently fresh in readers' minds to justify this arbitrary closing date. Consideration of space provided another recommendation for this decision .
No claim is made that our chronicle is complete. or even approximately so. Here and there the date we give may not be strictly accurate because a maker may have completed an engine or installation some time before it was announced. In the main it is concerned with matters of technical development. Little is included about personalities: and in order to keep the feature within, a fairly restricted number of pages we have scarcely attempted to note marine diesel and motorshipping progress. The field is too vast to include here, and it is not strictly within our editorial scope. This is the reason why the names of some firms who have done much more in this important sphere than in the stationary and/or traction worlds do not recur almost yearly, as could have been justified.

(The opening line of the above paragraph mentions 28 pages this included illustrations of engines and injection equipment, to keep the content abbreviated and relevant to the Gardner marque I have selected entry's which are generally relevant to the development of the High Speed Oil Engine in the United Kingdom. Ed)

1909
Crossley Bros. designed a double-acting horizontal gas engine with double cylinders A new vertical tandem gas engine was all introduced.
Dr Diesel himself then tackled the problem of the road vehicle diesel with an experimental 30 b.h.p. at 600 r.p.m. directly-reversible engine which was also adaptable to marine work, A 5 b.h.p. at 600 r.p.m. single-cylinder engine was produced to Dr. Diesel's designs in the same year. It returned a consumption of 0-53 lb. per b.h.p. per hour. A two-cylinder engine of the same cylinder dimensions, with attached compressor, was also made. This had push rod operation of the valves and other automobile features.
1923
Bosch commenced the development of a fuel injection pump for small high speed oil engines
1925
Bosch took over the patents of **Fritz Lang** in connection with the Acro combustion chamber arrangements and the fuel injection equipment designed to be used with the Acro designs. Later in the same year Lang and Bosch both developed pumps in which a single plunger was responsible for delivery and metering of the charge.

That was the real beginning

Norris Henty & Gardners Ltd commenced investigation of a smaller two stroke oil engines with direct injection. An experimental single cylinder engine of 4 ½" bore by 5" stroke was used for both surface and compression ignition investigations

1929

First **Gardner** production high-speed oil engine built. With marine use in view, it developed 38 b.h.p. at 1,000 r.p.m. in four cylinders 4 ¼". bore by 6in. stroke and was of direct-injection four-stroke type with Bosch pump and Gardner multi-hole injector. This was the forerunner of the famous L2 series. *(This is I believe the engine now at the Anson Engine Museum) Ed*

The first **Paxman** stationary engine to operate with the Buchi system of turbo-charging (an eight-cylinder 15½". by 20", diesel) was set to work at Basingstoke. A similar engine was later supplied to Ashford, these being the largest airless-injection stationary engines in Britain at the time.

Airless injection introduced for their large engines by **Sulzer**. It is significant to note that serious experimental work on this development began an Winterthur as early as 1915. Airless injection had been adopted for smaller engines in 1926 .Three-cylinder experimental two-stroke double-acting engine built by **Sulzer**. Of 600 mm. bore, 2,400 bh.p. was developed at 214 r.p.m., direct injection being used. The same firm accepted their first double-acting engine

1930

Introduction of automotive version of **L Gardner** high-speed diesel running at 1,300 r.p.m. and producing 50 b.hp. in four (4¼" by 6in.) cylinders. Full load specific consumption, 0-43 lb. per b.h.p. per hour.

General Motors Corporation acquired the **Winton Engine Works**, Cleveland, Ohio, and so entered the diesel market. in the Same year they installed their diesel in a switching locomotive for the first time.

Mirrlees produced a horizontal opposed piston single-crankshaft two-stroke engine the rocking-beam type (similar to the **Sulzer** and, very much later, **Rootes** design which gave 20 b.h.p. per cylinder at 1,000 r.p.m.

Mirrlees commenced work on the development of airless injection for their engines.

1932

A larger **Gardner** engine (the L3- 5½" bore by 7¾" stroke) was announced for road,rail,marine and stationary duties. At 1200 rpm the eight cylinder example produced 204 b.h.p.

A Bentley car with a **Gardner** 4LW oil engine completed a 1,000 mile R.A.C rally run with an overall consumption of 29.4 m.p.g.

First **Gardner** engine (a 4LW, the shorter type with light alloy crankcase) fitted into a motor car was driven in a R.A.C. Rally The Manchester firm introduced their L3 series in the same year. This was a larger version of the earlier L2 design with a bore and stroke of 5½" and 7¼" respectively

F Perkins rented small premises in Peterborough and entered the high speed diesel engine field. Initial output was one engine a week with a works staff of four men

1933

Leyland Motors Ltd offered for sale the first vehicular type oil engine, although they had had exhibited one at the 1931 commercial Motor Show. A six cylinder engine rated at 88 b.h.p at 1,800 r.p.m., It employed a combustion chamber of original design.

In June we briefly described the new **Perkins** high speed diesel engine of only 3" bore which could attain 4,000 r.p.m.

Rushton Hornsby Ltd completed the worlds largest order for marine diesels, 92 six cylinder engines of about 100 b.h.p. For river buses and tugs in Russia.

1934

Gardners introduced a smaller (3 ¾" by 5 ½") four cylinder engine developing 53 b.h.p. at 2,000 r.p.m. Crankcase and sump were of magnesium alloy. This engine weighed 700lb an was later put into production as the 4LK

1936

An injection pump delivery valve was evolved by **Bryce** to avoid infringing Bosch-Atlas patents and a multi camshaft type pump was put into prototype production. This was dimensionally the same as the Bosch Pump

Britain put into service her first diesel powered life boat using the Ferry engine

Mercedes Benz began series production of a diesel engined salon car, being the first maker to offer such a vehicle as a standard model.

1938

F Perkins Ltd introduced their six cylinder P6 engine upon which the rise of the firm as a leading high speed diesel engine producer has been based

Foden developed six cylinder lightweight two stroke diesel for vehicles,capable of producing 130 b.h.p at 2,000 r.p.m.

1945

An eight cylinder version was added to the Gardner LW range ; the output was 140 b.h.p at 1,700 r.p.m

R.N.L.I announced a large lifeboat replacement programme in which diesel propulsion was to be used exclusively,The Ferry engine was chosen.

1950

Horizontal version of the LW **Gardner** oil engine introduced in four-five and six cylinder form for under floor location in buses,coaches and railcars.

From Gas and Oil Power May (Golden Jubilee Number), 1955

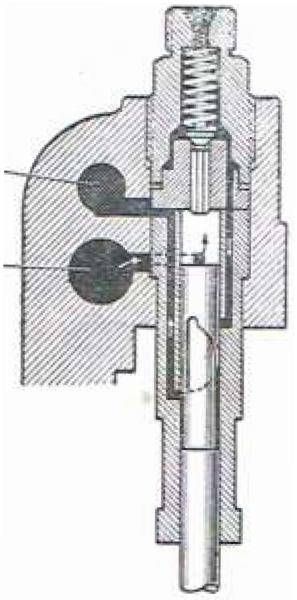
The Proprietary Injection Pump

The Reliance which so many of the World's Oil Engine Manufacturers and users place upon the Propriety "Jerk" Pump, The Rapid Rise of One Particular Design of Pump,and the influence this had upon High Speed Engine Progress in Particular, Form an Important Chapter in Diesel Engine History over the Past Quarter Century.

There is nothing original in drawing a parallel between the development of the high-tension magneto in the early years of the present century and the emergence of the proprietary fuel injection pump in the sphere of the high-speed diesel engine about twenty years later. It has been mentioned many times before; and it is inevitable ,and accurate—that the name of the Robert Bosch A.G. should be referred to in connection with both developments. Bosch made a success of the high-tension magneto market and quickly dominated it before the first world war. Years later when various firms were bringing along high-speed diesels, or hoping to evolve satisfactory ones. Bosch repeated history by offering makers dependable injection equipment for their new quick-running small engines. It is not underestimating the work of the designers and builders of these early high-speed engines to say that without Bosch fuel injection equipment

Many of those early engines would have taken much longer to develop. The satisfactory nature of Bosch injection gear undoubtedly encouraged a number of firms to bring out high-speed oil engines, and market them years before it would have been possible without dependable "off the shelf" injection equipment being available at a comparatively reasonable price.

That broad picture of the young high speed oil engine industry in the middle twenties is familiar enough; but few engineers aside from those closely concerned with engine development know anything about how the Bosch pump was evolved or how long its development to the commercial stage took. It is all so very much an integral part of the history of oil engine development during the second part of this journal's career that this Jubilee Number would be incomplete without it. We therefore offer these few notes and illustrations in the belief that it will give many of our readers some facts which are new to them.



In this pump design the Bosch engineers Improved upon Lang's 1926 Layout by separating suction and spill chambers, Therefore avoiding pressure waves In the pump suction

Origin of the Bosch pump

The main impulse given to the development of an injection pump by Bosch was applied after a board meeting in Stuttgart on December 28, 1922. The development programme then envisaged had four objectives in view:

To produce a pump capable of handling all likely liquid fuels from petrol up to tar oil;

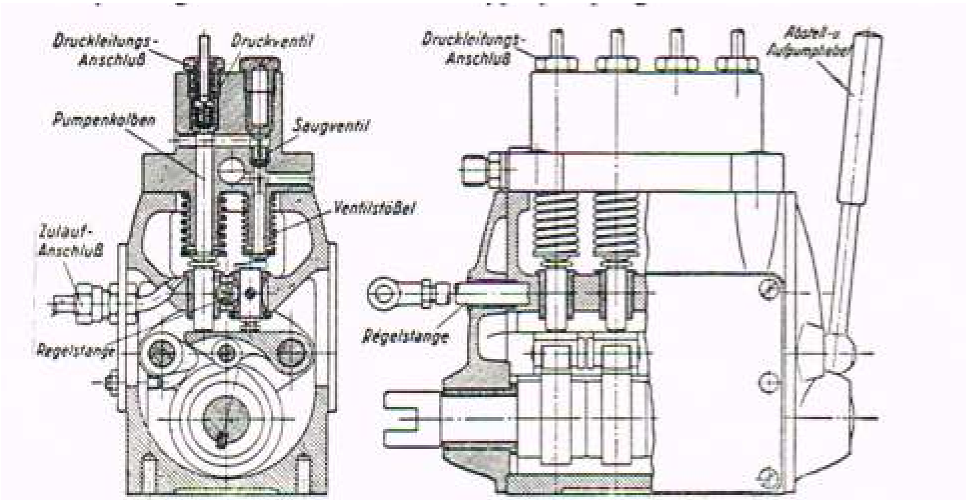
To obtain the desired delivery characteristics from the pump;

To be certain of achieving accurate metering;

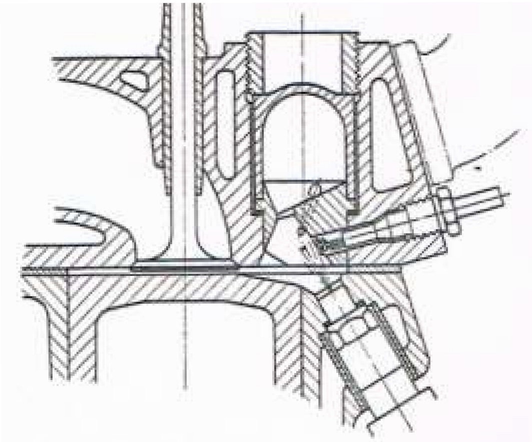
And to ensure that performance was maintained over long periods;

Meeting all of these requirements could, naturally, only be expected from an extremely well developed and well made precision product. Work commenced the following year. In entering this new sphere Bosch was to a great extent operating in its own basic field of precision engineering with quantity production in view, and they approached the task with characteristic thoroughness.

Early fuel injection experience
Earlier, occasional tests with fuel injection had given the firm a certain amount of experience. For instance, as early as 1912 a petrol engine had been run with petrol injection. A Bosch mechanical lubricator, operated with an oscillating drive mechanism and with the usual piston acting as a low-pressure fuel injection pump, was employed. In the following year, 1913, an experimental pump of drum form, with five pump elements, oscillating drive and rotary valve control of output, was evolved.



The four-cylinder Bosch plunger pump of 1923
Druckleitungs-Anschluss—Delivery Union; Pumpenkolben—Pump Plunger; Zulauf-Anschluss—Leak off Union; Saugventil—Suction valve; Regelstange —Control Rod; Druckventil—Delivery Valve; Ventilstossel—Spill Valve Push Rod; Abstell-u-Aufpumphebel—Cut Out and Priming Lever



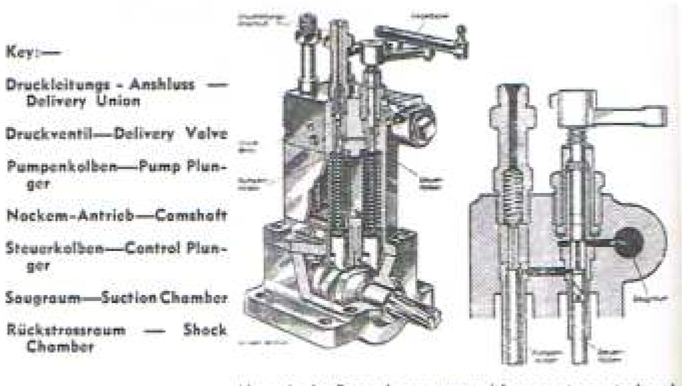
Acro air cell combustion chamber arranged in the cylinder head. Note chamfer on the piston in the region of the nozzle and the location of the heater plug. In some engines the Acro chamber was in the piston crown

Further fuel injection tests were carried out in 1917 on a Körting engine in the Bosch works at Stuttgart.This tentative approach to the problem was replaced by a carefully drawn up experimental programme after the board decision of December, 1922, when work started in earnest. The aspects of the problem to be tackled first were the achieving of delivery accuracy and the minimising of wear of the barrel and plunger and other parts. Various combinations of pistons and diaphragm pumps, some with plunger rotation and others with valve control, were tried. Both lever and cam operation were tested on bench-type pump rigs and also on both two and four-stroke engines. The first illustration shows an example of a four-cylinder plunger pump built in 1923, with which volume control was effected through a rotary suction valve.

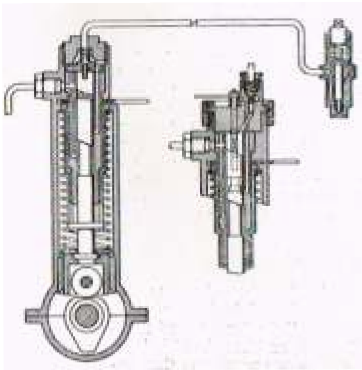
The Acro patents and Bosch

In order to acquaint themselves thoroughly with the problems of diesel engine development and also to help further it. In 1925 Bosch took over the patents concerned with the Acro air cell diesel engine and the fuel injection pump developed along with these ideas. Franz Lang was the patentee and he continued to work on their inter-related problems with Bosch until October. 1926.

The Acro-Lang pump of that date, as shown in the illustration on the right, had, for each discharge, a separate control piston in addition to the working piston. It is worth noting that even at that time the control piston had an oblique scroll face and was designed to be rotated in order to effect control. This de-



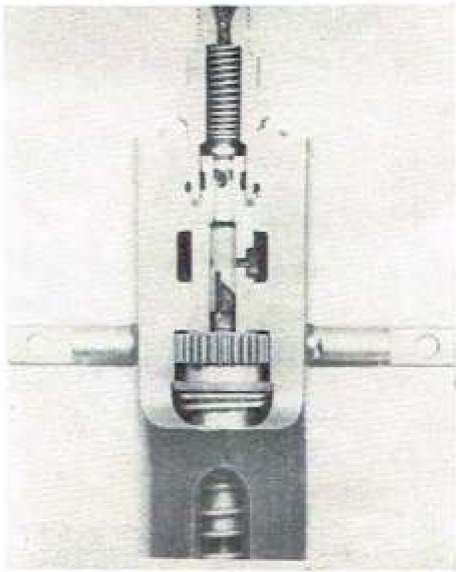
Above is the Franz Lang pump with separate control and delivery. It was built in 1925 for the Acro engine sign appeared to be too complicated to the Bosch designers, who had mass production as their ultimate aim. In addition, its characteristics as injection pump did not fulfil the desired requirements. The single-plunger type of pump was preferred.



Single-plunger pump developed

Since the testing and further development of the Acro engine was to carried out with an alteration to the original fuel injection equipment, a plan conceived in the summer of 1925 to combine the delivery and control one pump piston was, for the time being, not pursued as the research programme was heavy enough. At the end of 1925 Lang himself also turned his attention to this idea and applied for patent. An experimental pump with single plunger capable of being rotated so that an upper scroll face machined on it could control the suction port and a lower helix could take care of the return to the suction side (see illustration) was developed.

As can be appreciated from the drawing, the drilled return passage through the barrel do which superfluous fuel could return below the lower helix and so, by way of the second drilled passage, up to the suction line was a relatively long path for the fuel. This unfortunately led to hydraulic surge, which had undesirable effects upon the delivery characterises, with resultant difficulty in matching multi-cylinder pumps with the perfect unloading of the pressure line with a consequent reduction of hydraulic vibrations and their effect upon injection.



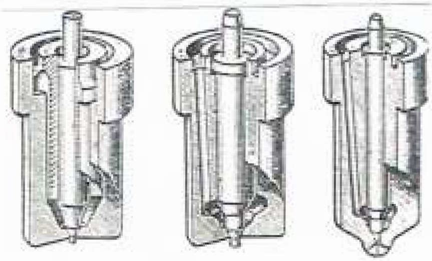
The basic Bosch pump showing the return groove in the shortened pump piston, and the radial bores in the pump cylinder to the common suction and shock chamber

Another ideal was to obtain delivery characteristics which came very close to the theoretically required values, but this could not be attained with the long drilled passages in the pump cylinder sleeve which were still retained at that time. Because of this, the Bosch proposal of 1925 was resurrected and the return oil flow was led from the pressure space directly along a lengthwise groove machined in the pump plunger.

With this arrangement, the suction and return bores could be arranged at the same level in the pump sleeve and the control helical edge moved upwards. The long channels in the pump sleeve were, in this modified pump, replaced by a large surge-free suction space which was also common to the shock chamber, as the fifth illustration brings out. This new design immediately showed good test results and was put into production; in many important respects it has remained to the present day. The leakage of fuel past the plunger, which was possible at high pressures, was eliminated in the larger pumps by providing a ring groove in the pump cylinder. This unloading chamber is connected by a passage to the suction side of the pump so that the leakage fuel is led to the suction chamber.

Nozzles

As in the case of the fuel pump, so also with the complementary injection nozzles. It was necessary to develop specially good mechanical production methods for injector and pump manufacture and to carry out very careful materials' tests. Design problems were not so onerous as those encountered in the development of the pump. In order to ensure sufficient operational reliability when faced with small tolerances (of the order of one to two thousandths of a millimetre) and the considerable mechanical and thermal stresses which were encountered, the two-part Acro-Lang pintle nozzle shown in the first nozzle illustration was developed into the single-piece Bosch pintle type shown alongside it, to which was later added the Bosch multi-hole nozzle also illustrated.



Above are seen three types of nozzle. On the left is the Acro-Lang two-part pintle, in the centre is the Bosch single-piece and on the right the Bosch multi-hole type

It is worthy of mention, as a tribute to the soundness of this early work, that these basic Bosch forms have, in the main, been retained up to the present time. Naturally, however, as the years have passed, and user experience has accumulated, small alterations have been made. Others have been suggested in the light of the ever more onerous requirements of the newer and better engines as they have been produced.

Gardners no doubt benefited from the early development by Bosch, using this type of pump on all the engines that were built from the L2 onwards, with their own speed governor, only changing after 55 years with the introduction of the 6LXDT in 1984 when they used the CAV Majormec pump, which operates on the same principal. (Ed)

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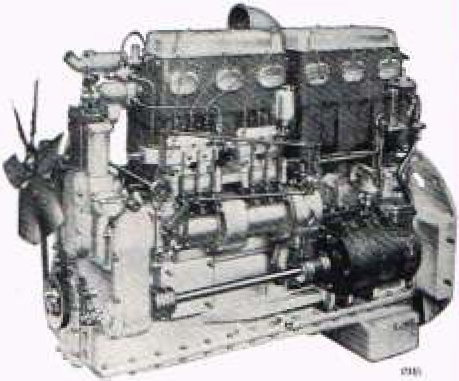

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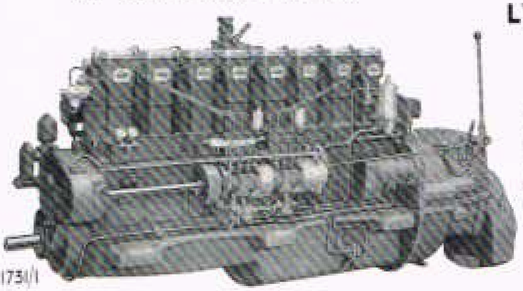

1731/1

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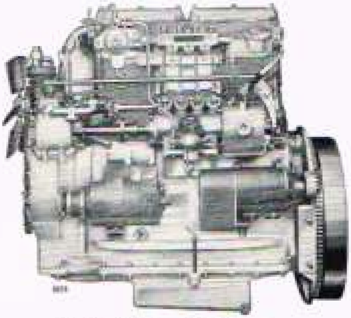

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CANALS & WATERWAYS

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