THE SERPOLLET AUTOMOBILE

By Daniel Bellet, Paris

The progress that has been made of recent years in France, in the construction of automobiles, is largely due to the enterprise of M. Serpollet, the well-known French manufacturer. As far back as 1895 we called the attention of our readers to the Serpollet steam cars, as they were built at that comparatively early stage of automobilism.* Since then they have been much improved in every detail, and have achieved great success. The present description applies to the latest types now in use, and which are styled "Gardner-Serpollet Automobiles."

As an illustration of the high speed that can now be obtained from steam-propelled cars, we may mention that, at a recent race for the Rothschild Cup, at Nice, for cars weighing 1,430 to 2,205lbs., carrying at least two passengers, a Serpollet steam car ran a flying kilometre in 29⅘secs., equal to slightly less than 75 miles per hour. Four years ago a Bollée car ran at a speed of 1 kilometre per minute (37½ miles per hour), this rate of speed causing at the time general amazement. Last year a Serpollet car ran a flying kilometre in 35⅘secs., equal to 100⅓ kilometres (62⅓ miles) per hour. A 40 horse-power Jenatzy electric car took 35⅘secs.; and a 40 horse-power Mercédès petroleum car, 35⅘secs., a speed equal to that of the Serpollet car; while a 20 horse-power Darracq car took only 35⅕secs., giving a speed of 64¾ miles per hour.

In a steam car, built for speeds up to seventy-five miles an hour, the most important part is the boiler. As is well known, M. Serpollet introduced some years ago, a type of generator almost instantaneous in its action; it contained a thick serpentine tube, flattened down in such a way that the inside of the tube was reduced to a very narrow slit. The water that flowed in the tube through this narrow slit was rapidly converted into steam, the latter being supplied direct to the motor. This could be considered, for all practicable purposes, an inexplosible boiler; it had withstood pressures up to 2,205, 3,675, and 3,985lbs. per square inch. The steam-producing power was a very high one; thus, for a boiler 405 cubic decimetres (14.305 cubic feet) in capacity, measured from the ash-box to the base of the chimney, the evaporation was .162 kilogramme per cubic decimetre (10lbs. per cubic foot) of the boiler capacity, per hour, for a fuel consumption of 1.215 kilogrammes per square decimetre of grate area (24.6lbs. per square foot) per hour. The boiler, therefore, took up but little space in comparison with its duty, and seemed admirably suited for automobile service, especially as it required no supervision. As originally designed, however, it contained several disadvantages, among which may be mentioned the rapid choking up of the flattened tube, even when using distilled water; the irregularity in the steam pressure; and the too high superheating of the steam.

In order to do away with these disadvantages, while maintaining the characteristic features of his boiler, M. Serpollet has designed a new type, which he now uses on his high-speed cars. This boiler is shown in Figs. 1 to 8, pages 181, 182. The flattened down serpentine tube of the original design has been replaced by three sets of special shaped coils, made of small diameter tubes, fitted one above the other. The arrangement of the upper set of coils is that of a continuous tube, bent as shown in Fig. 1 to form a number of horizontal layers. Fig. 2 shows two such layers placed in position, one above the other. The second, or middle set of coils, is formed of tubes bent as shown in Fig. 3; these tubes are of the same outside diameter as those forming the upper set of coils, but their wall is thicker, and their junction curves smaller in radius. Figs. 4 and 5 show the lower coil; this is of rectangular shape, and is made of tubes of similar section to those of the middle set of coils. The general arrangement of the boiler is shown in Figs. 6 to 8, Figs. 7 and 8 being vertical sections through the centre of the boiler. The arrows show the direction of circulation; water is

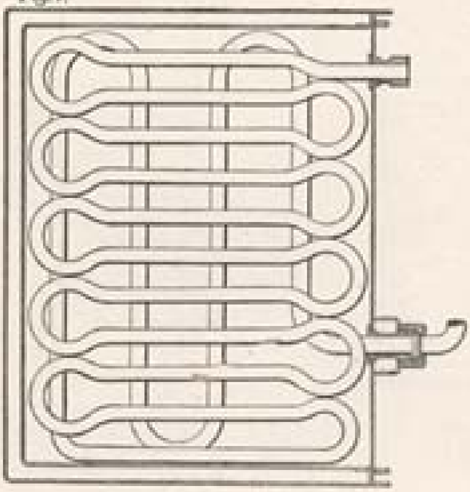
* See *Engineering*, Vol. LX, pages 471 and 499.

supplied from a tank or a feed pump, and enters at *a* (Figs. 6 to 8), at the top part of the upper set of coils; it flows through tube *b*, and is led down through the tube *c* to the lower coil of thick tubes. It enters this coil at *d*, leaves it at *e*, and arrives at *f* in the middle set of coils; it leaves this set at *g*, and rises through pipe *h* to

a manner that, should one get damaged, it could easily be removed for repair. The outside shell is built up of steel plates; the various parts are held together at *w* and *y*, and in order to remove a layer of tubes, the corresponding joints are unscrewed, and plate *x* is lifted off.

The smoke-box is illustrated in Figs. 9 and

Fig. 1.



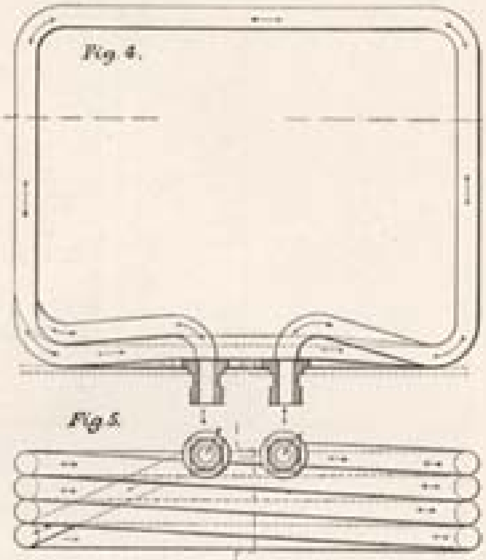


Fig. 4.

Fig. 5.

Fig. 2.

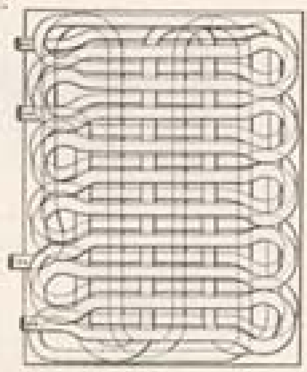
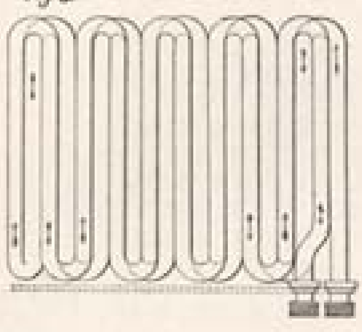


Fig. 3.



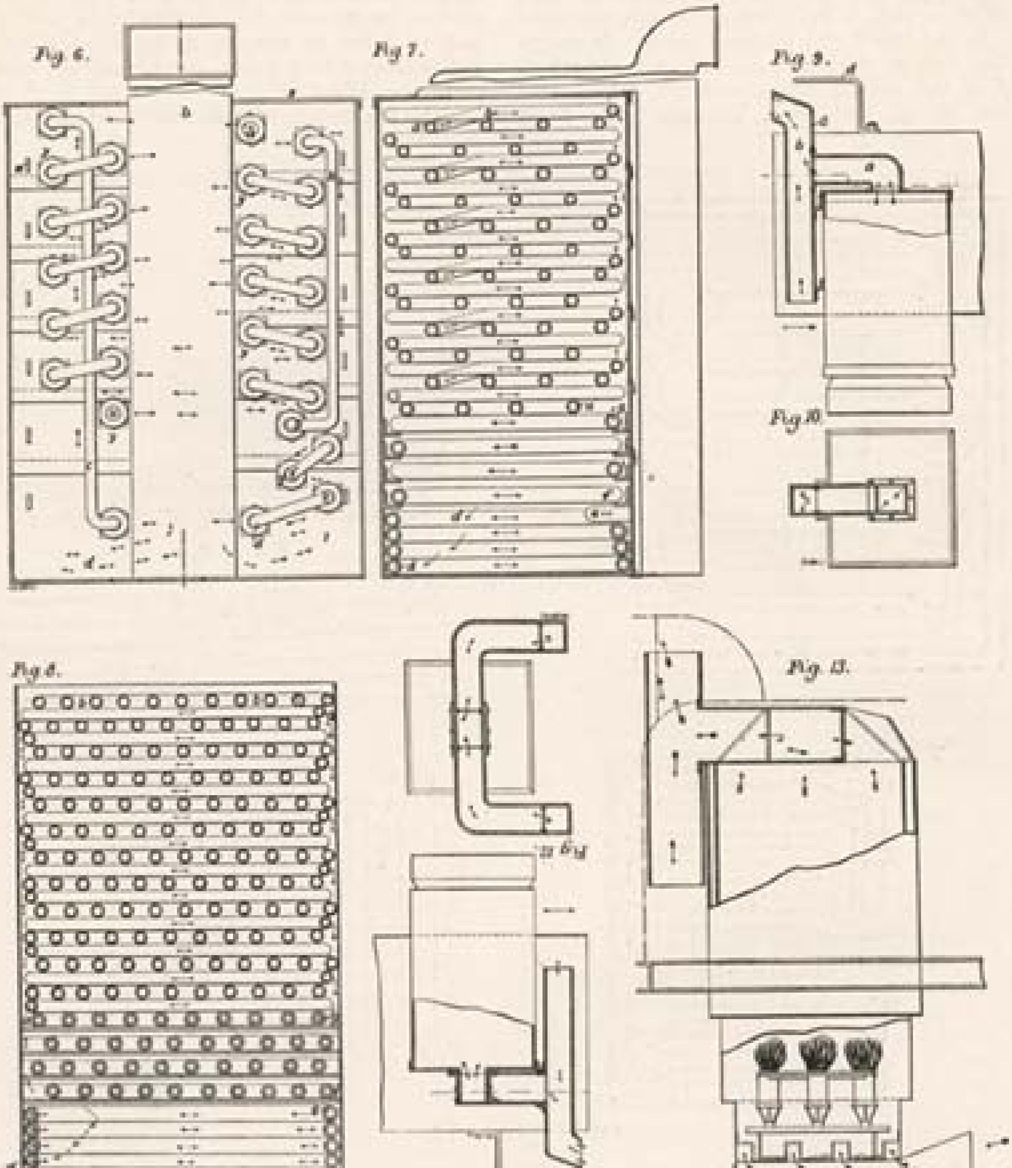
Details of Serpollet Boiler

re-enter the top set of coils, which, as will be remembered, is formed of tubes having a larger internal section. It ultimately leaves this set at *u* as steam.

The layers of tubes forming the coils are grouped together two by two in such

10, page 182. In order to prevent a down draught, a vertical pipe, *b*, square in section, is fitted on the horizontal outlet, *a*. The vertical pipe is open in the rear, at *c*, and is protected by a screen, *d*. An alternative arrangement for the smoke escape is illustrated in Figs.

11 and 12. Fig. 13 shows the air inlet to the burner and the gas escape.



Details of Serpollet Boiler, Furnace, and Smoke Box

Although recent experiments made with alcohol have given good results, the fuel chiefly used is kerosene. This, on being led down to the burners, gets volatilised, the vapour jets burning when coming in contact with the air, in a device similar to that of the Bunsen burner. The heating of the boiler tubes is proportioned to the steam output, and to the supply of feed water to the boiler, and although superheating is always ensured, as well as evaporation, the tubes are never carried to a dangerous temperature.

The frame and mechanical parts are shown in Figs. 14 and 15, Plate XL. The kerosene is contained in the receiver marked P; this is on the forward part of the frame, and under the front seat when the car is built to carry four persons. A certain pressure can be created over the kerosene surface, when required, by acting on the small horizontal pump marked O. The automatic kerosene pump is marked F on Fig. 15, and the automatic water pump, G. These pumps are worked by levers, carefully designed to ensure proper proportion. The starting pump is marked H; it is worked from a lever placed on the right-hand side of the driver, and by which water is injected in the boiler while the car is at a standstill, and pressure given for starting. The boiler S is in the rear. On leaving the boiler, the steam enters the obturator, or steam valve E, which is worked by the foot lever D. The closing of the obturator is absolutely automatic; the action of the foot on the lever allows the steam to flow from the boiler to the motor, and the steam is cut off when the action of the lever ceases. This is important, both with a view to ensure a quick stoppage of the car, and its remaining at a standstill when all the passengers have alighted. It is true that the driver must have his foot constantly on the lever when the car is running, but this he can do without any trouble or fatigue. When in the open country, the steam inlet is allowed to remain fully open by the driver, the changes in the speed being obtained by variations in the feed. For temporary slowing down, in populous districts, for example, the steam admission to the motor can be made to vary by pressing more or less on the foot lever. The brake action can also be combined with the wire-drawing of the steam. The steam passes from the steam valve to the motor M. At the same time it flows, as described further on, through a branch pipe to a needle valve, illustrated in Fig. 16. The exhaust steam from the motor is directed first to a collector, provided with a diaphragm, in which the oil is deposited, and is allowed to run out through a special orifice. The steam then flows to the condenser R (Fig. 14). This consists, according to the power of the engine, of a greater or less number of straight copper tubes. From the condenser, in which the steam is almost completely condensed, it is delivered at the top of the tank marked Q. Before it is used again for feed the condensed water is made to flow through a strainer.

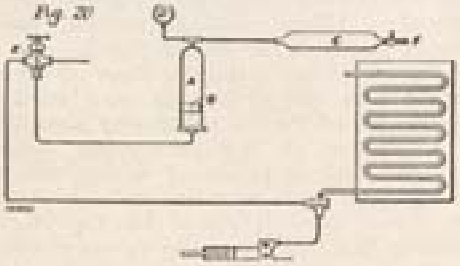
The car is steered by means of the hand wheel A. This acts on the front axle through a system of gearing that ensures smooth and safe working, without any reaction. Underneath the hand wheel are two small handles, one, B, to the right, which works the pump rod to vary the supply of water and of kerosene, and one, C, to the left, which acts as a reversing lever. The hand brake is worked by the lever J, and the rod K. A double-acting brake can also be set by the foot lever N. Lubrication is ensured by a Serpollet lubricator, marked Y, which supplies oil to every part requiring it. The chain-wheel is shown at U; the burners are at V. Pressure gauges show the pressure of the kerosene and of the steam at the steam valve.

Fig. 17, Plate XLI, reproduced from a photograph, shows a Gardner-Serpollet motor. It has four single-acting cylinders, in two opposite groups. The design of the cylinders is that followed for ordinary petroleum motors. One of the main objects aimed at in this construction has been to do away with the stuffing-boxes, as these generally cause a large amount of trouble. In this particular motor the connecting rods are joined direct to the pistons, the tightness of the latter being ensured by four segments. Distribution is effected by valves. These are practically under no wear and tear, as they are not exposed to shocks, the eccentrics that work them following them in the whole of their action and preventing them from falling hard on their seat. The series of eccentrics that work the valves are cut on a shaft. The action on the valves for starting, stopping, or backward running, is obtained by shifting the eccentric shaft laterally by means of a small handle which the driver holds in his left hand. At the dead point the cylindrical portions of the eccentric shaft are in contact with the rollers at the end of the valve rods. To start the motor the eccentric shaft is driven back in one direction, when one valve at least, but generally two, are on admission, while a third, or generally the two remaining ones, are on exhaust. The admission of steam by one valve only is sufficient to start the motor, when the working regulates itself. When running there are always two valves on admission and two on exhaust alternately. If the eccentric shaft has been driven back the other way the action is reversed, and the car is made to run backwards. The whole mechanism runs in oil in a tight casing. The steam distribution device also allows of various degrees of cut-off at will. To obtain this it suffices, when the motor is started, to displace the eccentric shaft laterally more or less, by acting on the small handle above referred to, the eccentrics being set in a way to ensure various degrees of cut-off. The action of the motor is transmitted direct to the rear axle by means of a single chain, protected from mud and dust inside the frame, which joins the motor pinion to the driving wheel of the balance-gear drum. M. Serpollet prefers this system of transmission on account of reduced friction, and believes that to this, among other arrangements, is due the efficiency of his cars, these, although of only 6 and 12 horse-power, working better than many other automobiles of 20 and even 35 horse-power. Thus, at runs made in Austria, September, 1901, on a gradient of 4 in 100, six miles long, a number of 6 horse-power Serpollet cars maintained an average speed of twenty-six miles an hour, giving a much better performance than 12 and 20 horse-power petroleum cars.

One of the characteristic features of the Serpollet car is the proportional feed device, by which the steam production is made to vary to meet constantly the need of the motor without it being necessary to attend to the working of the burners. It will be remembered that variations in the steam production of the Serpollet boiler depend entirely upon variations in the feed of the boiler. The feed pump has a variable stroke, and is connected to a lever worked by a non-continuous cam, formed by the fitting together on a shaft of a series of eccentric discs, which can be displaced to coincide in turn with the roller on the pump lever. The device is shown in Fig. 18, Plate XLI. The disc marked 0 is concentric with the shaft; the one marked 1 is brought out of the centre by 2 millimetres compared with the 0 disc; that marked 2 is out of the centre by 2 millimetres compared with that marked 1, and so on. The stroke, and consequently the output of the water feed pump, increases in proportion with the eccentricity of the disc which comes in contact with the roller on the pump lever. The working is further illustrated in diagram Fig. 19, Plate XL, which shows the discs and various positions taken up by the pump lever. As it is necessary that the heat produced should increase in proportion with the increase in the water supply, the lever also works the kerosene pump, as shown in the diagram. The connecting levers operating the two pumps, and the difference in surface of the two pistons, have been calculated upon the quantity of water that can be practically transformed into superheated steam by a litre of kerosene. The kerosene pump, therefore, delivers to the burners a quantity of liquid fuel which is in constant proportion with the quantity of water injected by the water feed pump. The driver never needs to inquire into the intensity of the flames, as it corresponds always with the required steam production. In Fig. 19 the automatic water feed pump is marked P, and the kerosene pump P1. The respective pump valves are shown at S and S1. The starting pump is shown at *p*; it is worked by the hand lever L, and its valve is marked S2. The eccentric discs are shown at C; the roller and lever above referred to, are marked respectively G and X Y. The arrows in the diagram show the circulation of water and hydrocarbon.

The latter arrives under pressure in tube 2, and is driven to the burners through tube 3; it passes over the burners, and is vaporised. The pressure gauge shows at what pressure it is supplied to the burners. The feed water, according to whether it is delivered by the starting hand pump, or, in normal working, by the automatic pump, passes through a^2 and b^2, or through a^1 and b, after flowing, in both cases, through pipe *a*. It then rises through tube *c* and is delivered partly in the boiler *d d*, and partly, should there be any excess, to the needle valve, K, through pipe *f*. The object of this valve is the following: The water which has been fed in the boiler gets vaporised; most of the steam flows to the motor, but a certain quantity flows also through *h* and *g*, to the lower part of the needle-valve piston. The needle valve, as will be seen, communicates with the water tank, and all excess in the feed water is thus made to flow in the tank. The references in the view (Fig. 16) of the needle valve are the following: P, piston on which the steam pressure acts; the piston is fitted with a rod, T, and is loaded by the antagonistic spring R. The rod T acts on the spindle K, which lifts the spherical valve D. The top part of the valve D is under the pressure of part of the water which comes from the feed pump through the orifice B. The spindle K is fitted with a handle M, within reach of the driver, and the strength of the spring R is so calculated that until the steam pressure reaches a certain limit, the valve D remains in its seat, and all the water from the feed pump enters the boiler. As soon as this limit is reached, the valve D rises and part of the feed water, the overflow, is delivered to the water tank through the pipe E. The pressure in the boiler then gets lowered, the valve D falls back on its seat, and the feed water flows exclusively again to the boiler. When it is required to empty the boiler, the handle M is raised by hand, and all the water in the piping and in the boiler flows to the tank. It occasionally occurred, at first, that the spherical valve did not close hermetically, when part of the feed water always ran to the tank, this meaning a loss of power and the defective working of the system. M. Serpollet has devised a means to obviate this leakage, by placing a two-way cock A (Fig. 16) on the return pipe to the water tank. This shows whether there is a leakage or not, and eventually the valve is inspected and regulated.

Another interesting device which forms part of the mechanism is the auto-starting device, or accumulator, the main object of which is to do away with the working of the hand pump. It would prevent, also, the rapid and untimely emptying of the boiler by the raising of the needle valve, caused by a sudden increase of the boiler pressure, due to the car coming to a standstill, in the congested part of a town, for example. Fig. 20 is a diagram showing the device in question, which consists of a vertical cylinder A, in which travels freely a piston B, covered with oil to prevent the parts under friction from getting oxidised, to facilitate the action of the piston and increase its tightness. The top part of the cylinder is connected to a metallic receiver C, and to a pressure gauge D. The lower part of the cylinder is in communication with the feed, through a stop-cock, E, placed within reach of the driver. The apparatus is charged with air, or carbonic acid gas, through the cock F; it is in working order when the top of the cylinder A, and the receiver C, are filled with air or gas at a pressure of about 300lbs. per square inch. This is arrived



Auto-starting Device

at without difficulty, as carbonic acid gas bottles can readily be obtained, failing which an ordinary automobile air-pump for inflating the tyres would meet the case. The system remains under pressure for weeks at a time. The cock E is open when the car is running; it is closed by the driver every time a stoppage has to exceed a few minutes. The device acts as follows: When it is under the full air or gas pressure, the piston B is at the bottom of the cylinder. The motor can then be started in two different ways. In order to start rapidly, the boiler is filled with water by means of the hand pump, the stop-cock E is opened, and the water pressure is allowed to rise in the boiler to 600lbs. per square inch. This boiler pressure acts on the lower surface of the piston, and drives the latter to the top of the cylinder; the air, or gas, is compressed, its volume is reduced by one half, and its pressure is doubled, giving thus an available reserve of 90 or 180 cubic inches—according as the car is of 6 or 12 horse-power—under a pressure of 600lbs. per square inch. Before starting, the cylinders are warmed by means of the hand pump, and in order not to waste the water from the auto-starting device, the latter is isolated for a time by closing the stop-cock E. On starting with the stop-cock E open, the pressure in the boiler will drop and the piston B will force in the boiler tubes the reserve of water contained in the auto-starting device, thus giving time to the automatic feed pump to ensure the feed in proportion with the steam consumption. The second manner of starting demands no preparation; the operation is carried out as though there were no accumulator; the cylinders are warmed by means of the hand pump; the feed hand lever is opened out full, and the motor starts in the usual way, care being taken to open the stop-cock, E. The accumulator thus gets charged automatically. When running, the feed hand lever is placed at the suitable notch.

The following examples show the important part played by the auto-starting device: When the car is running normally, at a pressure of, say 220lbs. per square inch, and that, by reason of an impediment on the road, it is necessary to slow down, the steam valve is closed by the driver releasing the foot lever, the pressure rising rapidly to, say 440lbs. and 580lbs. per square inch. The piston B (Fig. 20) rises in its cylinder, and gives place to a quantity of water, which increases should the car continue to remain at a standstill.

When the driver comes to a gradient, he charges the accumulator in advance, by letting the boiler feed increase slightly more than is necessary, and by causing the steam to be wire-drawn on its passage through the steam valve. To do this he releases the foot lever slightly. The steam produced not being all used, the steam pressure rises, and the accumulator is charged. The gradient can thus be mounted with a reserve of energy. When the car has to remain at a standstill for any length of time, the device is also made to act in the same way, but in this case the driver closes the stop-cock E before leaving the car, and he feeds the boiler by a few strokes of the hand pump, before using the pressure in the device on opening the stop-cock when resuming the run. When the car has completed its service, and the fires are to be put out, the accumulator is charged to its maximum, and the stop-cock, E, closed.

The lubricator is shown in Figs. 21 and 22. It is worked from the motor or from any part of the car mechanism, and stops therefore when the car is at a standstill. It can be regulated to work under pressures varying from 15lbs. to 375lbs. per square inch. It consists of an oil receiver, which contains the spindle worked by a ratchet wheel; and of a hollow piston, fitted with a cam, in which are cut suction and delivery ports. The flow of oil is regulated, for pressure, by acting on a piston weighted by a spring, the quantity distributed

Fig. 21.

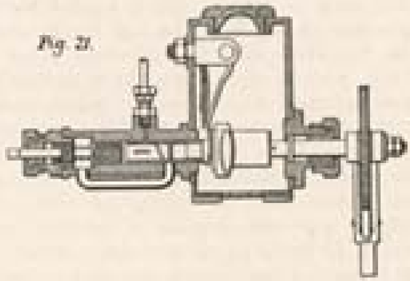
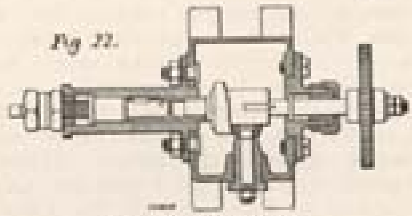


Fig. 22.



Automatic Lubricator

depending, as usual, upon the speed of the ratchet wheel.

A new Serpollet steam car, or one that has been out of use for some time, is started working in the following manner: The burners are first heated for about five minutes by burning a small quantity of alcohol that has been poured round them, and when the pressure over the surface of the kerosene in the kerosene tank has been raised to about 1lb., the hydrocarbon is led down to the burners. No smoke is discharged when the burners have been suitably heated. The driver then takes his seat and presses down the foot lever which works the steam valve, giving a few strokes with the hand pump, to warm the cylinders and start the motor. He continues to feed the boiler with the hand pump until the car has reached a certain speed, by reason of the automatic feed coming into play. The handle which regulates the working of the feed pumps is then placed in the notch corresponding to the rate of speed required. Slowing down, as above mentioned, can be obtained by wire-drawing the steam to the motor; or the steam valve foot lever is released and the brake set. The boiler valve is weighted for a pressure of 375lbs. per square inch; this comparatively low pressure for a Serpollet boiler is due to the caution of the French Government authorities. All the levers and instruments are within easy reach, or within sight, of the driver. When the car is running the pressure in the kerosene receiver is maintained constant—from 1.5lbs. to 3lbs.—by a few strokes of the special pump above referred to, in order to obtain the right utilisation of the fuel. The driver has always to use the hand feed pump sparingly, as it does not deliver water to the boiler in proportion as kerosene is supplied to the burners.

The Serpollet cars are not free from mishaps any more than those of other systems. The burners may work badly; the water feed may be insufficient, and the needle valve may remain open, causing water to flow to the tank; pipe joints may get loose and pump valves fail to act. But all these defects can easily be made good, and as the car is provided with hand as well as automatic feed, a run can always be completed should the automatic device get out of order. The high speed obtained with the Serpollet cars is due to the fact that the amount of steam produced is always that required by the motor; this enables them, as stated, to master steep gradients without difficulty.

As the use of methylated spirits for fuel is gaining ground rapidly every day, the results given by a Serpollet car, the boiler of which was fitted up specially for burning methylated spirits, will be found of interest. The car in question, apart from the boiler, was of the usual type, of 12 horse-power, to seat four persons; but besides the condenser, it carried also a ribbed radiator. With two persons, the average speed works out at 35¾ miles per hour; on a level the speed often reached 52 miles. The total water consumption for a run of 81½ miles was 41.3 pints, showing that the car could run 310 miles without having to renew the feed water supply. The consumption of methylated spirits, including two experiments for lighting the burners, amounted to 96.8 pints. A pint of methylated spirits, costing 1.9d., the cost works out at 2¼d. per mile. With ordinary kerosene, costing 1.7d. per pint, the consumption is 1 pint per mile (1 litre for 3 kilometres), equal, therefore, to 1.7d. per mile. The higher expenditure of methylated spirits is explained by the fact that high racing speeds were maintained.

We illustrate in Figs. 23 and 24, Plate XLII, and in Figs. 25 and 26, Plate XLIII, various views reproduced from photographs, and showing respectively the frame and mechanism of a Serpollet steam car; a Serpollet steam car for long-distance travelling; and the latest type of high-speed Serpollet steam cars.

Fig. 14.

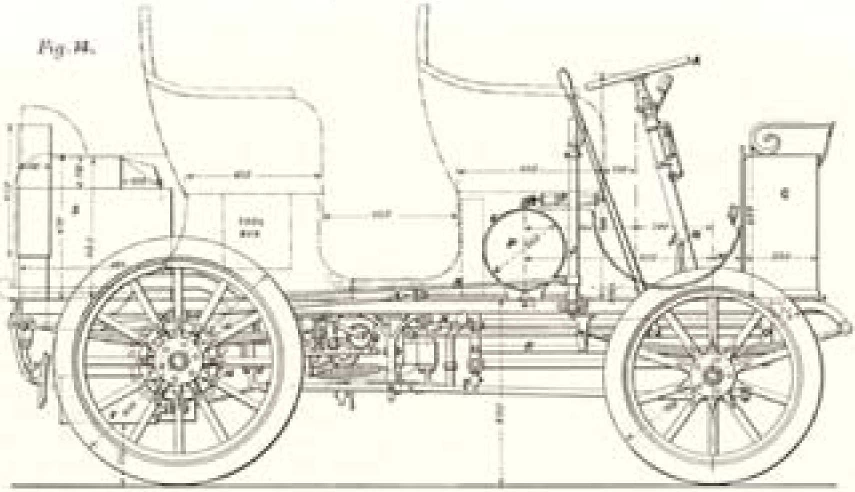
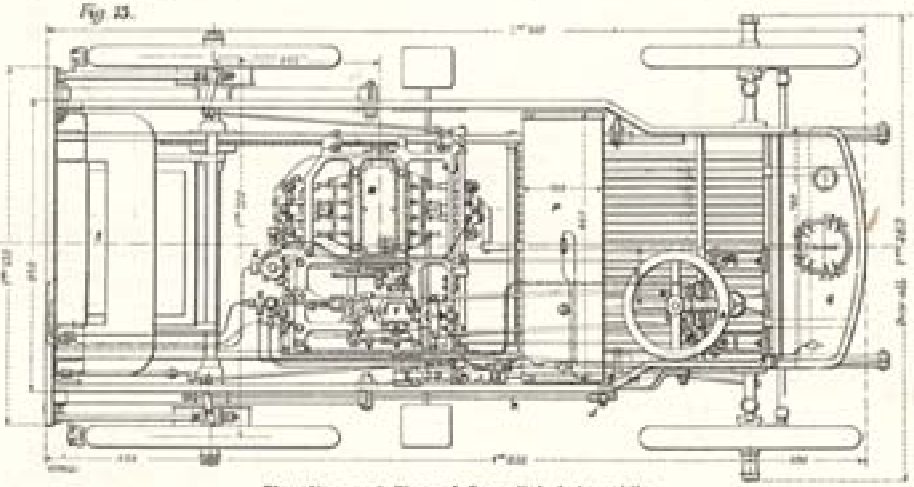
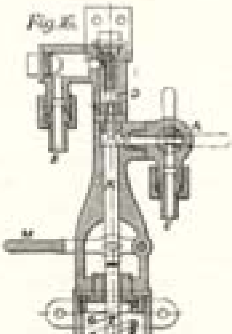


Fig. 13.



Elevation and Plan of Serpollet Automobile

Fig. 16.



Water Relief Valve

Fig. 15.

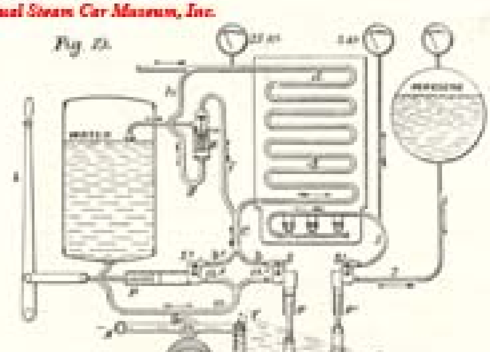


Diagram showing Variable Feed Device

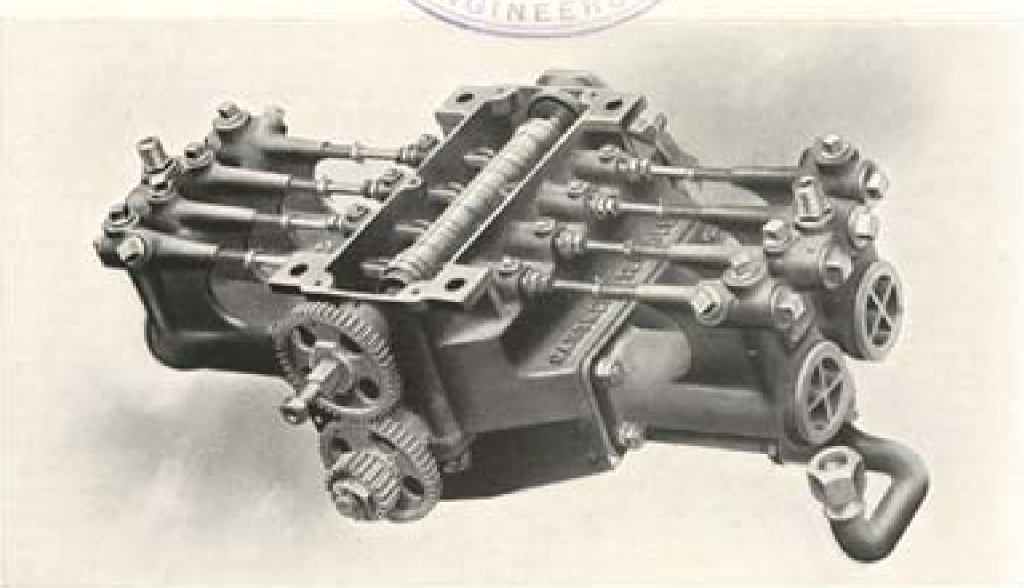


Fig. 17.—The Gardner-Serpollet Steam Motor

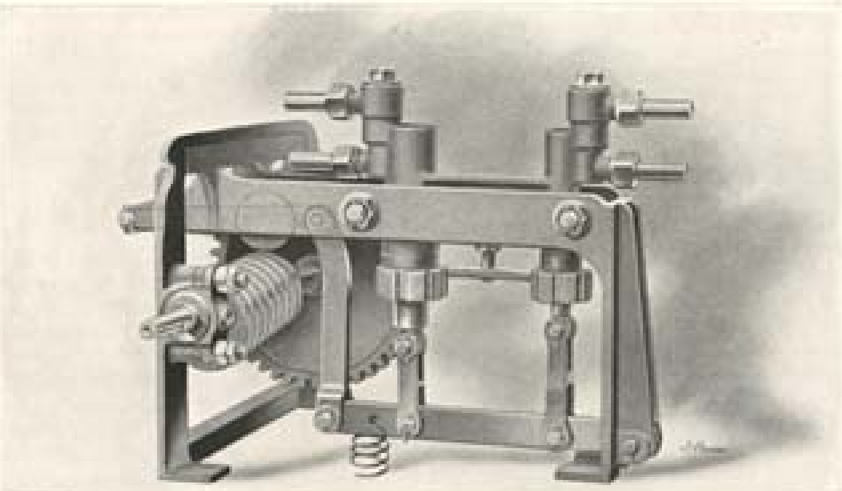


Fig. 18.—Water Feed Regulating Device

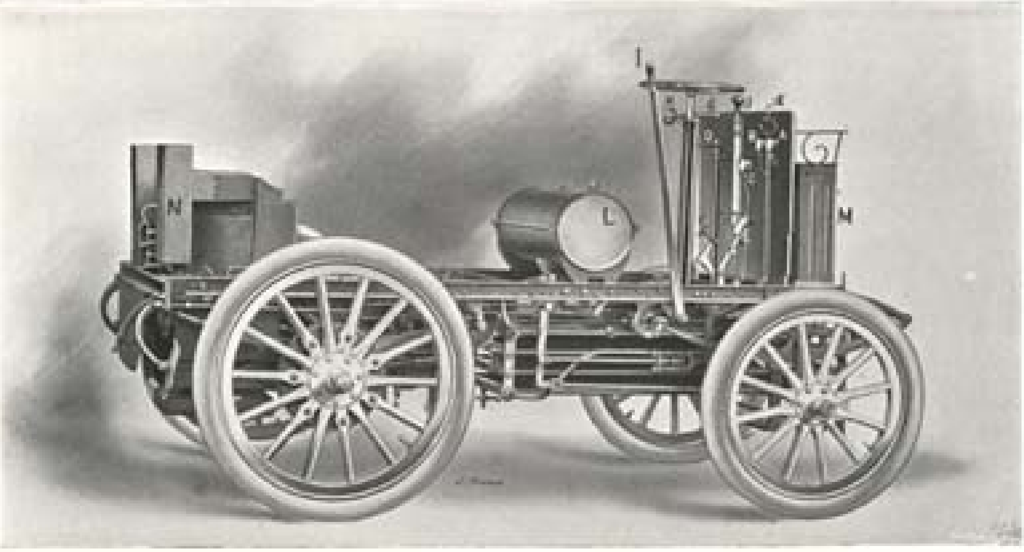


Fig. 23.—Frame and Mechanism of Serpollet Steam Car

Fig. 24.—Serpollet Steam Car, for Long Distance Travelling

Fig. 25.—Serpollet Steam Car, Latest Type

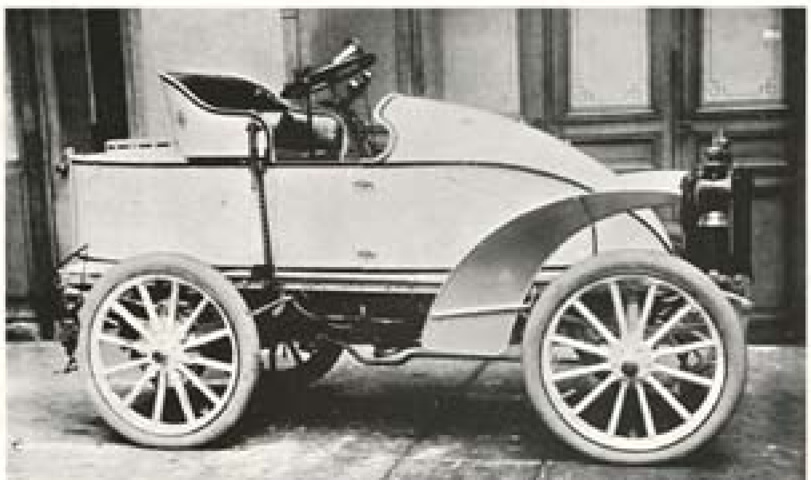


Fig. 26.—High-speed Serpollet Steam Car