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**Address on Saurer History, Experiences and Latest Achievements given by Mr. A. Lampert at the Meeting of the City Swiss Club on October 6th, 1931.**
(Continued).

## HEAVY OIL ENGINES FOR USE IN TRANSPORT VEHICLES.

The history of the Heavy Oil Engine is, comparatively speaking, very old. This is proved by the fact that the first patent application for the use of oil as a means of producing motive power was taken out in the year 1791. The first practical oil engine, however, does not appear to have been produced until 1870.

It is somewhat strange, considering the early date of the first patent application, that the Heavy Oil Engine, especially for road transport, should not have received more attention, and has not come into its own until recently.

The reason for this apparent delay in the development of this particular type of engine may be found in the fact that it was much easier to produce an engine running on lighter oils, such as Benzine, Naphtha, Petrol and Gasoline, because these are much more easily vaporised. It was so much simpler to introduce into a engine cylinder, compress and explode, such readily inflammable mixtures that designers and inventors appear to have followed the line of least resistance.

It was the continuous increase in price of these lighter oils, owing to the great and ever increasing demand, which stimulated interest in Heavy Oil Engines. Add to this the fact that the latter are able to run on much cheaper fuels and show a considerably greater efficiency than the light oil engines.

The principal difficulties met with in the use of Heavy Oil Engines on transport vehicles have been the great load and speed variations to which these vehicles are subject.

For stationary power plants and marine work, where only small variations in speed and output are required, Heavy Oil Engines have been greatly developed and are to-day extensively employed.

Experience obtained with these stationary power units has naturally benefited designers of Heavy Oil Engines in the application of the principle to transport vehicles. The different methods employed to introduce this fuel into the cylinder, ignite and burn it, have been enough to fill books.

The principle most extensively employed by manufacturers has been the injection of oil fuel by air blast under great pressure and speed, and employing the Diesel principle for the ignition and burning of the injected fuel.

In recent years a new system of direct fuel injection has been widely studied and developed. This, known as the solid injection principle, has been found to be the most suitable for transport vehicle engines, and very successful developments have taken place in this direction. Thus an important and serious rival to the present day petrol engine for motor vehicles has entered the market.

As stated before, the Heavy Oil Engine, as now developed with solid injection, can not only run on much cheaper fuel, but is also much more economical in consumption.

## GENERAL WORKING PRINCIPLE OF HEAVY OIL ENGINES.

The Heavy Oil Engine is a machine with compression ignition and can be built on the 2 or 4 stroke principle. The Saurer Heavy Oil Engine is built on the 4 stroke principle.

Many systems are employed to achieve thorough dispersion of the fuel as this is essential. Some engines have been built for air blast injection whereby very highly compressed air, carrying the fuel with it, is injected into the cylinders, and the high speed of the air creates the necessary dispersion of the fuel within the compression chamber. To obtain this high pressure a special heavy air compressor is required. For Heavy Oil Engines used with road vehicles the air blast injection principle can hardly be employed owing to the great weight of the necessary air compressor and the machine in general.

On other types of Heavy Oil Engines the fuel is injected directly, under very high pressures ranging from 3,500—7,000 lbs. per square inch, through very fine holes into a specially shaped compression chamber. This fuel spray must have a very high kinetic energy in order to penetrate as deep as possible into the compressed air.

The distribution of the fuel is often assisted by a specially designed compression chamber for creating turbulence.

The difficulties of obtaining and the dangers attaching to, such high pressures, were the great drawbacks to the employment of this principle for road transport engines.

With another type of engine, a different system of fuel injection is employed. In this the fuel is injected under comparatively low pressure into a so-called pre-combustion or ante-chamber. As this inner space is part of the compression chamber only a small part of the injected fuel will find the necessary quantity of air required for its ignition, therefore causing pre-combustion, which in turn will create a certain pressure increase.

The influence of this pressure increase is such that the fuel is driven out of the ante-chamber through specially arranged holes into the compression chamber. These engines are known as ante or pre-ignition chamber engines and work on the straight flow principle.

Another new principle investigated during recent years (the return flow principle) has resulted in the development of the air storage or turbulence chamber machine (Acro-Engine).

Tests made by Saurers, extending over many years, proved this system to be the most advantageous for engines in road vehicles. The Saurer Heavy Oil Engine has been developed on this principle with the air or turbulence chamber situated in the cylinder-head. (On the original Acro-Engine this chamber was situated in the top of the piston).

## COMPARISONS BETWEEN HEAVY OIL AND PETROL ENGINES.

The working principle of the ordinary petrol engine is known to the greater part of the motoring world, but it will, doubtless, be helpful to draw comparisons between them and the Heavy Oil Engine, in order to appreciate the pros and cons of the two types.

It is well known that on the down stroke of the piston of a petrol engine a mixture of petrol and air is drawn into the cylinder from the carburetter. With the down stroke in a Heavy Oil Engine pure air only is drawn into the cylinder. With the up-stroke on both engines the contents of the cylinders are compressed.

Owing to the air in the petrol engine cylinder containing petrol gasses, this mixture can only be compressed to a certain limit if pre and self ignition are to be avoided.

When the piston reaches top dead centre the petrol mixture is ignited through the medium of an electric spark, which is produced by the magneto and discharged through the sparking plug.

With the Heavy Oil Engine however, the air drawn into the cylinder does not contain any fuel or fuel gasses. The air can therefore, with the upward stroke, be compressed to any degree desired. Fuel is injected in a very fine spray at high pressure through an injector, shortly before the piston reaches top dead centre.

With the compression of air, heat is generated which increases with the height of the pressure. This compressed hot air then heats the fuel injected until ultimate ignition occurs. Combustion therefore occurs without the aid of an electric spark to ignite the charge. The injection moment is so timed that when the mixture begins to burn the piston has just passed top dead centre.

From the foregoing explanation it can be seen that neither sparking plugs, magneto, nor carburetter is required for the Heavy Oil Engine. In place of these apparatus a special fuel injection pump together with injectors is employed. To create by compression, the high air temperature required to ignite the injected fuel, the compression space in the Heavy Oil Engine is naturally much smaller than in the petrol engine. The compression ratio of the former engine is 1 :15 as against an average ratio of 1 :4.5 for the latter.

It is necessary for the compression of the air in a Heavy Oil Engine to reach such a high degree that the temperature is considerably higher than the ignition temperature of the fuel oil. The ignition temperature of the principal fuel oils used with the Heavy Oil Engines lie between 300°-350° C. (575°-665° F.)

Owing to combustion in the Heavy Oil Engine taking place under much higher pressures (greater efficiency) the fuel consumption is considerably less than on a corresponding petrol engine. The high efficiency of the former type is also maintained over a greater range of load variation. As a motor vehicle has to work under constantly varying loads the employment of a Heavy Oil Engine will result in considerably greater economy in fuel consumption.

## WORKING DESCRIPTION OF THE SAURER, TYPE BLD, HEAVY OIL ENGINE.

Owing to the high pressures under which the Heavy Oil Engine has to work, which tend to cause a certain roughness in running, it has been decided, (and found to be a great advantage) to use a 6-cylinder engine. With such an engine much smoother running is obtained owing to the better distribution of explosion impulses, giving also a more constant torque, which would not be possible in a 4-cylinder engine.

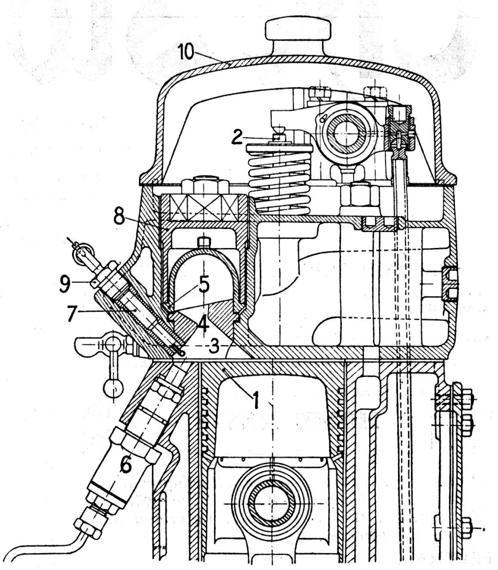


**FIG. 1.**
**Section through Armstrong-Saurer Engine, Cylinder upper part.**

Figure 1 shows a section of the upper cylinder half of the Saurer, type BLD, Heavy Oil Engine. Referring to this figure the working, during one complete cycle, is as follows:—

With the down stroke of the piston (1) air is drawn into the cylinder through the inlet valve (2). With the upward stroke the air is compressed. Approaching top dead centre the piston comes to within one-sixteenth of an inch of the top of the cylinder.

The air in the cylinder is thereby driven, under intensive force, from the cylinder through the venturi hole(4) into the air chamber (5).

The air speed in the venturi hole rapidly increases with the aproach of the piston towards top dead centre, and reaches its maximum shortly before. At this moment *i.e.* 10°-12° (crank angle) before top dead centre, the fuel injection begins at the injector. (6).

The injection of the fuel takes place in the direction of the venturi hole, and the air passing this at high speed carries with it the fuel and at the same time both become thoroughly mixed.

By striking the hot air the fuel mixture becomes heated over its flame point and ignites. The piston in the meantime having passed top dead centre, is moving downwards.

Simultaneously the direction of the air flow has been reversed and same flows out of the air chamber (5) through the venturi hole (4) into the cylinder. Ignition of the fuel having already taken place and with combustion thus prepared, the actual burning of the mixture continues immediately below the venturi hole (3). With the further downward movement of the piston more air flows from the air chamber into the burning zone and fuel which is still being injected finds here the air necessary for its combustion.

From the foregoing it can be seen that no special cooling is required for the air chamber, because the combustion takes place outside same. The temperature of this chamber never exceeds 400°C (750°F) whilst the combustion temperature reaches about 1700°C (3120°F).

As the whole combustion takes place under rapidly moving currents, every particle of the fuel finds the necessary air for burning, thus ensuring complete combustion, and the emition of invisible and odourless exhaust gases at lower temperatures than that from a petrol engine.

The air currents which flow into the cylinder vary according to the speed (number of revs: per minute) of the engine. The air supply or return flow, from the air or mixing chamber, and the speed of combustion, therefore, also vary with the engine speed. In other words, the air supply and combustion adapt themselves automatically to the speed of the engine. As an automobile engine has to work under great variations of speed and load it is naturally very important that the combustion adapts itself easily to all these varying conditions.

The requirements for the regulation of automatic combustion are well provided by this air storage, or mixing chamber principle as employed on the Saurer Heavy Oil Engine. The pressure increases during combustion and remains within reasonable limits, thus ensuring smooth running of the engine.

The compression pressure obtained on a Saurer Heavy Oil Engine is approx: 30 atmospheres (450 lbs. per square inch). The temperature reached at the end of the compression is in the neighbourhood of 550°C (930°F), this is ample to ignite the fuel oil, the ignition point of which is about 300°-350°C. (575°-665°F.) With the normal setting of the injection moment the pressure during combustion increases to approx: 36-40 atmospheres (530-590 lbs. per sq. inch). The gasses in the cylinder expand and drive the piston downwards (power stroke) and shortly before it reaches bottom dead centre the exhaust valve opens and part of the burnt gas escapes into the atmosphere. The remainder is driven out of the cylinder with the next upwards stroke of the piston, during which the exhaust valve is open.

In order to realise the importance of the various working factors, and the accuracy required for the fuel supply, an example is given below.

A 6-cylinder Heavy Oil Engine, running at a speed of 1,600 r.p.m. and giving an output of 83 H.P. would have, at that speed and output a fuel consumption of 240 grammes per H.P. hour. The consumption per hour therefore would amount to 20,000 grammes (20 kilogrammes approx:) of fuel oil, while the amount of fuel required per second would be 5.55 grammes. At the above speed (1,600 r.p.m.) the number of revs. per second would be 26.7, and as the engine works on the 4-stroke principle 80 explosions or combustions would take place in that time.

During one complete working cycle under full load (83H.P.) only approx: 7/100th's of a gramme of fuel is injected; with an output of 20 H.P. only, the injected quantity becomes much smaller, approx: 2/100th's of a gramme. The quantity of 7/100th's of a gramme, mentioned in the first case, corresponds to a ball of approx: 5.3 m/m. in diameter. This small fuel quantity has to be injected during approx: 30° of the crank movement when running under full load. The time therefore allowed for the injection of this quantity under full load (83 H.P.) and (1,600 r.p.m.) is 1/320th part of a second; at 20H.P. output 1/960th part of a second.

The precision with which all these functions have to be performed will be well realised after the following further explanation.

The small oil quantities as mentioned above have to be injected at a very definite moment, neither too late nor too early; this injection moment must be kept accurate, and the same on all six cylinders. Variation of the injection moment of only 2° (crank angle), would be felt in the running of the engine: *i.e.* at an engine speed of 1,600 r.p.m. the injection moment must not vary more than 1/4,800th part of a second early or late.

## THE STARTING OF THE SAURER HEAVY OIL ENGINE.

As already mentioned, the air in the cylinder is compressed to approx: 450 lbs. per sq. inch, by which, under the normal conditions, the air is heated far above the ignition temperature of the fuel oil.

With such a high compression it is naturally not possible to start the engine by hand. A powerful electric starter therefore is employed to turn the engine at a speed of 150-200 r.p.m.

As the cylinder walls, pistons, air chambers, etc., are cold when starting the engine the first time, much heat generated during the compression stroke is absorbed by these cold parts. Further as the necessary temperature for ignition of the charge is not reached during the first few revolutions, the engine cannot start after only the first few turns.

To ensure a definite start, and to save the starter and batteries from wear and over-load, special electrical glow-plugs (7) figure 1, are employed on the Saurer Heavy Oil Engine. The wire coils at the end of these plugs are in the neighbourhood of the passing fuel spray, and are fed from the special 2 volt battery, which brings them to a glowing heat. A few drops of the passing fuel spray reach the glowing coil, ignite, and commence combustion. With this arrangement the engine will start readily from cold after the first few turns.

## CONSTRUCTIONAL DETAILS OF THE SAURER HEAVY OIL ENGINE. TYPE BLD.

1. *Crankcase and Cylinders.* The crankcase is of special cast iron, in one unit with the cylinders and is three point suspended on rubber sleeves in the chassis.

The rigid construction of the crankcase and cylinder unit, eliminates transversee distortion.

Such a unit casting avoids the employment of many bolts and nuts, especially the inaccessible ones so often found on bolted units. The enormous strength also obtained by this form of construction ensures the unit withstanding usage under very severe conditions.

The bores of the cylinders are fitted with liners the replacement of which is a simple operation when necessary after wear. By this means the cost of over-size pistons, re-grinding of cylinders, etc., is eliminated.

The cylinder head which is detachable and free from all complications, carries the valves and part of the valve gear. This form of construction permits the combustion chamber being machined, thus ensuring uniform compression in all cylinders.

2. *Crankshaft.* The crankshaft is of unique type, a product of most excellent and accurate workmanship; it consists of 7 single sections which are bolted together. The ends of the sections are flange shaped, and carry the main roller bearings. The wide flanges ensure perfect rigidity when bolted together. This is further assisted by the flange faces being ground together, giving a most perfect face contact. By this construction each crankshaft section can be perfectly heat-treated and case-hardened. The case-hardened crank-pin naturally has a considerably longer life than the ordinary pin of a shaft which is in one single piece and does not therefore allow such perfect heat-treatment without considerable distortion. The complete crankshaft is carried on 7 large main roller bearings, thus eliminating crankshaft whip. The mounting of the crankshaft is quite a simple operation. The crankshaft is drilled throughout its length, the passage serving as an oil channel for feeding all the bearings. This channel is of ample size, thus reducing to a minimum the possibility of blockage.

3. *Camshaft.* The camshaft is situated in the crankcase, and runs in a separate housing, fully immersed in oil. It is mounted on 7 bearings, the front one is a ball-bearing and the others slain bearings. It is made in one piece and is fitted with a balancing cam. The function of the latter is to equalise the reactions from the cams, thus ensuring a driving pressure in one direction only, and avoiding shocks and back lash which would otherwise be transmitted to the timing wheels and thus cause much noise and wear.

4. *Connecting Rods.* These are of high quality material and machined all over to ensure correct balance. They have been made as long as is practicable in order to reduce side pressure of the pistons on the cylinder walls. The big end bearings are lined with anti-frictional metal and are of generous proportion. The same applies also to the size of the small ends.

5. *Pistons.* A special alloy has been chosen for the pistons. Owing to the greater working pressures existing in the Heavy Oil Engine, a greater side pressure of the pistons on the cylinder walls naturally results. In order to distribute this side pressure over a larger area and at the same time maintain high efficiency, also reduce wear, the pistons have been made exceptionally long but are kept within reasonable weight limits. This permits of higher revolutions from the engine, whilst still retaining a sufficient factor of safety 6 pistons rings are fitted. The gudgeon pin, which is of a very large size, is of the fully floating type.

6. *Air Intake.* This is through a collective induction pipe and efficient air filter. The air supply remains constantly open as no valves or shutters are employed.

7. *Air Chambers and Adapters for Venturi Holes.* As shown in figure 1, the air chamber (5) is situated on the side of each cylinder, while below is a special adapter with venturi hole. Both are held in position by a cap screw (8) and copper washers under the contact faces ensure an air tight joint.

The cap screw is specially shaped to prevent heat losses. These units (on the side of the cylinders) are protected by an easily detachable cover (10) which also encloses the valve gear.

8. *Electrical Glow-Plugs.* These plugs, which are only used to assist starting the engine from cold, are fixed to the side of the cylinder by means of the nipple (9).

One plug is employed per cylinder and all 6 are connected by a thick wire; by means of which they are switched in parallel.

9. *Injectors.* As shows in figure 1, the injector (one per cylinder) is situated below the air chamber and is set at such an angle that injection of the fuel is in the direction of the air current set up in the cylinder during the compression stroke.

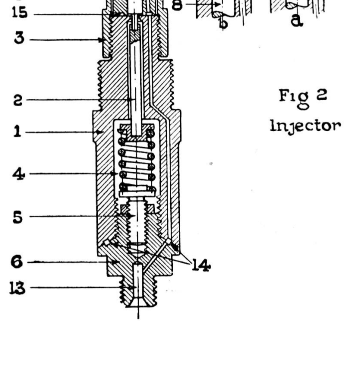


Fig 2
Injector

The injectors are of the Bosch type (details in figure 2) and consist principally of the injector body and the nozzle. The latter is held on the body by the nozzle securing nut (3) thus facilitating exchange..

The injector body (1), is drilled throughout its length and inside is the pressure needle (2), and the necessary spring (4). The spring tension is varied by the adjusting screw (5); alteration of this screw will naturally vary the injection pressure.

The inlet connection (6) on the top of the injector body, leads the oil through the body towards the nozzle valve.

The lower end of the body and its nozzle cap (7) have been ground to fine limits. By means of the securing nut (3) the nozzle cap makes contact with the body, no packing material being necessary between the faces.

The actual nozzle consists of valve body (7) and the valve (8). The latter carries a small cylindrical extension (11) which fits into the valve body in the closed position of the nozzle, figure 2, position (a). In this position the seat (12) of the valve is in contact with the valve body, the whole being held in this position by the spring (4). The nozzle valve is constructed as a differential piston.

The fuel oil entering through pipe 13 is led through a drilled nipple (6) towards the ring grooves (14) existing in the nipple (6) as well as the injector body (1). From these top ring grooves the oil is further led through the holes in the injector body towards the lower ring grooves (15) of the nozzle valve body (7). Thence from there through three holes into the small chamber (9). The fuel oil when under pressure acts on the differential surface of the nozzle valve causing same to lift.

Simultaneously the little plunger of the nozzle valve is withdrawn allowing the oil to escape into the cylinder, figure 2, position (b). Owing to the sharp edges on the nozzle end the oil spray is partially broken into small particles. The opening of the small nozzle end increases or decreases, according to the speed of the engine, whilst the pressure remains the same under all conditions.

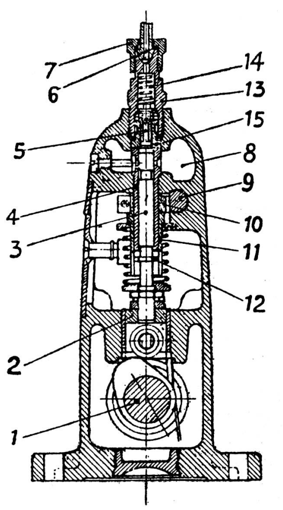


**FIG. 3.**
**Section through complete Injector Pump.**

10. *The Injector Pump.* The injector pump, situated on the offside of the engine, is driven through a special reduction gear.

The injector pump is of the Bosch type, figure 3, shows a sectional view.

The pump is of the plunger type, the number of plungers corresponding to that of engine cylinders. Figure 3 shows a sectional view of one of the pump units.

The camshaft (1) has six cams which are offset to each other by 60°. Each cam operates a plunger (12) over each of which a pump unit is fitted. Each pump unit consists of a piston (3) and a cylinder (4).

A spring loaded pressure valve (5) is situated in the top of each cylinder. The oil pipes (6) leading to the injectors are held on the body of the pressure valve by a retaining nut (7).

The suction chamber is situated in the upper part of the pump housing. Fuel is brought into the suction chamber (8) by a small electrical autopulse pump, which first passes the fuel through an efficient filter.

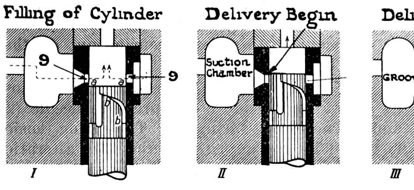


Fig 4

Fuel Injection Pump

**Enlarged upper part.**

Reference to figure 4 with the piston at its lowest position, shows the suction chamber is connected with the compression chamber through the holes (9) in the cylinder. The stroke of the piston remains the same for all speeds. The top part of the piston is shaped to act as a regulator. The top edge of the piston (a), regulates the pressure or delivery begin, whilst the spiral edge (b) regulates the pressure or delivery end.

A special sleeve (11), carrying a toothed sector, is fitted over each cylinder. This toothed sector engages into the toothed rack (9), figure 3. The special sleeve has two slots at its lower end in which the cross piece (12) on the piston (3) slides up and down. Thus by the movement of the toothed rack or regulating plunger (9), the pistons are turned round on their axis. By this means the spiral edge on the top of the piston is brought earlier or later opposite the holes (9) which are in communication with the suction chamber. This fuel oil pump piston therefore itself regulates the quantities of fuel injected. The action of the pump is as follows :

Figure 4 shows the piston positions for maximum delivery; on the left the piston is at the bottom of its stroke, and on the right at the top (delivery finish). In its lowest position the holes (9) are uncovered by the piston thus allowing the fuel oil to enter the cylinder from the suction chamber. With the upstroke of the piston a small quantity of fuel oil is pressed back into the suction chamber until the top edge (2) of the piston reaches the top edge of the holes (9). From this moment the pressure begins, causing the valve (5) to lift, and deliver the fuel to the injectors. This position therefore, is the pressure or delivery start.

As already stated the delivery end is regulated by the spiral edge of the piston. As soon as this edge passes the hole on the right the cylinder is in communication with the suction chamber and the oil is thus released into the latter. By turning the piston the fuel quantity to be injected can thus be varied as required.

The pressure valve (5) has a hollow body ending in a cylindrical part and is held on its seat by the spring (14). On the upstroke of the piston the valve is lifted from its seat permitting the fuel to pass into the fuel line. During the pump stroke it continues to float under the equal pressure in the pump cylinder and in the fuel line.

When the pump cuts off, (spiral edge comes opposite hole on right) the pressure in the cylinder is instantaneously reduced so that the pressure in the fuel line returns the valve to its seat. By this means the volume in the fuel line is increased by the amount corresponding to the displacement of the cylindrical portion of the pressure valve. This small increase in the volume of the fuel line is sufficient to reduce the pressure in the latter practically to zero, so that the nozzle valve closes immediately, preventing any fuel dripping.

*Fuel Filter.* Most fuel oils frequently contain an amount of grit and other foreign particles which if allowed to reach the injector pump may cause blockage of the fine oil passages and premature wear of the pump and its working parts. An efficient filter is therefore necessary when filling the fuel tank, but this alone is not sufficient and an additional filter is needed. This is mounted on the engine side of the dashboard, and is easily dismantled for cleaning. The filter is not only capable of segregating grit but also water and air. The importance of separating air bubbles from the fuel will be realised when the precision with which the injector pump and the injectors have to work is taken into consideration.

Owing to the movement of the fuel in the tank, air bubbles will constantly be created. The expulsion of these, before the fuel reaches the injector pump, is essential to the maintenance of regular, smooth, and smokeless running.

*Cooling.* The cooling of the engine is, in principle, the same as on a petrol engine, *i.e.*, through the radiator, fan, and water pump.

Owing to the greater thermal efficiency of the Heavy Oil Engine less heat is given off from the cylinders to the cooling water.

It has been found a great advantage to keep the cooling water at a constant temperature of 70°-80°C. (160°-180°F.). A thermostat therefore is introduced into the cooling system for this purpose.

*Controls.* The control of the injection quantity is regulated through the plunger (9) figure 3, described in paragraph 9. The movement of this regulating plunger is restricted by a special blocking ring which allows for just the necessary quantity of fuel to be supplied to give full engine output and smokeless exhaust.

The regulating plunger is connected to the governor through links, which are in turn connected to the accelerator pedal and the throttle control lever on top of the steering column. This regulating plunger can be compared with the throttle valve in the carburetter of a petrol engine.

The timing of the injection moment is variable by the small hand lever on top of the steering column. The injection moment can thus instantly be set to suit the particular fuel oil used, and the load under which the engine has to work.

**FUEL.**

Having extended largely on design and construction of the Heavy Oil Engine, I am sure you will now be greatly interested to know the types of Oils which can be used on these high-speed direct injection engines.

Oils which have been actually tried out were, Gas Oils, various distillates of Crude Oils, Paraffin Base, Naphthalic Base and Aromatic Base. Certain tar oils have also been tried, and oils from coal (low temperature carbonisation), and finally even vegetable oils. All these oils gave, naturally, various results in the running of the engine.

Fuel of the following characteristics will be found most suitable.

*Fuel Specification as recommended for Armstrong-Saurer Heavy Oil Engines.*

Name : Mineral gas oil.
Use : For Semi Diesel Engines.
Colour : Brown.
Viscosity : Max. 2° Engler by 20° C.
Flash point : Approx. 60° - 70° C. (Pensky-Martins).
Ignition temperature : (With oxygen at 1 atm.) Not to be over 350° C. (In winter it is recommended not to be over 320° C.)
Freezing point : The oil should still be fluid at 5° C. No decomposition should occur.
Calorific value : Upper 10,600 cal. Lower 9,900 cal.
Residue : None.
Specific Gravity : Over 0.84 and under 0.9.
Asphalte contents : None.
Ash contents : None.
Water contents : Max. 1%.
Sulpher contents : Max. 2%.
Distillation : Start at 200° C. when reaching 350° C. 75% of the fuel should be distilled.
Solubility : The fuel should dissolve in normal benzine.

In order to improve the running of the engine with certain oils, tests were made by doping the oils with various dopes, such as Ethyl Nitrate and Amyl Nitrate. Although a considerable range of various oils can be burnt in these heavy oil engines, enormous different devices become necessary to ensure perfect atomisation of these oils, and hundreds of patents are in existence for this purpose; but, it is believed by now that we have come to the limit of achieving complete atomisation by mechanical means, and it will be the chemist who will have to enter the field to find out methods of treatment of oils to make them suitable to run successfully with the existing mechanical devices.

**GENERAL ADVANTAGES OF THE HEAVY OIL ENGINE OVER THE PETROL ENGINE.**

(1) Forty to fifty per cent. lower consumption—*i.e.*, more miles per gallon.

(2) Low price of the Fuel Oil. 3½d. per Gallon *In Bulk.*

(3) Higher thermal efficiency, thirty to thirty-five per cent., as against twenty to twenty-five per cent. of the petrol engine—thus less waste.

It is also a fact that the heat loss in radiator water on a heavy oil engine, is only thirty to thirty-five per cent., as against heat losses on the petrol engine, of forty-five to fifty-five per cent.

(4) Much less fire and explosion danger.

(5) Owing to the danger of fire of these fuels being much less, storage arrangements can be simpler and, therefore, much cheaper.

(6) The exhaust gasses do not contain any poisonous gases, such as the deadly carbon-monoxide, which occurs with petrol engines and which has been responsible for so many death.

(7) *Better Starting* : It is possible after the first few revs. of the engine to engage the gears and drive away. No necesity of warming up as in the case of a petrol engine.

(8) *Less Maintenance* : It has been definitely established that the maintenance of a heavy oil engine is considerably less, in fact, in the computation of running costs, this is definitely taken as being between ten to twenty per cent. less than that of a petrol engine.

Combining the low fuel consumption and the low price of same, the actual saving in the fuel costs for running a vehicle with a heavy oil engine, as against a petrol engine, is seventy-five to eighty per cent. There is little wonder that the heavy oil engine has been readily adopted by many large firms, keen on having up-to-date transport ; and, in fact, the heavy oil engine Chassis turned out from the Saurer Factories number already over 1,350, and there is no other firm in the world who have turned out the number of vehicles with heavy oil engines as SAURER—a proof that this type of engine has definitely come to stay.

There has been often an argument against this great saving in the fuel of these engines, that the price of the fuel oil would rise if the demand for such oils increases, especially since the output of the oil is controlled by the big Oil and Petrol Combines. Against this, it can be said that, if one-third of all the heavy vehicles in Great Britain (this would occupy all the commercial vehicle factories in this country for some years before such a number of vehicles could be put on the road) would be running on heavy oil, it would increase the already existing consumption of heavy oil in this country by only 3.3 per cent., and this could hardly be a justification for increasing the price.

Another way of looking at the matter (as quoted some time ago by another authority) is that, a motor-engined liner, such as the ss. "AUGUSTUS" consumes daily 27,500 gallons of oil ; whereas a five-ton heavy oil-engined lorry would run 140 miles per day for over nine years on the same quantity. Although as I have said before, already hundreds of heavy oil engine road vehicles running with as good reliability, and with more economical results as the petrol engine of to-day, which took over thirty years to perfect. The venture of the heavy oil engine is still in its infancy, being the beginning of a new epoch of great historical importance. The heavy oil engine will also before long replace the steam engine, especially the steam locomotive. The new modern heavy oil engine for electric traction is so economical in running, that the steam engine cannot, for this very reason, hold its own much longer. The whole world is out at the present time to economise, and the heavy oil engine is one step towards this end to prevent waste.

It is very gratifying to know that SAURER, as a Swiss firm, has been so instrumental in the development of the high-speed heavy oil engine for road transport, and that the high-power heavy oil engine for rail transport has been brought to a perfection by another Swiss pioneer engineering concern, our Confrères, Messrs. Sulzer Brothers, of Winterthur, so that our little country can definitely claim a big share in this new era of great industrial developments that will rival the introduction of such epoch making machines as the Steam engine, Petrol engines and electric generators, etc.

## Inaugural Luncheon given by the Armstrong-Saurer Commercial Vehicles Ltd.

On the occasion of a luncheon given by the Armstrong-Saurer Commercial Vehicles Ltd., at the May Fair Hotel on Thursday, October 29th, an announcement of great importance was made, to the effect that an agreement has been made between the Armstrong Whitworth group of companies and the Société Anonyme Adolph Saurer (Arbon), as a result of which commercial vehicles using heavy oil engines will be manufactured at the Armstrong Whitworth works at Scotswood, Newcastle.

The Chairman, Major-General G. P. Dawnay stated, that no longer were Armstrong Whitworth only makers of armaments. "To-day we are making ploughshares out of swords, and are embarking on a new development for the production of heavy commercial vehicles."

Colonel P. D. Jonides, Chairman of the manufacturing company and Vice-Chairman of the whole of the Armstrong group, said it was hoped that by the launching of a well-tried heavy oil vehicle such as the Armstrong-Saurer, built at Newcastle, work for some thousands of people could be found.

M. Adolph Saurer, the well-known Swiss motor-car engineer and Sir Malcolm Campbell, the world renowned racing motorist, also addressed the luncheon party. Amongst the numerous company was M. M. Golay, Manager of the Swiss Bank Corporation, who is a Director of the Armstrong-Saurer Commercial Vehicles Ltd. The new Armstrong-Saurer commercial chassis are to be seen at the Commercial Transport Motor Show, which opened on Thursday at Olympia. There will be a four-wheel 6 ton chassis, a six-wheeler carrying 12 tons, and a four-wheeler four ton high speed chassis for coaches and fast freight work.