The Making of An Automobilist

Grant

THE MAKING OF AN AUTOMOBILIST

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FOREWORD.

The writer feels that he has been most fortunate in securing articles on the following subjects by men recognized in their various lines of manufacture as being the greatest American authorities:—

"AUTOMOBILE MATERIAL AND CONSTRUCTION." By Jonathan D. Maxwell, Vice President and Superintendent, Maxwell-Briscoe Motor Co.

"THE COOLING OF EXPLOSIVE MOTORS." By Frank Briscoe, President Briscoe Manufacturing Co.

"TIRES AND TIRE CONSTRUCTION." By Horace DeLisser, President Ajax Standard Rubber Co.

"THE IMPORTANCE OF OILING AN AUTOMOBILE." By C. W. Kelsey.

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PART I.

INTRODUCTON.

Now that the automobile has proved its worth and has demonstrated that it can be relied upon, there are thousands of business men, doctors, contractors, builders and the like, who are considering the advisability of using it, as well as a large class, who intend purchasing for pleasure only, or pleasure and business combined, but are deterred from doing so by a lack of knowledge of the subject.

An automobile, as is the case of any well designed piece of machinery, requires intelligent care, and the amount of work and enjoyment that can be gotten out of it is wholly in proportion to the attention that it receives.

A locomotive is operated by a trained engineer,—one who knows his engine down to the smallest detail. Yet there are automobile owners who run high powered cars comparatively successfully, but who do not understand the first principles underlying the operation of their engines. They make the occasional neccessary adjustments by blindly following the instructions sent by the manufacturers without knowing what they are doing or why they do it.

This class of owners do not get the full pleasure from their car as they are afraid always lest some conditions arise which are not covered by the instruction book.

To the man who possesses a knowledge of his car comes the full enjoyment of motoring; for he feels himself master of the situation and competent to make adjustments and ordinary repairs, whether it be on the road or in the garage.

It is an evident fact that the simpler a car the less there is to give trouble, and for the average owner, one who does not care to go to the expense of a chauffeur, the two-cylinder horizontal motor located under hood has many points of advantage over the four-cylinder vertical type. Especially is this true in the case of cars of 20 or less horse power.

In locating trouble, the process is largely one of elimination. In fact, he is a good motorist who knows what to let alone.

It is the intention, in this booklet, to go into theory so far as to make clear the principles underlying the operation of a gasoline motor. The rest will be devoted to the general care and maintenance of an automobile, or, in other words, keeping the car in proper tune.

PART I.

CHAPTER I.

TYPES OF AUTOMOBILE ENGINES.

Steam, Electric and Gasoline.

There are at the present time three distinct types of engines in use in automobiles, viz., gasoline, steam, and electric.

A steam engine uses the gasoline as a fuel only to generate steam. The hydro-carbon motor, more commonly known as a gasoline motor, on the other hand, uses gasoline directly in the cylinder and depends upon the principle that air and gasoline vapor when mixed in the right proportions form an explosive mixture. The expansion of the mixture when ignited in the cylinder develops the power that is transmitted to the crank shaft and thence to the rear wheels.

It is evident therefore that the power is more directly applied in this case than in the steam engine, and it is this fact that has led largely to the popularity of the hydro-carbon engine.

The electric motor, although suitable for cities, is useless for touring, relying as it does for power on storage batteries. Its radius is limited by the capacity of the storage cells, and it has been found that they cannot be relied upon for more than forty-five or fifty miles of fairly level roads.

The time then taken to recharge these cells is so great, consuming several hours, during which time the car remains idle, that with the exception of local use the electric vehicle is not practical.

The steam car, while possessing a lower touring radius than the gasoline car, has more to recommend it than the electric vehicle. However, the high pressures that must be carried on this type, together with the numerous packings and gaskets that are employed, keep the driver of this kind of car constantly on watch lest some packing blow out, necessitating a roadside repair, or perhaps the service of some farmer's horse.

It must be remembered with reference to steam that all connections between the boiler or the generator and the engine proper must be steam tight at a pressure of several hundred pounds. Even the gasoline tank and all of its connections are subject to a very high pressure, while with a gasoline motor, on the other hand, there is no pressure exerted on any of the connections other than atmospheric, and it is not until the gasoline in vapor form enters the cylinder that a pressure above atmosphere is reached.

The problem of water supply on a steam driven automobile is also a serious one, and, as the tank must be refilled about every thirty miles, the driver is constantly on the lookout for water. As any car will average fifteen miles per hour this means that water must be taken on every two hours.

Trouble is also experienced on windy days by the blowing out of the pilot light.

The cost of operating a steamer is greater than a gasoline machine, as it is not so economical in the use of fuel.

The flash steam generator, as used now to some extent, though reducing the time necessary from the moment of firing until enough steam has been generated to start the car (about seven minutes), cannot be compared in simplicity of operation and economy of time to the operation of cranking; this being all that is necessary to start a gasoline car, no matter how long it may have been standing.

These points, together with simplicity of construction, have made the gasoline car **the automobile par excellence** for general touring.

CHAPTER II.

GASOLINE MOTORS.

The internal combustion motor can be divided into two great classes, viz.: The two and the four cycle motor.

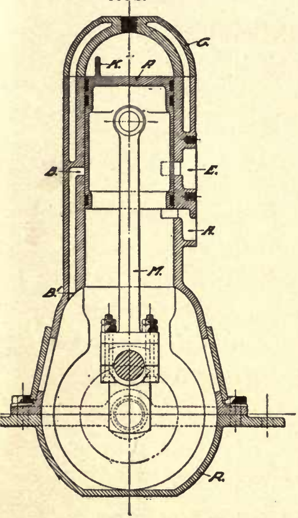
The former type, though used up to the present time largely for small boats and launches, has not gained much popularity among automobile builders, and it is a noticeable fact that the majority of motor boats now employ the four cycle type, as do their land cousins, the automobile.

EXPLANATION OF CYCLE. A cycle as applied to a gasoline motor means the successive series of operations in the cylinder of the motor.

TWO-CYCLE MOTOR. To understand this clearly refer to Fig. 1.

As the piston P moves up, the volume in the crank case becomes greater with a corresponding decrease in pressure, this pressure becoming less than atmosphere, 14.7 lbs. per square inch. An explosive mixture of gases passes through port **A.** When the piston has reached its outer dead center the gases in the crank case and the lower part of the cylinder have again reached atmospheric pressure. Upon the descent of piston **P** the gases in the crank case are forced through passage B—B into the upper part of the cylinder and are compressed into a small volume and ignited at the proper time. The burnt gases after expansion, being above the pressure of the atmosphere, expel themselves

Fig. 1.



The diagram shows a typical two-cycle motor in which

C = Cylinder.
P = Piston.
M = Connecting rod.
A = Inlet port to crank case.
R = Crank case.
B—B' = Inlet port to cylinder.
K = Baffle plate.
E = Exhaust port.

through port **E**, this being uncovered by the downward movement of piston **P**.

The baffle plate **K** prevents the new gases, entering B—B' by deflecting them upward, from mixing with the burnt gases being expelled at **E**.

It is then seen that in this type of motor the processes of expelling the burnt gases and forcing the new charge into the cylinder are performed during the same downward stroke, the exhaust being uncovered first by the piston and allowing the greater part of the burnt gas to escape before the inlet port B—B' is uncovered, the baffle plate preventing the incoming charge from flowing out of the exhaust port.

Hence in a two-cycle motor one impulse is received for each revolution of the fly wheel, while in the four-cycle type two revolutions of the fly wheel are needed for each power stroke.

It would seem then that the two-cycle motor should be capable of higher efficiency than the four cycle. **The reverse is true.** A two-cycle engine operates successfully at low speeds, and at such will show a higher efficiency than the four-cycle type, but on high speed, such as is necessary in an automobile motor, the operation of charging, compressing, firing and exhausting cannot properly be accomplished during one revolution.

Owing to the limited use of the two-cycle motor it will not be considered further.

FOUR-CYCLE MOTOR. As has been seen, a motor of the four-cycle type has one power stroke for each two revolutions of the fly wheel or one impulse for every three dead strokes.

The successive operations are:—

1—Charging the cylinder with an explosive mixture of air and gasoline.

2—The compressing of this charge from 14.7 lbs. per square inch, or atmospheric pressure, to about 70 lbs. per square inch.

3—The firing of the compressed charge by an electric spark.

4—The exhausting of the dead or burnt gases to permit recharging with fresh mixture.

This completes the series of operations, four in number, and constitutes the cycle.

CYLINDERS. Cylinders are made usually of gray iron castings, the jacket and cylinders cast in one piece. It was considered good practice a few years ago to cast the cylinder head and the cylinder separately, the two being then bolted together and the joint made tight by asbestos packing. The difficulty, however, in keeping this tight and the possibility of blowing out the gasket, necessitating a somewhat lengthy repair, has brought the one piece casting into general use.

PISTONS. Pistons are made of cast iron and in automobile construction are of the trunk pattern.

In order that the compressed charge of gases may not leak between the cylinder and the piston, the pis-

FIG. 2.

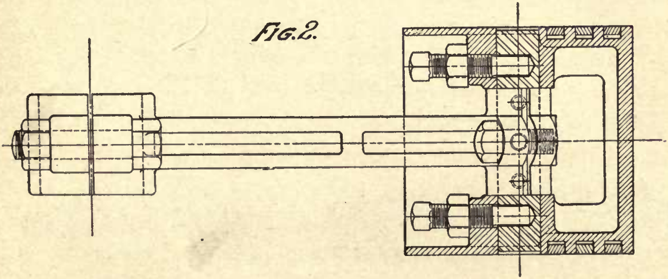


Diagram of piston and connecting rod.

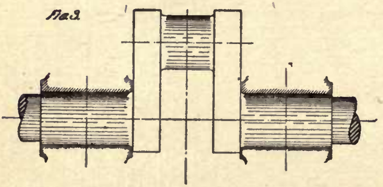
tons are fitted with rings, usually three in number. These piston rings fit in grooves cut into the piston, and spring against the walls of the cylinder. When properly made they afford a gas tight joint.

The importance of having perfect rings can not be overestimated, since if there is a leak between the piston and cylinder the compression will escape with a corresponding loss in power.

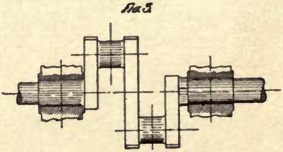
CONNECTING ROD. The connecting rod must be of sufficient strength to withstand the pressure as exerted by the expanding gases on the piston. At normal speed the connecting rod is not subjected to great strains, but under load the strain becomes excessive, while at extremely high speeds the rods are subjected to severe shocks.

CRANK SHAFT. The crank shaft is perhaps one of the most important parts of the gasoline motor. It is subject not only to the thrust due to the explosion in the cylinder but must withstand the momemtum of the piston and the fly wheel. Crank shafts are made of special steel and drop forged.

TYPICAL CRANK SHAFTS.

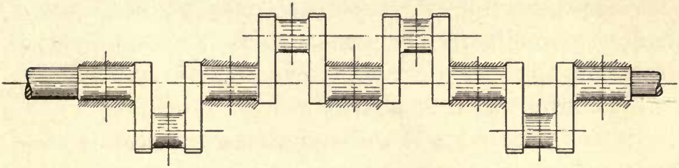


Single cylinder.



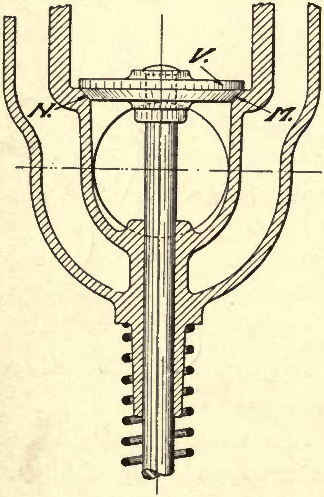
Double cylinder.

FIG. 3.



Four cylinder.

FIG. 4.



VALVE AND VALVE MECHANISM. Diagram of poppet valve and seat.

Valves are made of cast iron or steel and are mounted on a steel stem. In order that they shall open and close correctly, a device is used known as the time gear. Upon a secondary shaft are located the cams that open the valves at the proper time, a spring returning the valves to their seats. Since a valve must open **once in two revolutions**, the secondary shaft must revolve through 180 degrees while the crank shaft turns through 360 degrees. The secondary shaft is known as the **half time shaft.**

It is of importance that the **timing gears, cams, etc., shall be inclosed,** preferably in the crank case, for in this position they receive lubrication from the splash of the cranks.

FIG. 5.

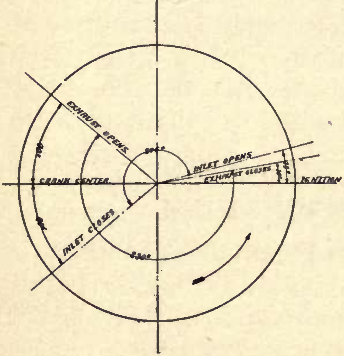


Diagram showing correct valve timing.

While it would seem that the opening and closing of valves should be at dead centres, yet in practice this is not the case, for it is necessary, in order that the fresh charge be not diluted by the dead gases, to rid the cylinders as nearly as possible of the products of combustion from the previous charge. It is best accomplished by opening the exhaust valve while the gases are still under considerable pressure.

It must also be remembered that with an engine running at 1500 R. P. M. the valves will close later on piston stroke than when turning 300 to 600 R. P. M. This is due to the fact that it takes the spring an appreciable length of time to close the valves, and at high speed the valve will lag behind its correct closing time in reference to piston travel.

DIFFERENTIAL. The object of the differential or, as it is sometimes called, the equalizing gear, is to permit one wheel to travel over a greater distance than the other. In turning a corner, the outer wheel must necessarily turn faster than the inner. Hence, it is evident that the two cannot be connected by a rigid axle.

In shaft and single chain-driven cars, the differential is placed on the rear axle, and in the double side chain, the equalizing gear is located on the counter shaft.

Both spur and bevel gear differentials are used, the former being the more popular.

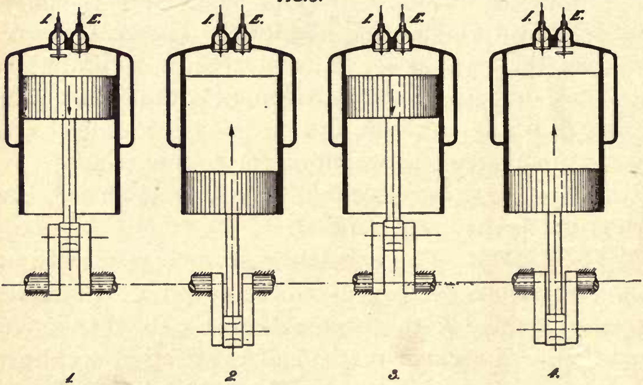
MUFFLERS. The exhaust gases being released at a pressure considerably above atmospheric must be properly muffled if the engine is to be at all quiet in operation. The usual method of muffling is to allow the gases to expand in the muffler through a series of compartments, the charge finally escaping at a pressure slightly above atmospheric and with little or no noise.

MUFFLER CUT-OUTS. Some cars are fitted with a device whereby the gases are exhausted directly into the air without passing through the muffler. This is known as a muffler cut-out and effects a slight saving in power by eliminating back pressure on the motor.

However, as they are exceedingly noisy and make an automobile a nuisance on a public highway, they are not to be advised.

OPERATION OF MOTOR. The following diagram shows the position of the piston in a cylinder at the beginning of each stroke.

Fig. 6.



Referring to Fig. 6:—

The process of charging consists in filling the cylinder with an explosive mixture of air and gas. Assume that a pressure of one atmosphere exists in space between the cylinder head and the top of the piston (1). As the piston moves down the volume above mentioned **increases** with a consequent **decrease** in pressure. A valve I being open permits a mixture of air and gasoline vapor to be drawn in. This valve closes when the piston has reached its inner dead center as shown in 2.

The **upward** movement of the piston compresses the charge; that is, the volume **decreasing**, the **pressure** or **density** of the mixture is **increased.**

When the piston has reached this position, as shown in 3, the charge is ignited, the expanding gases driving the piston downward. This is the **power stroke.**

The pressure per square inch on the piston before ignition is approximately 70 lbs. Upon explosion the pressure rises to several hundred lbs., **falling** as the volume increases. 4 shows the position of the piston at the beginning of the exhaust stroke. The exhaust valve E opening permits the dead charge to escape during the **upward** stroke of the piston. This completes the cycle. The next operation is that of charging the cylinder with a fresh mixture as shown in 1.

For simplicity it has been assumed that all valves **open** and **close at dead centres.**

Experience has proved that owing to the inertia of gases at high speeds certain modifications of the above valve setting are advisable. (See Fig. 5.)

CHAPTER III.

CARBURATION.

As has been seen, a gasoline engine depends on the explosive properties of a mixture of gasoline vapor and air. At first glance it might appear that the proper proportioning of the two wouludl be a comparatively simple matter. If an engine ran always under the same conditions, viz., at constant speed and under constant load, thereby necessitating no throttling of the mixture, the problem would be comparatively simple. However, in actual practice the reverse of these conditions is true, as will be seen later.

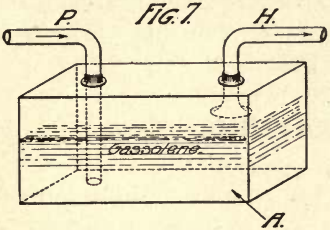
FUNCTION OF CARBURETER. The function of the carbureter is to mix in fixed and unvarying proportions such weights of gasoline and air that, when compressed in the cylinder, will result in a mixture that will be highly explosive.

TYPES OF CARBURETERS. There are three general types of carbureters, viz., Surface, Constant Level or Float Feed, and Compensating.

SURFACE CARBURETERS. Of the various forms of carbureters, the surface type is the simplest. However, it so imperfectly fulfilled the conditions imposed upon it that it has been discarded for the more modern and efficient types.

DIAGRAM OF THE SURFACE CARBURETER.

FIG. 7



The accompanying diagram shows the action of the surface carbureter.

A=gasoline tank.

P=pipe debouching into fuel.

H=pipe leading to cylinder.

A pipe P debouches into a tank of gasoline. The suction due to the motor creates a partial vacuum in the air chamber.

This becoming less than atmospheric pressure air is drawn through pipe P and passes up through the gasoline. The result is a fully charged but far from homogeneous mixture. The actions at various motor speeds in this type are also not reliable.

FLOAT FEED CARBURETER. To overcome these troubles, the constant level or float carbureter was designed in which

L=float.

S=valve spindle.

N=valve.

G=gasoline feed.

V=vaporizing nozzle.

C=float chamber.

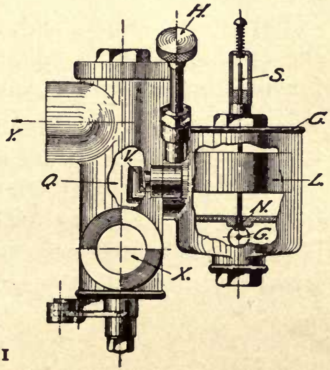
Q=mixing chamber.

X=air supply.

Y=pipe leading to cylinder.

H=needle valve controlling flow of fuel to vaporizing nozzle.

FIG. 8.



COMPENSATING CARBURETER. The compensating carbureter is fitted with an auxiliary air valve admitting more air as the engine speed increases, thus compensating for the increased richness of mixture.

THEORY OF CARBURATION. The problem in carburation is to feed at all engine speeds and at all points of throttle opening an even and uniform mixture to the cylinders.

In the surface carbureter a fully charged mixture was obtained, but it was in no sense homogeneous since with a pipe debouching into gasoline and with air sucked through it the resulting mixture contained drops of liquid. These either condensed on the walls of the supply pipe or, entering the cylinder as drops and not as vapor, produced a slow burning mixture necessitating a well-advanced spark, which put a back pressure on the engine. This slow burning of the charge had also decided heating effect on the cylinder walls.

The spray carbureter, or constant level type, divides the gasoline into an infinite number of drops, thus affording the maximum amount of surface for vaporization. If a single drop of gasoline is placed in the air it will be seen that the vaporization will not be as rapid as if this same drop were divided into a number of infinitely small drops. The suction draws the gasoline from the nozzle in the form of a spray or mist, which uniting with the air forms a gas which is delivered to the cylinder as such, thus affording to the cylinder a uniform mixture.

Experiments have shown that if air and gasoline are mixed by weight in the ratio of 5 to 1, the resulting gas will, when ignited, develop a maximum of power. Therefore, a carbureter, to be absolutely correct, should feed a mixture approaching the limits above given.

The weight of fuel per engine stroke is dependent on the speed of the motor. That is, at high speed the suction increases as the engine speed increases. The rate of increase is greater for gasoline than it is for air since gasoline will continue to flow after suction has ceased, due to the inertia of the column of liquid in the vaporizing nozzle. The result is that a fias is produced which is too rich at high speeds. By proper design of the carbureter this can be overcome.

In order that the mixture shall be a perfect gas, it has been found advisable to heat the air before feeding it to the carbureter.

The modern carbureter has, however, been so carefully designed and so thoroughly meets the above named conditions that when properly adjusted it is productive of but little trouble.

CHAPTER IV.

THE COOLING OF GAS ENGINE CYLINDERS.

Upon the firing of a charge, the cylinder, could it be inspected, would be seen to be filled with a sheet of flame. It is estimated that the temperature of the gases reaches as high as 2500 to 3000 degrees F. Under such intense heat lubrication is impossible. Therefore some means must be provided to keep the cylinder walls at a proper working temperature.

Two systems are employed for cooling the cylinders of a gasoline motor:—**Air, or direct, cooling, and water, or indirect, cooling.**

AIR COOLING. The air-cooled motor, though never gaining popularity in Europe, is used to a limited extent in this country, and for small cylinders up to a 4-inch diameter has been fairly successful. Beyond this point, however, the external cooling surface that can be employed will decrease as the number of square inches of heating surface is increased, or in other words, the cooling surface cannot be increased in the same ratio for large as for small cylinders. Also, the range in variation of temperature will necessarily be wider for air than for water-cooled motors.

Water has about eight times as high a capacity for storing heat as iron for equal weights of each and for this reason the temperature cannot be controlled so perfectly in an air-cooled motor as in one cooled by water. The result is that the cylinder of an air-cooled motor can pass readily from one of perfect safety to a seriously overheated condition, with a consequent damage to valves, and even cylinder and piston, for in this connection it must be remembered that in gas engine operation, roughly speaking, about 20% only of the heat units are utilized. Of the remaining 80%, 30% are carried off through the exhaust, leaving 50% to be taken care of by the cooling system.

Owing to these difficulties, cooling a cylinder by circulating water around it has come into general use.

WATER COOLING. It is evident that by the proper designing of a cooler or radiator, the number of square inches of cooling surface as compared to the number of square inches of heated cylinder area can be so proportioned that the cylinder can never attain dangerously high temperatures.

It is a mistaken idea that the cooler the water the better the motor will work; on the contrary, experiments show that an engine will operate at its highest efficiency, all other things being equal, when the jacketing water leaves the cylinder at about 210 degrees Fahrenheit.

In order that the water may circulate around the cylinder, pass into the radiator, and when properly cooled return to the cylinder jacket, some means of circulation must be provided.

There are two methods in use, viz: circulation effected by a pump, and natural circulation or the thermo-siphon system. Both are efficient and largely used.

There are, however, objections inherent with all pumps, namely, that a certain amount of power is absorbed in driving the pump. The most serious objection to them is that a pump is always a fruitful source of trouble and must be frequently repacked to keep all connections water-tight.

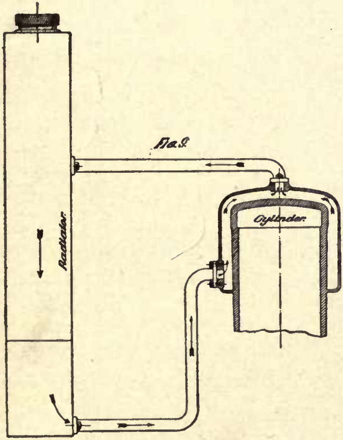
If, during a run, the pump springs a leak, the entire contents of the radiator may escape without the operator having the slightest idea that everything is not as it should be, until it is suddenly brought to his attention by the overheating of his engine.

Another objection which can be cited against the pump is that driven from the motor shaft it pumps in proportion to motor speed and not in proportion to the temperature of water; that is, on a long hill that can be negotiated on high speed, the cylinders are receiving a full charge of gas, and therefore a maximum amount of heat must be taken care of by the cooling system; but just here when the circulation of the water should be the strongest, the reverse is true, owing to the reduced speed of the engine.

On the other hand, on the level when the motor is speeded up and the car is travelling at a high rate of speed, the pump is working unnecessarily hard, as the increased speed augments the cooling.

THERMO-SYPHON. The thermo-syphon system depends on the well-known fact that cold water, being heavier than hot, for equal volumes will displace heated water, causing the latter to rise.

The advantages of this method are evident; the circulation depends upon the temperature and is independent of motor speed; that is, on ascending a steep grade with full throttle and engine slowed down under load, the circulation of the water is correspondingly increased, while on the level running with closed throttle, the circulation is reduced. The result of this is that the cylinders are kept at an almost constant working temperature with a very slight variance.



The strongest point perhaps in favor of this system is its simplicity and its reliability. As it has no moving part there is no possibility of failure, and if ordinary care is taken to see that the radiator is supplied with clean water so that no stoppages, due to dirt and outside matter getting into the pipes, can occur, circulation will be efficient and positive in action.

CHAPTER V.

TRANSMISSIONS AND CLUTCHES.

It must be remembered in connection with a gasoline motor that the power developed by the explosions in the cylinder is stored as energy in the fly wheel and that full power is obtained only when the fly wheel is revolving at its rated speed under load. If, for example, an engine developes full power at, say, 1000 revolutions per minute and in ascending a grade is slowed down to 400 revolutions per minute, the motor will not then be developing nearly its full power. It is evident also that it is just here where full power is needed.

In order, therefore, that the engine shall turn up to approximately its normal speed a change speed gearing must be interposed between the engine proper and the rear wheels.

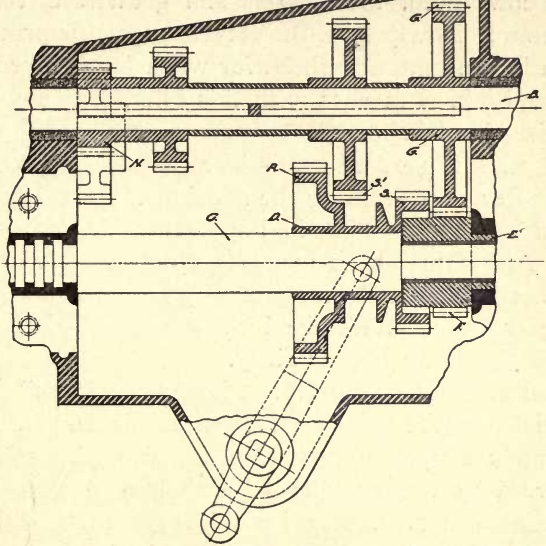
There are four distinct types of transmission:—

Sliding gears, Planetary gears, Individual clutch and Friction drive.

The first two systems are in general use, the individual clutch being used only to a limited extent and the friction drive has but one or two advocates.

SLIDING GEARS. On all large cars, the sliding gear transmission has come into use to the practical exclusion of other types. It consists essentially of a

Fig. 10.



clutch, a secondary shaft B, and a square shaft C, on which slides the gears D and S. When the clutch is released, the engine is free to revolve, but no power is transmitted to the shaft C. When the clutch is engaged, gear F drives the secondary shaft B through gear G.

On high speed, the gear D is removed forward until fingers in D engage corresponding members in F, the shaft E. and C. revolving as a unit. On second speed, D is moved until gear S engages S′. The shafts C and B now revolve at a different rate of speed, shaft C revolving at a lower rate than B.

On low speed, the ratio is still greater, C turning much more slowly than B. Reverse speed is produced by an idler in mesh with N, for when D is moved still further back, R meshes with this idler, thus changing the direction of shaft C.

All sliding gear transmissions should be provided with a device preventing the shifting of gears with the clutch engaged. This is important, for, otherwise, should an attempt be made to shift gears with the clutch engaged it would probably result in stripping the gear teeth. With the locking device before mentioned this is an impossibility.

PLANETARY GEARS. Planetary transmission is especially suited to small cars of ample power. It is extremely simple in operation and for this reason is preferred by women who drive their own cars. It is essential, however, that for this type to be efficient the gears be encased and run in a bath of oil. The majority of runabouts do not meet the above important point.

Now that the automobile has passed the experimental state, as much should be expected of a small as of a large car in point of durability and efficiency. In fact, it should seldom be necessary in a good runabout under ordinary road conditions to resort to low speed, and in high speed the planetary transmission is fully as efficient as sliding gears.

FUNCTION OF CLUTCH. In starting as well as in stopping, it is necessary that some device be used to disconnect the motor from the transmission. This is the function of the clutch.

Cone Clutch.

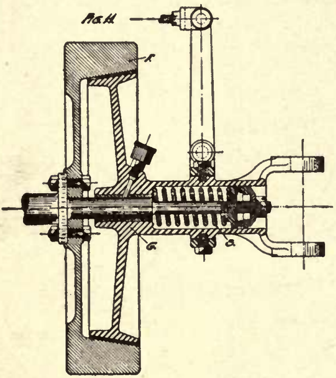


Figure 11 shows the cone clutch, in which

F = fly wheel.
G = cone clutch.
S = spring.

When the cone is let into its seat on the fly wheel and held in engagement by a powerful spring, the friction between F and G is sufficient to cause G to revolve as a unit with F.

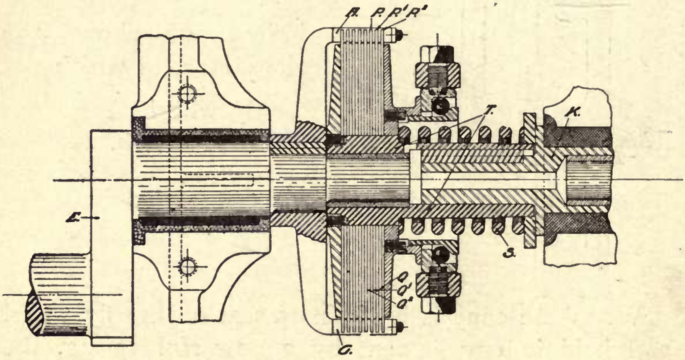
DISADVANTAGES OF CONE CLUTCH. In this and similar types of clutches the wear between the two members F and G is excessive and the clutch requires constant adjustment.

In crowded traffic and when slipping the clutch, as in starting, the absence of any proper means of lubrication causes the clutch to become too "fierce," as it is called, or, in other words, the car is too jerky in motion, instead of the clutch taking hold gradually and picking up the load.

Owing to these disadvantages, a type of clutch known as **the multiple disc** is fast gaining favor.

Multiple Disc Clutch.

Fig. 12.



Let E be the crank shaft and arms A and C be integral with it. A number of steel discs P, P′, P″, etc., are fastened on their periphery, as shown in Fig. 12.

Upon a sleeve T mounted on shaft are a corresponding number of small discs fastened at their centres.

If the spring S is engaged the discs are pressed together, the result being that shafts T and E are driven as a unit. Upon disengaging the spring S, the shaft E or motor shaft revolves; but since no friction occurs then between plates P, P′, P″ and Q, Q′ and Q″, the secondary shaft T is stationary.

ADVANTAGES OF MULTIPLE DISC TYPE.

The advantages of this type are that

(1) Owing to its compactness it can be encased.

(2) All moving parts are of steel and their discs running in oil are not subjected to any appreciable wear as the working load per square inch is no greater than that of any other wearing part of the motor.

(3) Owing to its perfect lubrication the clutch can be slipped without injurious effects.

As the steel plates run in a bath of oil, it is evident that each time the clutch is released, the plates separate and oil works thoroughly between them.

When the clutch is engaged the oil is forced out, but before the discs seize, a certain slip, due to this oil filament, will occur. The advantages of this one point cannot be overestimated, since this slipping effect relieves the transmission and the rear axle of strains due to too sudden an engagement of the clutch and not only improves the riding qualities of the car but adds to the life of the tires as well as to the car itself.

CHAPTER VI.

DRIVING MECHANISM, BRAKES AND FRAMES.

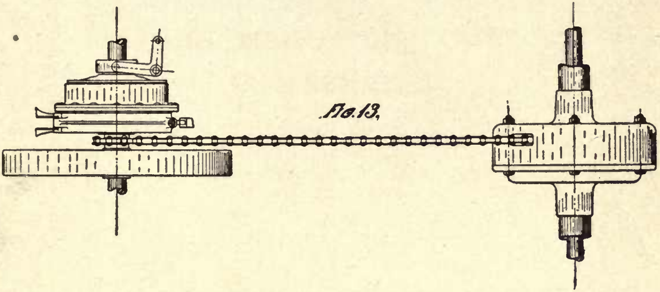
The earlier carriages were driven by either single or double chains. The shaft drive has, however, gained in popularity to such an extent that the future will probably see it used to the exclusion of the other methods.

In order that any piece of mechanism shall be efficient, it is necessary that suitable means of lubrication be employed. It is obvious that in the case of chain driven cars there is no satisfactory means of lubrication.

A chain is exposed to all the dust and dirt of the road and becomes so filthy that it frequently has to be removed and cleaned. It is subjected to heavy wear due to the grit that it picks up, and this necessitates frequent adjustment.

With regard to the efficiency of the two methods there is little difference. Were it possible to operate a car and keep the chain thoroughly lubricated and clean, the wear and consequent friction would be reduced, making this method compare favorably with the shaft driven car; but in practice, experiment shows a slight gain in favor of the gear drive.

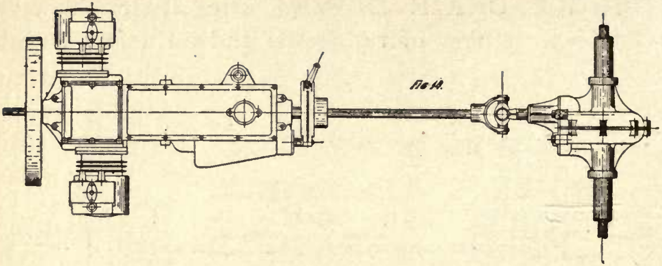
SINGLE CHAIN DRIVE. The single chain is used on a number of runabouts and on a few larger cars.



The principle advantage that can be urged is its cheapness. However, due to its length, constant stretching, and inefficient means of lubrication, the single chain drive is rapidly being displaced by the shaft drive.

DOUBLE CHAIN DRIVE. While the disadvantages inherent with single chains are present in the side chain drive, yet, as the latter are comparatively short and accessible for cleaning, they afford in heavy cars a satisfactory means of transmitting power.

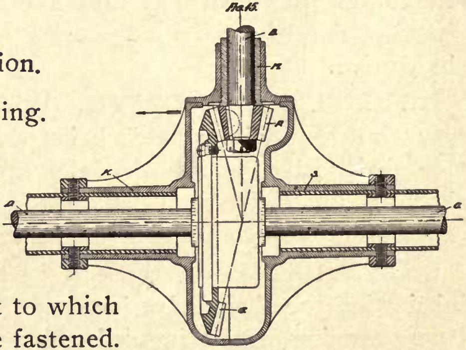
SHAFT DRIVE. Because of its perfect means of lubrication the shaft drive has come into general use. Every moving part is encased and runs in grease, and no matter how muddy or dusty the roads it is impossible for any of the grit or dirt to get into the gears themselves.



REAR AXLE, EMPLOYING SHAFT DRIVE, SHOWING OIL TIGHT CONSTRUCTION

Owing to this construction, the shaft drive requires little or no attention.

COMPENSATING SIDE THRUST. As in the case of any bevel gear construction, some means must be provided for taking the side thrust from the driving pinion.



P = Driving pinion.

S and K = Housing.

B = Steel shaft.

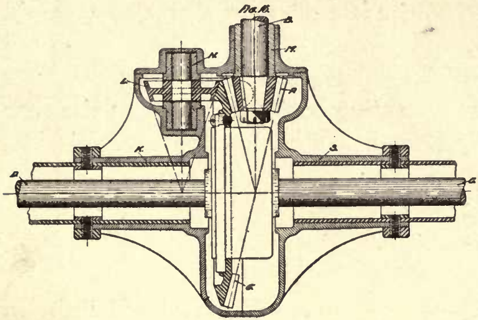
M = Bearing.

G = Bevel gear.

C and D = Shaft to which
rear wheels are fastened.

The power from the engine is transmitted by shaft B and from pinion P to bevel gear G; there is then a thrust against G as shown by arrow.

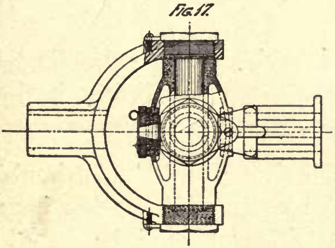
To overcome this refer to Fig. 16:—



A blank roller L of same size as drive pinion P is fitted against the bevel gear G. This roller is held against G by bearing N. Therefore any thrust as shown by arrow is taken up by the roller and does not permit the gear G to get out of alignment.

This device, though simple, is a most efficient means of compensating the side thrust.

UNIVERSAL JOINTS. In order that the power may be transmitted at an angle and also to compensate for inequalities of the road, two universal joints should be employed on a shaft driven car.



These joints should be provided with ample space for holding grease and oil.

BRAKES. There are two general classes of brakes.

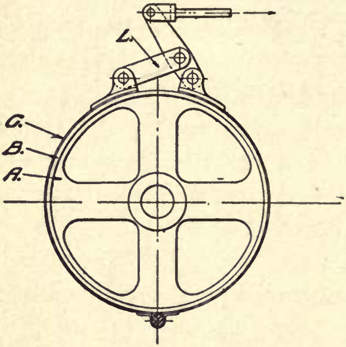
1—Hub or Drum brakes.

2—Shoe brakes.

The first class is used to the exclusion of the latter type, inasmuch as any pressure on pneumatic tires such as is applied to the iron shoe of a carriage, would wear it through.

The majority of large cars are fitted with two sets of brakes; one set operating on steel drums on the rear wheels, and the other on a drum on the transmission.

Fig. 18.



A = Drum.
B = Brake band lining.
C = Band.
L = Bell Crank for tightening and loosening band on drum.

BRAKE LINING. As is evident, an exceedingly tough material must be employed for lining brake bands. Leather or fibre is must commonly used.

CARE OF BRAKES. The drums and bands should be kept free of oil or grease as any lubrication here defeats their very purpose. They should be so adjusted that the band exerts no drag when properly released and yet should be capable of locking the wheels when full braking effort is applied.

Brakes should be frequently examined and relined when necessary, care being taken to countersink the rivets.

FRAMES. The pressed steel frame, owing to its combination of strength and lightness, is used on the majority of large cars. On some runabouts the armored wood frame is still employed and on a few the tubular construction. The pressed steel frame is now being adopted for the higher class of runabouts and the future will see this used to the exclusion of other material in all types of automobile frames.

CHAPTER VII.

LUBRICATION.

The proper means of lubricating the moving parts of a motor car is a subject that has been given careful thought by designers and the instructions sent out with each car should be strictly followed.

THEORY OF LUBRICATION. It is a mistaken idea that any piece of metal, no matter how carefully finished, has a perfectly smooth surface; were this examined under a microscope, it would be seen to be irregular.

If two pieces of metal are carefully machined and ground and are then rubbed together under pressure, the breaking off or grinding of these irregularities in the surface of the plates generates heat.

When this occurs between a shaft and its bearing, the result is a seizure between the two, stopping the car until the bearing has cooled.

The object of lubrication is to prevent this friction and consequent wear by interposing an oil filament between the shaft and the bearing.

The bearing must be so designed that the pressure per square inch of bearing surface does not exceed certain limits. Then there will exist between the shaft and bearing an oil filament that will prevent the metal surfaces from coming in contact. If the pressure per square inch is too great, the oil will be forced out with a consequent damage to bearings.

THE LUBRICATION OF A GASOLINE ENGINE CYLINDER. A specially prepared mineral oil of high fire test is necessary for the proper lubrication of the cylinder. Too much importance cannot be placed on this point as an engine can readily be ruined by employing an unsuitable oil.

Since the temperature in the cylinder will average about 1000° Fahrenheit, it is necessary that an oil be used that does not carbonize. It is a "penny wise and pound foolish" policy to economize in the quality of cylinder oil. The best is none too good.

OILING DEVICES. There are three means of supplying oil to the moving parts of an engine, viz., by gravity feed, compression and pump driven oilers.

The gravity oiler though simple is not altogether reliable since the viscosity of the oil is dependent on its temperature and this necessitates constant adjusting of the flow as atmospheric conditions change.

The compression oiler and pump driven lubricator afford a satisfactory means for supplying oil to the various parts of a car. For vertical engines, oil fed to the crank case and then splashed by the cranks affords a means of lubricating the cylinders. For the opposed horizontal engine, a positive feed is preferable to splash lubrication, as oil is fed in proportion to the motor speed and each cylinder receives at all times its proper amount of oil. With the splash system, it is a case of either a feast or a famine. Trouble from sooted plugs will also be experienced with this method.

GREASE CUPS. These are used when a heavier lubricant than oil is necessary and also when the location is such that it is impossible to feed from the mechanical oiler.

CHAPTER VIII.

IGNITION.

As already shown, a charge of air and gasoline in gaseous form is drawn in and compressed in the cylinder and at the proper time ignited.

What means then are used in firing the charge?

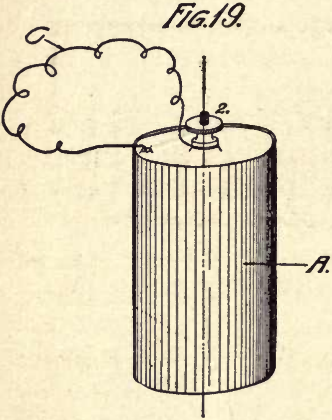
In the early engines various systems were employed, among which can be cited **the open flame, the hot head, and the incandescent tube.** The latter system gained some popularity for automobiles, but, owing to inability to time it properly, it has given way to the present ignition by the electric spark.

It is a fact that fully three-quarters of the trouble that the average motorist experiences is due to a lack of knowledge of the ignition system on his car. The power developed by an explosive motor is largely dependent on the intensity of the spark and many an automobile has been condemned for lack of power and sent to the repair man, whereas, had the operator possessed some knowledge of the principles upon which ignition depended, he would have himself been able to make the comparatively simple adjustments necessary to restore his motor to full power.

At the present time two general systems of electric ignition are in vogue, the make and break or primary igniter and the **jump spark** or high tension system.

This latter method is used in this country almost to the total exclusion of the other.

PRINCIPLE OF THE JUMP SPARK. It must be understood that an electric current will flow only through a closed conductor. Referring to Fig. 1.

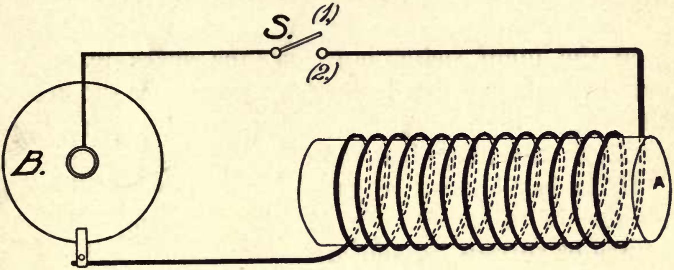


A represents an ordinary dry cell. The two electrodes are connected by a wire **C** thus affording an electrical path for the current. If, however, the wire is severed the action ceases.

A dry cell or any other form of electrical energy does not generate a current, but forms a differerence of pressure between the two electrodes and the flowing of this current is an effort to establish equilibrium in all parts of the closed circuit.

For example, if two jars placed on a table are filled with water to different heights and are connected by a small pipe, the water will tend to find the same level in both jars. This action can be compared to the flowing of the current from one electrode to another in an effort to establish equilibrium between the two. When, however, the water reaches the same level and there is no existing pressure between the jars, this would be analogous to a dead cell, that is, one in which there is no difference in electrical pressure between the electrodes.

FIG. 20.



Before considering the induction coil and induced current, refer to the diagram. If the source of electrical energy is at B and A is a core made up of soft iron wires surrounded by a number of turns of insulated copper wire as long as switch (S) is open no current will flow through the coil. Now, suppose the circuit to be closed: a current will flow through the coil, thoroughly magnetizing the core A. If then the connection at S is broken, a spark will follow the break between the points (1 and 2), this action demagnetizing the core, or nearly so.

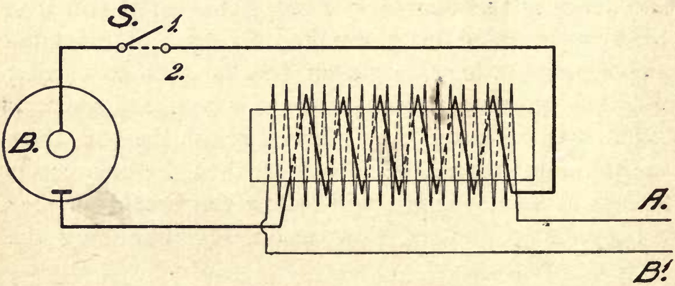
While this is sufficient to work satisfactorily with the make and break type of ignition, it will not be strong enough for the jump spark system, because the difference of electric pressure between the points (1 and 2) is not sufficient to cause the spark to jump across the high resistance air gap between the points of a spark plug.

It must be understood that in the coil, as shown in Fig. 20, a spark follows only the break between the points 1 and 2, and that an electrical path was offered to the current.

In the jump spark, however, the spark must arc across an air gap that is always open; hence the necessity for the high voltage. In order to obtain this high pressure, advantage is taken of the induced current.

If, as in Fig. 21, we have a core surrounded by a number of turns of insulated wire, and supplied by a source of current, B, and around this coil another coil of fine insulated wire is wound, then, it is a fact that

FIG. 21.



if a current be made to flow through the first coil, it will induce in the second coil a current whose voltage is proportionate to the number of turns of wire with which the second coil is wounded. The two coils are known as the primary and the secondary.

If the secondary wiring is broken as at points A and B, a spark will arc across these points each time the current is broken in the primary. If, therefore, S is a switch that is alternately open and shut each time that it is closed a current will flow through the primary wiring and will bring the iron core from zero to full magnetization. If the switch is now suddenly opened there occurs a change in the magnetic field and a reversal of current in the primary winding inducing in the secondary a current whose voltage is proportional to the number of turns between the two.

The strength of this induced and opposite current in the primary is proportionate to the rapidity with which the current can be broken or interrupted.

Therefore the majority of coils are fitted with a vibrator (an electrical means for rapidly opening and closing the circuit) for the purpose of magnetizing and demagnetizing the core with as great frequency as possible. Care must be taken not to confuse this with the closing of the circuit by the ignition cam on the engine, for were the vibrator not used, only one single spark would result at each breaking of the ignition cam from its contact in the commutator; that is, the core would be demagnetized but once, giving but one spark at the plug. With the vibrator on the coil, however, the coil is brought from zero to full magnetism several times, producing at the plug a series of fat, hot sparks.

FIG. 22.

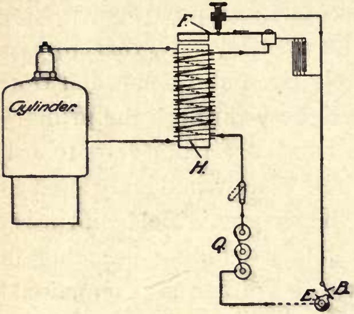


DIAGRAM OF WIRING SCHEME FOR JUMP SPARK SYSTEM EMPLOYING VIBRATOR AND CONDENSER.

Referring to the diagram, suppose Q to be the source of current; when cam E reaches a contact with spring B there exists in the primary a closed circuit. This magnetizes the core H. The moment this becomes thoroughly saturated, the vibrator F is attracted towards the core, thus breaking the circuit, and, as we have already seen, producing a spark between the points of the plug. The core becoming demagnetized allows the vibrator to spring back, closing the circuit again and permitting the remagnetizing of the core. This action is continued as long as E and B are in contact, thus producing at plug C a series of intensely hot sparks.

COMMUTATORS. The commutator is a device whereby the primary current is so timed that the ignition occurs at the proper instant in the cylinder.

FIG. 23.

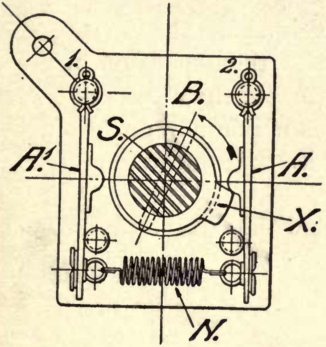
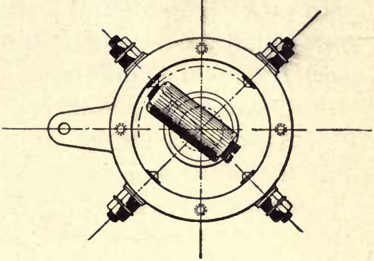


FIG. 24.



COMMUTATORS.

The accompanying sketches show simple and efficient commutators for a two and a four cylinder engine. In Fig. 23, B is a fibre block, A and A^1 are steel arms thoroughly insulated from each other. S is half time shaft driven from the engine. N is a spring holding the arms A and A^1 in proper position. X is ignition cam. As the cam revolves it successively makes contact with the springs A and A^1 distributing the primary current, and so timing the ignition that the spark occurs in each cylinder at the proper moment. Other commutators of which there are a number on the market are modifications of this principle.

VARYING TIME OF IGNITION. There are two means by which the speed of the motor can be regulated: one, throttling the mixture, and, two, regulating the time of ignition. The effect of the first is to cause the cylinder to receive a less weight of gas, that of the second to regulate the time of igniting the charge.

In order that the full power of the expansion of the gases shall be exerted on the piston, the charge should be ignited while compression is maximum, or, in other words, when the piston is at its outer dead center on its compression stroke.

If the ignition is retarded and the charge fired after the piston has passed its dead centre, there is a consequent decrease in compression. The force of the explosion is reduced, resulting in the slowing down of the engine.

It would appear that, since the ignition cam revolves in proportion to engine speed, this would automatically take care of the spark. This would be so were it not for two causes: one, that though it takes an inappreciable length of time for the magnetizing and demagnetizing of the core it is sufficient at high speed to so delay the ignition that the point of maximum compression has passed before a spark occurs. Also if combustion of a charge of gas could be seen, it would be founud that the combustion was not absolutely instantaneous, but that a certain amount of time was necessary for the flame to propagate itself throughout the mixture. Therefore in high speed engines the charge is fired actually before the piston has completed the compression stroke in order that the full expansion of the gases shall be converted into work. Care must be taken when the engine is running under load not to advance the spark too much, as then the comparatively low speed of the motor gives the gases sufficient time to expand, before the piston has reached its dead centre, thus not only putting negative work on the engine, but subjecting the motor to severe strains and producing an unmistakable metallic knock familiar to all motorists.

There are three sources of electrical energy, viz., dry cells, accumulators and mechanical generators.

DRY CELLS. The dry cell is used as a source of current on many cars and has generally proven satisfactory owing to cheapness, cleanliness and simplicity.

The cell consists of a zinc casing, this forming the negative electrode. The carbon or positive electrode is encased in manganese dioxide and coke. The electrolite is usually a compound of sal-ammoniac and chloride of zinc.

The dry cells possess one advantage over storage batteries, inasmuch as their internal resistance is high, that they are not so quickly damaged by short circuiting.

If caught on the road with dry cells apparently dead, they can be regenerated enough to get home by removing the paper cover, boring holes in the zinc and immersing in weak vinegar. New ones should be procured at the earliest opportunity.

ACCUMULATORS. Although the original cost is high, the small expense of recharging accumulators has led to their extensive use.

An accumulator consists of a jar containing an electrolite, usually dilute sulphuric acid [specific gravity 1.25] in which are suspended plates made of lead and lead covered with lead peroxide.

When charged and ready for use, the lead plates are a dead gray color, the lead peroxide plates being brown. When in a discharged state all plates are of approximately the same color.

Before purchasing an accumulator it is well to ascertain the nearest source of direct current for charging purposes, as an alternating current cannot be used except in connection with a rectifier, not usually procurable at the ordinary stations.

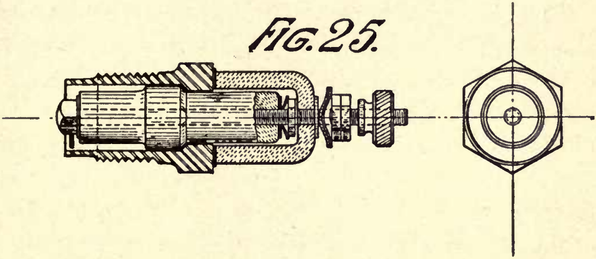
You should never allow an accumulator to become exhausted, but at the first sign of weakness have it recharged, strictly according to directions given by the makers.

THE MECHANICAL GENERATOR. In the cheaper forms the mechanical generator is not advisable, except in the very highest priced cars, and even then a good accumulator is often productive of less trouble and greater satisfaction. However, there are several excellent igniters of this type on the market.

SPARK PLUGS. In order that a spark shall arc between the points of the plug, it is necessary that the two points be thoroughly insulated from each other. As has been seen, the high voltage or pressure of the secondary will leap across a gap placed in it, in an effort to establish equilibrium in all parts of the circuit, and it is this electrical spark arcing the points of the plug that ignites the charge.

The accompanying diagram shows the construction of a plug.

FIG. 25.



SPARK GAPS. If an engine shows a decided tendency to soot its plugs—and if this cannot be remedied by properly adjusting the flow of oil—it is an excellent plan to introduce in the secondary wiring a device known as a spark gap. This can be located either on the dash or near the plug.

The simplest form is shown in the accompanying diagram.

FIG. 26.

To apply this device, it is necessary only to open the cable near the plug, wiring each end of the cable securely to the terminals of the spark gap.

There will then exist an air gap between the points.

The advantages of this are that it allows the voltage to obtain considerable pressure before the spark will arc across the points; and a spark of greater intensity will result. There is little danger of sooted plugs if this is used.

PART II.

CHAPTER IX.

POWER LOSSES.

As previously stated, it is the intention of the writer to go only so far into the principle underlying the operation of a gasoline motor as to make clear the chapters now coming.

There are certain sounds in a motor, such as "missing explosions," or "skipping" as it is called, that may be due to one of several causes, or to a combination of circumstances; and an experienced motorist can by a process of elimination locate the difficulty.

As with a physician all depends on a proper diagnosis, for the trouble once found the remedy is obvious.

If on a tour the motor stops, it is evident that no amount of tinkering with the electric system will help matters when the trouble lies in an empty gasoline tank, nor will it do any good to take the carburetter apart if the ignition is faulty.

The keeping of an engine in proper tune consists in looking after the details.

There are three causes for loss of power in a gasoline motor, viz:—defective compression, imperfect ignition and improper carburation.

LOSSES BY DEFECTIVE COMPRESSION.

As already seen, a charge of air and gasoline is drawn into the cylinder. The inlet valve then closes and the gases are compressed to approximately 70 lbs. per square inch.

Any leakage of this charge will cause a serious loss of power. There are three places where such leakage may occur,—in the valves, the piston rings, and the spark plugs and the valve caps.

LEAKY VALVES. When a car leaves the factory the valves are thoroughly seated. That is, the bevel face of valve V (See Fig. 4), has a perfect bearing against a corresponding bevel face M and N.

However, after a car has been run several weeks the intense heat to which the valves are subjected particularly the exhaust, has a tendency to pit the face or to leave a deposit of carbon on the seat.

The valve then instead of being evenly seated by spring (S) does not close sufficiently tight to prevent a certain amount of compression from leaking out. To overcome this the valves should be properly ground.

GRINDING VALVES. Remove the valve plugs and spring. The valve can then be pushed out. If both valves are taken out together, care should be taken not to mix them up.

As in everything else there is a right and a wrong way to grind a valve. Make a paste of flour of emery and oil, wipe the face of the valve and seat carefully. Then apply a small amount of paste to the valve.

The grinding is best done using a screw driver and turning the valve in its seat half a turn one way and then another, frequently lifting the valve clear of the seat in order that no particle of emery shall become embedded in it with a consequent damage to the seat.

The operation will take some five minutes. The valve and seat should then be wiped clean and the valve replaced and given a few turns. Examination will prove whether the seat is perfect or not.

Great care must be taken to prevent the emery from getting into the cylinder proper.

If the operation of grinding in a valve is entirely unfamiliar it is an excellent plan to get some one who understands grinding to do it the first time, as much that cannot be written can be learned by watching.

LEAKAGE BY PISTON RINGS. The piston is fitted with rings which, springing against the walls of the cylinder, afford a gas tight joint.

In a well-built engine loss of compression from this cause is unlikely.

It often happens, however, owing to either the use of a poor quality of oil or too much lubricant, that rings become so gummed that they stick in the piston grooves and do not spring tightly against the cylinder; thus compression is lost.

If the engine is turned over by hand a hissing in the cylinder will indicate trouble of this kind.

To free the rings, remove the spark plugs and pour in about a half cupful of kerosene. Turn the engine over a few times and then draw off the kerosene by opening the pet cock. The kerosene will cut the oil and free the rings. It is well to leave the cocks open a minute or so after starting the motor.

The frequent use of kerosene in this manner keeps the cylinder and piston in fine condition, the only objection being that it has a tendency to soot the plugs. These are, however, easily cleaned.

LEAKS AROUND SPARK PLUGS AND VALVE CAPS. If the spark plug leaks compression due to the blowing out of its packing, the remedy is a new plug. Care should be taken also, to see that the valve plugs and spark plugs are screwed tightly into the cylinder. If either are suspected of leakage, oil can be squirted around the joints. Any appreciable leak will manifest itself by bubbles.

The compression can be tested by screwing a gauge into the cylinder in place of the spark plug, and taking a reading as the motor is turned over by hand.

After becoming familiar with your particular motor any loss of compression can be detected by cranking.

LOSSES BY IMPERFECT IGNITION.

The ignition system in a car, particularly that employing either "dry cells" or "accumulators" is comparatively simple. Yet it is a fact that nine-tenths of the trouble that the average motorist meets is due to lack of knowledge on this important subject. The chapter on ignition [PART I.] explains the principles upon which it depends and should be carefully studied.

When "skipping" or missing explosions, the car will run in a jerky manner, the missing being particularly noticeable when running with full throttle under load, as is the case when ascending a hill.

A gradual falling off in power without the engine actually missing can also usually be traced to a weak or partially depleted source of current; not always, however, as a gradual loss in compression will produce similar results. (See Loss of Compression.)

CAUSES OF POOR IGNITION.

1—Weak batteries or accumulator.

2—Loose connections in any of the low tension circuits.

3—Corroded or rusty terminals.

4—Insufficient contact at commutator.

5—Grounding of current in either primary or secondary.

6—Short circuiting in one or both circuits.

7—Sticking or improperly adjusted vibrators.

8—Sooted or dirty spark plugs.

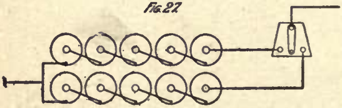
WEAK BATTERIES. Every motorist using either dry cells or an accumulator should provide himself with an ammeter or ammeter-volt-meter combined, Dry cells should be tested with an ammeter, and any cell falling under six amperes should be rejected. As a set of cells is usually installed at the same time, the entire battery will probably be found weak. New cells should be substituted. The majority of cars are equipped with two sets of cells and provided with a switch so arranged that either or both sets can be used.

Accumulators should be tested with a volt-meter. DO NOT USE AN AMMETER. A fully charged accumulator rated at "six volts" will show over this when fresh. When voltage falls to five and seven-eighths, it should be removed from the car and recharged, the usual cost being 50 cents. A good accumulator will in a two-cylinder engine give approximately 1,000 miles.

SERIES WIRING. Five dry cells usually make up the battery and are wired in series. That is, the positive and negative poles are alternately connected, the positive wire running to one side of the switch.

Another set of five cells similarly wired is attached to the other side of the switch. The negative poles of both sets are grounded.

FIG. 22



In operating a car so wired, it is advisable to distribute the use equally between both sets. That is run on one battery for half an hour, and then change over to the other side.

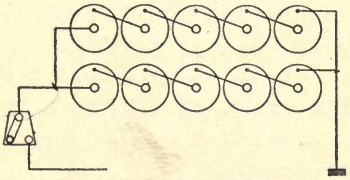
The advantages of this are:—Greater opportunity is given the cells to recuperate, insuring longer life; also the cells will then become weak at about the same time, making it possible to wire them successfully in parallel.

PARALLEL WIRING. When both batteries have fallen to approximately seven amperes per cell, extra mileage can be obtained by wiring the two batteries in parallel and using one side of switch only. In connection with this, it must be remembered that when cells are wired in series, the voltage is increased as the number of cells is increased, the amperage remaining constant. In parallel wiring, the voltage remains constant and amperage increases.

If, then, two batteries whose cells are wired in series are connected in parallel, the result will be double the amperage of either battery with the same voltage.

Diagram showing connections of two batteries in series connected in parallel.

FIG. 28.



Since successful ignition depends primarily upon the source of current, much trouble will be avoided if the cells are frequently examined and tested. In connection with this, it must be remembered that in testing with an ammeter, the cell is short circuited. Hence, the reading should be made as rapidly as possible.

LOOSE CONNECTIONS. Loose connections in the low tension system will cause the engine to miss, particularly on rough roads. Care should be taken that all battery connections are tightly screwed down.

Do not use an ordinary copper wire for connecting cells, but especially prepared "battery connections."

The wiring on the coil should be examined to make sure that all connections are tight, as should also the wires to the commutator.

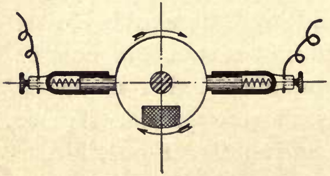
CORRODED TERMINALS. A rusty or corroded terminal will not give proper contact. All connections should be clean, as dirt, rust, etc., increase the resistance in the circuit.

This is particularly true with accumulators, for if the acid spills over, the terminals on the battery will become corroded. When this occurs they should be carefully cleaned and polished with fine emery cloth, after which a thin coating of vaseline is advisable.

Though apparently a good contact is made at the commutator, a careful examination will sometimes prove this not to be the case, particularly on that type of commutator in which a definite break is not made.

Referring to diagram.

FIG. 29.



A = fibre disc.

B = metal strip.

C and C^1 = contacts.

As A revolves, B makes contact successively at C and C^1. Small particles of metal and fibre are ground off and mix with the oil, providing at times an electrical path as shown by arrows, thus tending to short circuit the batteries.

With commutators operating on this principle, the disc A should be frequently washed off with gasoline and the contacts so adjusted that a good bearing is escured.

A commutator of the form as shown in Fig. 23 is less likely to short circuit, as an air gap exists always between cam B and contact blocks C and C^1, except at the proper firing point.

GROUNDING. A short circuit is sometimes a difficult matter to locate. If it occurs in primary wiring, the batteries will be rapidly depleted, particularly an accumulator, due to its low internal resistance. If the short circuit occurs in the "high tension" system, no spark will jump at the plug. If the batteries deplete themselves too rapidly, the primary wiring should be thoroughly gone over and any defects in insulation wound with "electric tape."

A common cause of short circuiting is often due to the leaving of tools, such as a wrench, screw driver, etc., on top of the batteries. Care should be taken that nothing of a metallic nature is left there.

A short circuit in secondary is usually easily located, as the high voltage in this system makes the leak apparent. It can often be detected by a buzzing noise, such as is made by the spark jumping the points of a plug.

Never attempt to repair a broken secondary cable, but replace with a new one, and do not use ordinary bell wire in the high tension circuit.

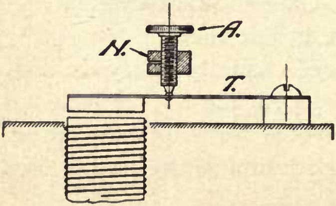
VIBRATOR ADJUSTMENTS. Referring to chapter on Ignition, Part I, it was seen that the primary current was made and broken with great frequency by the vibrator on the coil. If the platinum points on either vibrator or adjusting screw become so pitted as to cause the vibrator to stick, no spark will occur at the plug. The vibrators should be frequently examined, and if the platinum points are not flat and smooth, they should be rubbed down with a small dead smooth file, care being taken not to dress more than is necessary for a good contact.

The proper tuning of a vibrator is of vital importance, for if it is not correctly adjusted, the car will run unsatisfactorily, no matter how perfect the rest of the ignition system.

There are two methods of making this adjustment:—

1—Tuning vibrator by ear. 2—Adjusting by trial.

FIG. 30.

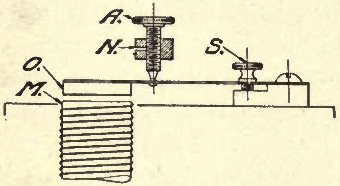


When a car leaves the factory, the vibrators are properly set, and should give the right "buzz" Hence, it is an excellent plan to familiarize one's self with this sound, as future adjustment can be made with this in mind.

Diagram No. 30 shows an arrangement of the trembler and adjusting screw. The tension on spring T is varied by screwing up or down on A.

To properly adjust a coil of this type, loosen set-screw N. Then so adjust A that a sharp steady buzz is heard, after which A should be locked into place by tightening set-screw N.

FIG. 31.



A similar coil is shown in Diagram 31, in which a double adjustment is permitted by varying not only the travel of the trembler by the adjustment at A, but also the tension of spring by set-screw S. In adjusting a coil of this type, it is advisable to give the trembler about one-sixteenth of an inch travel between O and M, the final adjustment being made at S until the proper buzz is obtained.

When a coil has been so set that the vibrators have the proper sound, a further adjustment can be made while the engine is running.

In the case of a single cylinder car, one coil only is used. Speed up the motor. Then so adjust the tension on the vibrator that the maximum motor speed is reached. In making this adjustment, the spring tension is controlled by either screw A as in Fig. 30 or S as in Fig. 31. It must also be remembered that as batteries weaken, the spring tension must be decreased. A car that runs perfectly when cells are fresh will show a falling off in power after having run some 400 to 500 miles. A readjustment of vibrators will then greatly increase the power.

Two cylinder cars employ two coils. To adjust them, the same method is used as in the case of the single cylinder, except that one vibrator is held down. One cylinder only will then fire. After this has been adjusted treat the other trembler in a similar manner. The same method is followed for adjusting coils on three or more cylinders.

SOOTED PLUGS. Another cause of poor ignition is the fouling of spark plugs due to the carbonizing of oil in the cylinders.

An electrical path is then offered to the current, no opportunity being given the voltage to attain a pressure high enough to jump the resisting air gap between the points of the plug.

If the vibrators are working properly and yet no ignition is effected, the plugs should be removed and examined. The points will probably be found to be covered with a sooty deposit. Plugs should be cleaned by soaking in gasoline, then given a scouring with a stiff brush, rinsing again to be sure that all deposits of carbon are removed. Many plugs are made so that they can be taken apart, facilitating a thorough cleaning.

Extra plugs should be carried at all times and when trouble of this kind occurs, insert a new plug. The old one can be cleaned later.

In testing a plug, lay the metal portion on some part of the engine fastening the cable in place, as if the plug were in the cylinder, care being taken that this end of the plug is free from any contact with the engine or frame. Throw the switch and crank engine slowly over. An intense white spark will jump across the points of the plug. If no spark or a weak one occurs, try another plug. If this acts in a similar manner, try the same plug on the other side. If it gives a good spark here, the fault is evidently not in the plug.

In working with the high tension system, be sure that the switch is open. Otherwise, an unpleasant shock will be experienced if ignition cam is at the firing point.

LOSSES BY IMPROPER CARBURATION.

As has been stated the function of the carbureter is to mix in fixed and unvarying proportions such weights of air and gasoline that the resulting mixture shall be explosive.

If the ratio between the two varies between too great limits, or in other words, the mixture becomes too rich or too poor, the motor will either show less than normal power or will skip, which amounts to the same thing. The remedy for this is to properly adjust the needle valve, regulating the gasoline supply.

There are so many types of carbureters on the market that it is impossible to give directions for the proper setting of each. The directions as sent by the manufacturers should be carefully followed.

A simple and efficient carbureter is that shown in Fig. 8. To properly adjust this, the throttle should be opened and spark advanced. Then so adjust the needle valve that a maximum motor speed is attained with regular explosions. A second adjustment is permitted, the object of this is to so regulate the air supply at low speed that the motor will not miss and yet will turn over slowly. To make this adjustment, close throttle and retard spark. The motor may now run either too fast or it may stop altogether.

Loosen set-screw and so adjust arm on quadrant that the motor will run at lowest possible speed with regular explosions. When the proper point has been found, tighten the adjusting screw.

A well-designed carbureter is productive of little trouble. The following difficulties will effect its proper operation:—

1—Sticking of float.

2—Float too heavy, increasing the richness of the mixture.

3—Water in the gasoline.

4—Loose connections between carbureter and cylinder.

5—Choked or clogged vaporizing nozzle.

FLOAT STICKING. A float will occasionally stick, causing a flooding of the carbureter. This is easily remedied by unscrewing cover to float chamber and freeing the float.

FLOAT TOO HEAVY. A float made of cork may increase in weight after being used for some time, owing to the fact that it absorbs a certain amount of gasoline. This increases the richness of the mixture and also causes flooding. The remedy is to decrease the weight of the float, until the column of gasoline is flush with the top of the vaporizing nozzle. If the float is made of metal and springs a leak the result is the same, in which case it should be carefully soldered, using only just enough to stop the leak, otherwise the float will be made too heavy.

WATER IN GASOLINE. Water in gasoline causes more carbureter troubles than any other one thing, and yet it is easily avoided if care is taken to see that all gasoline is strained through a chamois skin before being put in tank.

If the motor misses and the cause is not due to poor ignition, the trouble may be located by removing the plug in the bottom of the carbureter and catching the contents in a cup. If any water is present it will settle as globules in the bottom.

A large funnel in which is placed a chamois skin should always be carried; and make it an unvariable rule never to use any gasoline that has not first been strained through it. By always adhering to this, much unnecessary trouble will be avoided. If a needle valve leaks it should be ground in its seat until a tight joint is obtained.

LOOSE CONNECTIONS. All connections between cylinder and carbureter must be tight. If any of the joints become loose the mixture will become diluted, causing the motor to miss. These connections should be periodically gone over to make sure that all is tight.

VAPORIZING NOZZLE CLOGGED. It often happens that a small particle of grit or dirt gets stuck in the vaporizing nozzle, either causing the motor to stop altogether, or seriously impairing its power.

The nozzle should be removed and blown out. If the gasoline is carefully strained trouble from this cause will be avoided.

CHAPTER X.

CAUSES OF KNOCKS IN MOTORS.

There are two distinct causes of knocks in motors:—that due to a loose bearing, and the metallic hammering caused by too early ignition.

LOOSE BEARING KNOCKS. Loose bearings on crank shaft, connecting rod and wrist pin will produce a noticeable pound, particularly at high speeds.

Wrist pin bearings may wear considerably without causing a pound. Any looseness in crank pin or main bearings will produce a serious knock.

In a two-cylinder opposed motor it is an easy matter to adjust not only the crankpin bearings but the wrist pin as well.

On the crank pins a certain amount of side play is allowed. An easy way to ascertain if the bearings on the big end of connecting rod are loose is to place the cranks in a vertical position. Then rock the fly wheel a trifle. Any play on the crank pin is readily detected.

In adjusting a bearing it must be remembered that a certain expansion occurs, and it must not be adjusted so closely that the bearing becomes too tight after the motor has run for some time. Any binding can be detected by turning the engine over by hand.

In a four-cylinder vertical motor the crank-pin bearings can be examined by removing the hand hole covers and any wear taken up.

The adjustment of the main engine bearings is a more difficult matter. On a well-designed car these should last a season. The car should then be given a thorough overhauling.

Another cause of knock is a loose fly wheel on shaft. Any looseness here will produce a serious pound and should be attended to at once.

IGNITION KNOCKS. If on the compression stroke the charge is ignited, the force of explosion will tend to drive the piston back. The inertia of the fly wheel and that of the moving car will overcome this, carrying the piston beyond dead centre. This pre-ignition will cause a metallic knock or pound that is unmistakable, and is a frequent cause of broken rods or sprung shafts.

At high speed the charge is actually fired before the end of compression stroke, as it takes a certain amount of time for its complete combustion.

The quality of the mixture is another factor governing the proper firing of the charge. If the mixture is slow burning, caused by either being too rich or too poor, the engine will not knock, as the pressure does not rise rapidly enough.

On the other hand a perfect mixture or one a trifle weak will ignite almost instantly throughout its entire mass. Hence, a position of the spark that is safe for one mixture will cause a decided knock with another, provided the engine speed remains constant.

This pounding is most apparent where the engine is slowed down under load, with full throttle, as is the case when ascending a grade. Ignition then should be gradually retarded just enough to cause the knock to cease; more than that, and power will be sacrificed, as the full effect of the expansion of the gases will not be utilized.

Another cause of knocking is due to the self ignition of the charge. An excess of oil, carbonizing in the cylinder head and on the valves, becomes incandescent. This occasionally gets so bad that the motor will continue to run even after the switch is open.

The frequent use of kerosene as before suggested will prevent this deposit from accumulating.

The proper management of the spark is acquired by use. Generally speaking, it is a good practice to run with a well advanced spark using no more gasoline than conditions of road, speed, etc., demand, and it is poor operating to run with a retarded spark and rely on the throttle, as it is not only wasteful of fuel but tends to overheat the motor.

CHAPTER XI.

ON THE ROAD.

The difficulties that a motorist meets while touring are of two kinds. The first consists in breaking some part where repair is out of the question, or it may be possible to make a temporary repair in order to run the car home under its own power. It is surprising how much can be done with an ordinary repair outfit and a plentiful supply of wire. Such occurences are, however, rare, and more often result from accident than through failure of any important part. The second and larger class is that covered in the chapter on "Power Losses."

If a motor has been running well and begins to miss, the trouble increasing till the engine stops, the ignition should come under suspicion.

The first step would be to test the "batteries." If these are found strong, that is, all showing over seven amperes, examine the coil and see if vibrators have the proper sound. (See chapter on Ignition for the proper method of tuning vibrators.) If not they should be properly adjusted.

Now crank the motor. If it does not start readily, the plugs should be removed and tested. (See chapter on Ignition, Sooted and Dirty Plugs.)

If no spark occurs try new plugs. If still no spark occurs and the vibrator works, there is a short circuit in the high tension system. All cars employ such heavy secondary cables that short-circuiting here is unlikely.

An excess of cylinder oil will carbonize on the plugs, short circuiting them. These should be either cleaned or replaced by new ones. The pet cocks in the cylinder should then be opened, allowing the excess of oil to blow out, after which the cocks must be closed. In adjusting the oilers follow the advice given by the makers.

If a motor suddenly fires on one cylinder only, the trouble probably lies in a sticking vibrator, sooted plug, or a loose coil or commutator wire.

A choked nozzle in the carbureter will either stop the motor at once, or cause it to miss several explosions, then fire rapidly, a moment after which it will miss again. On opening the throttle the motor will probably stop. In this case the remedy is to remove and clean the nozzle. (See chapter IX.)

CARE OF TIRES. Though subjected to the hardest use, tires usually receive little or no attention. The life of the tire is in proportion to the care it receives.

Oil and grease are ruinous to rubber, and tires should be kept free from them.

Never run with flat or partially deflated tires, but be sure that they are always hard.

When cuts appear in the outer shoe so as to expose the fabric, have the same promptly repaired, otherwise water will get under the rubber and rot the fabric; this will later result in a blow-out.

When applying the brakes do not engage them so suddenly as to lock the wheels. Sudden starting as well as stopping imposes unnecessary wear on the tires and strains the entire chassis as well.

Punctures in inner tubes can be patched if care is taken. However, vulcanizing is much the surer and safer way. At least two inner tubes should be carried in the car at all times. It is almost impossible to properly repair a tire on the road.

When a puncture occurs remove the casing and insert a new tube. The punctured tube can then be sent away and properly repaired, after which it will be as good as new.

A blow-out or bad cut in the outer casing requires a new shoe, and for this reason an extra one, properly covered to protect it, should always be carried.

A fact that must never be lost sight of in deciding upon the tire equipment for a car is the ratio between the weight of the car and diameter of tire. This problem has been carefully worked out by every manufacturer, and their standard equipment is correct on this all important point.

An interesting instance of this was shown in the recent Burrelle tire test at Long Branch. This was a failure, inasmuch as it did not prove conclusively which tire could withstand the most abuse.

The test, 2,000 miles, was covered with but little tire trouble, though the most adverse conditions were experienced. It was intended that the test should be so severe that the wearing qualities of the various makes would be tested and a comparison then made. Owing to the excellent showing made by several tires, this was impossible.

Hence, the test, though a failure in one sense, established an important point—that a tire can successfully withstand 2,000 miles of abuse, provided it is large enough.

It is safe to say that had smaller tires been used on these same cars they would not have completed the first thousand miles. Another interesting point aside from the tire question, though really a part of it, and more closely allied to it than is generally understood, is the proper proportioning of weight in the cars used, this being such as to impose a minimum of wear on the tires.

Until recently the tires were almost invariably too small for the load to be carried. Now that this subject is better understood the future will see immunity of tire trouble from this cause.

SKIDDING. On wet asphalt or on muddy or clay roads, the greatest care must be exercised to prevent what is known as "skidding," or a lateral movement of the car.

This is particularly objectionable when rounding a turn or on too sudden an application of the brakes. If proper judgment is used, there is no danger on this score.

When approaching a sharp corner on a wet or slippery day, release the clutch and let the car coast around, after which the clutch can be engaged.

WINTER DRIVING. There are many motorists who use their car throughout the entire winter, and by dressing warmly the car can be used with considerable enjoyment.

In order to obtain traction in the snow or ice, the tires should be fitted with some special tread or grip. There are several tires especially prepared for this purpose. Chaining the rear wheels also answers the same purpose.

In the winter, care must be used to prevent the water from freezing in the cooling system, as ruined cylinders and radiator will result.

On extremely cold days the car should not be left standing with the motor dead; it is safe to leave a car with the motor running. When a car is put up for the night, unless the garage is properly heated, all water should be drawn from radiator and cylinder jackets.

As this entails considerable trouble, it is advisable to use some good anti-freezing solution.

CHAPTER XII.

ANTI-FREEZING SOLUTIONS.

CALCIUM CHLORIDE. Make a saturated solution of calcium chloride by dissolving fifteen pounds of commercially pure calcium chloride to a gallon of water. This will make two gallons of saturated solution. Dilute with an equal part of water. This makes a cooling solution that will stand a temperature of 15 below zero. Specific Gravity 1.20.

The above solution is largely used. There is, however, a danger of injuring the cooler by a prolonged use of this solution, as the liquid has a tendency to attack the solder. A small amount of lime added to the solution will remove any tendency to acidity.

GLYCERINE. Glycerine and water is also used. A 33% solution will withstand a temperature of 10% above, while a 50% solution will not freeze at 10 below zero.

There is no danger of injury to the cooler from using this solution. Glycerine has, however, a tendency to disintegrate rubber.

WOOD ALCOHOL. The disadvantages inherent in both the Calcium Chloride and Glycerine Solutions are eliminated by the use of a solution of alcohol and water.

The advantages of this solution are that it has no injurious action on either metal or rubber.

The percentage of alcohol and water depends upon the climatic conditions to which your car is exposed.

A 15% solution will prevent freezing at a temperature of 15° above zero, such as late fall and early spring weather. Later in the winter season, a 40% solution is safe, as such a mixture will not freeze at 25° below zero.

A certain amount of vaporization will take place; such should be replaced by a 50% solution. It will be found that in a well-designed radiator the evaporation will be exceedingly small.

Per Cent. Alcohol.	Temperature in Degrees F. that Solution Will Withstand.
10	18° above
25	0°
40	24° below

CHAPTER XIII.

THE STORING AND HANDLING OF GASOLINE.

There are certain conditions imposed by insurance companies and city authorities governing the handling and use of gasoline, and an owner of a car should first post himself on these before installing any system. In cities where the car is kept at a garage, the problem is solved. In the case of an owner having his own garage there are several excellent systems in use all complying with the insurance regulations.

Gasoline cannot economically be kept in barrels, as the evaporation, even though the barrel be tightly sealed, is excessive. A simple and efficient arrangement for the country consists in a cylindrical iron tank hung on a suitable frame. The gasoline can then be piped to some convenient place. The advantages of this system are its simplicity and cheapness. In more populated territory, or where the tank would be unsightly, some underground system must be employed. It is important to install a tank of sufficient size, as it not only saves the annoyance of having to refill it constantly but better rates can be obtained than when buying gasoline in small quantities. A proper gasoline storing outfit is fairly expensive. It is, however, poor policy to economize here, as a good reliable system will last almost indefinitely and always prove a source of satisfaction.

In this connection, a word about the combustibility of gasoline may not be out of place. To the general public, gasoline is a dreadful substance, whose object in life is to "blow up." While this is not true, as many a motorist can testify who has vainly tried to get a charge to ignite, at the same time care must be used in handling it, and it should never be brought near an open flame. In case a gasoline fire starts, do not pour water on it, as it only makes the matter worse. Dry sand, salt, or some dry chemical extinguisher should be used. Two or three fire extinguishers hung in the garage may at some time be the means of saving not only the car but the building as well.

If possible, a square hole should be made in the floor. An old register is an excellent covering for it. Then if any leakage occurs in the gasoline system of the car, the vapor being heavier than air would sink and pass out.

Oil soaked waste should not be kept lying around, as more than one fire has been started by spontaneous combustion. In this connection it is only fair to say that conditions must be exactly right for this to occur. There is no danger from either explosions or fire, provided gasoline is properly stored and handled.

CHAPTER XIV.

SUGGESTIONS.

Don't examine your gasoline tank at night with a match—it's dangerous.

It is an excellent scheme to mark the wires, both high and low tension, by pasting numbers on them and similar ones at their proper terminals. They can then be assembled readily should occasion arise making it necessary to remove them, without the bother of trying and testing in order to rewire properly.

A vent is provided in the gasoline tank—this must be kept open. Otherwise the fuel will not feed readily to the carbureter.

Don't neglect to strain all gasoline through a chamois skin.

After a long run a little kerosene squirted into the cylinders will free the rings and leave the motor in good condition.

The valves of an engine should be occasionally ground. If a valve is well-seated, but little grinding is needed to keep it tight, whereas if it becomes pitted from long neglect the operation is lengthy and tiresome.

Nuts that have rusted tight can frequently be loosened by kerosene. This failing, heat must be applied.

In cranking a motor do not press down against the compression for if the spark lever has carelessly been left advanced a serious kick will result, and possibly a broken arm or head.

In cranking a motor pull up. If then it back-fires, no harm will be done.

The condition of an accumulator can be ascertained by the color of the plates. When charged, the positive plates are of a chocolate color, the negative plates being lead color. When in a discharged condition the plates are both reddish.

Don't neglect to see that all tanks are full before starting on a run, or a late return may be experienced.

A leaky carbureter is a dangerous thing. Make sure the needle valve is tight so that flooding does not occur.

Proper lubrication is of vital importance. See that all the moving parts receive their supply of oil.

Don't move from the garage without a jack and a spare inner tube. Punctures always occur at inopportune times.

Attention should be paid to details. All nuts, bolts, etc., should be provided with some satisfactory means of locking. The vibration to which a car is subjected has a tendency to loosen the nuts. The brakes should receive attention and be relined when necessary.

An engine that leaks oil constantly is unpleasant to run and has a disagreeable odor. If all joints are properly fitted or gasketted, trouble on this score will be averted.

A spark plug that is sooted can often be cleaned without removal from the cylinder by detaching the cable from the plug. Then start the motor and hold the wire about one-quarter of an inch away. This makes a spark gap and the plug will fire, even if badly sooted; the plug will often burn itself clean.

If on replacing the wire the cylinder again misses, the plug should be removed and cleaned, or a new one substituted.

A choked vaporizing nozzle can often be freed by flooding the carbureter or speeding the motor; the increased suction is frequently sufficient to carry away the obstruction.

In passing a frightened horse, it is best to pass as quietly as possible rather than stop. The sudden stopping has a tendency to cause the horse to whirl in the shafts, overturning the carriage.

If the driver signals by raising his hand, the car should be brought to a stop at once. Most states require this by law.

Any unusual noise should be investigated at once, as it is a sure indication that something is wrong.

A squeak means a lack of lubrication at some point and a possible break-down later on. This should be attended to at once.

A knock such as is caused by a loose bearing needs attention at the earliest possible opportunity.

Tires should be pumped up until hard. If in shaking the car a side roll is noticeable, the tire is not inflated sufficiently.

If on a cold morning the motor does not start readily, a small amount of gasoline squirted through the pet cocks into the cylinders or on the gauze in the intake pipe will overcome the difficulty.

A car coming in covered with mud should be washed at once. If left to harden over night, the varnish will be spotted and the fine appearance of the car ruined.

In using a wrench, be sure that it exactly fits the nut. Otherwise, the corners will become rounded making its subsequent removal difficult.

The gear case and housing for drive gears and differential should be thoroughly washed out with kerosene and then repacked once or twice a season.

Valve springs should be at the proper tension; both inlet and exhaust should be occasionally removed and stretched.

Racing the engine should be avoided. It is poor operating and unnecessarily racks the motor.

Any failure in the circulating pump will cause the water to boil in the radiator. Clouds of vapor issuing from the steam vent in the cooler indicate trouble from this cause. If the car is run without water in the cooling system it is needless to say that the cylinders will overheat and probably be ruined. This is due to rank carelessness on the part of the operator. Should a seizure of a bearing occur due to this cause allow the motor to cool off. Do not pour water on it. After it has cooled the radiator can be filled and the motor plentifully supplied with oil.

CHAPTER XV.

EQUIPMENT.

The proper equipment for a car is a matter that should be given careful attention.

No hard and fast rule can be laid down, as an equipment necessary for an extended tour would be unnecessary and cumbersome if the car is to be used locally. At the same time, it is better to carry a full set of tools, spare parts, etc., and never need them, than to want them some time and not have them.

The following list is fairly complete and should meet ordinary conditions:—

TOOLS. Complete set of wrenches as furnished by the manufacturer, including open end, socket and valve plug wrenches.

12 inch Stilson wrench.
6 " Alligator "
Bicycle "
12 inch Monkey "

If the car is chain driven, an extra chain or spare links should be carried.

8 inch Screw driver.
2 " " "

This latter is particularly desirable in adjusting vibrators, oilers, etc.

Three-quarter pound machinist's hammer.

Combination plyers.

Punch.

Cold chisel.

Rat-tail file.

Half round file.

Box of assorted nuts, screws and cotter-pins.

The above are small and require but little room. So much time is saved on a road-side repair by having the proper tools that they are well worth taking along, rolled compactly in a tool sack.

ELECTRICAL ACCESSORIES.

Battery terminals.

Battery connections assorted sizes.

Spool of insulated copper wire.

Spool of iron wire.

Pocket "ammeter-voltmeter" combined.

Small dead smooth file for dressing platinum points.

Extra spark plugs (at least three).

TIRES. Inner tubes (at least two of these should be kept in a water-proof bag and sprinkled with French chalk).

Extra casing (properly protected from the weather by some suitable cover).

Tire manchon.

Large roll tire tape.

Tire repair outfit.

Jack.

If touring in a section where roads are clayey, "tire chains" should be carried. These can be quickly applied and give excellent traction even on ice.

MISCELLANEOUS.

Tire pump.

Goggles.

Calcium carbide for gas lamps.

Gre-solvent for cleaning the hands.

Old pair of gloves.

Old duster or overalls.

Small can of compression grease.

Quart can of cylinder oil.

Oil gun.

Waste.

Extra parts.

Funnel filled with chamois skin for straining gasoline.

This list though more complete than the average motorist is apt to carry is none too large where any extended touring is contemplated.

It can be enlarged or cut down as experience seems to dictate and gives a basis to which a novice can refer.

CHAPTER XVI.

HINTS ON OPERATING A CAR.

Sliding Gears.

When a man becomes the owner of a car he should look for instruction to the agent from whom the car was purchased. In this connection it might be well to say something concerning the duties of an agent. There are too many so-called agents who feel that all responsibility ceases when the car is once sold. Such a short sighted policy does untold damage, not only to the agent himself, but to the manufacturer whom he represents.

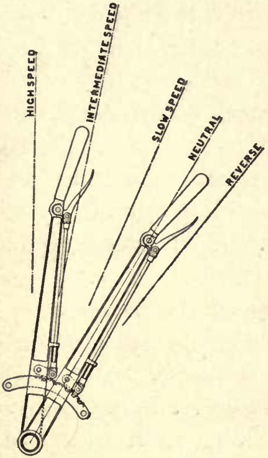
A customer becomes either enthusiastic or dissatisfied according to the service that the car gives. And it lies in the power of the agent to largely control this.

It happens often that a car is brought into a section in which there is no agent or competent instructor. In this case the instruction book as furnished by the factory should be carefully studied and every detail mastered before any attempt is made to run the car.

TO PREPARE FOR A RUN. See that all tanks are properly filled. If there are any grease cups on the car these should be packed with grease, the brakes should be examined to be sure that they hold—the tires should be hard.

TO START THE MOTOR. Put the gears in neutral position. In the progressive system this is usually the second notch on the quadrant from the front.

Fig. 32



Lever position denoted in diagram. If you are not certain which is the neutral position let in the clutch, then make sure that the switch is open. Crank the engine. If the car does not move the gears are at neutral point.

When all is in readiness close the switch, prime the carbuter and reard the spark. This is important as a back kick will result if spark is carelessly left in an advanced position.

Crank the motor—in this connection, do not press down, but pull up against the compression. The motor should start immediately. In cranking, one or two quick turns is preferable to an hour of slow turning.

When the motor has started, turn on all lubricators that are not automatic. The motor should be so adjusted when it leaves the factory that it will run slowly with retarded spark and closed throttle.

The operator should take his seat and speed the motor up moderately by opening the throttle and advancing the spark. (Do not race the engine). Press down on the foot clutch and throw gears into low speed, that is, the lever is advanced one notch. The clutch should then be let in gradually.

To stop, press down on both pedals. It is a safer and surer method for the beginner to release the clutch by the hand lever, the objection to the use of the foot pedal being that the moment the pressure of the foot is released the clutch engages, while with the hand lever it cannot spring back by accident.

The car should be run on low speed until the matter of steering becomes easy and the operator has gained some confidence in himself. Then second speed can be tried.

SHIFTING TO SECOND. Speed the motor moderately. Then press down on the clutch-release at the same time advancing the gear control lever to the next notch, after which the clutch should be let in gradually. The second speed is an excellent one upon which to practice, for the motor does not have the same tendency to overheat as when used constantly on low, and at the same time an excessive speed cannot be obtained.

HIGH SPEED. After becoming familiar with the operation of using spark and throttle, also stopping and starting, the high speed can be tried.

As before, press down on the foot pedal and bring the gear lever sharply back as far as it can go. Then immediately let in the clutch.

Do not attempt fast driving until complete mastery over the car is obtained. Steering is an easy matter, more so at high than low speed. At the same time an accident can easily happen and at high speed a beginner may not be able to act quickly enough to prevent it.

REVERSING. Before attempting to reverse, the car should be brought to a complete stop. The clutch should be released by the hand lever. The gear lever should then be thrown forward as far as possible after which the clutch should be gradually engaged. As a car is backed for short distances only, the operator should keep hold of the clutch lever so that the car can be instantly stopped.

POINTS ON OPERATING. The foregoing has simply described the operations in changing gears. There are, however, a number of little points, niceties in operation, that make either a good or indifferent driver.

In attempting to change gears when the car is standing the gears often will not mesh.

If the clutch be very gradually engaged till the friction surfaces barely touch, the gears on the counter shaft will revolve. Then the gear lever can be shifted to the desired position. As, however, all sliding gear cars should be provided with a lock, making it impossible to change gears when the clutch is engaged, it is then equally impossible to let in the clutch if the gears are not fully meshed. Hence this plan cannot be used in cars fitted with this safety device. A slight movement of the car or a change of position in the clutch lever will let the gears readily mesh.

A good plan is to shift into second or low before the car entirely stops. The change is then easily made and the car ready to start. Usually speaking the gears should be left at neutral point particularly if car is left with the motor running.

The secret in changing gears is to mesh them sharply. Do not make the change slowly as the edges of the teeth then only grind. Never look down at the quadrant to see if the lever is at the proper notch. The attention of the driver should be concentrated on the road. It requires some practice to know exactly when the gears are meshed, but the driver soon becomes so familiar with the proper position of the gear lever for each different speed that it is never necessary for him to look at the quadrant in order to hit the right one.

In changing gears the speed of the car before changing should approximate the speed changed to, that is, on ascending a hill that cannot be taken on high, the clutch should be withdrawn and gears quickly shifted to second. The motor then should be so speeded, that when clutch is let in the two speeds should correspond. Never continue on high speed so that the motor labors, as it will not only strain the engine, but the vibration also becomes unpleasant.

In changing from a low to a higher gear the ideal condition would be to speed the car and slow the motor. As it is impossible to speed the car except by the motor, the change should be made rapidly in order that the car lose as little of its momentum as possible,

The sliding gear construction is standard on large cars and for such has proved itself the most satisfactory. The pleasure and satisfaction that is attained by their proper manipulation, is well worth the little time it takes to thoroughly master this type of transmission.

THE OPERATION OF PLANETARY GEARS.

. The usual type of planetary transmission gives two speeds forward and one reverse, all being controlled by a single lever at the side.

This construction gives two neutral points, one between high and low speed, the other between low and reverse.

TO START THE CAR. The lever should be in neutral position between either high or low, or low and reverse, the latter being preferable for starting. The motor should be moderately speeded, then lever gradually thrown forward until the low speed engages. The car should start evenly. If it starts with a jerk it is a sign that the low speed clutch or band was too suddenly engaged. When the car has obtained a fair speed push the lever as far forward as it will go. This engages the high speed clutch. In stopping, the lever should be withdrawn to neutral point between high and low and brakes applied.

When running on high speed do not pull into low until the car has been slowed down to approximately that of the low speed. It must be remembered that the low speed acts as a powerful brake if engaged when the car is running fast, and will bring the machine up with a suddenness that will probably throw the occupants out or break some part of the transmission or differential.

It is possible when running on the high to pull through low provided it be done quickly, care being taken not to throw over into reverse.

The object as in sliding gears is to maintain as even a movement of the car when changing speeds as possible. This is readily acquired by a little practice.

CHAPTER XVII.

Automobile Terms and Their Equivalents in French, German and Spanish.

ELECTRICAL	ELECTRIQUE	ELEKTRISCH	ELECTRICO
Dry cell	Pile sèche	Trockenes Element	Pila seca
Accumulator	Accumulateur	Akkumulator	Acumulador
Commutator	Commutateur	Kommutator	Conmutador
Induction coil	Bobine d'induction	Induktions-Spirale	Bobina de inducción
Spark plug	Cheville á étincelle	Funken-Stöpsel	Clavija de chispa
Switch	Interrupteur à levier	Umschalter	Conmutador corta corrientes
Vibrators	Vibrateurs	Vibratoren	Vibrantes
Primary current	Courant principal	Primärer Strom	Corriente primaria
Secondary current	Courant induit	Sekundärer Strom	Corriente secundaria
Terminals	Bornes	Klemmen	Términos
Battery connections	Accouplements de baterie	Batterie-Verbindungen	Conexiones de batería
Ammeter	Ampèremètre	Ampèremeter	Amperímetro
Voltmeter	Voltmètre	Voltmeter	Voltímetro
Copper wire	Fil de cuivre	Kupferdraht	Hilo de cobre
Platinum points	Pointes de platine	Platin-Spitzen	Puntas de platino

CARBURATION	CARBURATION	KARBURATION	CARBURACION
Carburetter	Carburateur	Karburator	Carburador
Throttle	Soupape d'arrêt	Zulass-Ventil	Válvula de cuello
Accelerator	Accélérateur	Beschleuniger	Acelerador
Needle valve	Soupape à aiguille	Nadel-Ventil	Válvula de aguja
Air valve	Soupape à air	Luft-Ventil	Válvula de aire

ENGINE	MACHINE A VAPEUR	DAMPF-MASCHINE	MAQUINA DE VAPOR
Motor	Moteur	Motor	Motor
Valves	Soupapes	Ventile	Válvulas
Exhaust valve	Soupape d'échappement	Abzugs-Ventil	Válvula de educción
Inlet valve	Soupape d'arrivée	Einlass-Ventil	Válvula de aspiración
Valve springs	Ressorts de soupape	Ventil-Federn	Muelles de válvula
Inlet pipe	Tuyeau de prise	Einlass-Rohr	Tubo de toma
Exhaust pipe	Tuyeau d'échappement	Abzugs-Rohr	Tubo de escape
Cotter pins	Clavettes de fixation	Keil mit Gegenkeil	Chabetas de fijación
Piston	Piston	Kolben	Émbolo
Piston rings	Ressorts de piston	Kolben-Ringe	Argollas de émbolo
Cylinder	Cylindre	Zylinder	Cilindro
Crank shaft	Arbre en vilebrequin	Schrauben-Welle	Eje de biela
Crank case	Nille	Kurbel-Heft	Chaqueta de biela
Connecting rod	Bielle	Trieb-Stange	Biela
Wrist pin	Boulon de bielle	Triebstangen-Bolzen	Perno de biela
Nuts	Écrous	Schraubenmuttern	Tuercas
Bolts	Boulons	Bolzen	Pernos
Screws	Vis	Schrauben	Tornillos
Bushings	Doublure	Fütterung	Forro

COOLING SYSTEM	SYSTEME DE REFRIGERATION	KUHL-APPARATE	SISTEMA DE REFRIGERACION
Radiator	Radiateur	Ausstrahler	Radiador
Cooler	Réfrigérant	Kühler	Refrigerador
Fan	Éventail	Fächer	Abanico
Belt	Courroie	Riemen	Correa
Pump	Pompe	Pumpe	Bomba
Hose	Manches	Schlauch	Manguera
Hose clamps	Crampons à manches	Schlauch-Klammer	Grapas para mangueras

RUNNING GEAR	PARTIES D'AUTOMOBILE	AUTOMOBILTEILE	PARTES DE AUTOMOVIL
Frame	Train	Gestell	Armazón
Front axle	Essieu de devant	Vorder-Achse	Eje delantero
Rear axle	Essieu postérieur	Hinter-Achse	Eje posterior
Differential	Engrenage différentiel	Differential-Triebwerk	Engranaje diferencial
Wheels	Roues	Räder	Ruedas
Chains	Chaînes	Ketten	Cadenas
Shaft	Arbre	Welle	Árbol
Cardan joint	Jointure à la Cardan	Cardan-Gelenk	Juntura de Cardan
Gears	Engrenages	Triebwerk	Engranaje
Steering wheel	Roue directrice	Steuer-Rad	Rueda guiadora
Steering post	Barre directrice	Steuer-Stange	Poste-timón
Springs	Ressorts	Federn	Muelles
Spring clips	Pinces à ressort	Feder-Klammern	Grapas de muelle
Spring shackles	Crampons à ressort	Feder-Kuppelungen	Trabas de muelle
Balls	Boules	Kugeln	Bolas
Cones	Cônes	Kegel	Conos
Rollers	Rouleaux	Walzen	Rodillos
Brakes	Freins	Bremsen	Frenos
Brake lining	Doublure de frein	Bremsen-Fütterung	Forro de freno
Brake drum	Tambour de frein	Bremsen-Trommel	Tambor de freno
Clutch	Manchon d'embrayage	Kuppelung	Embrague
Clutch pedal	Pédal à embrayage	Kuppelungs-Pedal	Pedal de embrague
Clutch lever	Levier à embrayage	Kuppelungs-Hebel	Palanca de embrague
Grease cup	Boite à graisse	Schmier-Büchse	Caja de sebo

SUPPLIES	ACCESSOIRES	ZUBEHOR	ACCESORIOS
Gasoline	Gazoline	Gasolin	Gasolina
Cylinder oil	Huile à cylindre	Zylinder-Oel	Aceite para cilindros
Machine oil	Huile à machine	Maschinen-Oel	Aceite para máquinas
Calcium carbide	Carbure de calcium	Kalzium-Kohle	Carburo de calcio
Candy carbide	Carbure de candy	Candy-Kohle	Carburo de candy
Grease	Graisse	Schmierfett	Grasa
Water	Eau	Wasser	Agua
Kerosene	Pétrole	Petroleum	Petróleo
Freezing Solution	Mélange réfrigérant	Gefrier-Lösung	Solución para congelar

EQUIPMENT	EQUIPEMENT	AUSRUSTUNG	EQUIPOS
Wrenches	Clefs	Schraubenschlüssel	Llaves
Screwdriver	Tournevis	Schraubenzieher	Destornillador
Hammer	Marteau	Hammer	Martillo
Stilson wrench	Clef à molette à une seule mâchoire mobile	Stilson-Röhren-Schlüssel	Llave para tubería
Jack	Cric	Winde	Cric
Oil can	Burette à huile	Oelkanne	Aceitera
Wire	Fil de fer	Draht	Alambre
Rivets	Rivets	Nieten	Remaches
File	Lime	Feile	Lima
Horn	Corne	Horn	Cuerno
Oil lamps	Lampes à huile	Oellampen	Lámparas de aceite
Gas lamps	Lampes à gaz	Gaslampen	Lámparas de gas
Gas generator	Générateur de gaz	Gas-Erzeuger	Generador de gas
Odometer	Odomètre	Odometer	Odómetro
Speedometer	Indicateur de vitesse	Schnelligkeitsmesser	Indicador de velocidad
Gradometer	Gradomètre	Gradometer	Gradómetro
Rope	Cordage	Seil	Cuerda
Tire pump	Pompe à pneumatiques	Luftpumpe	Bombas para neumáticas
Valve plug wrench	Clefs pour chevilles de soupape	Schlüssel für Ventilbolzen	Llave para clavija de válvula
TIRE REPAIR OUTFIT	**EQUIPEMENT POUR LA REPARATION DE PNEUMATIQUES**	**UTENSILIEN FUR GUMMIRAD-REPARATUREN**	**AVIOS PARA REMENDAR NEUMATICOS**
Tires	Pneumatiques	Gummiräder	Neumáticas
Casing	Revêtement	Verkleidung	Estuche
Inner tube	Tuyeau intérieur	Innere Röhre	Tubo interior
Patching rubber	Caoutchouc à rapiécer	Reparatur-Gummi	Caucho para remendar
Patches	Pièces pour rapiéçage	Reparatur-Stücke	Remiendos
Cement	Ciment	Zement	Cemento
Tire tape	Ruban pour pneumatiques	Gummirad-Band	Cinta para neumáticas
Tire manchon	Manchon à pneumatiques	Gummirad-Manchon	Manchon de neumática
Puncture	Piqûre	Punktur	Puntura
Chalk	Craie	Kreide	Greda
Blow-out	Appareil à purger	Blase-Apparat	Aparato de expulsión
Vulcanize	Vulcaniser	Vulkanisieren	Vulcanizar

CHAPTER XVIII.

AUTOMOBILE MATERIAL AND CONSTRUCTION.

By Jonathan D. Maxwell, M. E.

There is no subject so important to the automobile as that of the material of which it is made.

The growth and development of the industry has been so rapid that the producers of the raw article have been taxed to their limit to meet the demands. Therefore, in the past the quality of the material has been somewhat neglected and has not been improved as much as it should have been.

In some instances, manufacturers of automobiles have considered themselves fortunate to get material of any quality, but beginning with the present and in future these conditions will change. The greatest revolution of the automobile in the next decade will be in the material of which it is made.

It has been said that we cannot produce automobiles in this country equal to those that come from abroad. This, however, is not a fact. The formulaes and specifications as well as methods used in Europe in the construction of automobiles are no secret in America to either the producer of the raw material or of the finished car.

We predict that within the next ten years America will lead the world in the production of motor vehicles of all kinds in both quality and quantity.

The fact is that in some of our medium-priced cars we are to-day using bronze, steel and other materials that are made from as good, if not quite the same, formulaes as are used in Europe on some of the most expensive cars, some of which are sold quite extensively in America for seemingly fabulous prices.

This statement can be verified by analysis. Where America excels is in simplicity, which is synonymous with perfection. American manufacturers in their popular-priced as well as some of their higher-priced cars have never been copiers of the foreigners, but have with characteristic independence proceeded to build them according to the American idea of the way an automobile should be made.

It is true that Europe had the advantage of us a few short years ago by reason of their earlier start in the business, but we accepted their challenge and to-day the "made-in-America" automobile can be seen in every civilized country where automobiles can be used. It has been truly said that "the sun never sets on an American built car."

The building of an automobile requires patient thought and much study. The designer should have placed before him, in such manner that he cannot overlook them, these motives: "Simplicity, Strength and Lightness."

Simplicity comes first, for complication results in the mulitplication of parts, with consequent likelihood of trouble and heavy cost of upkeep.

Strength must be uniform. This is by no means an easy thing to get. In some of the more complicated cars there are no less than three thousand different parts made of various kinds of material entering into their construction. Therefore the designer must take each one of these materials and study it for strength.

He cannot always confine himself to such as he can buy in the open market, but must bring into use new materials made from special formulaes, after which he shapes them into the proper forms, to produce the greatest amount of strength and rigidity.

Each and every part of an automobile from the ground up should be designed so that one part should be no weaker than another, yet every part must be made strong enough to do its legitimate work with a reasonable factor of safety.

While the designer is selecting his material and studying the various shapes he must keep before him the very important question of lightness. To obtain this he must use the very best material of the kind obtainable, made specially for the purpose for which he uses it.

Beginning with the wheels, an A1 grade wheel should be made from a selected stock of second growth hickory, but on account of the scarcity of hickory a number of manufacturers make every second or third spoke of second growth ash, which makes a very strong wheel and seems to stand the strain and wear quite as well as the all-hickory wheel; but the manufacturer who insists on cheapening his product by the insertion of too many spokes of inferior wood finds that it results in the spokes loosening and in some cases giving way altogether, with sometimes disastrous results.

There has never been anything discovered or invented to take the place of the wood spoke wheel of the artillery pattern. There have been wheels made entirely of steel of various kinds, some of them resembling the wood wheel very closely, but for various reasons, the principal one of which is the cost of manufacture, they have never become popular.

The wire wheel is the close competitor of the wood wheel and is somewhat lighter, but on account of the great difficulty of keeping a uniform tension on the spokes and their likelihood to rust, due to the impossibility of drying the spokes after washing, or running in the rain, it has not met with a great deal of favor.

SPRINGS.

The best springs are made from a special grade of spring steel. The better the steel the better the spring, although the quality of the spring does not depend wholly on the quality of the steel. A good spring maker will make a better spring of a poorer grade of steel than a poor spring maker can make of a better grade of steel.

There are no templets or gauges for a spring maker to go by when he is shaping the different leaves into place. He measures his first leaf or "plate" as he calls it. After that the rest of the work is done with his eye, each successive leaf being fitted to the other in a manner that allows it to carry its own proportion of the load.

Many a spring has had a broken leaf because the maker did not get it fitted properly, and not because it was too hard or the quality of the steel too poor.

It is the practice of some repair shops when a spring has a broken leaf to take a leaf out of another spring to replace it. In some cases that kind of a repair may be satisfactory, but it will often happen that the replaced leaf will break again or cause the spring to break in some other place because it does not fit properly. A broken spring should be taken to a spring maker for repairs wherever it is possible to do so.

AXLES.

The axles for automobiles seem to be a question on which a great many American designers as well as some of the foreigners hold different opinions as to shape and construction.

In this country a year or two ago there were about an equal number of solid axles of the round and square cross sections, as well as the tubular cross section, but about that time there was an axle brought out in Europe with an "I" section. This was copied to some extent in this country. Any of these designs if made of the proper material give very good results, but the tabular axle seems to be the only one of them that is its own guarantee of the quality of the material of which it is made.

A solid axle of any construction may conceal flaws that cannot be detected by any one until it lets go and breaks with its consequent results.

This is not so with an axle constructed of steel tube. It may bend if subjected to undue stress but it will not break, as there can be no concealed flaws.

A seamless steel tube cannot be made of anything but the very finest grade of steel on account of the process of drawing which it has to go through, this being the only kind of tubing used in the construction of axles.

There are not many people who know how seamless steel tubing is made. The first operation is to heat a large billet of steel which is placed in a powerful machine beween two rollers, the axes of which are located at an angle to each other, in which it is pierced lengthwise through the center. This is the first operation and the beginning of the steel tube.

The next operation is to reheat and draw it through a die which reduces the size and increases the length. This second operation is repeated until the tube is sufficiently reduced for the final operations of cold drawing.

The cold drawing is very similar to the previous operations excepting that they do not heat the tube again, but draw it through the dies cold, which gives it a bright polish and compresses the grain of the steel and adds to the stiffness quite materially. It is taken in this condition direct from the machine and used for axle stock. Being reheated after the final operation of cold drawing anneals and softens the steel, making it unfit for axle use.

It can be seen that if any flaws existed in the steel that they would easily be detected in the cold drawing operation.

BEARINGS.

There are about as many different kinds of bearings used in automobiles as there are different makers. Some makers are using a perfectly plain bearing throughout their cars, while others stick to the ball type, but the majority have gone to the roller bearings of various kinds.

Roller bearings for rear axles seem to have taken the lead and are giving the best satisfaction, while for front wheels there have been various kinds of roller bearings tried but the ball type seems to still hold a good place.

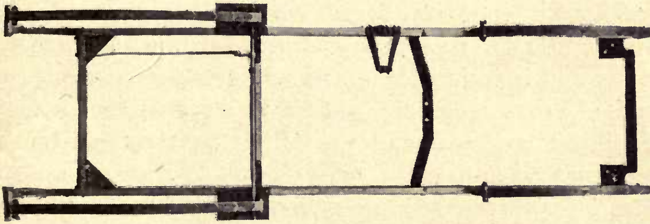
There have been used, with varying success, in a few cars, ball bearings on the crank shaft main bearings, and in some cases they have been used on the connecting rods, but their success has been a question which is still open and in doubt.

Some designers have tried roller bearings on cran shaft main bearings but their use has not proved success. Therefore for this purpose some of our be designers are using a special steel crank shaft wit a hard phosphor bronze bearing or a good grade Babbit metal.

In transmission gears ball and roller bearings a pretty generally used with the roller bearings gainir in favor very rapidly, principally on account of the flexibility, and their freedom from breaking and lik lihood to give down under sudden shocks or hea loads.

FRAMES

Frames have been made in a great many differer ways. In the earlier construction it was thought ne essary to use some equalizing device to insure fle ibility to compensate for the unevenness of the roa but this idea has long since been proved unnecessar



although automobiles are being used to-day over roa and under conditions of which no one ever dreame in the beginning.

The accepted design of frame at the present is that of the pressed steel channel, made full width in the middle and tapering toward the ends, although there are some makers that still adhere to the old style construction—that of the angle steel as well as the steel tube or a combination of wood and iron.

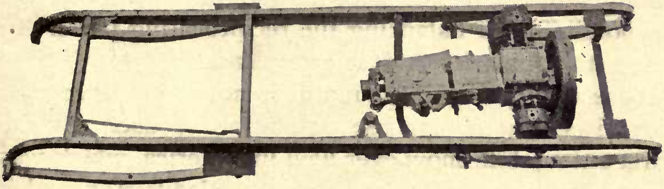
The angle steel and the steel tube frames have a disadvantage because it is impossible to reinforce or strengthen them in the middle where the greater part of the load comes without putting truss rods underneath. This it is not desirable to do on account of their appearance and also the likelihood of their coming loose and rattling.

The combination wood and metal frame is not subject to the same objections as the angle steel and tubular, but it has no advantage over the pressed steel frame and is somewhat heavier and not so strong when considered weight for weight.

The pressed steel frames give a better result when not used in connection with what is known as a "sub-frame." This sub-frame is usually built somewhat lower and is connected to the main frame by means of arched cross members, and it is designed to receive the motor and transmission. This construction has a tendency to stiffen the main frame to such an extent that it has been known to break when used on very rough roads.

Owing to the higher rate of speed and rough usage that users of automobiles are pleased to give them, flexibility is a very important question in frame construction. For that reason some makers use a frame consisting of two pressed steel side channels connected together by three or four cross members, suitably located.

The motor and transmission are combined into a single unit, which is mounted or suspended to or on the frame at no more than three points, thus involving the principle of a three-legged stool.



When the motor is supported in this manner, should any undue strain be applied to the frame at any point sufficient to strain it to the full limit of its flexibility, it cannot disturb the alignment of the motor and transmission gearing, and thereby cause damage or undue wear.

MOTORS.

In the short space of time since the advent of the use of the gasoline or hydro-carbon engine for automobile use, there has been almost every conceivable design brought out. There was the one cylinder, the two cylinder, the three cylinder, the four cylinder, the six cylinder and a few eight cylinders.

There has been the horizontal cylinder, the vertical cylinder above the crank, the vertical cylinder below the crank, cylinders located at an angle of 45 degrees and cylinders located in a number of other positions, but it is our intention to mention only two prevailing types of motors, that of the vertical cylinders above the crank and the horizontal cylinders.

The single cylinder motor of either the vertical or horizontal type is evidently a thing of the past, (except in the very low-priced cars,) on account of the impossibility of balancing the reciprocating parts. In fact, its popularity is dying very fast.

The multiple cylinder motor is not a new invention for either motor car use or stationary use. At the first automobile show ever held in America, which was at Chicago in 1895, there were several different models of motors on exhibition, but the one which seemed to attract the most attention was a two-cylinder opposed. This motor was awarded a special cash prize for its perfect balance and smooth running. The other multiple cylinder motors consisted of the twin type and the three and four cylinder type.

The merits of the three and four cylinder did not seem to be recognized at that time, for it was not followed up to any great extent for several years, but the two cylinder opposed has been used extensively ever since.

It was not until they began to build motors of very high power that the three and four cylinder types came into use. The three cylinders did not seem to last very long. They gave way and left the field to the two cylinder opposed and the four cylinder vertical, with a few six cylinders trying to find a place.

All three of the last mentioned styles of motors seem to have a place in motor car construction that they are likely to hold for some time, unless some revolutionizing invention or discovery is made to take their place.

It has been proved by long experience, since the adoption of the universal method of placing the motor forward of the dash under the bonnet, that the two cylinder opposed motor has many advantages over any other style, when made in units not to exceed 8-10 HP cylinders each. Above this power there should be more than two cylinders.

It is an admitted fact that in the multiple cylinders there is a multiplication of all the little troubles that are incident to the gasoline motors, such as connections to spark plugs, oil pipes, valves, springs, etc. Therefore it would seem advisable to limit cylinders to the smallest possible number.

As the majority of cars manufactured and sold in this country are of the two cylinder type, this is the one we will dwell upon.

First, for the purpose of balancing the motor, the cranks are placed on opposite sides of the shaft or 180 degrees apart. It will be seen by this that both pistons will be traveling in opposite directions at the same time. They will also both stop and start at the same time at both ends of each stroke. Thus it will be seen that one piston is a perfect counter-balance for the other at all times.

Another advantage of this form of motor is found in the oiling system. On account of the pistons both traveling on the outward stroke and the inward stroke at the same time, there is alternately a vacuum and compression in the crank chamber. By reason of this it is possible to use with perfect success the compression system of oiling—the motor acting as a perfect pump of unlimited capacity, forcing a pressure on to the top of the oil as well as sucking it out through the various distributing pipes.

In addition to this, owing to the fact that the motor is of the horizontal type, oil can be fed to the motor in such manner that it will drop on to the connecting rods. It will thereby be distributed through the action of these rods to both the crank shaft and the piston wrist pins. There it will be thrown off in the form of a vapor or mist which will lubricate the cylinders as well as all the other bearings inside the motor.

Another feature of the horizontal opposed motor which is by no means the least of its many advantages is the facility with which it is adapted to the thermo-siphon system of cooling. By hanging the motor well down in the frame with the upper side of the cylinder below the bottom of the radiator, the heated water is carried to the bottom of the cooler and is compelled to flow upward through the radiator before it can reach the over-flow or vent. It can be seen that if the radiating surface be sufficiently large the water will be cooled before it reaches the top and will therefore find its way to the bottom again. There it will be conducted by gravity through separate tubes to the lower side of the cylinders, there to replace the warm water which is continually flowing out at the top.

It is therefore evident that the two-cylinder opposed type of motor, which can utilize these cardinal points, is far superior to the four or six-cylinder construction, particularly for twenty or less horse-power.

CHAPTER XIX.

THE COOLING OF EXPLOSIVE MOTORS.

By Frank Briscoe.

The heat generated by the explosions in gas engine cylinders becomes so great that, unless means are found for dissipating it, various disorders arise, such as premature explosions, irregularities of the valves, or finally the sticking of the piston due to excessive expansion. According to leading designers the most efficient temperature at which a gas engine should run is 210° or just below boiling point.

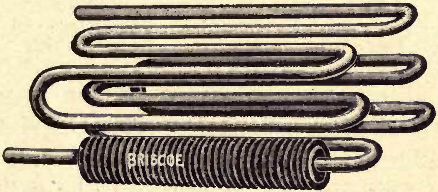
There are two means of cooling motors, air-cooling and water cooling.

Air cooling has been tried in America with some success though French and other foreign designers have almost entirely abandoned it as not possessing enough advantages to compensate for its defects. It is accomplished by attaching flanges, pins or other devices to the cylinder, thereby increasing the area of cooling surface, and then directing a strong blast of air across them. The lubricating oil also plays some part in air-cooled motors as its vaporization and discharge through the muffler dissipates considerable heat.

Water cooling is accomplished by encircling all or part of the cylinder and valves with a water jacket which is connected by tubes with a cooler or radiator, the hot water passing through the radiator and returning cooled to the water jacket. As the explosion chamber and valves require cooling much more than the rest of the cylinder, the ideal construction is to water jacket only a section of the cylinder, the head and the valves, and provide the other parts with air cooling devices.

Radiators are of two general types, tubular and honeycomb. Both have tubes but in the former the water passes through the tubes while in the honeycomb the air passes through the tubes.

TUBULAR RADIATORS. In this type the tubes are generally round, fitted together in a coil so that the water passes through the entire length of tubing, and these are provided with discs or fins to increase the cooling surface. The material, both of fins and tubes, is generally copper.



In the higher priced cars, the tubes are often flattened. This form, while more expensive than the round tube, is more efficient for the same length of tubing and lends itself to greater beauty of design. Flat tube radiators generally pass the water through each entire bank of tubes at the same time and have fins which are continuous from front to back over each entire bank of tubes.

In few tubular radiators are the banks of tubes more than three deep from front to back as more than three are inefficient. The reason is that the air absorbs heat as it passes each tube or fin so that the further it goes back the less capacity it has to absorb heat from the rear tubes.

Radiators are also made with vertical tubes running from a top tank into a bottom tank. In certain cases such radiators are quite efficient and may sometimes be used without a pump.

Tubes are sometimes used without fins but in this case are always greatly flattened. One style has them vertical but corrugated, having almost a honeycomb appearance. Another has lateral and straight flat tubes.

Fins are often made of iron or tin for economy as the decrease in cost of the material makes up for the additional quantity needed.

One form of radiator, called the Staggered Gang Fin type has the fins so shaped that while continuous from front to back of the radiator and presenting a straight front and back, each tube has a direct front exposure to the air, instead of being placed one directly behind the other as is usual with tubular radiators.

There are a large number of different and often contradictory conditions in radiators. A satisfactory result is of necessity a compromise. Radiators must cool, must be as economical as possible, look as well as possible, last as long as possible, and be as light as possible. Excepting efficiency, most of these points are problems for the manufacturer only and do not concern us here.

Efficiency depends primarily on the amount of heated air surface and secondarily on the material and form of this surface.

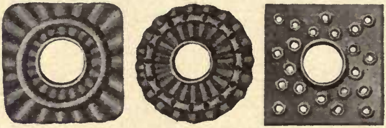
Copper is the best material on account of its great power to conduct heat, being six times as efficient as iron and three times as efficient as brass. But copper while a good conductor is one of the poorest metals as a radiator of heat being only one twenty-fourth as efficient in radiation as lamp black.

For this reason copper tubes and fins are used to conduct the heat to the surface but in order to **expel** the **heat** into the air they are coated with lamp black or some similar paint. Leaving a radiator unpainted, or painting it with bronze or aluminum or any shining material, decreases its efficiency.

Heat is similar in many of its phenomena to electricity. For instance, it tends to remain in the element it is in and with difficulty jumps an air gap. When the fins are put on the tubes, no matter how tight, there is an air space between. Therefore, it is necessary to solder them to the tubes in order to get metallic continuity. It is for this reason that aluminum is impracticable for fins, though an excellent conductor of heat.

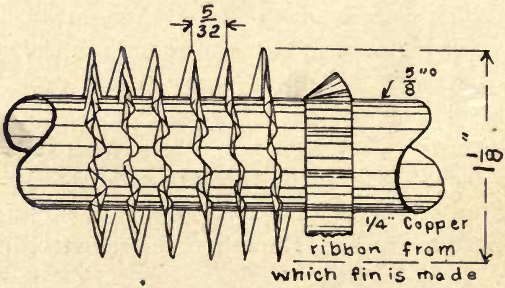
Heat is dissipated from a point, edge, or projection more readily than from a smooth surface. Therefore, fins are made with projections or perforations, or both.

In considering the fins it must be remembered that they give direct radiation only, not being in direct



contact with the original source of heat. On the other hand both sides of the fin are exposed to the air while in the case of the tubing only one side is exposed to the air.

The value of the continuous fin from front to rear is that it furnishes a continuous medium for the heat



Spiral fin & tube
Full size

from the rear, or hottest part, to travel to the front, or coldest part.

One form of fin, first used, it seems, in Germany, and lately introduced into this country, is the so-called Spiral Ribbon fin. This consists of a corrugated copper ribbon wound edgewise and spirally on a tube, the corrugation on the inner edge being increased and being stretched out nearly straight on the outer edge to make it rest edgewise on the tube. This type is economical, but is the least efficient form of fin for three reasons. First the copper in the ribbon must for mechanical reasons be so light that it has but slight conducting power. Secondly, the ribbon being continuous along the entire length of one tube, the heat tends to remain in and travel along the ribbon as electricity would cling to a wire. Thirdly, the deep corrugations at the base or hottest part of the ribbon form snug little air pockets in which the heated air nestles, to be withdrawn only by suction.

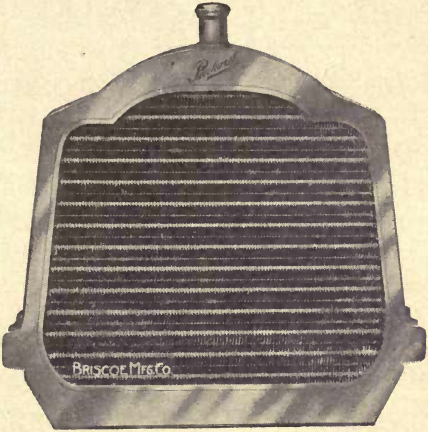
In all tubular radiators the water circulation is of great importance. A tank is necessary to act as a sort of stand pipe, or reserve, to take up evaporation. A pump is necessary except in some vertical tube arrangements. The pump must always force the cold water into the motor and never pump the hot water into the radiator as in the latter case it will at times have to pump steam, which is impossible. Attention must be paid to possible air, or steam pockets, in the radiator, or connections. These often cause serious annoyance in tubular radiators. The connecting pipes between radiator and water jacket must be ample in size else much of the efficiency of the radiator is choked; circulation is generally from top to bottom of radiator, but it may just as well be the other way, and in fact, is often down the back row of tubes, up the middle and down the front, or vice versa.

HONEYCOMB RADIATORS. These were originated in Europe and most foreign designs are copies and improvements of this type. In this type a number of short tubes with ends expanded are fitted together and the edges joined with solder.

Sometimes the body of the tube is shrunk by corrugation, or otherwise, instead of expanding the ends, or a hex end is swedged on a round tube. Any of these methods is for the purpose of forming a very thin space between the assembled tubes through which the water trickles. It is obvious that there is a lateral as well as vertical circulation possible and it is this feature wherein the great value of the honeycomb lies. Thus thermal circulation is always going on inside the radiator irrespective of the action of the pump, the coldest water is always delivered to the outlet, and the entire radiator is made to do its work uniformly in every part.

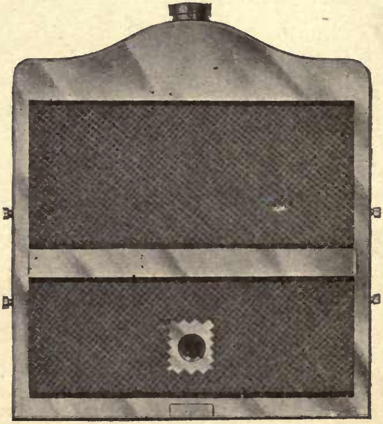
The weakness of the foreign types for American use, beside their expense, is their great delicacy and the extreme thinness (about 1-64 inch) of the water space, which is liable to become clogged with lime from the water.

An American honeycomb has been invented which makes use of the idea but applies it differently. In the American type of honeycomb, instead of sawing off single short pieces of drawn tubing which in the light gauges is treacherous, a multiple tube is formed out of sheet copper, seamed together and stamped into the shape of three or more square tubes with ends expanded. These multiple



tubes are then joined as in the foreign type, the expanded ends holding the sides apart so as to form a water passage of about 1-16 inch. This is large enough to prevent clogging and small enough to insure efficient cooling. The design is of greater strength as the joined edges being in groups of three have three times the bearing surface, for, one soldered joint an inch long is in less danger of breaking than three such joints each a third of an inch long. The material used is lighter thus saving both weight and cost. The corrugations in the water walls of the tubes allow for enough expansion so that bursting through freezing is rare. Lateral circulation is allowed every three holes.

This type lends itself readily to thermo-siphon circulation, a pump being unnecessary when the system is arranged with that end in view. As there is freedom of movement in every direction, the coldest water always finds the bottom, thence goes into the bottom of the cylinder water jacket. Being there heated it rises, finally passing out the top of the water jacket into the radiator, where the thermal currents carry it first to the top, then, as it cools to the bottom of the radiator again.



This American honeycomb is probably, taking into consideration all requirements of efficiency, durability, cost, appearance and weight, the most satisfactory type yet developed.

While freak radiators of many kinds designed usually by persons ignorant of the complex conditions, are continually making their appearance, the real development is along the lines above indicated. A thousand and one little technical points are yet undetermined, but are being gradually worked out so that each season sees a substantial improvement over the preceding one.

CHAPTER XX.

TIRES AND TIRE CONSTRUCTION.

By Horace De Lisser.

Pneumatic tires should be considered in the same relative position to an automobile as a foundation is to a house. As you would never place a fine house on a poor foundation, therefore you should never place a poor tire on a good automobile.

The best tires are those constructed solely of rubber and fabric. Avoid all such combinations as leather, metal plates, and the like, for a thorough vulcanization of the rubber with any other substance than cloth is impossible, and unless there is a complete adhesion between the rubber and the other substance, regardless of what it may be, the weaker of the two must necessarily give way to the stronger.

The two vital points in tire construction are Resiliency and Durability, after which common sense must be employed if the pneumatic tire is to be enjoyed.

The value of the pneumatic tire is only in its possession of a greater degree of resiliency than is found in the use of solid rubber tires, and comfort is the prime quality desired.

A method of construction must be employed which will preserve the resiliency and at the same time offer the greatest degree of resistance to obstacles commonly encountered, and this can be obtained only by the proper vulcanization of the very best grade of rubber, and the toughest and strongest fibre cotton, known as Sea Island.

It is vitally important that the fabric retain a complete hold on the rubber and that there be no friction or rubbing between the plies of cloth and the rubber covering; otherwise, the incessant pounding which a tire receives will have a tendency to separate the plies or layers, and, as the strength of a tire lies solely in the fabric, it will be readily seen that when the plies separate the tire weakens.

Friction heat, caused by the enormous speed of the tire over the ground, is another vital consideration, for as a tire is put together by heat, heat will naturally separate the layers, and this subject is an all important study on the part of tire manufacturers.

This is overcome by the use of pure, soft, Para rubber between the tread and the fabric, thus forming a cushion which not only increases the resiliency but prevents internal friction.

All unnecessary strain on the sides or wall of a tire should be eliminated if a perfect tire is to be constructed. This can be secured only by building the tire circular in form, whether inflated or deflated. If the tire is correctly shaped and not forced to assume a rounded form when carrying weight, then there will be no unequal strain on any part, internal or external.

Durability—The element of durability is necessarily dependent upon a proper construction of the tire as a whole. The old adage of "a chain being only as strong as its weakest link," might be paraphrased in connection with a tire too. "a tire is only as strong as its weakest point."

A thorough coating of pure Para rubber cement; a cushion of the same quality rubber between each ply of fabric, and a similar cushion between the outer tread and the top layer, all vulcanized into practically one piece, will prevent separation, or internal friction, and necessarily distribute equal strength to all points.

The bead or clinch of a tire should be so constructed as to be elongated at the toe and stiffened in the center, for it will then seat itself firmly and with the air pressure on the inner tube holding it in its proper place, it will be immovable, thus removing the source of rim cutting.

Common sense plays a most conspicuous part in the full enjoyment of a pneumatic tire. Always bear in mind that a tire is constructed only with rubber and fabric and put together with heat.

Avoid all substances known to be detrimental to rubber, and above all never rest your tire in oil, or allow oil or paint to touch it.

Keep the casing thoroughly soap-stoned, as the friction heat, caused by contact with the ground, will eventually cause an adhesion to the inner tube.

When your car is out of commission, either temporarily or permanently, always relieve the strain on your tires by jacking up the wheels.

CHAPTER XXI.

THE IMPORTANCE OF OILING AN AUTOMOBILE.

By C. W. Kelsey.

The question is often asked, "What is the life of an automobile?" This is easily answered. It depends upon two things; first, the way the car is handled, and second, the amount of oil it receives. With proper attention in both of these respects an automobile should last from five to ten years, depending upon the grade of car.

The handling of a car is a personal equation and no fixed rules can be given. The oiling, however, important as it is, is a very easy matter. Simply see that all the wearing surfaces get lots of oil all the time.

To properly appreciate the importance of oiling it may be well to see just what its functions are and how it performs them. If you look at oil through a very powerful microscope you will see that it is composed of thousands of globules, each one shaped like a ball. A properly oiled bearing has distributed all over its rubbing surfaces these small globules, which act exactly as if they were steel balls, preventing the two surfaces themselves from touching each other. The moment there is no oil there and the two surfaces come in contact they start to cut and it takes but a very short time for an expensive bearing to be destroyed.

The oil itself will wear out; that is to say, the globules will break and the oil will thus lose its lubricating properties. Therefore new oil must be added constantly.

As proper oiling is such a tremendous factor in the successful performance of a car, it is well to see that your automobile is equipped with as nearly an automatic system of oiling as is possible and practical.

The pump oiler which has to be handled every few miles by the operator is likely to be forgotten. This naturally would have disastrous results. There are several very good positive oiling systems; some of these are mechanical pumps which start when the engine starts and pump just the proper amount of oil to every part where oil is required, stopping when the motor stops.

Another and more simple arrangement which is well adapted to double opposed motors is to use the alternate compression and vacuum of the crank case, the pressure and vacuum starting when the motor starts and falling when the motor stops. In this method a pipe having a simple ball check runs from the crank case to the oil reservoir. Every time there is a compression in the crank case, which occurs as the pistons approach each other, there is a pressure put on the oil in the reservoir. This forces the oil to sight feeds, which should be situated on the dash in easy sight of the operator, and is thence distributed to the various bearings. As the oil leaves the sight feeds it is sucked to the piston and the engine bearings by the vacuum caused by the pistons receding from each other.

Great care should be exercised in procuring the very best oil. It is poor economy to use an inferior grade, it does not follow that because you are paying a big price for oil you are getting the best. There is probably more fraud practised in the oil business than in any other pursuit accessory to automobiling.

The writer has had oil offered to him as the very best at 80c a gallon and has been able to get identically the same thing in the open market for 10c a gallon.

The best oil for cylinder use is one having a very high fire test and a very low cold test, and which is rather thin. This same oil can be used for most bearings.

Gears should be run in a very heavy oil or a good quality of grease. The manufacturers of machines, however, always give instructions as to just what oil to use in each particular place where lubrication is necessary.

Remember that a gallon too much oil can do no damage other than to soot up the spark plugs, which are cleaned in a very few minutes. A drop too little oil, on the other hand, may destroy the whole power plant of the machine.