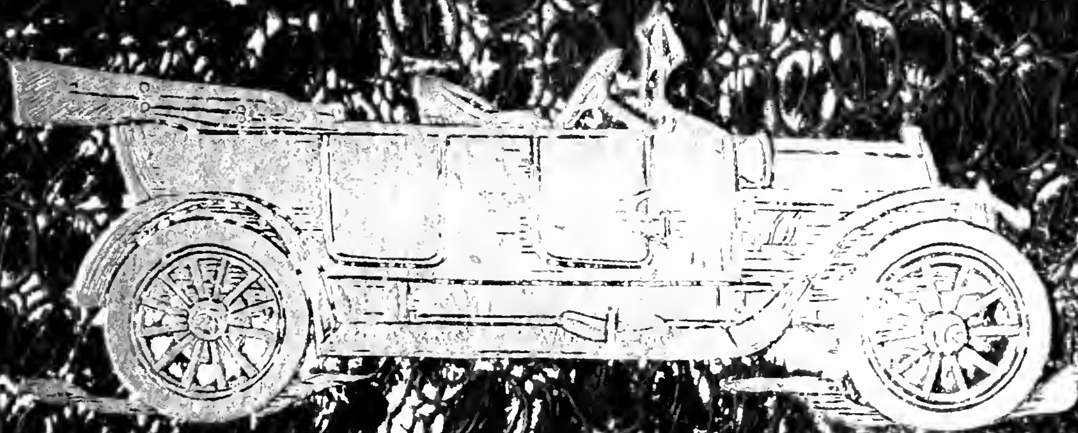
ENGELMAN'S

AUTOCRAFT



ENGELMAN'S

AUTOCRAFT

Being an Instructive Study of the Automobile; Its Care and Management; How to Drive; Locating Troubles and Repairing Them; With Chapters Exploiting Some of the Latest Devices Used in Automobile Construction.

BY

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INTRODUCTION

MAN from his creation has struggled with Nature to harness its forces. He has tried in numerous ways to annihilate space, and to conquer distance is another of his great problems.

The automobile is man's latest achievement for the purpose of fulfilling his desire. Long before the automobile had been invented man had perfected engines suitable for boats and trains. But like all other things, he became dissatisfied traveling in crowds on steamboats and trains, so he took it upon himself that a means of individual transportation must be devised, the automobile being the result—a "vehicle propelled by its own power."

* * * * * *

When self-propelled road vehicles were first introduced they attracted but a small share of public attention, and with the exception of heavy traction engines, road rollers and machines of similar type, they were little used.

No industry has ever been so rapidly developed as the manufacture of automobiles.

It is the intention of the author to introduce promulgation concerning the most recent developments of the industry. This is a subject that has been covered by numerous writers during the past twelve years; it shall rather be his aim to discuss the various parts of the automobile as they are found at the present time, and to arrange them into such classes as will be subserve to the reader.

The automobile became a commercial possibility with the invention of the pneumatic tire.

Following this great invention we are daily receiving from the engineers (who guide on the product through their skillful training and work) many improvements both in refinements and engineering feats.

For instance, the lighting of motor cars by gas was adhered to by all makers until very recently—a comparatively crude thing, but not vital, so it was not given attention by engineers until other more important problems were solved.

Then ignition has been so troublesome that manufacturers universally adopted the magneto, not because it was the ideal thing, but because it temporarily overcame one of the chief troubles of motor car users.

Magnetos were not ideal ignition, yet they were so much better than the ordinary coil systems that it was a wise move to adopt them temporarily.

But the crudest thing left on modern motor cars was the cranking by hand.

To overcome this unpleasant task we have another great invention known as the self-starter.

The truth is, the automobile will in a short time be universally adopted the world over for purposes both commercial and pleasure. It is interesting to note the many types of automobiles manufactured in various parts of the globe, but this is not a treatise on the origin of the automobile, therefore it is not in the scope of this work to inquire further into the interesting study, but to confine ourselves to the various improvements of the present time.

To make plain the study of the various parts used in the construction of automobiles, the author has classified them in groups.

With a limited amount of space to compile this work, it is the intention of the author to furnish the reader with information as far as possible necessary for the proper operation, care and maintenance of an automobile in simple and concise form, so that the busy man, who can ill afford to read with attention the many books relating to the automobile, but can quickly gather the desired information from this book. Should this work fulfill accurately the purpose for which it has been designed, then its appearance will have been appreciated.

THE AUTHOR.

Driving the Car

WITH the number of automobiles rapidly increasing the highways become crowded; therefore, in order to enjoy one's automobile, it is required of every driver to exercise a certain amount of caution.

We as automobilists have rights on the public road. These same rights envelop responsibilities to many users of the highway.

Some automobilists abuse their rights and heedlessly run over the rights of others. A wrong and a right will not make a right. Therefore some suffer for the wrongs of others. Each accident and wrong-doing on the highways has a tendency to arouse public sentiment against the motorist.

The responsible operators must take it upon themselves to control the irresponsible operators and show them that they must operate their cars without menace to life and limb upon the public highway.

Many drivers, usually through thoughtlessness, do not practice the consideration for others they should have. Many lives are in constant danger and accidents occur with the driver who takes a chance.

There is the driver who delights in exhibiting nerve stunts, such as remaining in the center of the road until almost upon the approaching vehicle, or the driver who will skid a car around instead of turning it as it should be done.

Many such foolish pranks have resulted into serious accidents, also causing the loss of life and limb.

A Good Tip on New Signalling System for Motor Car Drivers.

When approaching the street crossing always slow up, and if you intend to drive straight ahead, give one long toot of the horn. If you intend to turn north, south, east or west, indicate that purpose by giving a number of short blasts of the horn. The pedestrian who is about to step off the curb will be attracted by the sharp toots and remain on the sidewalk. Accidents will be reduced to a minimum. The public will quickly learn the meaning of the horn, and their lives will be further safeguarded. The rapid-growing antagonism to the motor car because of unscrupulous drivers will be gradually tempered. The horn—the most important accessory tc an automobile—is ofttimes used the least.

Law.

Traffic regulations have been adopted in nearly all cities, and while touring through strange sections it is well to become acquainted with them. We all know that it is unlawful to be without lights after dark. Nearly all the states require lamps to be burned on both front and rear of the car from sundown to sunup.

Roads Intersecting, and Turning into Another Road.

It is wrong to drive a car across an intersecting road or highway unless your view is entirely unobstructed. Many automobilists will drive over a thoroughfare unaware of what may be approaching on the road which crosses it at right angles. The blame for an accident in this event is the cautionless operator.

Turning into another road to the right, the operator should keep his car as close to the right-hand curb as possible. (Illustrated in Fig. 1.)

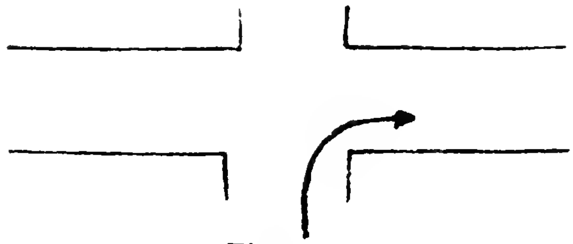


Fig. 1.

Turning into another road to the left, the operator should turn around the center of the intersection of the two roads (as in Fig. 2).

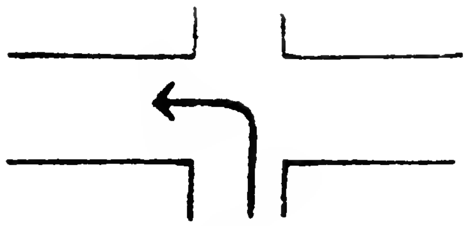


Fig. 2.

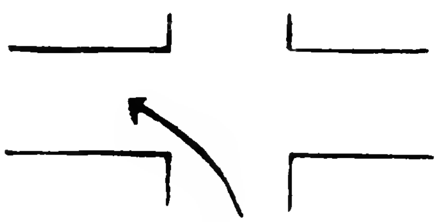


Fig. 3.

THE WRONG WAY.

The operator of any vehicle who intends to turn or stop should always give the proper signal.

In passing over railroad tracks it is advisable to drop back into second speed, in which instance you will avoid the possibility of stalling your motor on the track. Should you be compelled to unexpectedly drive ahead fast with your car in second speed your chances of escape are easier and more certain.

If you meet up with a frightened horse on the highway, drive your car to one side of the road and stop.

The Changing of Gears.

Before moving the gear shifting lever from one position to another the clutch should be entirely disengaged and the motor throttled to its lowest possible throttling point. Unwillingness and laziness to change gears are the cause of many accidents and often very destructive to the car.

At the proper time, instead of a driver changing back into second speed, many allow the car to drift along until caught into a tight place in the traffic, resulting often in an accident. Use the second speed as often as necessary; it was installed in automobiles for good purposes; make use of it. We should never be in such a hurry that we cannot spare a few seconds for safety. You often hear the remark, "He lost control of the car." Indeed, the driver in most all cases loses control of himself and not of the car. One is not an expert driver until he intuitively performs the operations which control the car, just as one walks or reaches out for an object.

Skidding.

Skidding, a most dangerous element of motoring, is a helpless situation. It remains for the driver not to become confused to apply the brakes.

Skillful handling of the steering wheel might in some instances prevent an accident from skidding. Reduce the speed of the motor, turn the front wheels in the same direction that the car is skidding, and don't apply the brakes.

If the front wheels skid, turn them in the opposite direction from which they are skidding.

In Crossing Street Car Tracks and Climbing Out of Ruts.

Skidding can be prevented, accidents can be avoided, and the life of your tires lengthened if you will learn how to turn your car out of street car tracks or ruts. Make a sharp turn of your front wheels. Do not allow the wheels to climb along the edge of a rut and finally jump off suddenly. And do not attempt to climb out of these conditions at speed. Haste surely makes waste in driving an automobile.

Watch Your Car Closely.

You will soon become accustomed to all the sounds your car makes. Any other sound, be it ever so slight, will be immediately perceptible. A good driver will immediately locate the cause for that new and strange noise. It is the warning signal that something is not normal. It may be a loose nut. It may be a cry for grease. Do not disregard these signals. Locate the cause and give them immediate attention. Thus you will lengthen the service of your car.

Driving Over Rough Roads.

The natural inclination of the driver is to throw out the clutch in coasting down hill or driving over rough roads. This should not be done. Keep the motor pulling your car over rough roads. Thus it keeps everything taut and lessens the shock and jar that the car gets through bumping over ruts.

Coasting Down Hill.

In coasting down hill use the motor as the brake. That is, close your throttle and let the car drive the motor. This, of course, will not be sufficient to hold the car on very long and steep grades. It will serve, however, to relieve the strain on the brakes, and it will enable you to keep the car under absolute control.

If the grade is long and steep, use the foot and emergency brakes alternately. This will prevent them from burning out.

A Car's Service Depends Upon the Driver.

Much of the satisfaction that an automobile gives depends upon the driver. If he neglects his automobile, if he does not lubricate it, or if he tinkers with it too much, he is bound to receive unsatisfactory service.

No machine can be absolutely automatic. All things must wear in time. The best preventive of wear, and the most certain thing for increasing the life of an automobile, is proper lubrication.

Familiarize yourself thoroughly with all the lubricating points of your car. Make the lubrication of your car as regular as is the eating of your meals. If you do this, you won't have any complaint to make of your car becoming noisy or of bearings wearing out. If you don't do it, you will not get the satisfaction from your car that you had expected.

Operate Your Spark Lever.

The spark lever is to be retarded, that is, brought down, whenever the motor labors or pounds. In driving over rough roads, through sand and mud, or up hill, or whenever there is a heavy load and the motor does not seem to run smoothly, retard your spark.

Driving Pointers

Don't Overlook the Spark.

Many drivers entirely ignore the spark. As a result their motors do not give perfect service, and some cause considerable trouble.

Coasting Mountain Roads.

Whenever you approach a long and steep grade, it is best to put your gear speed lever into first speed and allow the car to drift down on the motor. This is better than using the brakes. It gives you absolute control of the car at all times.

Coasting With Clutch Out.

There is a satisfying sensation in allowing the car to coast along with the clutch disengaged. But do not under this condition, if the car is speeding, let the clutch in when the motor is running slowly. It produces too severe a shock on the entire driving mechanism. Speed your motor up to as great or a greater speed than the car is traveling, so that the shock will not be so severe.

In all cars such a plan of driving results in strains, often so serious that the transmission is wrenched from its anchorage. The clutch is damaged, and accidents have resulted.

Know Your Car.

Your satisfaction will be greatly increased if you will learn the details of your automobile. Learn to make the simple adjustments. Do not depend upon some one else to do that which is so simply done, and which you can get such satisfaction in doing.

The Cost of Speed.

The law is just as immutable in that it collects a greater cost for speed in a motor car as it does of any machine or of man. If you run fast, if you work hard, you require more food to sustain you. If you drive your car at a fast speed all the time, it requires more fuel—more gasoline and more oil.

If you work fast and hard, you wear out more quickly, and so does an automobile.

Tires, for instance, last twice as long on a car that is driven at fifteen miles an hour as they do upon cars that are driven at thirty miles an hour.

Remember that the service your car gives you is as much dependent upon the manner in which you operate it as is your own health dependent upon the manner in which you care for it.

Compressed Gas or Acetylene Lights.

A yellowish tinge in the color of an acetylene gas flame is caused by a leak somewhere in the connections. If everything is right the lamps will begin burning with a bluish flame, turning to a dazzling white as the gas flows freely.

It seems absurd to suggest to a motorist to use a candle to light his way in the event of an empty tank or the acetylene being consumed. Yet it is a practical temporary lighter. Fasten the candles securely on the side of the jet-head or burner by shaving flat one side of the candle and fastening it with wire. The flame of the candle should be parallel with the acetylene flame when it was lighted, or centered in the reflector glass. Too low causes an upward light and if too high the light reflects on the ground at too short a distance. It will be surprising to note the good light that can be obtained from this two-candle power.

Through Sand and Clay.

Heavy sand: Deflate tires, but not to a degree dangerous to the rim. Use chains. Pump up tires immediately after passing through sandy stretch.

Soft clay, etc.: Do not deflate tires. Use loose chains. In very bad places at times when no friction is gained, do not spin the driving wheels as this only enlarges the hole and increases the trouble. Do not attempt to fill hole with stones or board. Jack up car first on flat board with stone foundation, then fill in the rut or hole that has been made. Most trouble occurs on the off-side of the road. Keep to center as much as possible.

Do Not Drive in Ruts.

Driving in ruts is not only bad for the tire, but it is equally bad for the highway. It is only the lazy driver that "sticks" in the ruts rather than being awake and on his guard to avoid them.

Continued driving in one line or spot quickly eats through the top dressing of the macadam road and wears the hole or rut in the body of the best road. This is the difficult damage to patch, without renovating almost the entire roadway, and motorists should be glad to co-operate to this extent in keeping good the better highway. *Do not drive in ruts.*

Don'ts.

Don't strain your motor through laziness of shifting into a lower gear. Serious results occur from forcing the motor on steep grades and heavy pulls in the high gear. By partly relieving clutch pedal, thereby slipping the clutch, the motor can always gain momentum while doing heavy duty.

Don't drive in car tracks, especially on wet pavements. Many accidents occur to motorists who haven't been capable of relieving their car from the rails when suddenly and unexpectedly they were required to do so.

Don't take chances of looking through the wind-shield or isinglass curtains while same are covered either with rain or snow. Always stop and clean off.

Don't forget that sometimes the pedestrian who would walk in front of your path may be some unfortunate blind or deaf person.

Don't be inconsiderate to the pedestrian on the walk by splashing him full of mud. It is easy enough to slow down or drive to one side of the road a trifle, thereby omitting this offense.

Don't test your automobile in the busy thoroughfares. After you have finished your work, drive out to some roadway where you will be free from pedestrians, traffic, etc. Many drivers and repairmen who work for garages centrally located often meet with accidents because after having made a quick and hurried repair they drive out in the down-town district, crowded with people and traffic, to determine the results of their work or test out the car.

Don't drive on in case of an accident.

Don't fail to be a gentleman under any provocation.

Don't exhibit grandstand acts by driving upon a crowd of people and suddenly opening the exhaust cut-out, at the same time racing the motor, or by skidding around instead of going back and forth until you have made a complete turn. Remember that while the automobile is flexible, powerful and easily controlled, you may make a slip.

Don't drink if you intend operating an automobile. Many accidents occur to automobiles driven by intoxicated operators.

Don't ever get rattled.

Don't try to race every car which passes you.

Don't drive your car on car tracks; it is an expensive luxury.

Don't drive fast around corners, as this will cause side strain and a grinding wear on the tread of tires.

Don't pass a street car while it is at a standstill. Passengers often alight without looking for any approaching traffic. Stop still until the street car is again in motion.

Don't try and dodge an excited pedestrian in the street. He or she will go back and forth much confused and finally run directly in front of your machine. Stop as quickly as possible, because in many instances it has proven to be either an intoxicated person or the one who thinks "Hit me and I'll sue you!"

Don't stop to argue with drivers of teams, trolley car motormen, etc. It often occurs that the other fellow is ignorant of your rights, and persistence on your part may some time result in an accident.

Don't forget that vehicles do not have the right of way at street crossings.

Don't pass another car on the road in trouble without inquiring if you can be of any assistance.

Don't curse police officers. We should all co-operate with the police force to assist in reducing the number of accidents caused by reckless driving. Careless pedestrians, particularly those in congested districts, lack attention in crossing streets. It is your duty as a citizen to understand the rules and regulations of "street traffic," and especially those rules concerning the community of which you are a resident. A definite knowledge will aid materially in causing traffic conditions to steadily improve.

Don't pass another car with the intention of lingering after you have passed, whereby they receive, in return for their kindness in allowing you the right of way, your dust. Either pass them, maintaining your passing speed, or continue to drive far enough ahead until you have reached such a distance that burnt oils and gases discharged from your car, together with the germ-filled dust, won't interfere with the following car.

Don't travel over unknown roads at a break-neck speed, for a little "thank-you-marm" might set you in the flowers.

Don't be a road hog because you have a smaller car or because you don't care to drive any faster than the speed you are traveling at the time. If another car is desirous of passing you, keep to the extreme right of the road until same has passed; then, if your roadway is again clear, return to your former position on the road, driving along at the speed which you care to maintain.

Don't neglect to test batteries.

Don't leave your car with motor running.

Don't stop your car on the wrong side of the street.

Don't fail to always release hand-brake before attempting to start.

Don't start out on a trip without attention to oil, gasoline and water.

Don't throttle your car in jumps, as this is very injurious to working parts.

Don't ever drive faster than the law permits; it will save you many a fine.

Don't forget to fill all the lamps; you may be badly in want of light some time.

Don't fail to keep brakes properly adjusted; it is more important to stop a car than start it.

Don't use the electric starter continuously to demonstrate its operation unless you in turn run the motor sufficiently to recharge the storage battery.

Don't forget to see that your gasoline tank is full before starting out on a long trip. It is much more convenient to fill the tank at a garage than when on the road.

Don't put acid in the jars of the storage battery to raise the specific gravity, unless the electrolyte has been spilled out, and it becomes necessary to mix up a new solution.

Don't forget the automobile is one of the finest pieces of machinery manufactured, and you will be repaid in excellence of service many times for the proper care and attention you give it.

Don't run on the dry battery unless the magneto circuit is somehow impaired. It is much easier to start on the dry battery circuit, and it should be kept in order for this purpose.

Don't fail to put a small quantity of distilled water in the storage battery occasionally. Water will evaporate, but acid will not. If the solution evaporates so that the wood separators are exposed to the air, they will be completely burned up by the acid and new ones will have to be installed.

In laying up your car for two months or more, jack it up clear of the floor, allowing the axles to rest on supports. Allow all air to escape from tires except enough to shape them.

Because rust eats into the fabric, rims should be sandpapered and painted preferably with graphite. Paint or any other rust preventive will do.

Cleaning the Car

Washing.

When a car is new, wash it with cold water, as it will help to set the varnish. Luke-warm or cold water are ordinarily used in washing the car, but never use hot water, it will ruin the painting.

To remove grease or oil on fenders and wheels, some brand of automobile soap (commonly known as soft soap), dissolved in water, can be used; however, *do not* use on body, as it affects the gloss of the varnish. When purchasing a soap of this kind, you can be somewhat safe by inquiring what it is made from. A soft soap made of pure vegetable oils, chemically neutral and containing no free alkali, or any other acid or grit to bite into fine finishes, is recommended.

Do not wash the hood when it is warm, as this will cause it to lose its lustre.

Do not rub body with sponge unless necessary; it always holds sand or grit. Wash by rinsing off as much as possible.

Do not play a sharp stream of water onto car while washing; it will drive small particles of sand, miniature stones, etc., into the paint.

It requires considerable skill to wash a car properly without injuring the finish; but the improved appearance makes it well worth the trouble. Automobiles are subjected to harder service than any other vehicle. They are exposed to all kinds of road and weather, spattered with grease from oiled roads, scratched by flying sand and gravel; they are left standing in sun, wind and snow, and as a rule no very great care is used in cleaning them afterwards.

The manufacturers spend much time and money in giving automobiles a fine finish with a high lustre. This finish can be quickly spoiled by lack of care, or may be preserved by using proper precautions.

Light dust may be blown off or removed with a feather duster. When necessary to use water, let it run slowly from a hose with a sprinkling nozzle or no nozzle at all. If a small nozzle is used which adds force to the stream, it will drive the sand into the finish and soon remove its gloss. Dried mud should be removed as soon as possible, as it injures the finish. It should never be wiped off dry. Soak it with water applied with a sponge or a gentle stream from a hose; after it is softened, wash it away carefully.

Soap is not necessary for removing dust or mud. It must be used, however, when the surface is stained with road oil or from some other causes. Never apply soap directly to the finish. It is much better to dissolve it in water and make suds of suitable strength. Any soap, no matter how mild or neutral, will injure varnish if left standing on it. Dissolving soap in water is much safer, and is also more economical, because it does not waste the soap.

Suds made as above will remove all greasy stains.

When through washing, dry carefully with a chamois.

CLEANING OF NICKEL-PLATED PARTS.

Lamp black or regular silver cleaner paste are most frequently used to clean nickel-plated parts. Use a soft flannel or chamois to rub with.

Lamp reflectors can be cleaned with Putz Pomade, applied and polished with soft, clean chamois.

Symptoms of Common Troubles

WHEN THE MOTOR STOPS:

1. Look at gasoline supply.
2. Wires disconnected.
3. Not enough oil in motor crank case (will be noticed by motor knocking, and finally stopping).
4. If the motor cannot be cranked, look for transmission to be engaged; bearing froze or seized due through lack of oil. Look for frozen water pump.

WHEN THE MOTOR MISSES:

1. Defective sparking plug.
2. Insulation broken in wire; wire disconnected.
3. If the motor spits back through carbureter, look for dirt in same. Gasoline supply cut off from water or dirt in gasoline line. Water in the gasoline pipe will sometimes freeze and cut off entire flow.
4. Compression weak in any one cylinder valve; push rod or valve sticking. Dirt under valve. Valves not seating properly, may need regrinding.

5. When the motor runs and quits, then runs again, it is probably due to something like water or dirt in gasoline line.

6. A missing cylinder can be located by opening priming cocks on top of cylinders one at a time. If the trouble is not in the spark plug, attention should be given the valve to note if it is seating properly as well as opening and closing at proper time. The loss of compression will be detected by turning motor slowly by hand. Each cylinder may be tested individually for compression by closing all priming cocks excepting one. After having tried one particular cylinder, open the priming cock in same and turn off another in some other cylinder. In this way you will have discovered the weakest cylinder.

7. Worn or blown-out gaskets of intake manifold joints will cause missing.

Power Loss:

Motor will run good on level travel, but loses power on hill or under heavy load.

1. Valves not seating properly, causing loss of compression.

2. Spark too far retarded. Ignition late.

3. Carbureter flooding, causing too rich a mixture.

4. Motor running hot through lack of oil or water.

5. Not enough gasoline, probably due to stoppage in pipe. If the motor spits back through carbureter upon sudden opening of the throttle, this indicates there is a lack of gasoline generating.

6. Tire down.

7. Weak mixture in carbureter.

8. Examine brakes. Feel to see if they are hot, due probably to dragging. Push car along the floor or road by hand and notice if it rolls easily.

Cannot Start Motor:

1. Examine gasoline supply.
2. Be sure switch is on.
3. Weak mixture.

Don't try to change adjustments without knowing why you are making them, as it will only cause more serious trouble.

Don't get excited. Many an experienced autoist has cranked his car a few hundred revolutions and finally discovered it wouldn't start because the switch was off.

When the Motor Knocks:

1. A light knock running at high speed invariably indicates a loose connecting rod bearing.
2. A heavy, dull pounding running at slow speed with the motor under load purposes to be a loose crankshaft bearing.
3. A motor laboring on hill or pull, due to the motor running too slow on direct drive, will cause pounding or knocking.
4. Carbon knock; excessive amount of carbon gathered in cylinders.
5. A light clicking or tapping sound is often contributed to too much play or space between valve push rod and valve stem.
6. A spark knock is often caused by operator carelessly advancing same too far.

Overheating of the Motor:

1. Water supply too low.
2. Fan belt slipping.
3. Gasoline mixture too rich.
4. Cylinders heavily carbonized.
5. Circulation stopped, due probably to pump not working or some stopped up water pipe.
6. Ignition too late.
7. Not enough oil in motor.

Helpful Hints

Kerosene Hints.

TO insure the best results from kerosene lamps the bowl should be cleaned at least once a month. Old oil and sediment retard perfect combustion. See that no moisture remains in the bowl before filling.

A soft, loosely-woven wick will give the best results. It must fit the tube perfectly, as one too narrow permits the vapor of the oil to reach the flame which, with inferior oils, often causes an explosion. If a trifle too large, it retards the flow of the oil.

Wicks are cheap, and new ones should be inserted rather than patched up old ones, which cannot give satisfactory results.

Trim the wick evenly and avoid the pointed flame. Trimmed straight across, it will produce an arc-shaped flame.

Burners must be kept clean and should be washed occasionally with soap or washing soda and water. When not in use the wick should be turned down, otherwise the oil will overflow the burner and cause a bad odor.

Burners as well as the wick must be perfectly free from moisture.

Fires from kerosene should be put out with flour, sand, dirt, carpets, etc., as water is not an extinguisher, but spreads the flame.

Kerosene is a splendid medium for cleaning clocks. When not practicable to bathe the works, a ball of cotton soaked in kerosene should be placed in the bottom of the case. Close the latter tightly and in four or five days a great change will be noticeable.

A tablespoonful of the very best kerosene mixed with water and soap in the wash boiler will cut the grease and dirt. Saves labor and will not injure the fabric.

Squeaks are indeed sometimes a very hazardous work to overcome, and while you may have oiled your car thoroughly, sometimes the fact that your car is new may be the direct cause of your trouble. For instance, paint in all probability has withheld the oil from reaching the vital points. Carefully examine oilers attached to spring hangers, etc., to determine that same have free passage. In some cases spring clips are tightened to such an extent that lubrication cannot possibly reach the point it is needed. Feel of all dust-pans, fenders, etc., to be sure that all are secure. Probably the body is out of alignment, causing it to rub or bind itself at times. This can be overcome by proper shining with leather strips. Instead of just oiling through the oiler cup, squirt a superfluous amount of oil around all moving parts, such as spring clips, steering connections, radius rods, brake connections, etc., etc. See that brakes are released completely and free from dragging.

Encourage your car's ability by careful handling.

A thin coat of ordinary grease applied between the body and frame will remedy certain body squeaks.

An examination of all steering connections occasionally is time well spent.

Expenses can be greatly reduced by regular oiling and examination of parts.

Loose spring clips often cause the breakage of spring leafs.

Minor Tire Repairs

How to Temporarily Repair an Inner Tube.

INNER TUBE must be removed from casing to repair puncture. If puncture is invisible, immerse inflated tube in water. Air bubbles will locate trouble.

For quick and handy roadside repair, use patches, as shown in accompanying illustration. Select proper size patch. Thoroughly clean tube around puncture with gasoline, and roughen slightly with emery cloth. Remove glazed muslin from patch, moisten tube and patch with gasoline. Apply by pressing down firmly to avoid small "air-pockets" under the patch. Sprinkle talc on repair before replacing tube in casing.

When using patches, select the required size of patch and thoroughly roughen the surface which is to be applied to the tube with emery paper and clean with a little gasoline. The surface around puncture in the tube should also be treated in a like manner. Cover the roughened surface of the tube around puncture as well as patch, with cement, applying three coats at intervals of about five minutes. Allow this surface to dry until the treated surface is quite sticky to the touch. This requires about twenty minutes from the time the first coat of cement is applied to the tube. Press patch down firmly. Spread some French chalk over the repair to prevent it sticking to the casing.

Before replacing the tube allow a short time to elapse for perfect adhesion.

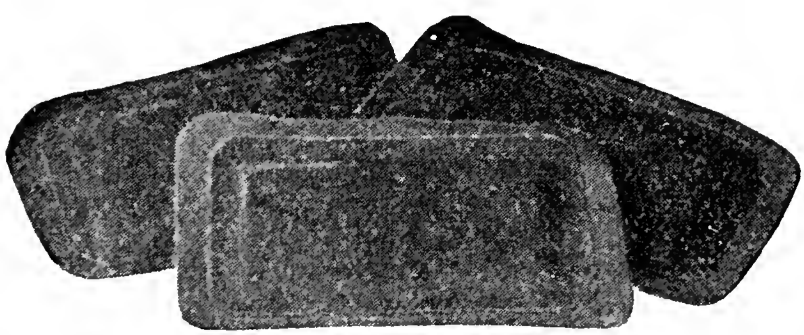
Before replacing the punctured tube, examine the inside of the case carefully, and remove the cause of the injury (in most cases a tack or small nail). Often this can be located only by a minute examination or by passing the hand inside of tire.

When using Quick-Detachable Clincher or Straight Side tires, see that the flap is properly adjusted before placing tube in casing. A pinched tube will cause a tube blow-out.

Note.—Place the tube in the hands of a competent vulcanizer at the earliest possible moment for a permanent repair.

A Temporary Repair to Casing.

If the puncture has been caused by a thin nail, use an Emergency Tire Saver Patch, which is

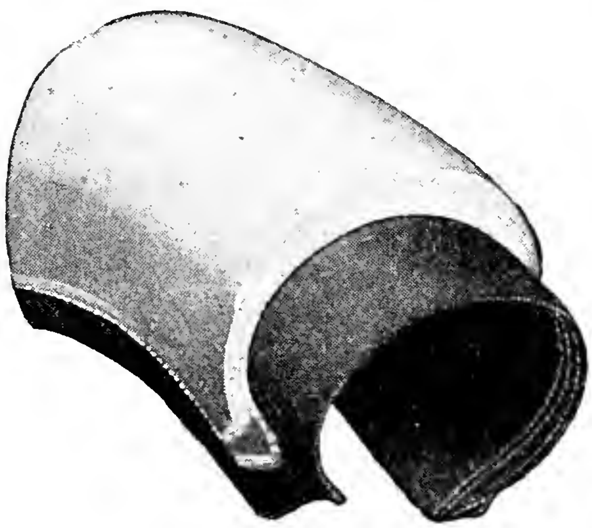


coated with rubber on one side. First clean the inside of the casing thoroughly with gasoline and roughen with emery cloth, then apply two or three coats of Dry Patching Cement, allowing each coat to dry until it is quite sticky to the touch.

Then remove the wax paper from the emergency Tire Saver Patch, moisten with gasoline, and apply to the inside of casing.

Even when the hole has been made by a blunt obstacle, such as a thick screw, an Emergency Tire Saver Patch, applied as stated, will make an effective temporary repair.

After the Emergency Tire Saver Patch has been applied, *do not neglect to freely sprinkle both patch and space about it with Tire Talc.* This is to prevent adhesion of the tube to the repair.



In case of a large cut or blow-out, use an Inside Blow-out Patch and Hook-on-Boot or Lace-on-Boot, thereby preventing sand and water from working into the tire and causing more serious injury to tube and casing. The flaps of the inside blow-out patch are locked around the bead of the casing and require no cement. The Hook-on-Boot is placed over the casing while deflated and hooks in the rim. When Lace-on-Boot is used it is placed on the outside and laced around the tire, rim and felloe of the wheel.

Tire Tape is an essential part of a repair outfit. Every motorist should carry a roll.

Note.—Put the casing in the hands of a competent vulcanizer at the earliest opportunity.

PUNCTURES.

There is no hard and fast rule for avoiding punctures. But you *can* keep a puncture from ruining the whole tire.

Don't run on a deflated tire.

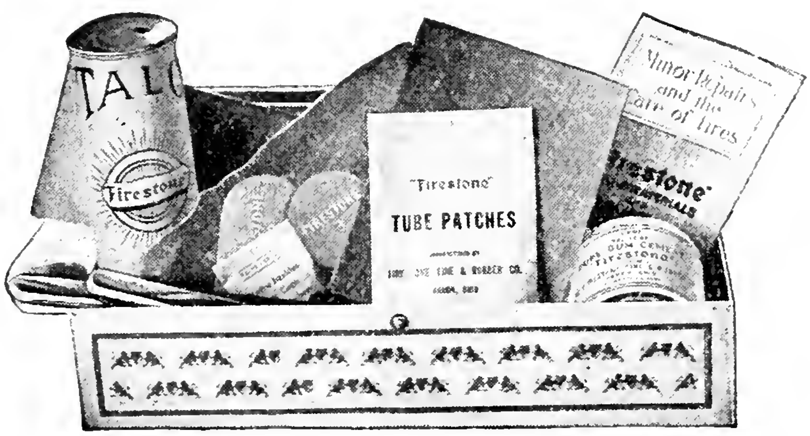
If you are unfortunate enough not to have demountable rims or even a spare casing or tube, stop short. Better take off the tire and run a short distance on bare rim, than continue on a deflated tire.

Blow-Outs.

. Blow-outs can be traced to a number of causes.

You may have bruised your tire last week, or last month, and even though the tread shows no sign of being injured, the inside fabric was broken and every revolution after that weakened the fabric, and a blow-out follows.

Overloading puts too much extra strain on the tire—a blow-out may result.



Under-inflation places a strain on the tire by bending the sidewalls and breaking the fabric. This never occurs if tire is properly inflated.

Cuts.

Watch for cuts in the thread.

Don't neglect the small, apparently unimportant ones. They will not remain unimportant.

Water will enter through cuts and rot the fabric. Sand and grit will work in between the rubber and the fabric, and in a short time will loosen the tread.

Examine the treads from time to time. Small cuts should be filled with Firestone "Cure-Cut" as soon as they are discovered.

How to Repair a Cut.

To fix a cut, first smooth the edges of the cut with a sharp knife, then roughen with a piece of emery paper and clean out thoroughly with gasoline. Apply a heavy coat of patching cement, and, while drying, take a little more than enough "Cure-Cut" to fill the hole and knead it with fingers until quite soft. When the cement is dry, press the "Cure-Cut" firmly into the hole and trim off any excess with a moistened knife until repair is flush with the rest of the tire. It is better if the repair can stand a few hours before using.

Large cuts, particularly where fabric is injured, should receive the immediate attention of the repair man.

Bruises.

Examine the inside of your casings from time to time for bruises.

A sharp blow from road obstructions, car tracks or curbing will bruise a tire, and may fracture the fabric inside the casing. You cannot locate a fracture of this kind on the outside of the tire.

The casing with fractured fabric should receive the immediate attention of the repairman.

Chafed Side Walls.

Avoid driving in car tracks, against curbs or in deep ruts, as it chafes the rubber on the sidewalls of a casing.

In order to give flexibility the sidewall compound has a much higher proportion of pure rubber than the tread, and consequently will not stand as much abrasion.

A badly worn sidewall permits water to enter and rot the fabric.

Don't Run on Deflated Tires.

If you run a tire deflated, the grinding and crunching between rim and road will speedily ruin it.

Examine Rims.

Be sure your rims are clean and true. Dents or irregularities in your rims often cut or chafe the sidewalls of the tire. This permits the entrance of moisture, and decay is sure to follow.

A little attention to your rims may save many bills for tire repairs.

Under-Inflation.

Tires are made to carry certain loads and withstand ordinary strains—but to do this the tire must be pumped up to the required pressure.

When you use less than the proper amount of air the casing itself must bear more than it was built to carry. Result: the length of your tire service is materially reduced.

Further, the constant bending of fabric when running tires soft, causes overheating and tears the layers of fabric apart. A blow-out will follow.

An air-pressure gauge will enable you to know when your tires are inflated to the proper degree. Don't trust your eyes, but get a gauge. See pressure table on page 31.

Overloading.

The strain of extra weight will fracture the tire fabric in a short time.

If you are accustomed to carrying more passengers or heavier baggage than your tires are intended to stand, *equip your car with over-size tires.*

More air capacity alone does not make an over-size tire; real over-size is obtained by thicker treads, and heavier sidewalls—heavier construction throughout the tire.

Chains.

Chains and other tire-destroying metal devices will materially lessen the life of a tire.

They will cut through the tread, and often through the fabric. Water will enter the breaks and rot the carcass. Grit and dirt will soon work between rubber and tread, ruining the casing beyond repair.

SKIDDING AND IMPROPERLY ADJUSTED BRAKES.

Brakes not properly adjusted are the cause of many casings wearing out prematurely.

One drum is sometimes tighter than the other, placing most of the strain on one tire.

This has the same effect on the casing as skidding. It soon grinds the rubber off the tread.

Have your brakes adjusted if your tire shows the tread ground down in spots.

DIFFERENT TYPES OF RIMS.

Remember that all detachable rims are made upon as simple a plan as possible. No matter how complicated they may appear, a few moments' study will enable you to solve them without resorting to undue force.

The common detachable rims are as follows:

Marsh—Fastened with a wedge. Remove lock bolt to loosen wedge.

Goodyear—Uses split ring to lock it. Force back inside ring and outside split ring can be readily pried off.

Universal No. 1 — Similar in principle to Marsh.

Universal No. 2 — Similar in principle to Goodyear.

Firestone—Similar to Universal No. 2.

Baker—Locked with a plate which must be removed.

Detroit—Locking plate turns on a pivot; a clamp is provided to draw up or separate ends of rim.

Booth—Hinged back which must be pried up.

Carrying Capacity of Pneumatic Tires.

(Per Wheel—Car Empty)

Size of tire	Air pressure recommended	Rear weight	Front weight
28x3	50 lbs	350 lbs	450 lbs
32x3	"	375 "	475 "
32x3	"	375 "	475 "
34x3	"	400 "	500 "
36x3	"	425 "	525 "
29x3½	60 lbs	450 "	550 "
30x3½	"	475 "	575 "
31x3½	"	500 "	600 "
32x3½	"	525 "	625 "
34x3½	"	575 "	675 "
36x3½	"	625 "	700 "
30x4	70 lbs	550 "	700 "
31x4	"	575 "	725 "
32x4	"	600 "	750 "
33x4	"	625 "	775 "
34x4	"	650 "	800 "
35x4	"	675 "	825 "
36x4	"	700 "	850 "
37x4	"	725 "	875 "
38x4	"	750 "	900 "
40x4	"	800 "	950 "
42x4	"	850 "	1000 "
32x4½	80 lbs	800 "	1000 "
33x4½	"	850 "	1050 "
34x4½	"	900 "	1100 "
35x4½	"	950 "	1150 "
36x4½	"	1000 "	1200 "
37x4½	"	1050 "	1250 "
38x4½	"	1100 "	1300 "
40x4½	"	1200 "	1400 "
42x4½	"	1300 "	1500 "
33x5	90 lbs	950 "	1200 "
34x5	"	1000 "	1250 "
35x5	"	1050 "	1300 "
36x5	"	1100 "	1350 "
37x5	"	1150 "	1400 "
38x5	"	1200 "	1450 "
39x5	"	1250 "	1500 "
41x5	"	1350 "	1600 "
43x5	"	1450 "	1700 "
36x5½	95 lbs	1250 "	1500 "
37x5½	"	1300 "	1550 "
38x5½	"	1350 "	1600 "
40x5½	"	1450 "	1700 "
37x6	100 lbs	1350 "	1600 "
39x6	"	1450 "	1700 "
41x6	"	1550 "	1800 "

The Care of Tires

The "Reason Why" of the Pneumatic Tire.

WHEN self-propelled road vehicles were first introduced, they attracted but a small share of public attention, and with the exception of heavy traction engines, road rollers and machines of similar type, they were little used.

Not until the invention of the pneumatic tire did the automobile industry become a commercial possibility.

The pneumatic rubber tire is especially adapted to the automobile, because of its resiliency (something akin to the "bouncing" properties of a rubber ball) which enables it to absorb the shocks caused by the unevenness of the road surface.

This combination of air and rubber—the two most elastic substances in existence, is ideal for the purpose, forming an efficient cushion, yet sufficiently strong and wear-resisting to carry the heavy weight of the car and its occupants over the worst kind of roads.

But rubber alone is not enough; it needs air and plenty of it. Air is so cheap, there is no excuse for rim-cutting or other similar troubles which are caused by under-inflation.

Principles of Tire Construction.

An automobile tire is something more than a mere tube of rubber with air inside it.

To build a tire with the requisite combination of strength and resiliency requires a combination of skill and experience such as is demanded of few other items of automobile equipment.

A strong tire alone would be easy. Steel is strong. A tire would be resilient if simply made of rubber alone, but would not wear. Hence the combination of rubber and fabric with which we are all more or less familiar.

To hold the tire on the rim, some kind of "grip" is required so that a complete tire casing consists essentially of a rubber outside, a fabric "carcass" and beads or grips to hold it in place.

The fabric is in itself the subject of special study.

Not every kind of fabric is suitable for tire purposes, and after many years of experience with materials of all descriptions, the only one found to possess the requisite qualities has been sea island cotton, of which, however, only the very finest long staple grades can be used.

At every stage of its manufacture, the material is carefully examined and the least defect is sufficient to cause its rejection. When received at the factory it receives a final rigid inspection and is then ready for the friction calendars. Here it passes through heavy steel rolls and is thoroughly impregnated with rubber.

Next, it is carefully cut into strips on the "bias" of the material, this being necessary for the proper distribution of the stresses evolved in running over the entire body of the tire.

This having been done, it is ready to build up into the tire itself.

Types of Tires.

The various plies of fabric having been previously frictioned and cut into strips, are carefully laid one upon another, on a form, care being taken that each layer "breaks joint" with the one below.

The first plies are slightly wider than the succeeding ones, for a reason which will be presently seen.

The requisite number of plies having been laid, the next processes are the applying of the side walls and beads. These beads are made of a harder compound and, having been laid in place, the first plies of fabric are carefully tucked in around so that the beads are firmly held in place.

Each succeeding layer is firmly rolled down onto its predecessor. Next a thick "cushion" layer of rubber is applied, then the "breaker strip," and lastly the tread is applied. This is much thicker than the side walls and is a specially tough compound suitable for withstanding the heavy wear and tear of the road. The function of the breaker strip is, firstly, to reinforce the tread, and, secondly, to act as a warning signal that the tread is getting worn out and the tire needs renewal or retreading.

In its essentials, then, a tire resembles a shoe, the fabric standing for the lining, the side walls for the uppers, while the sole of the shoe is replaced by the tread. Just as these three parts are of varying strength in the shoe, so they are in the tire, each carefully proportioned to the work it has to do.

Conforming in general construction to the regular lines already mentioned, it differs from other types mainly in the fact that the beads are made of rubber alone, and while firm enough to hold rigidly in place, are yet sufficiently flexible to allow removal from the ordinary one-piece (or clincher) rim.

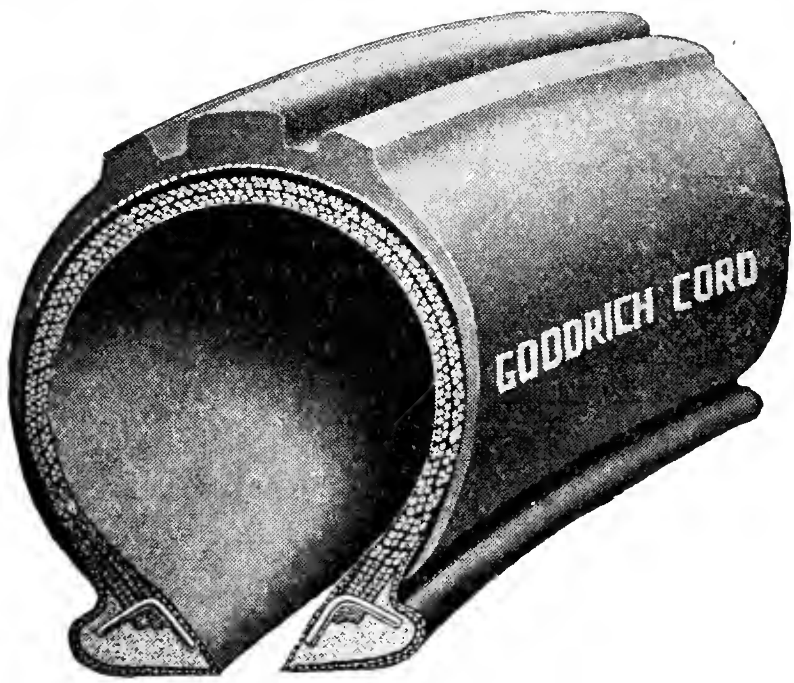
The only point of difference between this tire and the quick detachable type is the bead construction.

In the quick detachable tire the bead is stiff and inextensible, the removal of the tire being effected by removing side, a rim which is made detachable and held in place with nuts and bolts.

The ring being removed, the tire easily slides off, and is just as readily replaced.

The straight bead type of tire has some followers, but little different in construction from the ordinary clincher type, the change again being in the bead. In this tire the projecting bead of the clincher is absent, being replaced by a special form which depends for its grip on the pressure of numerous strands of fine wire embedded in the rubber.

Being used in a straight-side rim, the air space is slightly larger, while the rounded edges of the rim obviate any tendency to rim-cut when the tire is run "flat" (that is, empty), a practice, by the way, which cannot be too strongly cendemned.



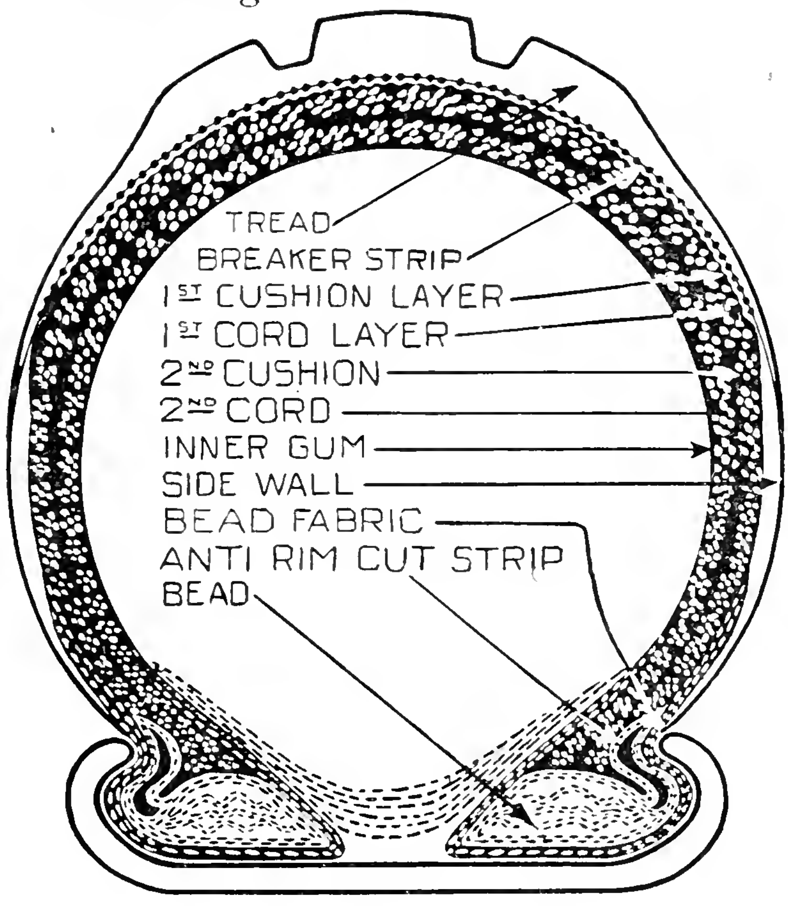
This tire cannot be used on a clincher rim, but may be used on an ordinary quick-detachable rim by simply reversing the flanges.

Two layers of these cords are applied one over the other in the following order:

First a layer of pure rubbed is applied to the form. Next a series of staples, 300 in all, are set at short stated intervals around the inner edge of the bead and on these the first layer of cords is laid by a machine, which places each cord accurately in its appointed place, giving it at the same time the requisite amount of tension.

When the first layer is completed, a second layer of rubber follows, then another of cord. A third cushion layer of rubber follows, finishing with breaker strip, tread, side walls and beads as in the other tires.

It is worth noting that in the process of manufacturing the cords each is twisted up of 24 separate threads, the threads themselves being thoroughly impregnated with pure rubber both before and after twisting.



GOODRICH CORD TIRE

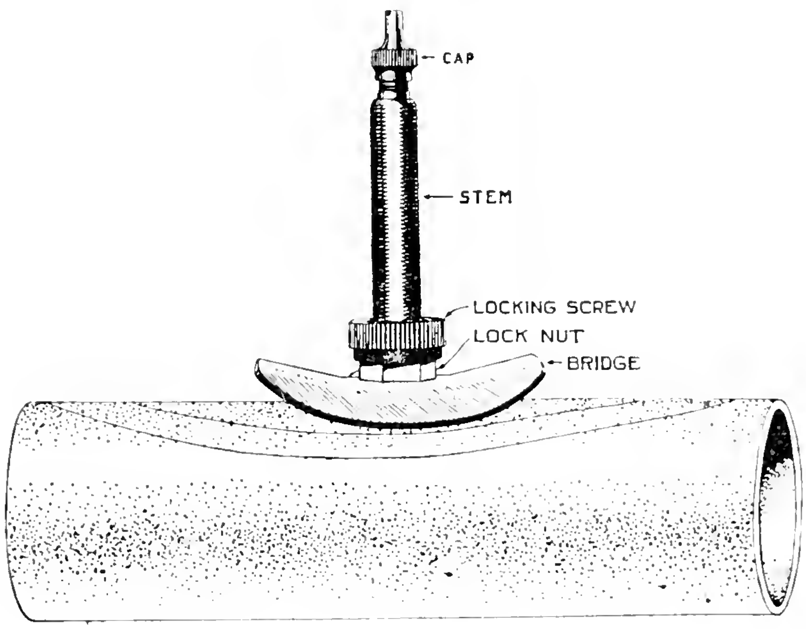
The great strength of this form of construction lies in the fact that each cord forms a separate unit, distributing the strain and blows of the road over the entire body of the tire, that it is more resilient because less rigid than a fabric tire and is more easily repaired.

Although of lighter construction than a fabric tire, it is for these reasons really much stronger.

THE INNER TUBE.

The inner tube has not been inaptly termed the "heart" of the tire. It is necessarily made of the best procurable quality of rubber, since it must withstand the heavy pressure demanded while at the same time preserving its elasticity.

In making a tube, the rubber is first rolled into sheet form, then wrapped layer after layer on a steel mandrel, each layer being carefully rolled



down on the preceding one until the requisite thickness is attained.

After curing, the tube is cut to the requisite length, the ends buffed and spliced, and it is carefully tested for possible defects before packing for shipment.

The illustration shows a small section of an inner tube with valve in place.

THE CARE OF TIRES.

Some owners run the year round without a single trouble, getting more enjoyment out of an old runabout than another man from his high-powered, six-cylinder, all up-to-date-and-a-bit-over auto of the most expensive build.

Maintenance is largely a matter of care and attention.

If you don't feed and groom a horse regularly, he soon gets out of condition, yet the car goes out into the rain, over the worst kind of roads and when it returns to its garage—manana!

In the matter of tires alone, over 75 per cent of the user's troubles arise from misuse.

"Neglected trifles" is a fair summary of the whole question.

Look over your tires today. Ten to one you will find at least one or two cracks or pinholes, apparently not amounting to anything at all. But! Clean one out carefully and follow it up. It extends right down to the fabric, and every time that part of the tread touches ground the tire is one more stage on its way to the "graveyard." Wet and sand find their way in until at last the tread blisters or peels off bodily.

An ounce of prevention is worth a ton of cure, and frequent overhauling of your tires and the immediate repair of even the smallest cut will materially help to lengthen the life of the tire.

Here is shown a tire that has blown out, due to neglected repairs. It originally had a small cut entirely through. An inside patch was applied by the owner, he feeling that this was all that was required to place the tire in good running order, but instead, the inside patch merely aggravated matters and, acting as a wedge, caused the tire more harm than good. The result, as shown in the picture, was that the tire blew out from bead to bead, that is, the inner patch wedged the fabric apart, causing it to break or pull apart from bead to bead.

By looking closely you can see how the patch has pulled away from the position it originally held, and has been forced through the break, protruding on the outside. (Shown in Fig. 1.)

BLISTERS CAUSED BY NEGLECTED CUTS.

We class this a condition due to a neglected repair, as it does not follow from any weakness in the tire, but has resulted from the tire not receiving the proper attention when it was first cut.

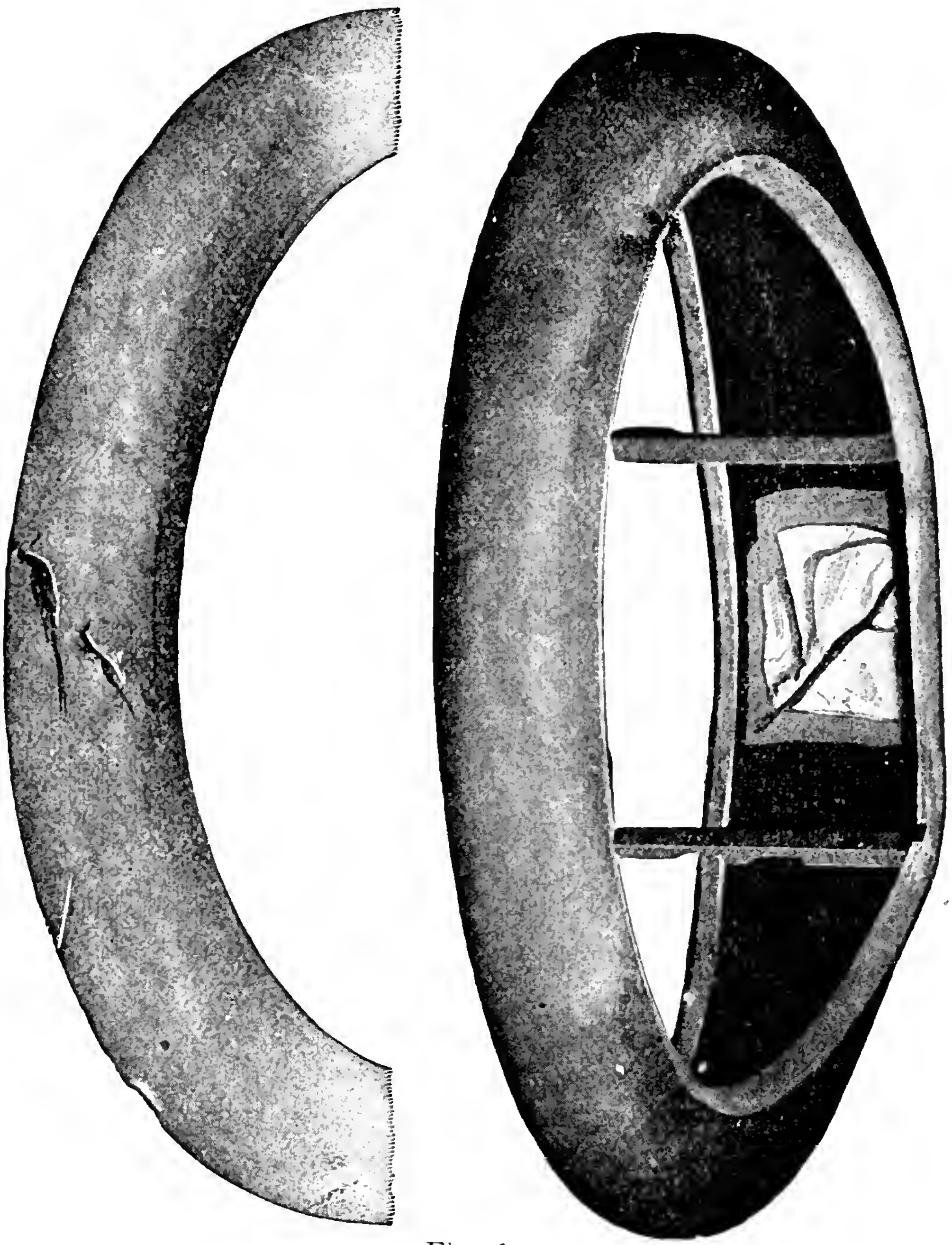


Fig. 1.
BLOWOUT FROM NEGLECTED REPAIRS.

UNDER-INFLATION.

Under-inflation produces over-heating. This in turn saps the life of the fabric in the tire, destroys the cohesion between its various plies,

RESULT OF
UNDER-INFLATION.

EFFECT OF
RUNNING OUT
OF ALIGNMENT.

and allows the tread to loosen up all round. If the injury were confined to the latter only, it could be repaired by retreading. The cost of this would be approximately one-third the original cost of the tire and the ultimate mileage would be reduced. So the penalty of running under-inflated is costly. On the other hand, where the plies of fabric separate, repairs cannot be made at all, and the tire if cut through or broken by a stone-bruise is worth only junk value.

Another point worth considering is the much talked of "rim-cutting." No tire will rim-cut if it be properly inflated, but any tire will be irretrievably damaged by being run ever so short a distance in a deflated or even partly deflated condition.

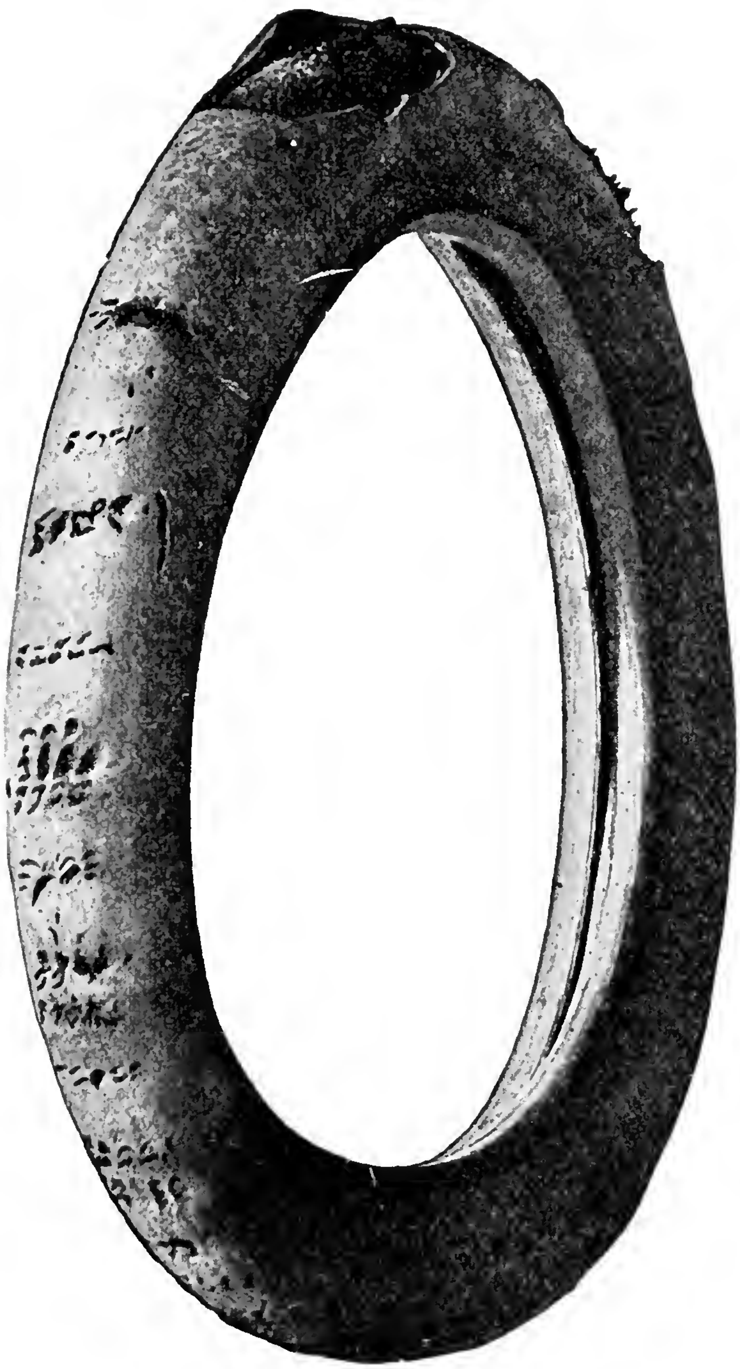
Running Out of Alignment.

This and many other tire troubles are clearly the fault of the driver and should never occur if the tires are properly cared for and small repairs attended to at once.

A common source of tire trouble is premature wearing out of the treads, from the wheels being out of alignment. This is generally a condition of the front wheels, though it may affect the rear wheels of chain driven machines. It can be easily located by measuring the distance between the two wheels with a stick, both ahead and behind the axle. The effect is to grind off the tread and ruin the tire. In aggravated cases, the damage may be complete in a hundred miles. The remedy is to have the alignment corrected and the tire retreaded, if it is otherwise in good condition. A very similar result is produced by a wheel out of true or wobbly, the wear appearing at fixed intervals around the tire.

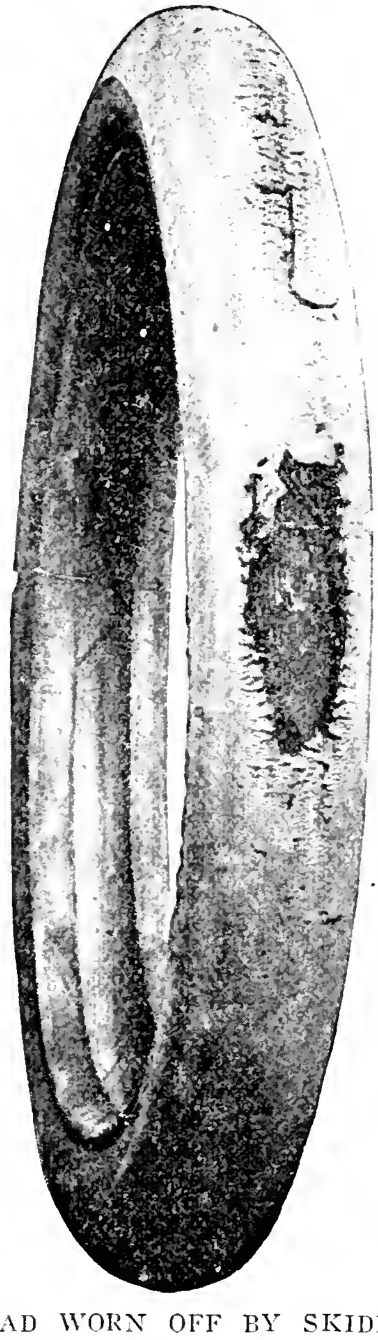
Any cut which reaches the fabric ought to be repaired with a vulcanized patch. If small, it can be sealed with a plastic compound, which keeps out moisture and dirt. It may not hold in the larger cuts, however, and these should be vulcanized.

There are a number of handy portable vulvan-



CUT AND TORN BY IMPROPER USE OF CHAINS.

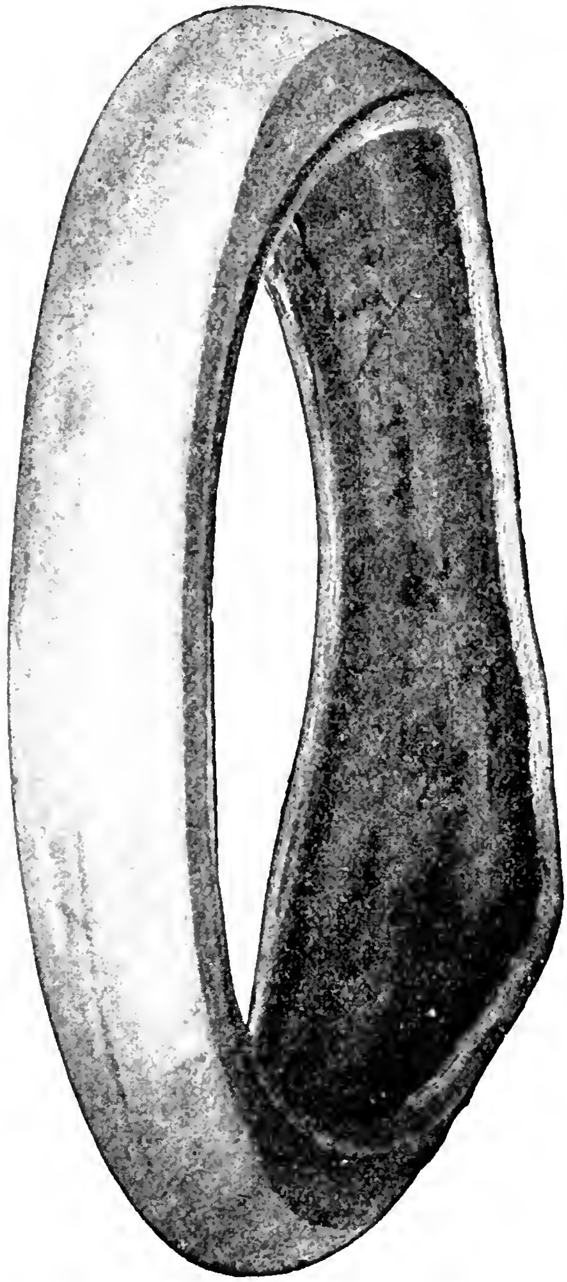
izers in the market which, if properly used, are all right for the average tread cut. Too large a repair should not be undertaken with them, as the necessary pressure for such cannot be secured. Great care should be exercised lest you burn the tire, for the heat is difficult to control in these small vulcanizing devices. To some extent this tendency can be overcome by putting a sheet of



TREAD WORN OFF BY SKIDDING.

paper between gum and vulcanizer. They are, however, more adaptable to tube repairs, which with a little experimenting can be worked out very nicely.

Judgment should be used in applying chains. These should always be adjusted loosely so that they strike the ground ahead of the tire. In this way the maximum non-skid effect is produced



FABRIC DESTROYED BY INNER LINER.

and they do not bind and tear the tire as they would do if adjusted without plenty of play.

Avoid locking your wheels with the brakes. No tire will withstand the strain of being dragged over a pavement in this fashion. The heat will burn it through in a few seconds if the speed and load be enough. Besides, the danger of accident from a skidding machine is increased. Let the brakes do the work of stopping the car, by proper application. Do not put this work on your tires.

The strain caused by the sudden stopping of a 2,000 or 3,000 lb. car, running at 20 or 30 miles an hour, is really tremendous, and no amount of human ingenuity can ever invent a material capable of withstanding such a shock. Steel itself would be disintegrated in time by such treatment. Heavy loads and excessive speed have the same tendency, the initial cause of which is the intense heat generated inside the structure of the tire itself, destroying the resiliency of the rubber and making it brittle and non-elastic.

Do not use too much soapstone inside your cases. This will accumulate at one point, friction will be set up, and the tube will soon be honeycombed with small blisters, presenting a bubbly appearance.

Keep away from inner liners in new or serviceable cases. They may extend the life of old and worn-out tires by an additional 500 miles or so, but they will ruin good tires through the frictional heat engendered.

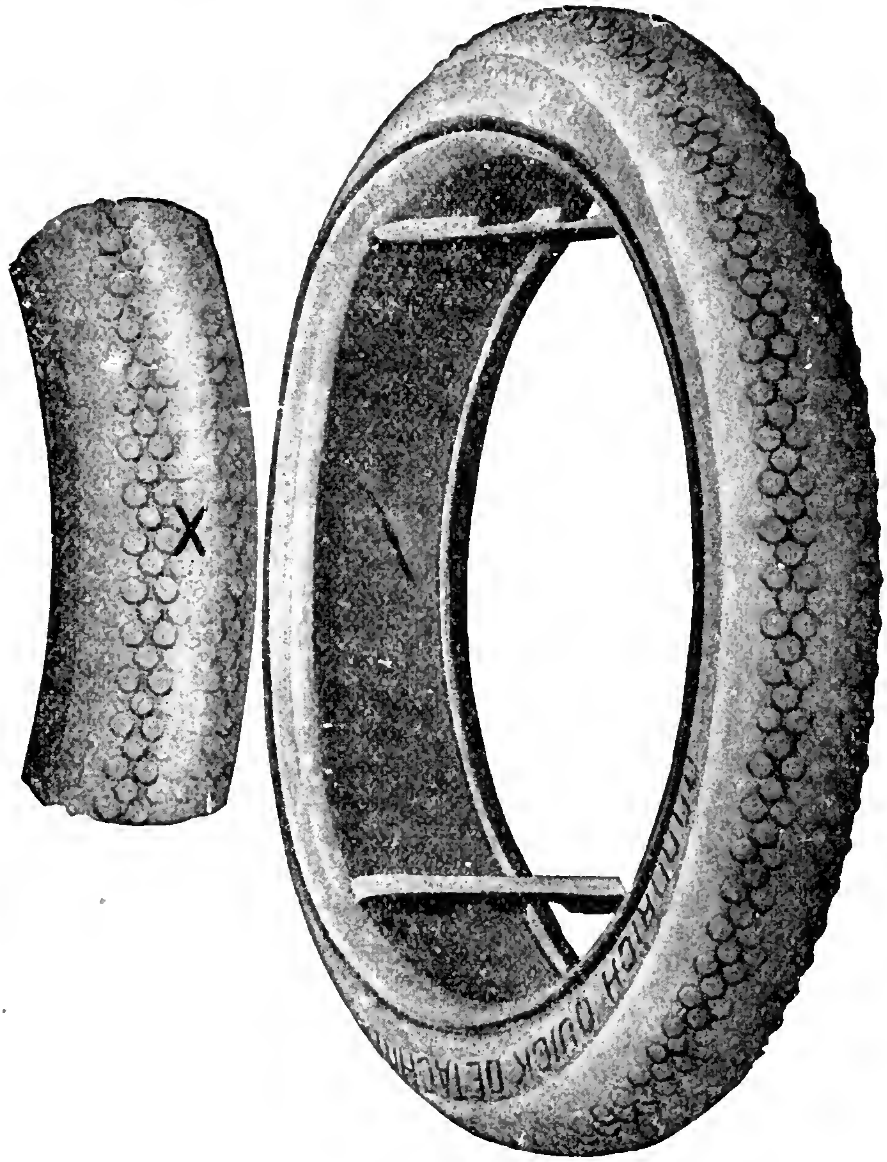
Stone bruises are not an infrequent trouble. Let us say at once, these are the motorist's own fault.

Any one who deliberately drives over a heavy stone or similar obstacle is literally asking for a blowout.

The reason is that the effect of a heavy car at a high speed, striking a stone, is just the same as that of a heavy missile hitting the tire. Something has to give way, and this is usually the fabric.

Sometimes this injury does not become known for a long time, but sooner or later a blowout is inevitable.

Running in ruts or car tracks is another easy way of spoiling a tire.

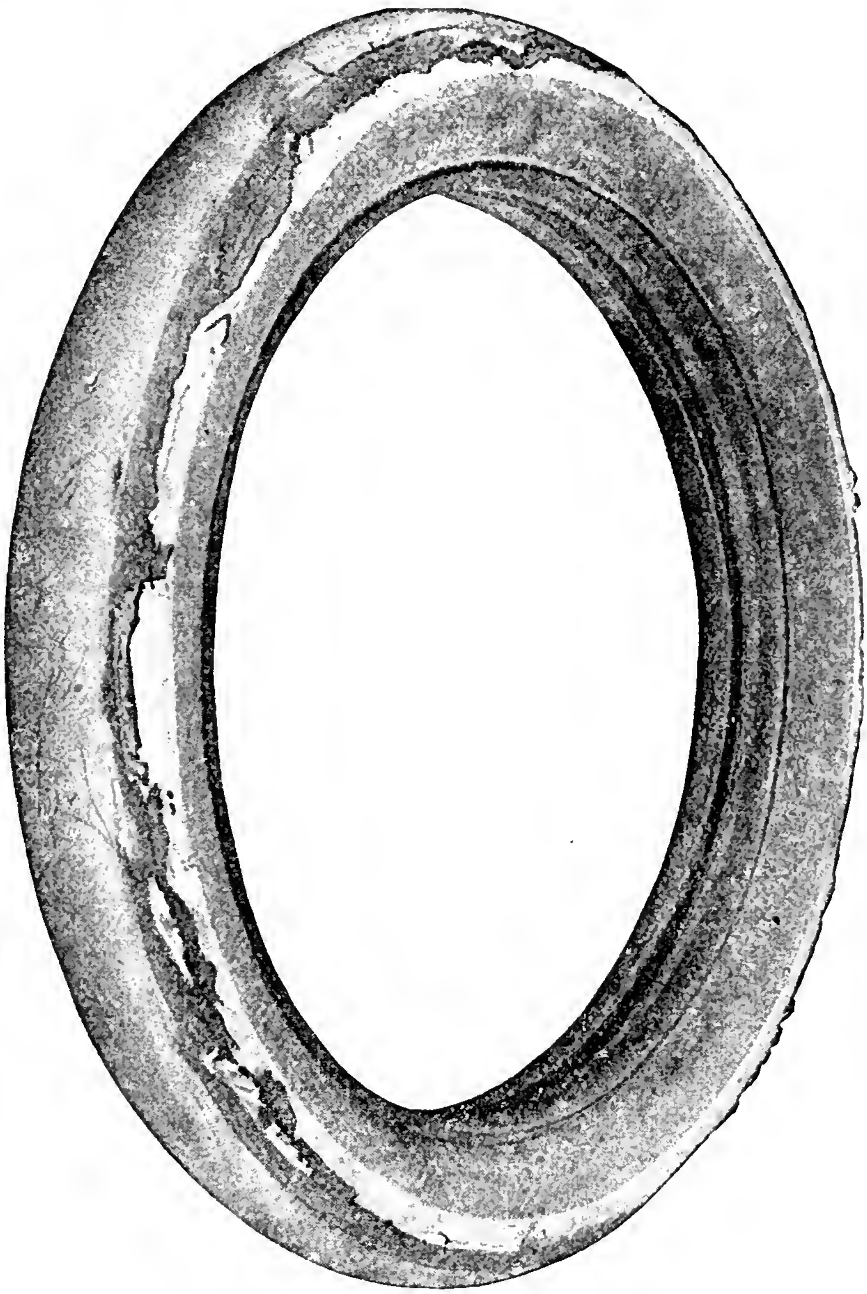


FABRIC BROKEN BY A BRUISE.

The tread is like a boot sole, made for hard wear, but the side walls may be compared to the boot uppers. The result of running in the manner indicated is to wear off the sides, which are speedily ruined, although the tread may be intact.

This kind of injury is almost impossible to repair, so every care should be taken for its avoidance.

The foregoing are some of the more common causes of tire trouble. All of them may be avoided by a little care and attention to common sense rules.



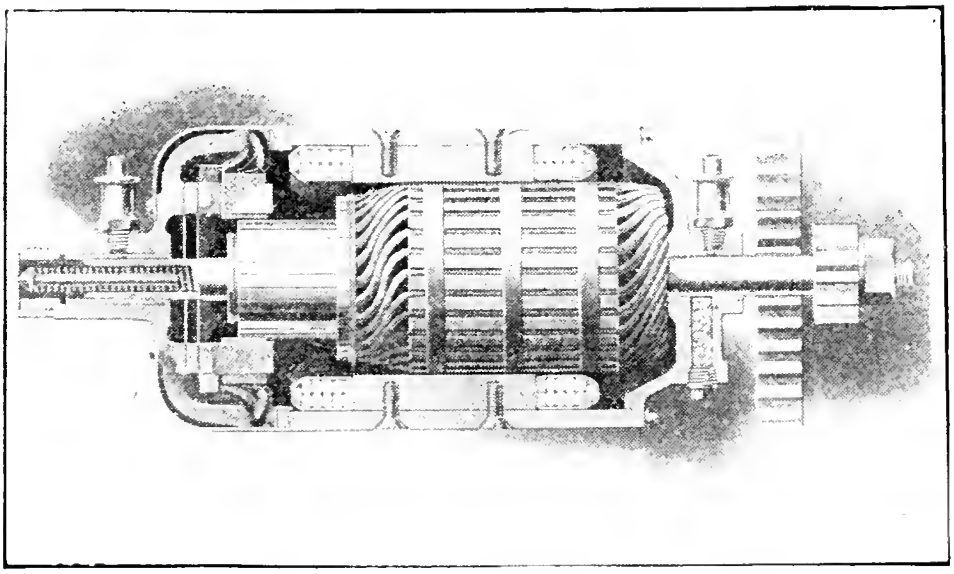
EFFECT OF RUNNING IN RUTS OR CAR TRACKS.

Reckless or careless driving cannot be too severely condemned. Even if no accident occurs, it is utterly destructive of both tires and machinery.

Self-Starter Devices

Rushmore Starting and Lighting System.

THE Rushmore Engine Starter and Dynamo are distinguished by extreme simplicity of mechanism, and action so completely automatic that none of the usual manipulations are needed either in starting the engine or in regulating the charge delivered at the battery.



RUSHMORE STARTER.

The Starter acts directly on the flywheel, the usual intermediate gears being omitted. A pinion on the armature slips automatically into mesh with the flywheel gear when the button is pressed, turns the engine over at a rate of 75 to 300 r. p. m., and slips automatically out of mesh again as soon as the engine picks up. The operator has nothing whatever to do with the performance after the button is pressed.

The illustration shows the starting motor in section with the armature out of action. The pinion at the right-hand end of the shaft is keyed fast, and the whole armature moves bodily endwise with its shaft to engage and disengage the pinion. The left-hand end of the shaft is hollow and carries a compression spring by which the armature is held out of action in the position shown. In this position the armature is out of line with the pole pieces of the field magnet.

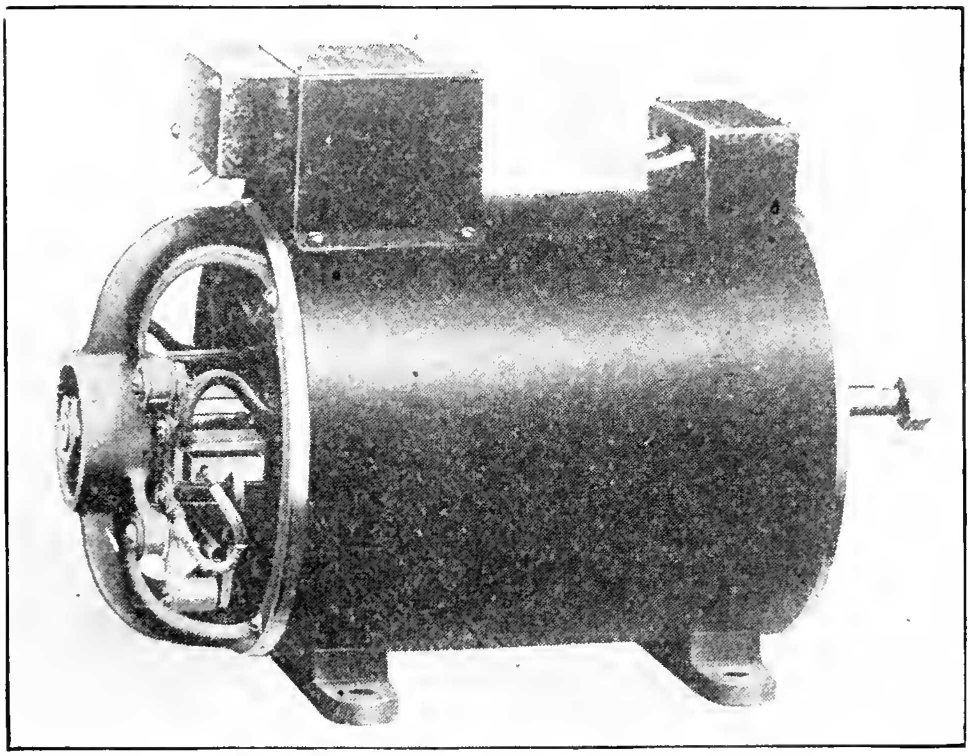
When the starting switch is closed the attraction of the pole pieces draws the armature strongly to the left, thus meshing the pinion and causing the armature to turn.

With the first explosion the armature is relieved of its load and the current which it draws from the battery drops instantly almost to nothing, so that the attraction of the pole pieces is not sufficient to hold the armature in its working position. The spring, therefore, instantly pushes the armature to the right, thus slipping the pinion out of mesh before one can notice any increase in speed. As the pinion does not stay in mesh after the engine starts, the usual noise due to the pinion running in mesh at high speed is absent. The whole operation, in fact, is practically noiseless.

To insure the pinion meshing properly when the switch is closed the switch has two active contacts. The first contact practically short-circuits the armature and puts the field coil in series with a resistance. The effect is that the first contact gives the armature only enough turning motion to make sure that the pinion goes into mesh. The second contact cuts out the resistance and puts the armature in circuit so that it starts to turn the engine.

The Starter is made in two sizes, Model B, weighing 47 pounds, for medium size engines, and Model A, for the largest engines. The Model B will turn a four-cylinder engine of 4-inch bore at 250 r. p. m. or faster, and a six-cylinder $4\frac{1}{2} \times 5\frac{1}{2}$ engine at 100 r. p. m., using 100 amperes after the engine gets started.

The Rushmore Dynamo is distinguished by having no mechanical current regulator. The output is governed by utilizing a peculiar property of iron wire, namely, that of increasing greatly in resistance at a critical temperature a little below red heat. The manner in which this property is utilized is simple and highly ingenious. The dynamo



NO. B DYNAMO WITH COVER C REMOVED OF BUSHER.

field magnet is wound with the usual shunt coil, and in addition with a "bucking coil" which is in series with the external circuit, so that the current delivered at the battery and lamps goes through the bucking coil. The effect of the bucking coil is to reduce the excitation of the field magnet. This reduction in strength is, however, desired only at low speeds, and here is where the iron "ballast coil," as it is called, comes in. This ballast coil, consisting of a simple strand of stove-pipe wire 10 inches long, is arranged as a shunt across the terminals of the bucking coil, so that the current delivered, instead of passing wholly through the bucking coil, divides between the bucking coil and the iron ballast coil on its way to the battery and lamps. When the ballast coil is cold it practically short circuits the bucking coil so that the latter has very little effect. As the speed of the dynamo increases its output increases also very rapidly, up to the point where the ballast coil becomes hot. When the delivery exceeds about 12 amperes the resistance of the ballast coil increases so much that a considerable portion of the current is forced to find a path through the bucking coil, thereby reducing the excitation of the field magnets.

The Dynamo is complete in two sizes, the larger designed to run about engine speed and the smaller to run about 2½ times engine speed. They give maximum outputs up to 18 and 14 amperes, respectively, though these outputs can be reduced if desired by using ballast coils of smaller wire.

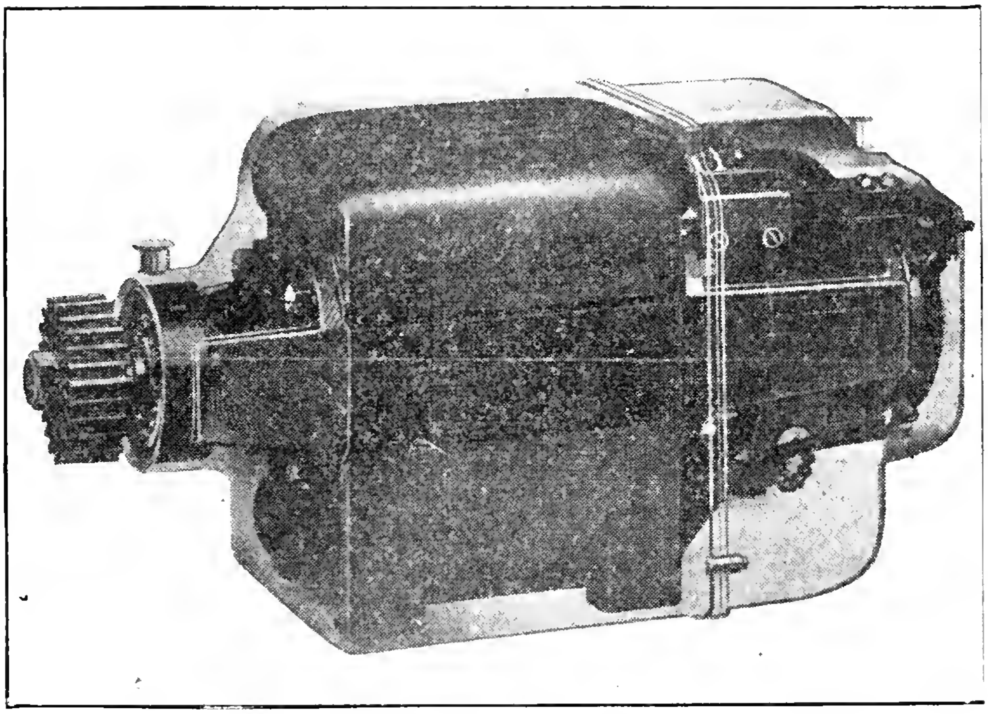
A switch connected to the headlight switch cuts the ballast coil out of circuit, so that all the current from the dynamo has to go through the bucking coil; this reduces the output to about three amperes average when the headlights are out of use. This small current suffices for the demands of the small lamps, horn, ignition system, etc. Owing to the normal output being so large, the battery is not drawn upon at all when the lamps are lighted, unless the speed drops below about 15 miles per hour. Consequently the usual daylight recharging is unnecessary, and danger of the battery being unexpectedly exhausted by excessive night driving is eliminated.

WHAT THE ELECTRIC DISCO CONSISTS OF.

The Electric Disco Starting and Lighting System consists primarily of three parts: (1) A generator and dynamo; (2) A storage battery; (3) An electric motor.

Wiring connections and controls are, of course, necessary.

The Generator Dynamo—This is small and compact. Weighs but 25 pounds. It is approximately 4 x 7 x 10 inches in size. Enclosed in a dust-proof, water-proof, easy-removable aluminum jacket. It is connected to the engine and is entirely automatic. Its function is to generate electricity and keep the storage battery charged.



THE DISCO STARTER.

The generator produces ample current to carry the lamp load and enough more to keep the battery fully charged. This production is maintained at ordinary driving speed and is of more than sufficient quantity to light and start the car at all times. The mechanism is so arranged that long drives or driving at high speed has no injurious effect on the battery.

The Disco generator is not merely a lighting generator. It is made especially for the requirements of both starting and lighting. It produces sufficient current to take care of the requirements of starting and enough more so that the battery cannot become discharged.

Nor can the battery discharge back through the generator. All these functions are automatically taken care of. The driver has nothing whatever to do with the generator.

The Battery.—It is carried in the usual way, beneath the car frame. Furnished in three sizes, depending upon the candle power of the lamps. The battery stores and distributes the amount and strength of current most efficient for starting and lighting.

The Disco use the 12-*volt* type of battery. Their extensive experience has proven it far more efficient for this duty than either a 6, 16 or 24-volt battery. Thus they have eliminated complicated switches and other means for throwing the batteries from series to multiple. And they have done away with overly large wires. The 12-volt system has all the advantages when it comes to simplicity in generator, motor, terminals, brushes, etc.

The Electric Motor—Is the same shape and about the same compact size as the generator. It is also enclosed in a dust-proof removable aluminum case.

It is mounted on the side of the crank case and connected by gearing to the flywheel, or by silent chain or gears to the crank shaft. When the driver pushes the starting button, the electric current from the battery rushes into the electric motor and instantly *spins* the engine. This is the sole purpose of the electric motor.

THE HARTFORD STARTER.

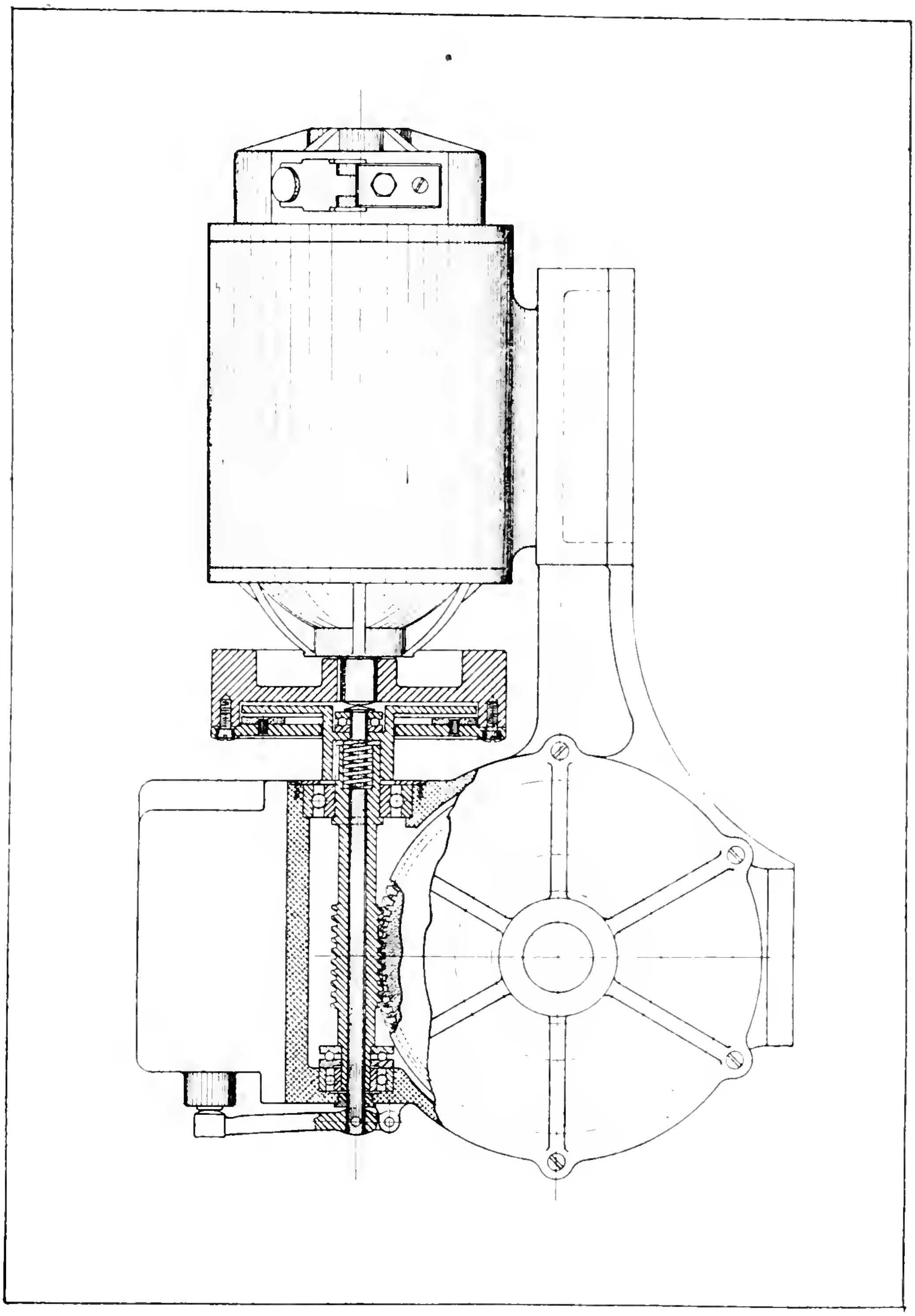
The Motor.

The Hartford Self-Starter consists of a small efficient, high speed motor, with a balance wheel mounted on the armature shaft; a clutch normally disengaged by means of which the motor and balance wheel may operate entirely free from the mechanism connecting the motor and the engine. The free clutch is so constructed that one portion of it, and the balance wheel, is keyed to the armature shaft, while the other portion is longitudinally movable along the free end of the shaft on which is mounted a steel worm of special design which meshes with a bronze worm wheel mounted on ball bearings. The shaft which carries this worm wheel projects through the case and may be utilized either for a spur gear pinion or chain sprocket from which the power is transmitted to the engine shaft, according to the method found to be most applicable. The gear or sprocket on the engine shaft has incorporated in it, a roller clutch which engages the engine shaft when the power is applied. This clutch releases immediately after the engine begins to operate under its own power and the motor and driving mechanism immediately come to rest.

The gear reduction in this device is normally 75 to 1, which taken together with the high speed of the motor, 5,000 to 6,000 r. p. m., and the energy stored in the balance wheel at such speed produces a torque, which when applied to the work, in an efficient and practical manner, produces results that to the uninformed, seem almost impossible of accomplishment.

Operation.

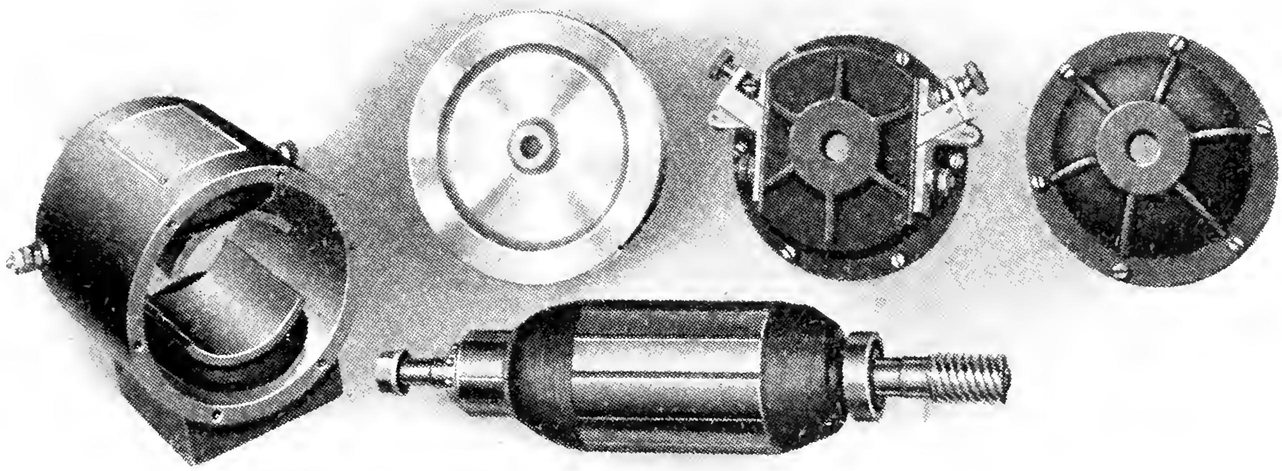
The operation is entirely automatic and so simple that it is easily and correctly operated by



View of Starter, showing cross section of worm gear, flywheel and clutch mechanism.

a child by following the simple directions of pressing a foot lever. This lever can be mounted in any convenient place and it is used for making the electrical contact and for operating the clutch.

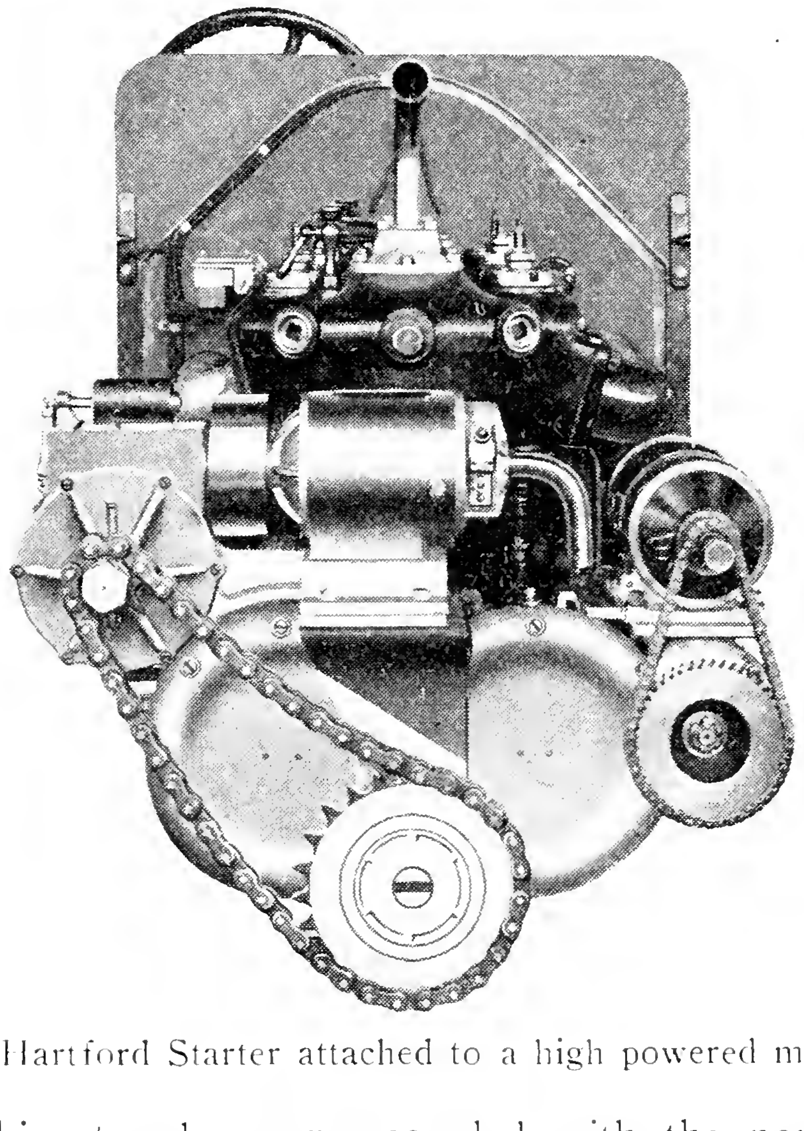
A twelve-volt battery of 35 amperes hour capacity with six-volt distribution for lighting is used in connection with the starter, although a six-volt system can be furnished if desired. The lever travels approximately two inches and at its first movement makes the electrical contact to the



Components of Motor—which is of series wound type. All parts are fully enclosed, readily accessible and protected from moisture and foreign elements.

motor. During the interval of pressing down the lever, the motor attains a speed of several thousand r. p. m.

It may be well to note that up to this point the motor and flywheel will be running free and the current consumption extremely moderate. Upon a still further movement of the switch lever, the clutch between the motor and the driving mechanism will be engaged and the energy accumulated in the flywheel at such high speed, is added to the torque of the motor, thus making available an amount of power, for a short space of time, many times greater than a motor alone would furnish to establish momentum and which is easily maintained by the motor for the length of time necessary to start.

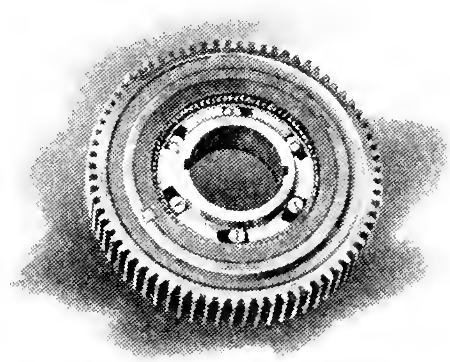


The Hartford Starter attached to a high powered motor.

This stored energy, coupled with the normal torque of the motor, brings the engine speed up to the firing point rapidly, causing, as it does, high velocity of air past the carburetor jets, thus providing an explosive mixture more quickly, and at the same time *heating the mixture,* owing to rapidity of compression, so that firing takes place more readily than would be the case under slow speed conditions. When it is understood that but two or three seconds' time are required to establish this speed, the advantages of the system will be appreciated.

Another important function of the balance wheel on the armature shaft, is that it continues to aid in carrying the pistons past the points of compression at this effective speed without any perceptible slowup, which also insures a good spark where magneto alone is used for ignition, thus providing, without question, two functions of the balance wheel as incorporated in this device. These features are original.

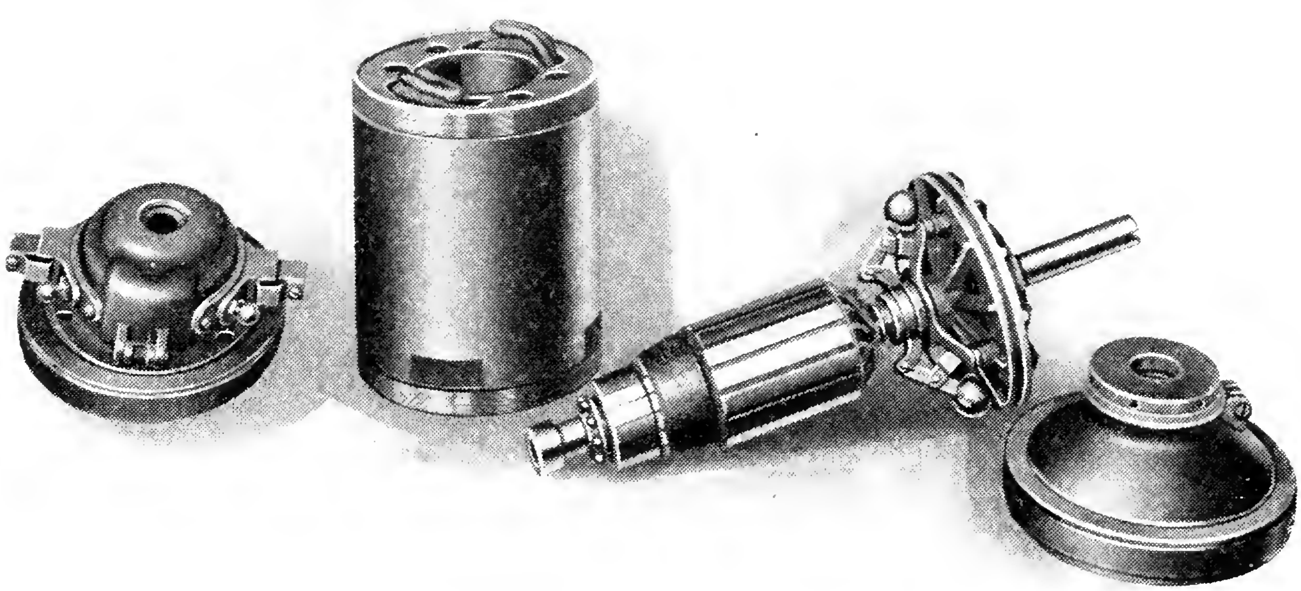
It will be understood that where an engine is extremely hard to start, owing to poor carburetion or congealed oil in winter, the time of operating the switch lever under the steering wheel may be slightly prolonged, thereby permitting the speed of the series motor to double, if necessary, before the clutch which connects the motor with the driving mechanism is thrown in. An idea of the increase in power to be obtained in this manner, may be appreciated when it is understood that the energy accumulated in the balance wheel of the motor increases as the square of the velocity; therefore, if the speed of the balance wheel be doubled, the available power is four times as great as the former speed. In this manner, engines of the largest size may be cranked past compression points at the rate of 150 r. p. m. and smaller engines at the rate of from 200 to 300 r. p. m.



The general construction of the motor and driving mechanism is of the most rugged type, materials being used for each part best adapted for the work to be performed.

GENERATOR.

The starter part of the equipment having been described above, the following information will deal with the generator and other necessary parts



Showing Generator disassembled.

of the equipment. The complete system is of the double unit type, this having been proven as having the greatest advantages in application, simplicity or circuit arrangement, maintenance and economy of power when in operation.

Another important factor in the two unit system is that it saves considerable in weight and permits of more practical application; also the series form of winding is most efficient for starting motors, yet it is not practicable for generators.

While it is possible to build a machine large enough to incorporate both windings, such construction would add complications and unnecessary weight. It would also mean that the engine would have to drive continuously a device much larger than what would be necessary to supply the required amount of current to keep the battery fully charged. With the two unit system, any

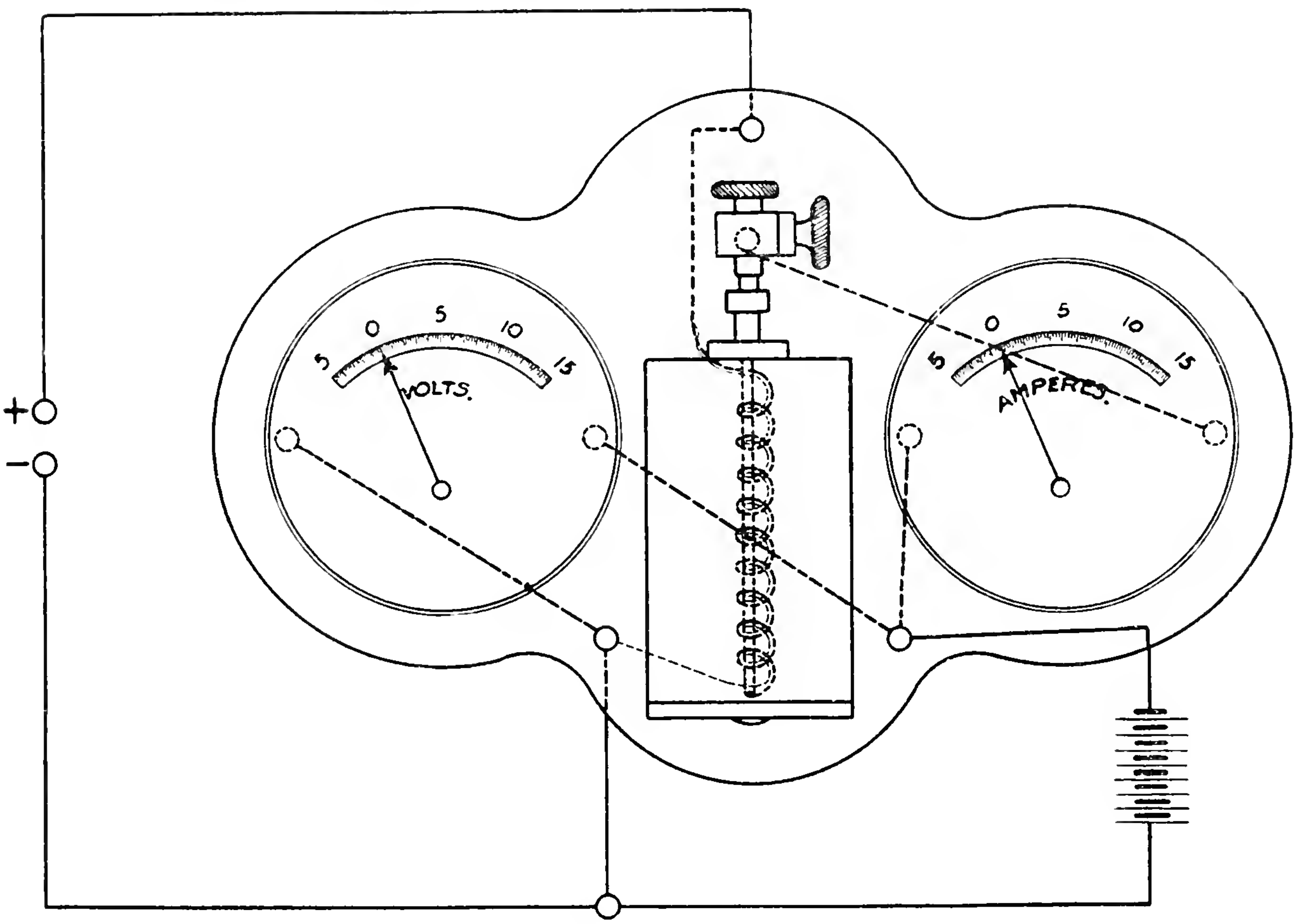


Diagram of automatic cut-out, showing method of wiring.

difficulty arising in one does not affect the other, whereas in a single unit system, any trouble that affects the motor-generator in any way necessarily affects both systems.

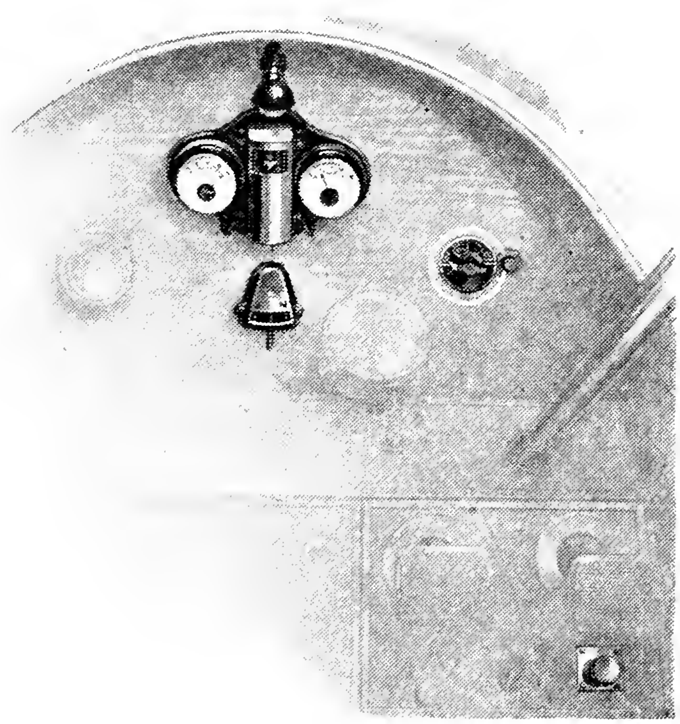
The Hartford generator is designed to furnish 100 watts continually and to carry a fifty per cent overload when conditions demand it. The design of the pole pieces and balance of armature and field windings insure a permanent polarity and prevent the possibility of reversal. Ball bearings are used throughout.

Special consideration has been given to maintenance and accessibility. The brush holders and brushes may be removed or replaced very quickly. A small hinged cover in the commutator housing facilitates inspection and cleaning when necessary, while a small opening is provided so that the commutator end of the shaft may be lubricated. This opening is provided with a dust-proof cover.

The lubrication of the governor end of the shaft and of the governor parts is cared for by a grease cup mounted on the opposite or driving end of the shaft. The generator is driven by means of sprockets and silent chain or by gears, the normal speed being approximately 1200 r. p. m. This speed is maintained by use of a centrifugal ball governor, which actuates a friction clutch on the armature shaft with an adjustment in driving end of the housing which may be regulated when the machine is in operation and by means of which a greater or lesser pressure may be placed upon the friction discs; the greater pressure meaning that the speed would have to be higher to cause the governor to separate the discs and thereby govern the armature speed while a lesser tension would mean that this action would occur at a lower speed of the armature. By means of this adjustment, the output of the machine may be regulated in the most accurate manner, to accommodate individual habits of driving which is not possible with any other method of control. It is well known that the demand on a storage battery will vary according to conditions, and having such a means of adjustment for regulating the output of the generator enables the operator to secure the most satisfactory service at all times. The generator is adjusted before leaving the factory so that it will hardly ever be necessary for the operator to make any radical change. There is a locking device by means of which the adjustment can be set after once being made.

Cut-Out.

An antomatic cut-out operated electrically, performs the function of connecting and disconnecting the generator and battery when the proper speed of the generator is reached. This connection is established when the engine has reached the speed that would propel a car on high gear at



Showing location of cut-out, starting button and switch.

about eight miles per hour. It is then that the generator begins charging the battery, the rate of charge increasing until the car reaches approximately fifteen miles per hour, at which point the governor on the generator becomes operative and maintains constant armature speed. This means that the charging rate is constant regardless of the variations of engine speed above that required to propel the car fifteen miles per hour, and the

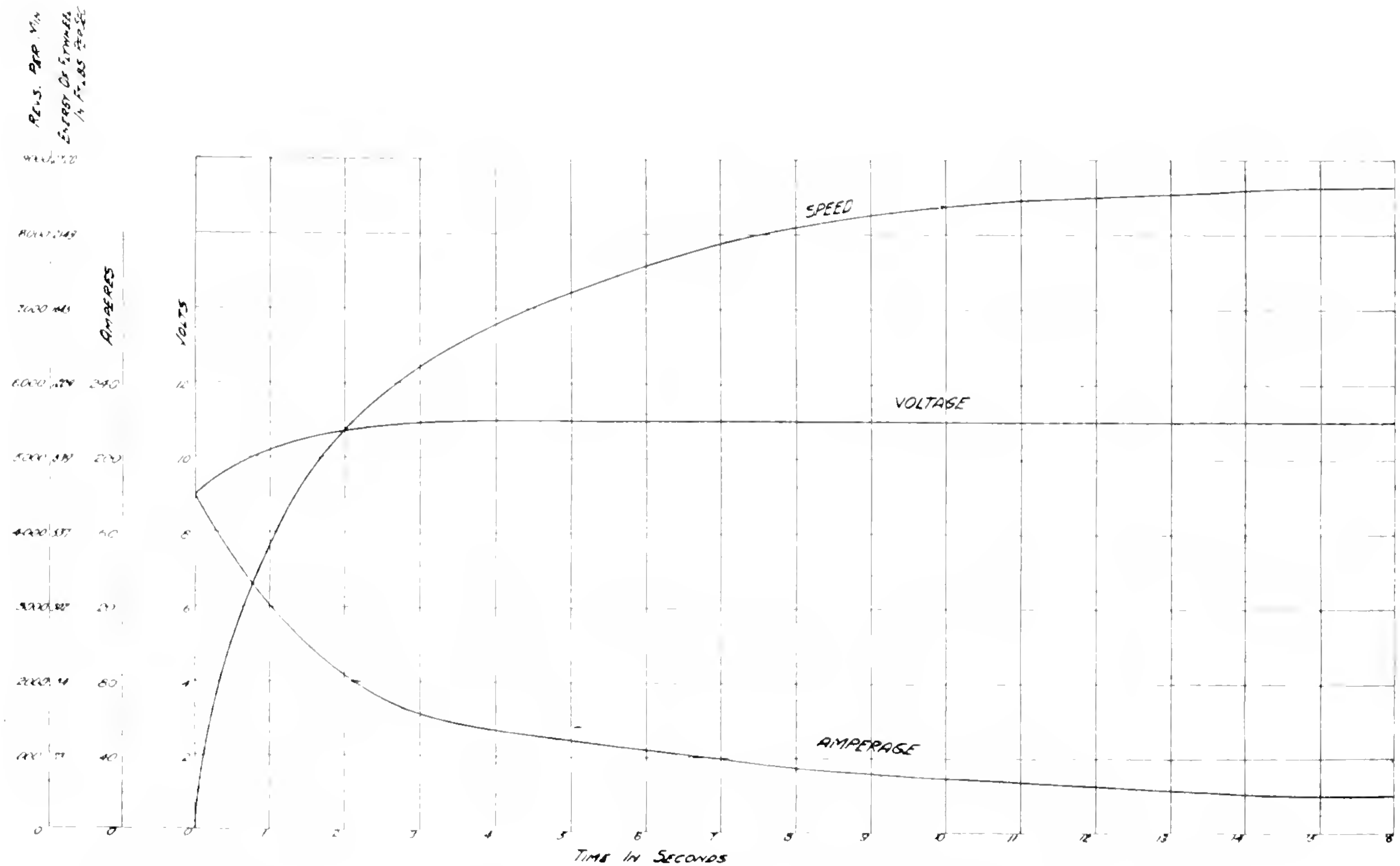
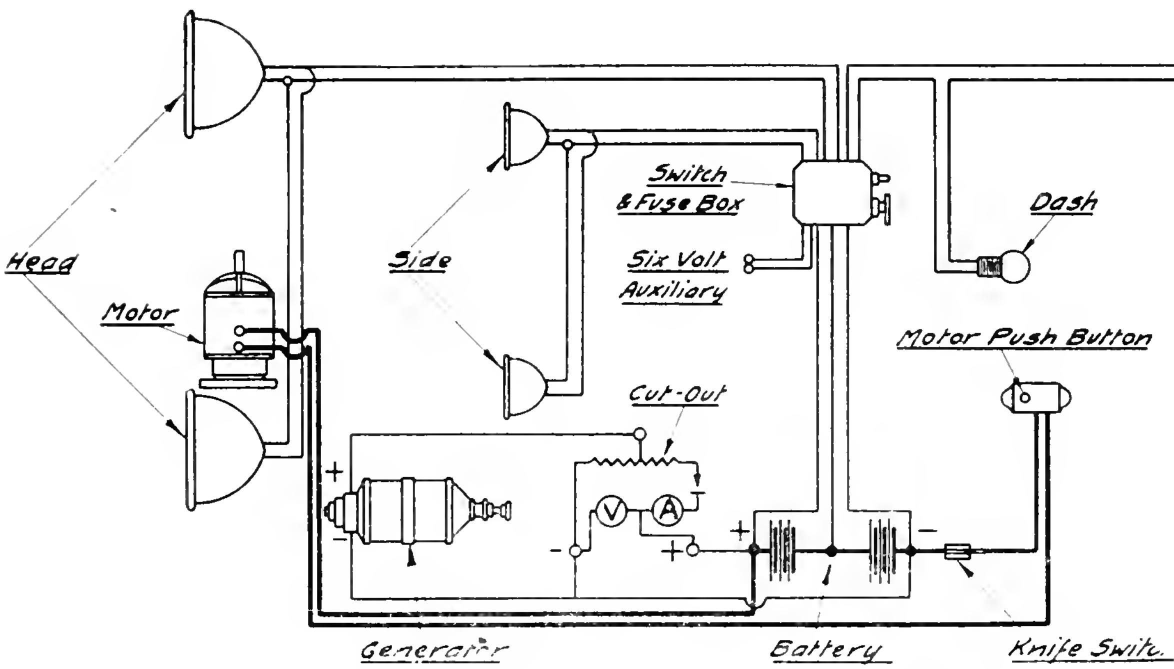


Chart showing characteristics of motor with flywheel attached in regard to time, accumulated energy speed and current consumption.

commutator winding and brushes are not subject to excessive friction or speed. When the speed is reduced below fifteen miles per hour, the governor becomes inoperative as the machine slows down and as the car reaches the speed of approximately six miles per hour, the voltage of the generator is reduced to a point less than that of the battery, which permits a slight reversal of the flow of the current through the cut-out heavy winding.

Inasmuch as there is still a low voltage current



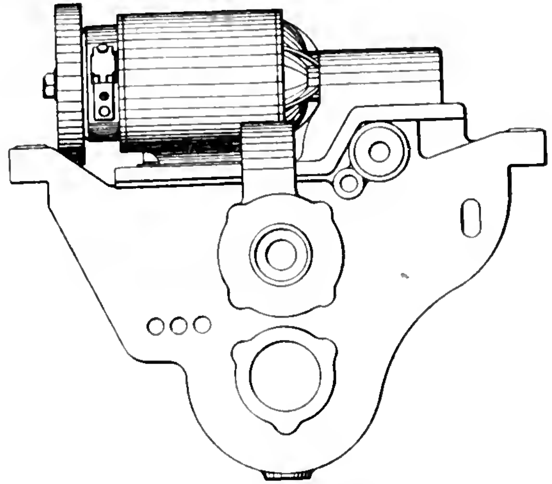
Wiring diagram of Hartford System.

flowing from the generator through the fine winding on the cut-out coil, the effect of the reversal of the battery current is to cause a partial neutralization, thus reducing the strength of the magneto field which holds, by means of a movable armature, the contact points on the cut-out together. When this neutral point is reached a spring forces the two points apart, thus disconnecting the battery from the generator and preventing any waste of current. As this action is instantaneous, there is positively no way in which the battery current can run back through the generator. This is a very important feature and should not be underestimated. The cut-out is protected by a brass cover in which a small window is located by means of which the working parts may readily be seen. As a further matter of protection, the cut-out armature is housed, so that it cannot be cut in accidentally. The cut-out requires no adjustment, and rarely, if ever, any attention after it is installed.

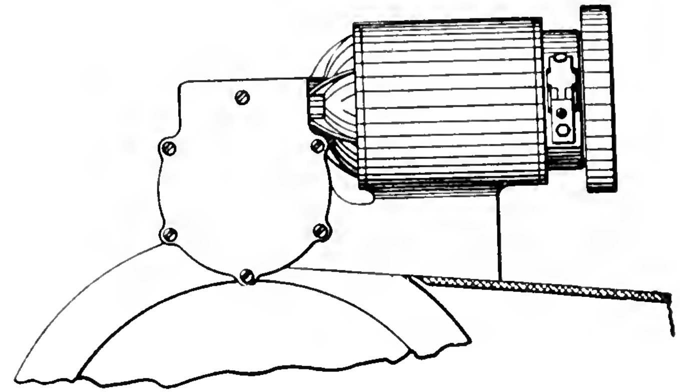
On the same panel with the cut-out an ammeter and voltmeter are mounted. The panel should be placed on the dashboard in a convenient place so that the readings of both meters may be readily seen. For convenience at night a dash lamp is installed directly over the panel. It is only by means of these meters that the true condition of the battery and the performance of the generator may be intelligently noted at any time.

Wiring System,

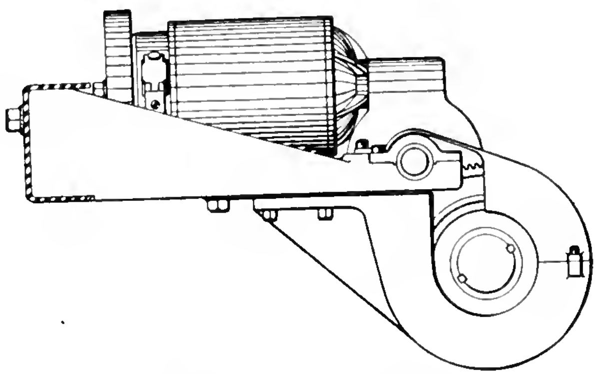
The wiring system is of the complete or double metallic circuit type arranged for six volt distribution, any connection with the frame or ground of the machine being entirely avoided. The advantages of this method as against the single wire system are in every way greater, and much more reliance may be placed in the double metallic circuit for many and sufficient reasons. In a single wire system should the insulation of any of the auxiliary circuits be worn through owing to vibration or for any other reason so that a contact is made with the frame, that particular part of the wiring system would naturally be grounded and would cause a heavy flow of current from the battery which would burn out the fuse in that particular circuit, thus rendering it inoperative until the leak was discovered and rectified, whereas with a double metallic circuit such a contact on one side of the line would not cause the same dif-



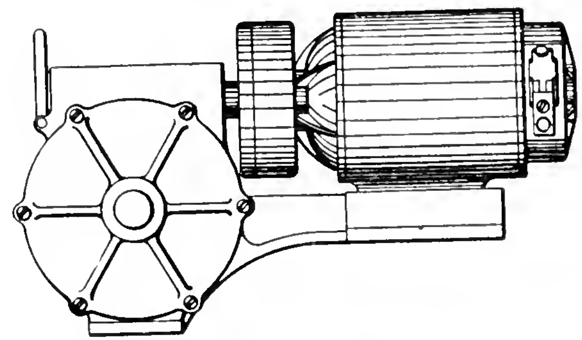
INTEGRAL WITH TRANSMISSION



GEARED TO FLYWHEEL



REAR OF FLYWHEEL



REAR OF RADIATOR

The Hartford Starter can be installed in any convenient location. These diagrams will illustrate the various applications possible with the use of the Hartford System.

ficulty. Should a ground be formed on a single wire circuit on the wire leading from the battery to the cut-out, it is obvious that owing to the opposite side of the battery being grounded the entire system would be put out of commission and the battery practically ruined.

The wire used in the Hartford system is of the concentric type. The inner wire is heavily wrapped with oiled linen insulation around which is woven the outer wire, the strands in each being of equal carrying capacity. Around the outer wire is a

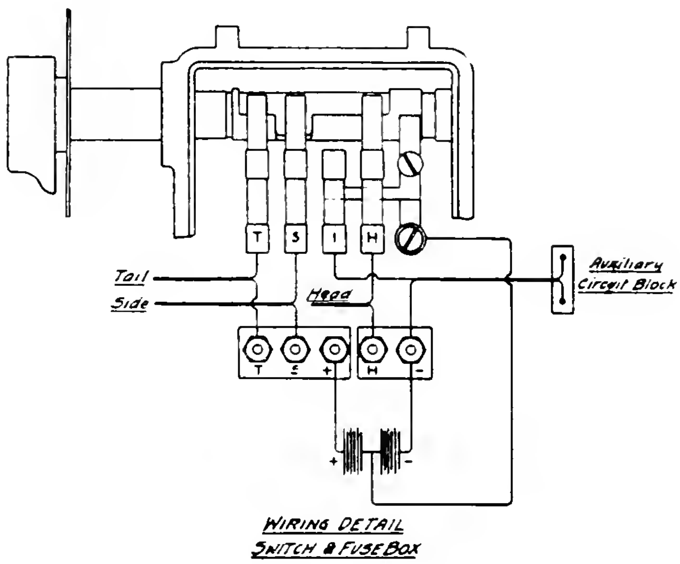


Diagram of switch and fuse box.

heavy insulation of oiled linen as well as a heavy woven covering which provides an extremely high resistance, not only against leakage, but against abrasion, all of which is impervious to oil and water.

From this description it will be understood that the center or inner wire is so extremely well protected that it would be practically impossible to short circuit unless by accidentally cutting or tearing the wire apart so that the ragged edge of both the inside and the outside leads could form a contact together or both be grounded. Such an accident has never occurred on any of these systems.

In addition to the main circuits leading from the switch-box such as the head, side, tail and dash light circuits, is an auxiliary, a volt circuit which may be used for electrical horns, trouble light, etc. To make connections to this circuit there is provided for use on the back of the dash, a connector block, to which the auxiliary service wires may be attached.

SWITCH-BOX.

The switch-box is carried on the dashboard and is arranged so that the head lights only, side, dash and tail lights only or all of the lamps may be lighted as desired. All circuits are fused in order to provide against overload. In fact, the entire equipment has been made as near perfect as a system of this kind possibly could be. This applies equally well to motor boat builders and owners as well as to automobile builders and owners, as the system can be applied equally as well to one as to the other.

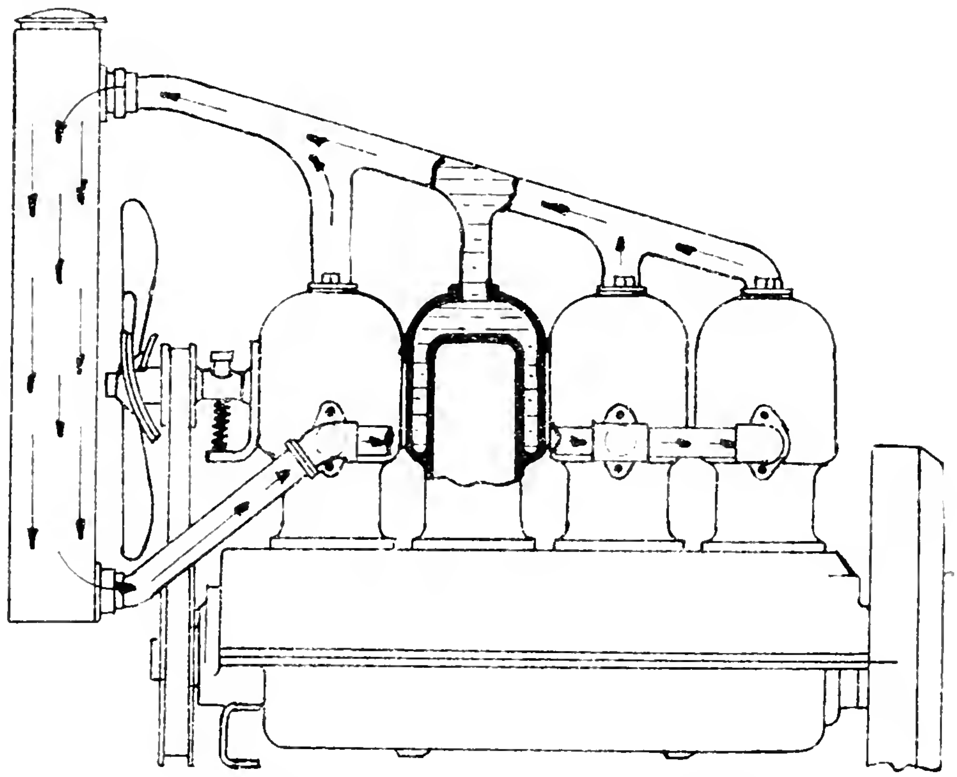
The Motor Cooling System

IT is the general impression that the office of the cooling system is to abstract the heat from the gases within the cylinders, this heat having been generated by the explosion. This impression is an erroneous one, for, as a matter of fact, the duty of the cooling medium is to keep the cylinder walls cool, the heat of the gases being converted into useful energy. These cylinder walls must be kept cool for two reasons. One is to permit of proper lubrication, without which the piston could not travel up and down in the cylinder. Lubricating oils have a definite flash point, and when this temperature is reached they will burn and leave a carbon residue. Thus it can readily be understood that the cylinder walls must be kept cool to prevent the carbonizing of the lubricating oil.

The second reason is to prevent pre-ignition. If the metal be permitted to heat up to a red heat, for instance, the fuel will ignite during the compression stroke, previous to the completion of same, and thus cause the engine to reverse.

There are two general types of cooling systems, the direct or air system, and the indirect or water system. The air system being termed a direct system, as there is no intermediate transfer of heat from the cylinder walls to the radiating surfaces, by means of a cooling liquid. Air cooling is generally effected by cooling ribs, which are cast integral with cylinder walls and some mechanical method of inducing air circulation. The air cooling system is mostly used on the light commercial cars with a capacity rating between 500 and 2,000 pounds. They are mostly low-priced vehicles, with two-cylinder opposed four-cycle or three-cylinder, two-cycle motors.

The indirect cooling system involves the circulation of a liquid, such as water, the function of which is to absorb heat from the cylinder walls and deliver same to a current of air which is passed over the surfaces of a radiator within which the water in its heated state is circulated, by means of a circulating pump, except in the



THERMO SYPHON COOLING SYSTEM.

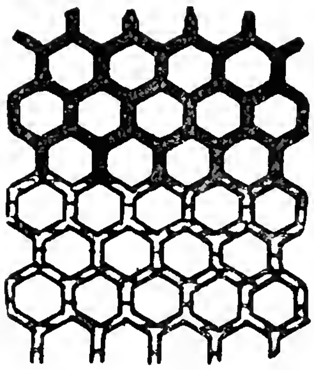
cases involving the thermo syphon system of circulation. All water-cooled motors, so-called, are of the indirect cooled type.

The indirect system may be depicted as follows: Water is passed from the lower tank of the radiator to the pump mounted on the engine, which forces the water through a distributing manifold to the various cylinders of the engine. This water is usually entered at the bottom of the water jackets, and as it becomes heated it loses its specific gravity, rises, and flows out through the upper manifold to the top of the radiator, where it is distributed to the various tubes, through which it flows to the lower tank and is again circulated. These radiator tubes are separated by air spaces through which air passes, carrying off the heat units in the water.

The thermo syphon system is generally referred to as the natural circulating system. In this system the pump is eliminated and the circulating is induced by the heat of the motor. The water under the influence of heat sets up a circulation, and it can readily be understood that the heat replaces the pump as the moving force acting on the water.

In order that the cooling may be effective independent of the car speed, a fan must be used. To cool an engine as used in the modern type of commercial car, under ideal conditions and most efficiently, would require a tremendously large radiator, if the car stood still, or the air was allowed to flow through it naturally. So to reduce the size to something that can be used, the relative efficiency is increased. This is done by inducing an artificial flow of air. This is brought about in two ways. One is that the radiator does not stand still, but is moved with the car, indicating an air circulating through it. This, however, would not be effective with the car standing still and the engine running, so a second artificial circulating means is provided in the fan. This fan is driven from the engine and so rotates when that rotates. If the engine runs slowly and has little heat to dispose, the fan runs slowly. When the former turns over at the maximum rate of speed, the fan, too, is making the highest possible number of revolutions. The fan is most generally placed at the front end of the engine and directly in the rear of the radiator, drawing air through the radiator only, while lately there has been a tendency to combine the fan with the fly-wheel, drawing air through the radiator and thence across the whole engine, thus effecting secondary cooling.

Many different constructions of radiators are in evidence upon the later models of commercial cars, among which may be found the honeycomb, sometimes called the cellular, flat vertical tube and the built up round and flat tube types.



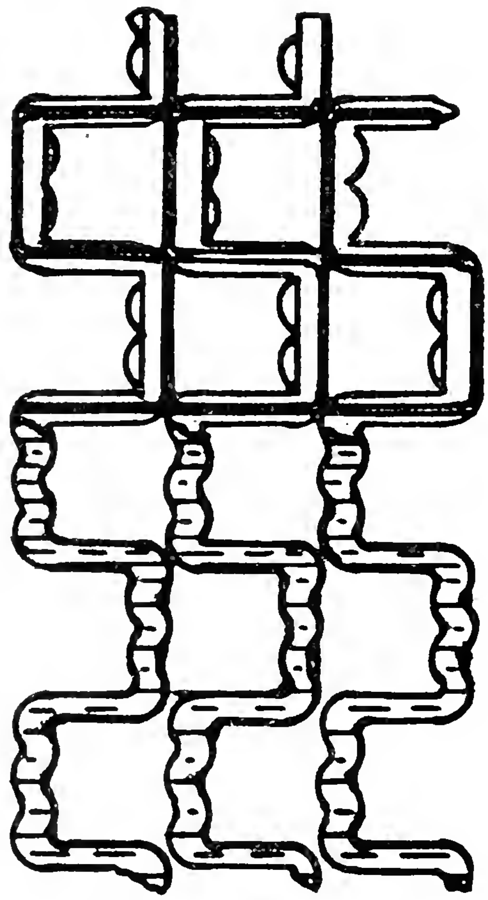
HONEYCOMB TYPE.

The honeycomb type consists of a series of six-sided or hexagonal tubes fastened into a header in such a way as to allow of space between the tubes for the passage of water. This construction is very expensive and seldom found on commercial cars. This was later replaced by what is known as the cellular type, generally being termed honeycomb type. The construction is similar to that depicted above, excepting that square tubes are used instead of hexagonal. Flat vertical tubes, tubes with square corrugations and swaged or soldered edges to form water spaces are also used.

The flat vertical tube type consists of a series of rectangular shaped tubes fastened into a header, with fins attached to the tubes for heat radiation and to strengthen vertical tubes. Various types of fin constructions are used, and sometimes these are of the continuous type, the result of this construction being a pleasing appearance similar to the cellular type. This latter type is more popular on the light popular-priced commercial cars owing to its lower first cost.

During the past season there has been a tendency to build up radiators from round and rectangular tubes with various types of fins. These radiators have a series of vertical tubes with fins soldered to them set in a cast aluminum header and tank, using cast spacers at each side between the header and tank to relieve the tubes of the strains due to the weight of the tank and header.

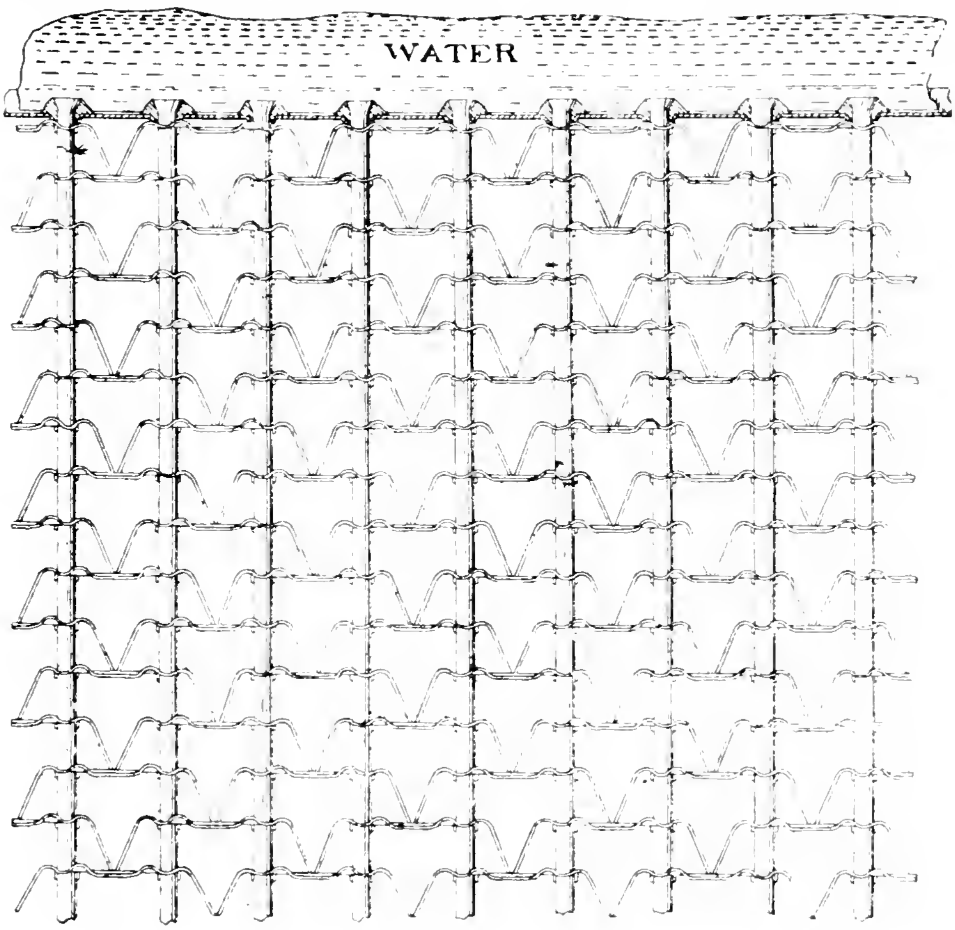
The Universal one-ton truck uses a radiator of this type, while it is also used on the Smith Milwaukee, Pierce Clark, and several others. On the Reo two-ton truck a radiator built up from rectangular vertical tubes is used. There are three rows of these tubes being held in place between headers by small clamps. The advantage of this construction being the simplicity of repair and the small cost of replacing tubes, should the section be damaged beyond repair.



MERCEDES TYPE.

In the majority of commercial cars the radiators are located at the front of the car and so set that the air currents pass almost unobstructed through the passageways. There are a few makes, such as the Kelley, Steward, Lippard-Steward, Adams, and a few others, using the Renault type of hood, placing the radiator in front of the dash; while in the Universal three-ton truck the radiator is placed under the driver's seat in the rear of the motor. The advantage in the two later constructions being a better protected radiator and a somewhat more accessible engine, while it requires a much larger radiator.

In order to protect the radiator from the very heavy vibrations accompanying high speeds on rough pavements and the distortion of the frame, they are provided with flexible mountings. Springs are usually provided to absorb the vibrations, while to protect it against frame distortion it usually is provided with a sort of thorn-point

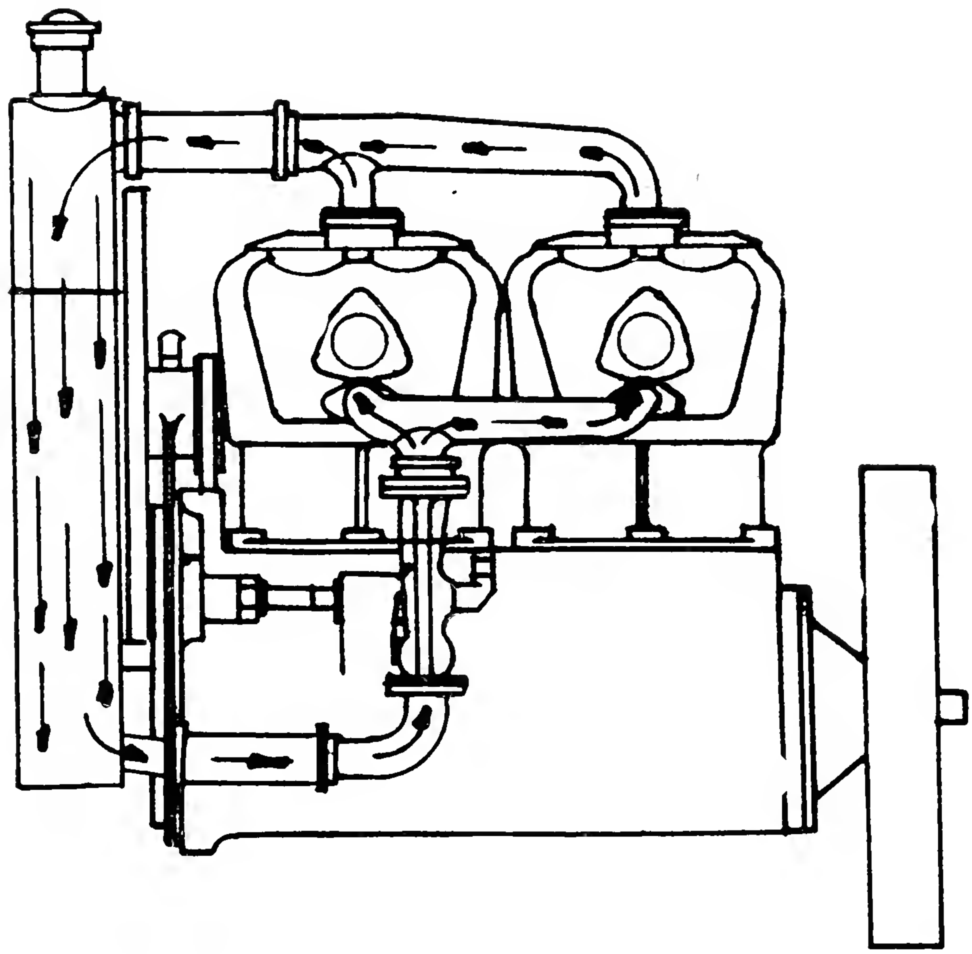


VERTICAL TUBE TYPE.

support. There is a tendency to make these supports of a universal type, so that the radiator can follow any distortional movement of the frame without the least strain, while the springs are either of the flat spiral or coiled wire type.

Owing to the multiplicity of ideas on this subject the writer is presenting several illustrations and comments on the various types of radiator suspensions which cannot but prove of interest.

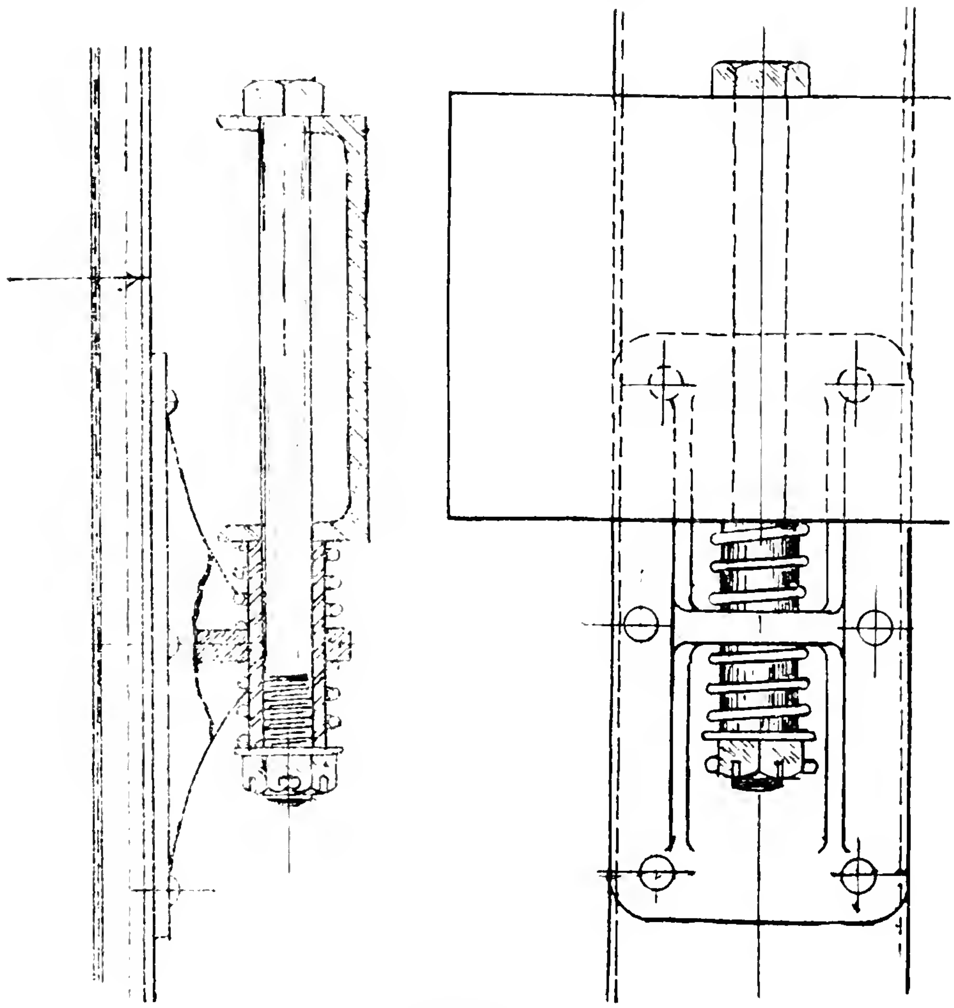
The Natco truck uses a spring of flat material, one end of which is bolted to the side of the frame channel and the end of which is rolled into an eye through which passes a belt, by means of which the spring is connected to the riveted bracket on the radiator. The Packard truck also uses this type of spring, but it is bolted to the top



FORCED CIRCULATING SYSTEM.

flange of the frame channel instead of the side. On the Standard truck a similar support is used; however, the fixed end extends some distance along the top flange of the frame channel to which it is bolted, while the pivot end is supported in a bracket riveted to the radiator similar to a vehicle spring bracket. On the Velie and Knox these two spiral springs are formed integral, so that the radiator may be attached to them by a number of studs. The advantage of this construction being a better support for the bottom of the radiator.

Various constructions may be found using coiled wire springs. In the Speedwell a long bolt belt passes through the upper and lower flanges of the frame channel and through the radiator



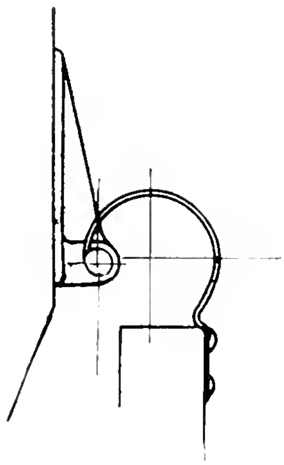
SPEEDWELL.

bracket, having springs between the frame and radiator bracket and the nut on the bolt.

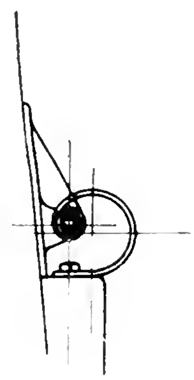
On the Mogul truck the radiator support consists of a vertical rod secured in brackets attached to the steel dash and seat structure. A bracket is riveted to the radiator through which the vertical rod passes and coil springs surround this rod between the various brackets.

On the Universal three-ton truck brackets secured to the radiator and upper frame flange have two sockets formed in them for coil springs. A bolt passing through the two brackets holds the springs in position.

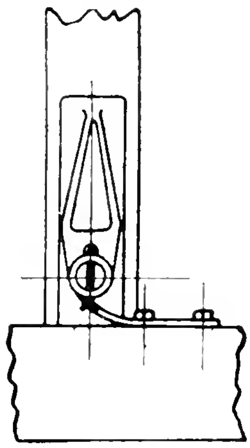
On the Y. M. C. two-ton truck the support is



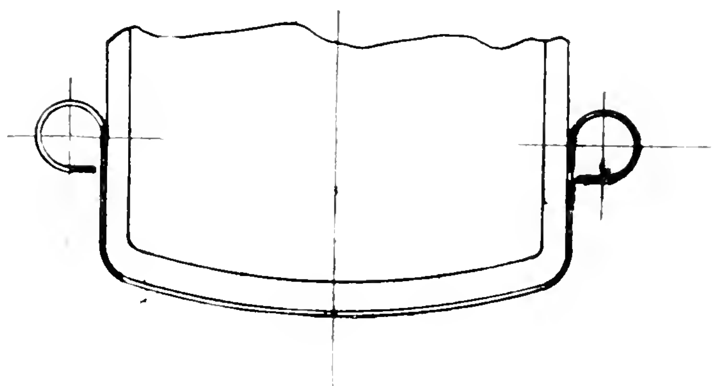
NATCO



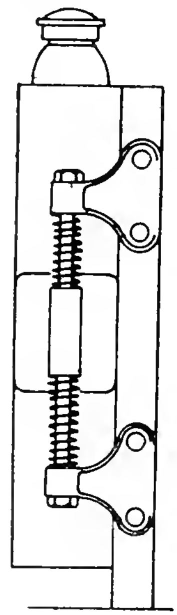
PACKARD



STANDARD



KNOX.

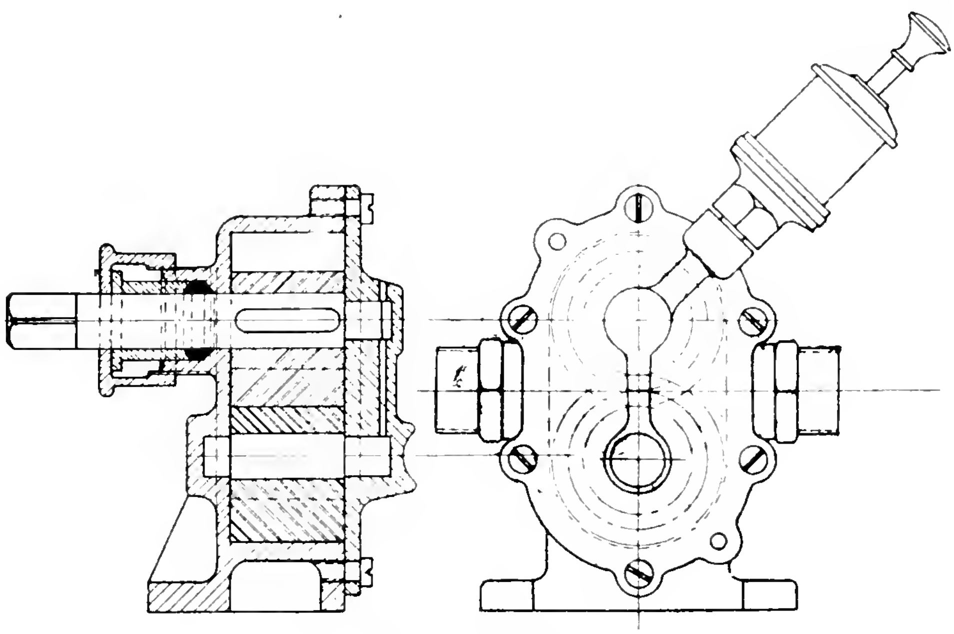


MOGUL.

of the universal type with springs inclosed. The front frame cross member forms the lower member of the support, while brackets attached to the radiator carry the clevis joint and rod which carries the coiled wire springs, the latter being placed on each side of the support.

On the Autocar an angle bracket is riveted to the side of the radiator, while a flat bracket is attached to the upper flange of the frame channel. A bolt carrying a coil spring is passed through these two brackets, while near the bottom another bracket is attached to the radiator. A stay rod attached to the frame carries two coil springs on either side of the radiator bracket.

Numerous other suspensions will also be noted on various trucks; however, space does not permit illustrating each type of mounting. In general



GEAR TYPE PUMP.

they are all based on the same principles as those mentioned before.

There are two general types of pumps in use at the present writing, the gear type and the centrifugal type. There is also the plunger and vane types; however, the former is used mostly for marine work, while the latter is not very popular on commercial cars.

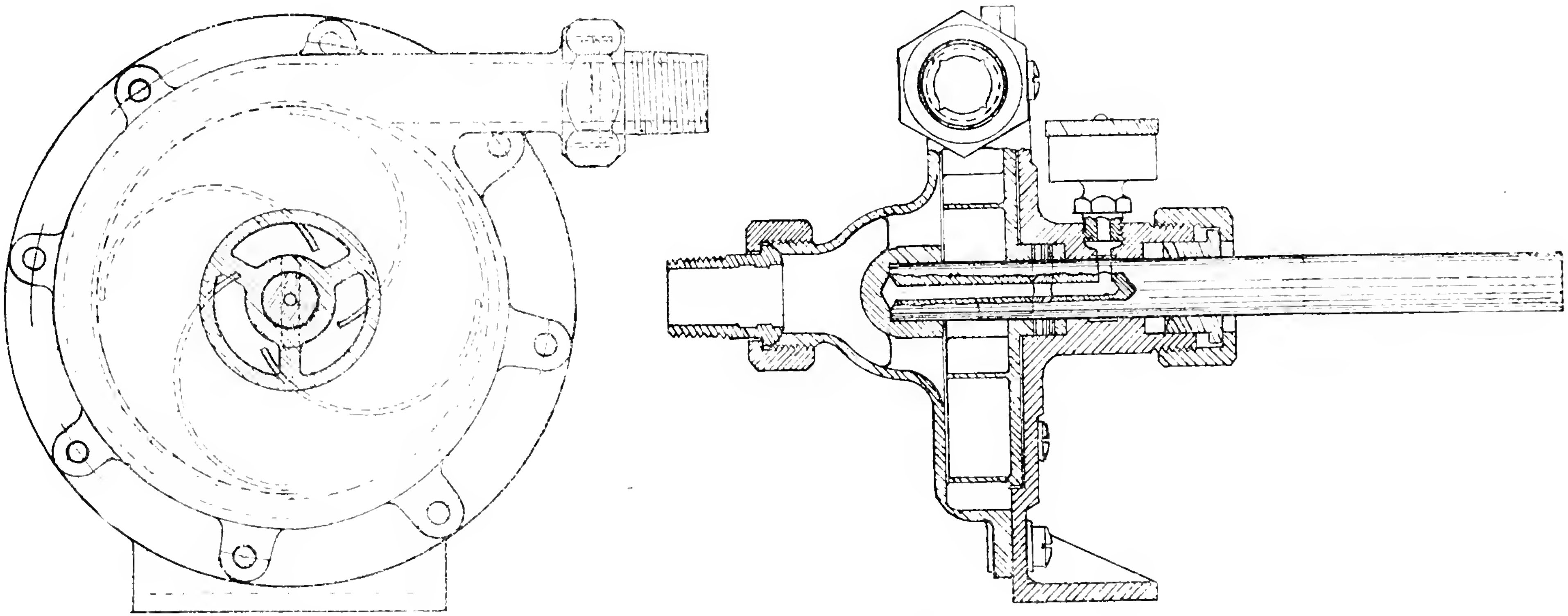
The essentials of the gear type of pump consist of a pair of gears, a pair of shafts for them to rotate on, and a case to house the gears, act as bearings for the shafts and to convey the water to and from the gears in the proper manner.

Water enters at the side of the mushing teeth and is carried around between the teeth and the housing to the outlet on the opposite side. The gear pump is simple in construction and maintenance.

The centrifugal type of pump is perhaps the easiest of all to understand. It consists of a rotating member, which may either be formed integral with or keyed to the driving shaft, and a case and cover which house the rotating member. In operation it is rotated at high speed and the water entering at the center flows out on the arms and at the extremities is thrown off by centrifugal force. This throwing off action is restricted by the case, so that the effect is to throw the water into the outlet pipe. Both the gear and centrifugal type of pumps possess an advantage over all other types, in that they provide a continuous stream of water. Between the two types there is very little or no choice; they both do the work under substantially the same conditions, unless it is that the gear pump is more likely to become noisy.

The pumps are generally driven by shafts extending from the turning gear housing and are provided with flexible or universal couplings. The coupling serving to keep the pump free from strains due to misalignment, and it is also in some cases so designed that when the pump freezes up the coupling will break before any damage is done to the pump.

Lately there has been a tendency to increase the size of the inlet and outlet pipes of the cooling system, providing as few bends as possible, in order to obtain a free passage for the water. Besides having these manifolds of adequate area, it is also necessary to arrange these manifolds so that one cylinder will not rob the other of its share of the cooling fluid.



CENTRIFUGAL PUMP.

The Care of Axles

Rear Axle Appendix.

THE following brief description of the character and functions of a differential is inserted for the benefit of those readers who may be unfamiliar with this exceedingly important part of the motor-car.

The differential consists of a set of bevel gears located at the center of the rear axle. Its purpose is to divide the power transmitted from the engine equally between the two wheels, and to do this in such a way that one wheel may revolve faster than the other when necessary.

In a wagon the rear wheels are mounted on a dead axle and revolve independently of each other. There is, therefore, no need for a differential. In a power-driven vehicle the rear wheels must still revolve independently and yet each must receive one-half of the power transmitted through the rear axle.

To illustrate the principle in as simple a manner as possible we show in Fig. 1 an experimental apparatus in which A-A' are the two live axle shafts to whose outer ends are fastened the wheels W—W'.

Mounted on the inner ends of the shafts A—A' are the bevel gears G—G'. Surrounding these gears and concentric with them is a belt-driven pulley B.

It will be clear that if we connect the two gears solidly by the rods R—R', which in turn are securely fastened in the web of the pulley B, movement of pulley B will cause both the gears G—G' to revolve at the same speed in the same direction;

and, since the wheels W—W' are, like the gears G—G', secured to the shafts A—A', the wheels will also revolve at the same speed in the same direction.

Now, to allow the wheels W—W', and, therefore, the gears G—G', to revolve at different speeds, we remove the rods R—R' binding the two gears together and substitute for these rods the pinions shown in Fig. 2. These pinions rotate freely on the web of pulley B and their teeth are in mesh with the teeth of the bevel gears G—G'.

It is clear that when the pulley B revolves, its motion is transmitted through the pinions to the gears G—G' and on through the axles A—A' to

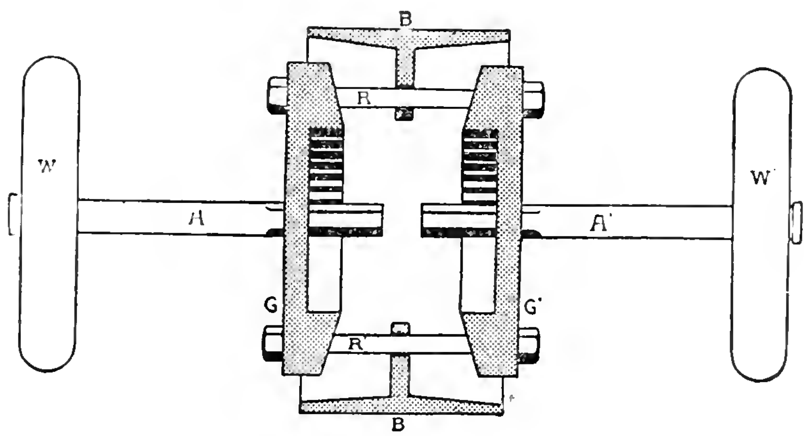


Figure 1.

the wheels W—W' just as it was transmitted in the apparatus shown in Fig. 1, but with this important difference—if wheel W is now prevented from revolving, the pinions will rotate on the web and thus allow the gear G' to revolve, carrying with it axle A' and wheel W'.

If gear G revolves slowly, gear G' can revolve rapidly, or vice versa, because the difference in their motion is compensated for by the rotations of pinions P—P'.

It will also be clear that in all cases, the pressure transmitted from the pulley B through the pinions P—P' to the teeth of the gear G and the gear G' will be equal, because the distances be-

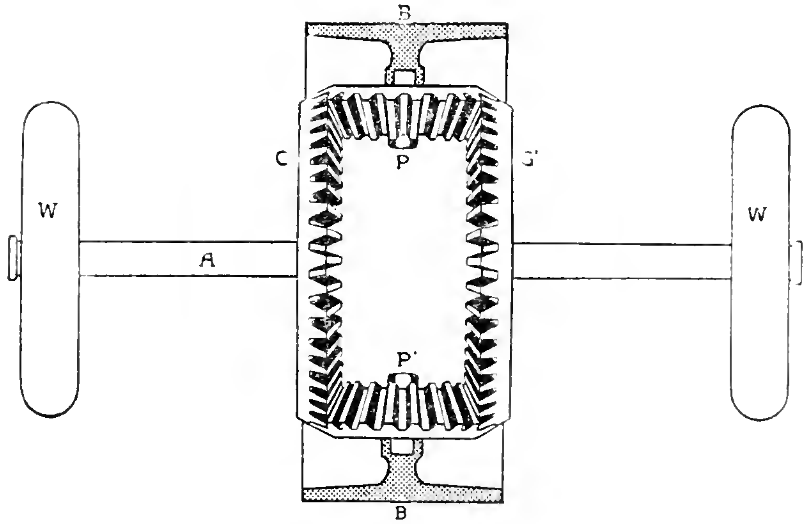


Figure 2.

tween the centers of the pinions and the teeth of both gears are always equal.

In the simplest language possible, when gear G remains stationary, gear G' *and the pinions* roll around, as it were, on gear G, the teeth of the pinions pressing forward on the teeth of gears G and G' with equal pressure.

Referring now to Fig. 3 we see the differential

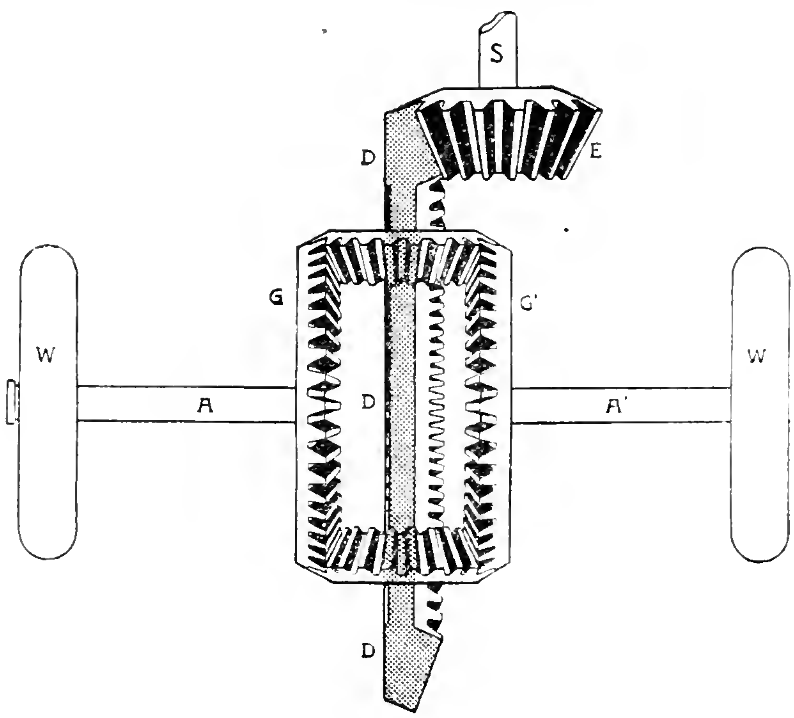


Figure 3.

as actually used in the rear axle. In place of pulley B in Figs. 1 and 2, we have the driving gear D, and instead of two pinions there are now four, but the action is the same as that described for the apparatus in Fig. 2.

The driving gear D receives the power from a beveled gear known as the driving-pinion, the

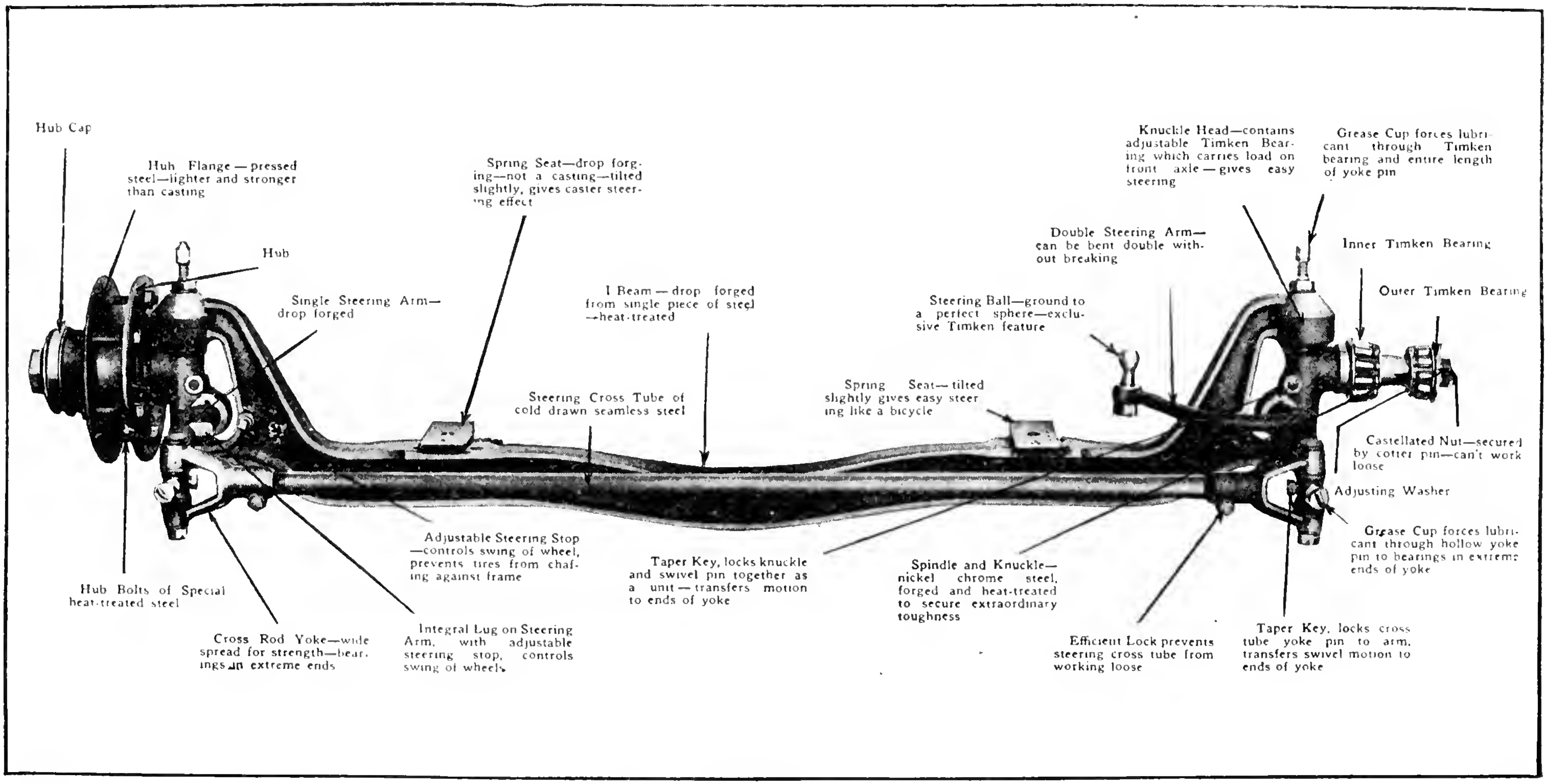
Pouring oil into the differential housing.

latter being at the rear end of a "pinion-shaft" coupled with the main propeller shaft which transmits the power from the engine.

Lubrication.

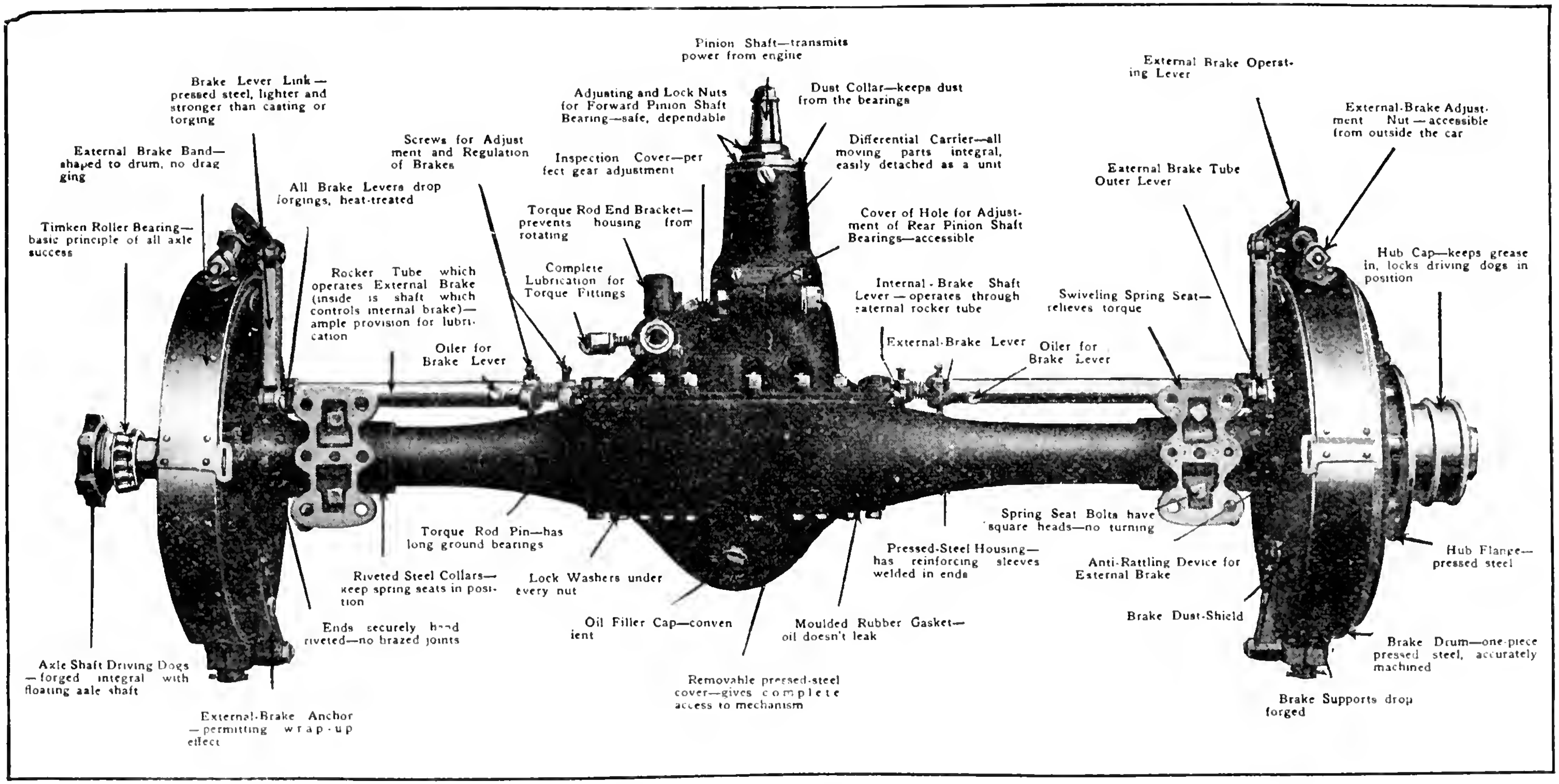
Grease-cups are provided at every moving surface. They are shown on the diagrams and are readily found on the axles themselves.

Make certain that every grease-cup is well filled



Timken Detroit Front Axle.

Careful reading of the lettering on this picture will be well worth while. It tells you the names of the important parts of a Front Axle.



Timken Detroit Rear Axle.

This shows you some of the important features of a Rear Axle.

with a high-grade, light grease, positively free from acid and from grit. Care in turning up the cups regularly cannot atone for oversight in not filling a cup with grease.

Keep your supply of grease in a tightly-covered can so that no grit or dust can get into it. If, by any chance, grit does get into the bearings or gears, the only thing to do is to wash them out thoroughly with gasoline and dry them; after which, clean grease should be applied.

In the rear cap of the differential housing are two plugged holes. Remove both the plugs and pour heavy oil in through the upper hole until it begins to come out of the lower hole. You will then have just the right amount of lubricant and can replace the plugs.

Specific directions as to how often to turn up the various grease-cups in order to force grease into the moving parts are impossible, because the periods of time will vary according to the amount of use of the car.

It is even impracticable to direct that one turn of the cup should be given every so many miles of travel, because so much depends on the grade of the grease and on conditions of weather and load.

There is just one simple rule to follow, viz.: force the grease forward in small amounts often, rather than in large quantities seldom; and err on the side of too much rather than too little. Grease is cheaper than bearings or gears.

Handy Bits of Information for the Owner and Driver.

WHILE there is reason in abundance for running a motor, without load, at reasonably high speed for the purpose of making carbureter adjustments and the like, there is no excuse for "opening her up wide" and letting "her" turn up to the last limit of speed. Under no conceivable practical conditions could the motor run in such a way in service, and there is little sense in forcing a motor to do things that are absolutely useless merely for the purpose of making a fearful noise—which is the most obvious result. Further, excessive racing must be productive of a certain amount of wear and tear and no small unnecessary strain due to the tremendous contrifugal force exerted by the rotating parts, and it is to the interest of the car to avoid whatever is unnecessary of this sort. Tuning a carbureter so that it will carry the motor at 3,000 revolutions per minute when it can pull the car when running over 1,700 revolutions is nothing short of foolishness, though it often goes to the extent of being a nuisance.

FAN BELT.

During the hot months the motor requires all the cooling available. The fan-belt is an important part of the cooling system, and attention in the shape of examining same to see that it is not slipping is advisable. If the belt is removed and thoroughly cleaned with gasoline, then allowed to soak a few hours in castor oil, this will refresh its griping powers and will make the oldest belt new.

Leaky Spark Plugs.

Leaky plugs can cause a lot of trouble that is very difficult to trace. They will make a motor miss at high speed or on heavy pulls, but will permit it to run quite properly, to all intents and purposes, under ordinary conditions. The principal trouble is cracked or porous porcelains, which allow the high-tension current to ground without jumping the spark gaps. The only remedy is to fit new plugs that are known to be in good condition, and to be careful not to crack the porcelain in tightening them in the cylinders.

Valves.

Anything that tends to push a valve to one side, or lift it by applying force in any way except centrally, is liable to cause unequal and abnormal wear of both stem and seating. For this reason the end of the stem and the top of the lifter or tappet should be true and square and make perfectly even contact, which cannot be done if either is unevenly worn. This is a matter that often has made trouble and it has been ascribed to other causes.

Battery.

The positive pole of batteries are usually marked (+). It may also be determined by the chocolate color of the plate. The negative pole is often recognized by mark (—). When a battery is to remain idle it should either be discharged and filled with water or charged and recharged at least once a week. By standing it will deteriorate.

Cleaning Ball Check Valves in Oil Pump.

The ball check valves which control the movement of oil through the pump where pressure feed lubrication is adhered to, should be cleaned occasionally to insure proper working.

Engine Starter Push Button.

It is not always possible to start a six-cylinder motor equipped with an automobile gas starter simply by depressing the starter button on the dash, for unless the crank shaft is in such a position that the circuit breaker of the magneto is closed no spark is produced in any of the cylinders, and firing is therefore impossible. Shifting the spark lever sometimes will close the gap, but the practice is not to be relied on. If a second push button is "bridged" across the terminals of the breaker, however, a spark always can be produced simply by depressing both buttons at the same time and the engine starter thus is made much more reliable.

Polishing Valves.

A practice that is said by some repair men to be beneficial is that of putting a sort of final polish on valves, after grinding, with graphite. After the grinding has been completed and all the oil and grinding compound thoroughly washed off, the valve seat is sprinkled well with dry graphite and the valve is worked on its seat just as in grinding. The result is said to be that the surfaces resist wear longer and retain their tightness better than without the graphite finish.

The Care of Rims.

The care of rims is important. They should be kept free of rust by the liberal use of sandpaper, and it is well to paint them with graphite occasionally. Ordinary stove polish is an excellent rim preserver. If the cams are bent or roughened, rim-cutting will result. These conditions should be remedied at once. The bolts or rivets fastening the rim to felloe sometimes work loose and project sufficiently to injure the tube. This can be corrected with a file.

Compression Leakage.

Compression leakage past the valves of a motor may be due to a great variety of causes. The valves may warp, due to the use of inferior material in their manufacture, or to faulty cooling of the valve chamber. This latter may be brought about suddenly by an obstruction in the jacket around the valve. Excessive grinding of the valve will reduce the clearances between the stem and cam, so that the member cannot close completely. This will be noticed immediately after grinding, and the remedy is to take enough off the stem to obtain the proper clearance. Deposits of carbon on the valve seat will also hold the valve off it and allow the compression to escape.

Leaky Inner Tube.

There is nothing much more mysterious or baffling than a tire which gradually loses its air, though it is positively known that the tube does not leak and that the valve is in good shape. But there is always a reason for such things, and one reason for loss of air may be that the pin in the tire valve is a trifle too long, so that when the cap is screwed on it makes contact with the pin and pushes the valve off its seat. Filing a little off the end of the pin is all that is necessary to end the loss of air.

Heating, Ventilating, a Touring Car.

A touring car may be warmed in winter with very little trouble, if it be fitted with storm curtains that can be drawn sufficiently tight to exclude most of the outside air. If this is the case, fit a large ventilator in the dash to allow the warm air from the motor and radiator to enter. A pipe may be tapped into the exhaust manifold and led through the radiator in the tonneau, exhausting into the open air.

Cleaning a Radiator.

One method is to use a pickling solution made up of sulphuric acid, or vitriol, as it is commercially known, the proportions used being about the same. A ten per cent solution will be found to be strong enough for all purposes. Mix with cold water by pouring the acid into the water slowly. Do not reverse the process, as the effect would be disastrous. The solution should be permitted to cool before it is used. In order to note how the sulphuric acid affects the brass of the radiator, draw off some of the solution from time to time, refilling with fresh solution. When it begins to run clear the work is completed and the radiator should then be flushed thoroughly.

Lamp Reflectors.

In order to prevent the silvering of lamp reflectors from tarnishing when not in use, it is a good scheme to give the surfaces a light coating of alcohol in which a little collodion has been dissolved. This will form an excellent protection, and is easily washed off with warm water. Of course, any polished metal surface can be protected in the same way.

Engine Used As Brake.

When using the engine as a brake in descending hills with the ignition cut off, open the throttle. This will materially cool and clean the cylinders, while if the throttle be closed a certain amount of oil will be sucked into the cylinders from the crank case.

Ball Bearings.

Worn or broken ball bearings should be replaced with an entirely new set, as one or two new balls will always be just a trifle larger than the worn ones.

Hand Motor Primers.

It sometimes happens that the motor has to be primed on the road, and there is nothing at hand with which to take the necessary gasoline from the tank. There are a number of make-shifts, however. A rolled-up handkerchief, a sponge on the end of a string, or some waste, will absorb such gasoline, and may be squeezed out over the cylinder pet-cocks.

A good way is to take a tire valve cap and lower it into the tank by means of a piece of string. One capful to each cylinder should be about the right quantity of gasoline to use. If a hand pump is carried, close its intake valve with a piece of tape, and use it as a suction pump. It may then be filled with gasoline by simply dropping the hose in the tank and drawing it up on the handle.

Oil On the Motor.

Oil on a motor is a most prolific dirt catcher, and dirt has no place about the automobile. If it hangs in masses outside, it is apt to get inside on the slightest opportunity, as in fitting in a new spark plug. Besides, it does not look well. Occasionally a driver will find one side of the motor dripping with oil; mysteriously appearing from nowhere, and especially plentiful after a hard run. The oil probably has been splashed up through the crank case breather. If the case has not been filled too full of oil, a brass tube carrying three baffle plates should be fitted inside the breather. This will stop the splashing out.

Water Pipes.

You can clear the water pipes with a hot strong solution of common soda; run the engine for a time for the solution to do its work; draw off and refill with water, running the engine until the water is hot, then draw off the water.

Carrying Extra Tubes and Casings.

Extra tubes should be folded and wrapped in cloth or put in a cloth bag. If left in the original cartons or thrown loosely under the seat they will chafe at points of contact. Never put them in the tool box or where they will come in contact with chains, tools or grease.

Spare cases should be provided with covers. The wind and sun dry them out and damp getting inside rots the fabric. Interchange your tires occasionally, for rubber deteriorates faster out of use than in. Remember it is no economy to carry retreaded or repaired cases as extras. Having been through a second heat of vulcanization they are liable to more rapid deterioration than new cases, but if put in service immediately, you will get full service out of them before this can have much effect.

Carbon.

Carbon trouble is one of the recurring annoyances of automobile motors which never has been entirely removed. The heat of combustion is so high that even the best of oils leave some deposit. This may be so small that it is not noticeable after an entire season's use, but, on the other hand, it might be so great that the motor refuses to function as it should. When going over the car it would be best to thoroughly clean the cylinders of all traces of carbon.

How To Hold Steering Wheel.

To properly hold the steering gear, let the right hand firmly grasp the rim just below the horizontal center with the forearm describing a right angle; the left hand should be just below the right in the same sectional space. The method is employed by racing drivers.

Bricks and Rocks.

On hills drivers of heavy vehicles often use large stones, bricks, etc., for holding their vehicle when they are forced to halt because of the steep incline. When they start off they invariably leave such stones, rocks, etc., lay on the highway. Many springs are broken, tires either blown out or causing the beginning of a blowout from driving over such bricks, etc. Watch for these obstructions on hills.

How to Make a Fire Extinguisher.

An automatic fire extinguisher may be made by dissolving three pounds of salt and one-half pound of sal ammoniac in one gallon of water. Suspend over a gasoline tank by a string and in a bottle that will break readily. Bottle must be high enough to break in the falling. When gasoline catches fire, the string will burn and the bottle will fall and break.

Interchangeable Tires.

If your tires habitually give low mileage, try an oversize. These will increase the cross-section of your air cushion, as well as giving a heavier and more wear-resisting tread, and if your tires have been overloaded, will overcome the trouble. Besides, there will be added comfort in riding and less wear and tear on the engine, by reason of decreased shock and vibration.

Piston Ring.

Should a piston ring be worn to the extent that it would cause loss of compression you can temporarily restore compression and its expanding properties by placing a small piece of clock spring behind the defective ring. Place the clock spring in the groove and be cautious that it is of the proper size to fit in the groove.

Adjustment for a New Spark Plug.

Don't fail to slightly tighten up all the parts of the spark plug after it has been used for the first time. Most manufacturers ship plugs with the brass bushings slightly loose to allow for the expansion of the metal parts from heat. This eliminates the possibility of cracking the porcelain when the plug is first used.

Magneto Cover.

It is important that magnetos be protected with a cover against dust as well as moisture. A certain amount of dust is always entering through the radiator and with the assistance of the fan is blown around the motor. The dust clinging to certain parts of the magneto will retain moisture and impair the ignition.

Emergency Repairs.

An invaluable accessory is an Inside Protection Patch and outside Emergency Band. These can be separately used, but should always be used together if possible, as otherwise the original injury will spread and make an ultimate repair either impossible or more costly.

Tires Heating.

The heating of the tire is the first direct result of the frictional action between the outer shoe and the inner tube. This can to a certain degree be avoided by rubbing French chalk over the inner tube before inserting it.

Rule of the Road.

Remember the rule of the road and don't drive on the wrong side. Should an accident occur while driving on the wrong side, whosoever was on the wrong side must pay the damages. It is a violation of the law.

Locating Squeaks.

Squeaks are sometimes a hazardous undertaking to locate. A body resting on the frame unevenly will in most instances cause a cracking sound. By placing strips of leather between body and frame (preferably where body bolts pass through frame) this often overcomes this noise. A rubbing or rattling noise can most frequently be attributed to the edges of doors rubbing against their frames. This is often the result of the body sagging in the center and can be remedied by placing a shim of the required thickness under body bolt on the side where the door rattles. It sometimes happens that a door will bind or stick; this is due from practically the same cause. In the latter instance, however, the body may be shimed too high on either side, and by removing a certain amount of shiming it may overcome the trouble.

Another annoying noise which often occurs is a sharp, dry squeak coming from spring shackle bolts, brake rod, cleves, pins, steering cross tube connections, etc. Many owners and drivers become discouraged in their attempts to obliterate such squeaks. Examine oilers or grease cups attached to spring bolts, etc., to determine that same have free passage. Probably some of the above connections are too tight or paint may be keeping the lubricant from reaching the vital points. Squirt a superfluous amount of oil around all moving parts. See that brakes are released completely and free from dragging.

Hard Rubber Repairs, Etc.

The hard rubber in storage battery jars is of excellent quality, and pieces from broken jars therefore are frequently of use in making repairs or doing work in which good, strong insulating material is needed.

Motorists, Beware of Winter.

One of the most important things to keep in mind if one is to use his car during the cold weather is that the water in the radiator and the cylinder jackets is spread out in such very thin sheets that it will easily freeze. If water in the machine does freeze something will give way when the resulting ice expands—either the radiator or the cylinder is cracked. To keep the cooling water from freezing denatured alcohol or wood alcohol, either alone or mixed with glycerine, may be used. About 40 per cent of alcohol added to water will keep it from freezing as long as the thermometer is above zero, but as alcohol alone evaporates it is well to mix glycerine with the alcohol and add it to the water. This mixture will not freeze until the thermometer gets 10 or 15 degrees below zero. The glycerine will last almost indefinitely and it will not be necessary to add alcohol so often. Here are some solutions useful to the chauffeur or the man who takes care of his car:

ANTI-FREEZING SOLUTIONS.

Will not freeze at 15 degrees above zero: Water, 4 gallons; alcohol, ½ gallon; glycerine, ½ gallon.

Will not freeze at 8 degrees above zero: Glycerine, 1 gallon 1 quart; water, 3¾ gallons; alcohol, 5 pints.

Will not freeze 20 degrees below: Water, 1 gallon 1 quart; alcohol, 2 gallons 2 quarts.

Dry Cell Bolts.

It is a common scene to notice many of the little brass bolts used on dry cells lying around garages, etc. They should be saved, as they often make useful fastenings for many places where rivets and screws are used.

Mr. Autoist, you are fifty miles from anywhere, and by chance a puncture occurs. You change the inner tube and everything is in readiness but the inflation of the tire. Then, to your dismay, you discover that you have no pump of any kind with you. You are at a loss to know what can be done. Disconnect your gas hose from headlamps, attaching same to Prestolight gas tank. A few amperes will be sufficient to run in on. However, at the first opportunity change the air, as same may injure the inner tubes if left in.

Encourage your car's ability by careful handling.

A thin coat of ordinary grease applied between the body and frame will remedy certain body squeaks.

An examination of all steering connections occasionally is time well spent.

Expenses can be greatly reduced by regular oiling and examination of parts.

Marking Front Gears.

While most all factories adopt a standard scale of marking the front gears (consisting chiefly of crank shaft and cam shaft gears), it occurs sometimes where it is necessary to move a gear ahead or behind one or more teeth to attain the proper timing. Should you remove any such gears and do not understand thoroughly the method of timing a motor it would result in improper timing and possible loss of power or cause the motor to knock. You can avoid such difficulties when disassembling any of the front gears by marking the gear and shaft with a center punch; also mark the gears where they mesh while in the same position. In assembling note that your marks correspond, which will be the same setting previous to removing the gears.

Short Circuiting, Wire Breaks.

Ignition derangements are often due to the insulation of the spark plugs being cracked or oil soaked. Then again there may be carbon or oil deposits or the points too close together or too far apart. The electrodes may be broken through using too much force and too heavy a wrench. Look the plug over carefully and test for all these things. Incidentally, don't forget to take a peek at the timer. The contacts may be worn or pitted, there may be dirty oil or particles of metallic matter, shoulders on the segments, worn bearings, loose or broken wires causing a short circuit. When your engine stops suddenly on the road it may be due to a score of things, and it will always pay to look after the following first. It is generally due, you will find, to some failure of the ignition service, failure of the spark, electric circuit disconnected, broken or loose wire, terminal loose on the coil, accumulator, contact maker, switch or sparking plug, break or chafe on the wiring under the insulation, or some magneto defect.

Sometimes, among other unheard of things, a wire breaks inside of its insulation and gives no exterior sign of the break. This may cause all sorts of trouble and very often the blame is laid at the door of the ignition department. Spark plugs are changed and magnetos pulled down, so that it is a good thing before taking everything else to pieces to make sure that there are no interior breaks in the insulation cable.

Wheels Out of Alignment.

Wheels out of alignment are the cause of many repair bills. Have your wheels trued up.

With wheels out of true, you are wasting power as well as tires and your steering is impaired to a marked degree.

Electric Lamp Bulbs.

If the electric lamp in your head, dash, or tail light burns with reddish color instead of the pure white that it did when you first put it in, it is played out, and it is time to replace it with a new bulb. This should be done, not only to give a better light, but to save money, as the lamp is consuming more electric current and giving less light. Unless the lamp is one of the Tungston or Tantalum types, you must not expect more than 600 hours' service out of it. This will surprise a good many people who think an electric light bulb is good for a lifetime. The filaments of the electric lamp are like the wick of a kerosene lamp, they become charred and finally burn away, and must be replaced, but, of course, after a much longer use. So if you want good lights with a moderate amount of current consumed, watch your lamps carefully and replace when the red color appears.

What Is a Watt?

Technical electric terms are difficult for the average person to understand, and of all these terms "watt" is the most familiar to every householder, this being due most probably to the fact that it meets his eye every month from his lighting bill. Very few people know the significance of a "watt" outside of its "dollars and cents" cost and value. As a matter of fact, a "watt" is the unit of electrical power and is found by multiplying volts and amperes together. An electrical horse-power equals 746 watts; it may be 746 volts and one ampere, or one volt and 746 amperes, or any other two factors of 746. A "watt" hour is the unit of power consumed; it equals one "watt" expended for one hour, and is the usual basis of charge on electric light and power bills.

How to Distinguish Direct from Alternating Current.

Direct and alternating current seem to puzzle a great many people. It does not make a great deal of difference what you are using so long as you have the right kind of appliances, as no accessory made for a direct current can be used on an alternating current, and vice versa. To find out which is which, one has to ask some one better informed or set about to educate yourself how to tell the difference, and the following simple way is open to every one. Hold a simple magnet bar near a lighted incandescent lamp; if the current is alternating the filament, that is, the part inside the lamp from which the light emanates, will vibrate; if the current is direct the filament will be attracted or repelled as the positive or the negative pole of the magnet is held near the lamp.

Hose Connection.

You can make a secure hose connection to gas headlights, or water connection by first wrapping a small piece of tape around rubber hose, then draw up with a piece of wire. By placing the tape around the hose it will prevent the wire from cutting through the rubber hose.

Magneto Vibrator Contacts.

Large contact points should be provided for vibrators intended for use with magneto current, as the currents handled are generally of higher voltage and current than with batteries, and a direct current spark generator is too liable to overspeed and the liability of freezing is increased.

Drilling.

When drilling a small piece of work you can keep same from turning by placing a stiff piece of emery cloth between piece of work you are drilling and table of drill press.

Laying Up Your Car, or Putting It Into Commission Again.

Before laying up your car for a period, jack it up clear of the floor, allowing the axles to rest on supports. Allow all air to escape from the tires, except enough to shape them, and then examine tires and rims carefully.

If tires are practically new or in good repair, and rims in good shape, it will be all right to leave them on the car. Be sure to remove all oil and grease from the tires. Wash them with good strong soap and water. If the rubber is cut to the fabric, be sure to have the injury repaired before using the car again.

Whether or not the tires remain on the car during a prolonged period of idleness, they should be wrapped to exclude the light and should be kept in a cool room.

Oil and the Commutator.

Thinner oil must be used for the commutator in the timer than any other part of the car, as the slightest gumminess will cause a tendency to skip or miss. About every thousand miles the timer should be taken apart and thoroughly cleaned, the process including wiping out the race, fiber, contact points and all, in order to remove collections of thickened oil and dust. If the oil has a tendency to gum excessively, kerosene may be used to thin it out. The correct proportion is about 25 per cent of kerosene. In cold weather especially this is of value.

Cleaning a Spark Plug.

If you want to thoroughly clean a dirty, sooty spark plug, soak it over night in alcohol. Another good and quick way is to insert the plug in the ground, terminal point down, and fill the shell carefully with gasoline and ignite with a match.

When the gasoline is burned out the plug will be found to be almost entirely cleaned of soot.

A Few "Don'ts"

Concerning the Automobile During the Winter Months.

Don't depend upon water in the radiator—use half and half, water and glycerine, or like proportions of denatured alcohol.

Don't purchase inferior "motor spirits" (gasoline)—the heavier products are non-volatile in cold weather.

Don't use viscose lubricating oil—get a standard brand of winter-body automobile lubricating medium, in sealed cans.

Don't run on partly deflated tires—they will crack in the cold.

Don't let dirt accumulate at the joints at any point—it will form a hard crust and cut like a knife-edge.

Don't neglect the springs—they make a noise, crying for graphite grease between the plates.

Don't fold the top down while it is wet—the fabric will freeze and crack.

Don't let mud fresh from the road keep an appointment with depreciation on the "finish" of the above—it will elope with the color.

Don't keep up a high speed on frozen and rough roads—battle-scarred tires will be the product.

Don't leave the lap robes at home—they long to snuggle up to you in the cold.

Don't risk roadside repairs—cold weather work of this character is biting and bad.

Don't forget the filter—Maranvillized lubrication puts the "sweet" in the running qualities in the power plant.

A Few Hints to the Tourist

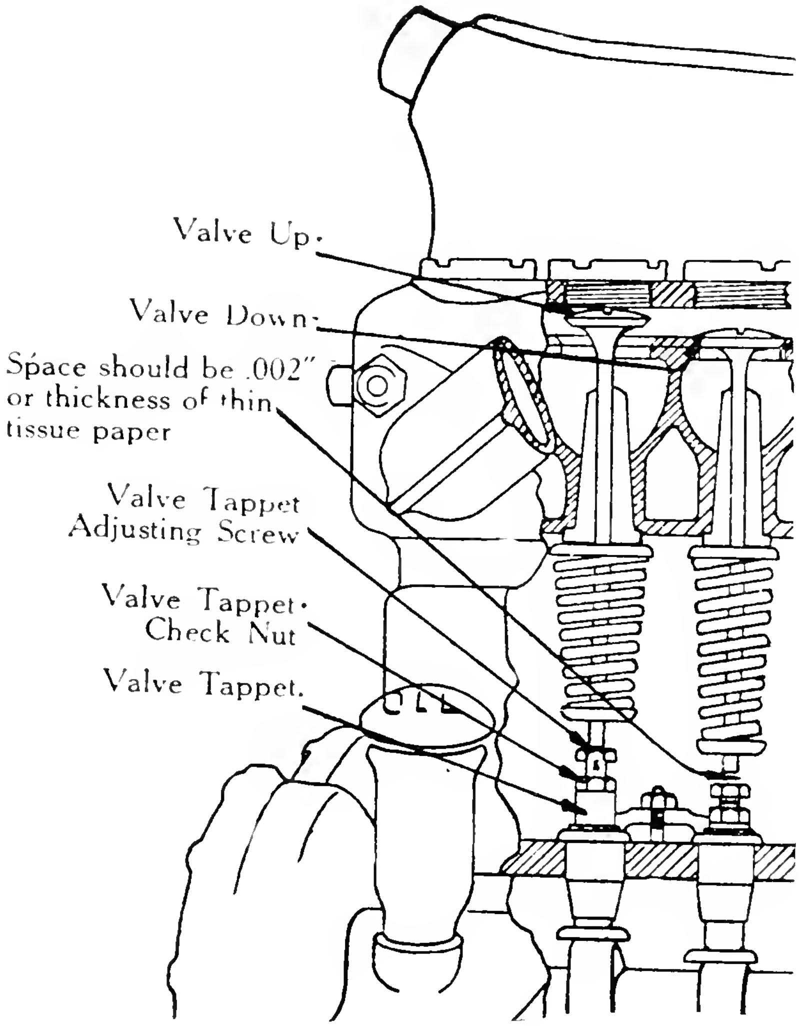
SOME of the following will be helpful for the tourist before starting on an extended trip:

THE MOTOR.

Your engine should be in proper trim and everything should be gone over carefully. Oil should be changed about every 500 miles. Examine motor bearings to discover whether there is too much play in connecting rod brasses (bushings). Place the crank on the bottom dead center, take hold of the connecting rod and try lifting it up and down. Should there be 1/32 inch play they should be taken up. By laying a smooth file on the bench the brasses or liners can be rubbed over same and reduced until the connecting rod bearing is again fitted properly. After each rod is fitted the motor should be turned over by hand to feel for any binding. Should too much be filed off the brasses, place either a thin piece of tin or zinc under the brasses.

VALVES.

You can determine the compression of each individual cylinder by opening all relief cocks excepting one. Turn motor over by hand until you buck compression, which will indicate you are trying the compression on the particular cylinder with the relief cock closed. By continuously rocking motor against compression a few times with crank handle the compression will either buck consistently or gradually loose. In the latter instance the loss of compression is due in all probabilities because the valves are seating improperly. Example: Close all cylinder relief cocks excepting No. 1. After having tried No. 1 cylinder, open same and close relief cock No. 2 cylinder, and so on, vice versa. Before grinding valves examine same to see if they are pitted, in which case a slight cut taken off in a lathe will save much time. A valve need not necessarily show a bearing all over the valve seating; however, it is not properly ground until it shows a contact all



An illustrated lesson in valve adjusting.

around the valve. When finished grinding adjust properly, and be sure there is at least 1/32 inch between exhaust valve stem and lifter.

Attention should be given the opening and closing of valves, which will also cause a loss of compression and power.

Ignition.

Follow all wires starting from battery box and leading to switch, also magneto to spark-plug wires, and examine carefully for loose terminals, or possibly a wire has loosened and by rubbing on some moving part worn through the insulation, causing a leakage of juice. Poor contacts on make-and-break contacts will cause misfiring. Good flat contacts are required and some attention in the shape of filing the platinum points on the make-and-break will remedy this trouble.

Steering Gear.

Examine with caution pins connecting on the steering arm, distance rod, and axle steering knuckle pins or bolts to determine same are all properly cotter pinned, greased and secure.

Transmission and Axles.

Starting from the front axle, detach all the wheels, remove all bearings, and after having washed off same in kerosene oil, as well as wheel spindle and inside of hubs, pack in a fresh supply of grease and attach again. Every time a wheel is removed the cup of the bearing is removed with it, and consequently the bearing must be properly adjusted when the wheel is replaced. The best method is to turn the bearing up tight, and then revolve the wheel a few times by hand, which overcomes any tendency to "back-lash."

Then back off the adjusting nut very slightly, so that by grasping the two spokes in a perdendicular line (one above and one below) you can begin to feel a very slight shake in the wheel. If this is more than barely perceptible, it is too much, and the adjusting nut should be a little tighter.

When you have it just right, lock it, and the bearings will give you the best of service.

Gear bearings should be turned up to snug fit, but not so tight to prevent the gears from turning freely.

Attention should be given the transmission and rear axle as well as the universal joints. Remove drain plugs from the aforesaid parts and allow all old oil, grease, etc., to empty out. Your next step is to replace plugs again and jack up rear wheels about two inches clear of traction. Pour about one to one and one-half quarts of kerosene oil in transmission and rear axle, with about one-half pint in universal joints if same are encased. With this all in readiness, start up your motor and allow same to run about two minutes on low throttle. This will loosen small particles of oil and grease clinging to the housings of the different parts, as well as wash the bearings, etc. Remove drain plugs again to drain off this cleansing solution, after which you insert plugs and refill with a fresh supply of oil, grease, graphite, or any such lubricant as is recommended for the particular make car or part.

Spring Clips.

Manufacturers employ different methods in attaching spring clips. For instance, some are installed with a double lock nut, while others use the lock washer and nut; still, it often occurs that spring clips loosen sometimes, causing the breakage of spring leaves or even an entire spring.

It would be advisable to look over the spring clips once a month and see that nuts are tight.

Brakes.

With the car still on jacks, give your brakes some attention, and caution should be exercised if any adjustments are made to the extent that with brake being applied that braking powers will be equally effective to both wheels, unless brake connecting rods have an equalizer or some other such compensating device, in which case it will be unnecessary. If brakes are not equally adjusted on each side it will cause the car to skid to one side when they are applied.

In trying brakes to determine how they are holding, also if they are gripping both wheels equally, do not apply fully, but gradually. With the brake only partly applied, you try one wheel, then the other, and by gradually applying more brake you will notice in pulling on the wheels again just which side is out of adjustment. After having made the required adjustments to brakes, be sure to see that there is no binding or dragging by spinning the wheels a few times.

Radiator.

In time a radiator will become somewhat clogged with grease or some other foreign body incased in grease and impair the circulation sometimes to the extent to cause overheating. The use of a little washing soda mixed in boiling water and allowed to stand a few hours will clean out a radiator wonderfully. Be sure to drain off solution again and flush good with the hose and a good force of water.

Spring Bolts, Grease Cups, Etc.

Manufacturers have provided a means to lubricate all moving parts wherever there is any friction or wear. However, some drivers and owners fail to regard seriously enough the value to be gained from regular oiling and greasing.

Spring bolts, radius rod support pins, brake connecting rod clevis pins, steering connections, and a few extra accessories, such as shock absorbers, speedometer, electric horn, etc., should be given daily attention. With a piece of waste and oil can, oil such parts as are supplied with oilers and give grease cups each one turn daily.

Tires, Tools, Accessories, Curtains for the Tour.

Having attended to the pointers mentioned in the preceding paragraphs, it now remains for the tourist to prepare for weather conditions, tires and the necessary tools to make minor repairs while on the road. With the top raised all curtains should be attached to assure they will fit properly to the buttons on top. Do not fold curtains; it cracks the isinglass and creases the cloth. Roll them to pack away.

It is advisable to replace badly worn casings and keep the older tires for emergency use. Inflate tires to proper pressure. With two extra casings, about four to five inner tubes, together with tire patches, fresh cement, chalk, about two blowout patches, and the tire equipment would appear complete. The tourist should next have a tool kit and be supplied with such tools as will enable him to make small roadside repairs.

The following can be used as a guide to help make up a tool kit. However, experience alone will in time dictate a complete outfit:

1 two-pound hammer.
1 small screw driver.
1 large screw driver.
1 No. 25 Double open end wrench.
1 No. 27 Double open end wrench.
1 No. 29 Double open end wrench.
1 No. 33 Double open end wrench.
1 Jack and handle
1 tire pump
1 complete tire repair kit.
1 oil-can
1 6-inch cold chisel with ½-inch face.
1 12-inch monkey wrench.
1 14inch pipe wrench.
1 pair combination cutting plyers.
1 10-inch flat file
1 set tire tools.
1 12-inch hack saw and blade.
1 box assorted nuts and bolts.

1 box lock washers and cotter pins.
1 spool wire.
1 piece 2 feet insulated wire.
1 spark plug.
1 6-inch drift.
1 canvas pail.
1 gallon lubricating oil.

The tire tools should consist of the following

1 Jack
1 air-pump.
2 tire removers.

1 repair kit box, containing:

1 piece emery cloth, ½ dozen small patches.
1 tube cement, ½ dozen large patches.
2 valve tubes, ½ pound French chalk.
2 valve tube nuts,
3 valve plungers safety valves.

Oils

Automobile Cylinder Lubrication

WE have all read and heard much about Automobile Oils—what they should be and what they should not be, and why. Unfortunately for those who are most interested and who are least in position to make extensive personal investigation, the majority of such articles have been written with the idea of exploiting some particular product or brand. Such articles do not give the motorist the unbiased information he is looking for and to which he is entitled.

In this article, therefore, it is the purpose to state the Automobile Oil specifications of the highest authority in this country, Mr. Henry Souther, Chief Chemist and Consulting Engineer of the National Association of Automobile Manufacturers. And as the technical terms used by Mr. Souther are not generally understood, it will be explained what they mean and their application to every-day automobile operation.

Following are the specifications prescribed by Mr. Souther for the most perfect Automobile Oil:

SPECIFICATIONS FOR AUTOMOBILE OIL.

Issued by Mechanical Branch, National Association of Automobile Manufacturers.

Viscosity at 100° F. Saybolt—not over 300°.
Viscosity at 210° F. Saybolt 40 to 55°.
Viscosity at 210° F. Tagliabue 60 to 75°.
Flash Point not less than 400° F.
Fire Test not less than 450° F.
Carbon Residue on evaporation not over 1.00%.
Specific Gravity 30 to 32 Beaume.

All other things being equal the lighter colored the oil, the cleaner and clearer, the better.

NOTE.—Cold test is not mentioned by Mr. Souther in the above specifications.

These specifications naturally fall into two distinct groups—*Essential* and *Non-essential* properties.

The *Essential Specifications* are Viscosity, which indicates lubricating body; Flash and Fire Tests, which show ability to resist heat; and the Carbon Test, which measures the amount of carbon residue which will be left after the oil has been consumed or evaporated.

The *Non-essentials* are specific gravity, color and cold test, which are of value only as they indicate to an experienced judge of oil the degree in which the *essential* properties may exist in the oil under consideration; cold test being also considered as a matter of convenience.

Let us start at the beginning by explaining just what these properties are, why they are necessary, and to what extent they should be present in a high-class and dependable automobile oil.

VISCOSITY.

Viscosity is the "body" of an oil—that property which enables it to maintain a film between the wearing surfaces. Lubrication can be efficient only so long as the oil keeps the metallic surfaces from coming in contact. For the efficient generation of power in the gas engine, the lubricant must also provide a sort of seal between the cylinder walls and piston to hold the gas in the cylinder.

But the viscosity of oil decreases as temperature increases. Obviously, the oil that shows the *slowest decrease in viscosity* in proportion to the *increase in temperature* is the best lubricant. That is why Mr. Souther makes two tests for viscosity —one at 100° F., and the other at 210° F., which is approximately the working temperature of the cylinder walls of a gasoline engine.

It is true that thick oils have more viscosity than thin oils at normal temperature; and it is sometimes necessary to use medium or thick oil on account of the method of feed or the condition of the motor; but the viscosity of thick oils is not perceptibly higher than thin oils when hot; and as thick oils contain more carbon it is always best to use a light or medium oil in preference to the heavier grades.

Oil made from Pennsylvania Crude retains its viscosity under heat to a greater degree than any other. You can therefore use a thin Pennsylvania Oil and still get plenty of lubrication. Oils from western crudes often look like Pennsylvania Oil and have the came viscosity *in the can;* but when subjected to high temperature they become thin and watery, and totally unfit for engine lubrication. They run out of the cylinder, the resulting contact of metal to metal immediately producing excessive heat, friction and wear. They allow gas to escape from the cylinder into the crank case, with consequent loss of power. Moreover, the excessive thinning of such oils causes them to work past the piston into the combustion chamber, where they form troublesome deposits as explained under the heading "Carbon."

To give the best possible results the viscosity of an oil should be within the limits prescribed in Mr. Souther's specifications. This test can only be made with a viscosimeter, an expensive laboratory appliance not available to the average person. Looking at the oil in a bottle at normal temperature is no indication whatever of its viscosity at engine temperature. Therefore the motorist has no means of forming a first-hand judgment of the lubricating value of an oil, except by practical test of his machine. Such tests often prove exceedingly costly, as a bearing may be ruined in an instant by melting, cutting or scoring due to the failure of the oil to lubricate under heat.

In practice, then, the owner of a car should insist upon Pure Pennsylvania Oil only, and should have absolute confidence in the knowledge, judgment and integrity of the manufacturer from whom he buys.

Flash and Fire Tests.

Flash Test of an oil is the temperature at which it gives off vapor that will flash or ignite when exposed to flame, but *will not continue to burn.* The Fire Test is the temperature at which the vapor will ignite and *continue* to burn; it is usually from 40° to 60° higher than the flashing point.

Mr. Souther says: "The ideal auto oil must have a flash test of not less than 400° F. and a fire test of not less than 450° F."

Now, the temperature of the exploding gas in a cylinder is approximately 2,000° F. The walls of the cylinder, however, are kept cooler by the circulation of water or air. The outside walls of a water-cooled motor do not get much over 212° because that is the temperature at which water goes into steam.

But the inside walls, where the oil is, do get hotter than that because the heat of 2,000° is being applied constantly.

The wisdom of a 400° F. flash point is obvious: if oil is exposed to a temperature exceeding its flash test *it is immediately converted into a vapor,* and in that form it cannot accomplish its function of lubrication.

As to the fire test, experts have proved that an oil with a very high fire test will deposit excessive carbon—while that with a moderately high fire test will burn up much cleaner—leaving no troublesome carbon deposit.

It is therefore important that while the flash test of an oil should not be too low, it is equally necessary that the fire test should not be too high.

Carbon.

We have seen that the temperature of the exploding gas in an automobile engine is about 2,000° F.; and that any oil suitable for this service is changed into a vapor at or below 500° F. Theoretically, this vapor ought to burn up clean at the time of the explosion, without leaving any residue; *but in practice it does not always do so.* To understand this, we must take into consideration the composition of oil.

All mineral lubricating oils are hydro-carbons—a chemical union of hydrogen and carbon. Besides the carbon chemically combined with hydrogen they contain more or less *uncombined* and *free carbon* in the form of suspended impurities—the coloring matter of the oil. The carbonizing or non-carbonizing properties of the oil depend upon the percentage of this free carbon.

Little or no free carbon allows *complete* combustion. The carbon is all burned or carried off through the exhaust. An excess of free carbon gives *incomplete combustion.* The unburned carbon deposits on spark-plugs, interfering with ignition; it gets into the valves, unseating them and causing the gas to leak out of the cylinders. It prevents the free working of compression rings in the grooves of the piston; this allows the gas to escape from the cylinders into the crank case, resulting in back pressure and loss of power. In fact, this free carbon is so troublesome that Mr. Souther, in an official report to the N. A. A. M., says that *any oil showing over 1% carbon residue cannot be classed as a high-grade lubricant.*

Free carbon can only be removed by re-distillation and filtration; and as the carbon in the coloring matter of the oil, it is evident that when it is removed the oil becomes lighter.

As a rule, *thin* oil is lighter in color and contains less free carbon than a thick oil of the same class, because it is much more difficult—in fact, practically impossible—to make a thick oil extremely light in color by filtration.

Now, filtration is a slow and tedious process, and very expensive. For this reason some manufacturers bleach their oils with acids. Of course, this does not *remove* the free carbon; it merely changes its color so that it cannot be detected—until deposited in the engine cylinders.

It is thus made clear that light color does not necessarily show absence of free carbon; the only real indication is a delicate chemical distillation test, made by evaporating the oil in a retort by means of a gas flame.

However, carbonization is not always the result of free carbon in the lubricating oil. Other conditions may cause it, such as:

(1) *The use of too much lubricating oil,* indicated by blue smoke in the exhaust. This may result from overfeeding with a force-feed system, or from carrying oil in the crank case at too high a level; but more frequently it comes from using oil that is too thin, especially if there is much space between cylinder walls and piston. In such cases a very thin oil runs through too rapidly, a surplus collects in the combustion chamber, combustion is incomplete and an excessive carbon deposit results. The remedy is to reduce the feed or use a thicker oil which will not work past the piston.

Western or asphalt base oils lose their body and become very thin when exposed to high temperature, as explained under "Viscosity." The above explanation shows why they produce excessive carbonization in practical service, even though they have a satisfactory free carbon test chemically, and abundant viscosity when cold.

(2) *Inferior or impure gasoline* will cause a deposit of carbon. The remedy is obvious—use better gasoline and strain it through chamois.

(3) *Too rich a mixture* of gas causes carbon deposits because of incomplete combustion. To remedy, adjust the carburetor to feed less gasoline and more air.

(4) *If the exhaust valves are too small,* or if there is too much back pressure from the muffler, a carbon deposit will result. In this case the fault is in the design of the motor.

(5) *Dirt or dust* may get into the combustion chamber through the carburetor. A fine wire screen over the air-intake will correct this.

Gravity.

The Gravity Test shows the difference in the weight of various oils, and is important because it indicates the crude oil basis of the oil under observation. It is ascertained by means of the Hydrometer, and is expressed in *Degrees Beaume at 60°* temperature.

We have fully explained why Pennsylvania Oils are superior to those made from western or asphalt crudes; and that the inferior oils may easily be made so as to exactly resemble Pennsylvania Oil *in appearance*—that is, in color and apparent "body" or viscosity when cold. But *pure* Pennsylvania Oils of the required viscosity are 30° to 31° gravity (about 7.27 lbs. to the gallon), while the asphalt or mixed base oils run from 26° down to 20° gravity (7.48 to 7.78 lbs. to the gallon). Gravities between 26° and 30° generally indicate mixtures of eastern and western oils.

Color.

The color of an automobile oil, while of itself absolutely non-essential, is generally considered an important indication of the percentage of free carbon. And yet after all it is only a partial test; while a dark color shows a great deal of free carbon, a light color may or may not mean that the oil contains a small percentage of that troublesome material.

Free carbon darkens the oil. Removal of free carbon lightens the color. Therefore, an oil containing little or no free carbon is light in color. *But it does not follow that all light-colored oils contain little or no free carbon.* Treating oil with sulphuric acid gives it a light color, but *does not remove carbon,* or improve its quality. On the contrary, if the slightest trace of acid is left in such oils, it attacks the metal of the engine, resulting in pitted or corroded cylinder walls, pistons and compression rings—a serious injury.

Color has no effect whatever on the viscosity, flash or fire test; it is only half a test for carbon. It is always wise to select a light-colored oil because as a rule dark oils are not good in gasoline motors; but further than this you should not depend upon color when buying automobile oil. It is safer to rely upon the chemical test, or the reputation of the maker.

Cold Test.

Cold test of an oil is the temperature at which it congeals; it is important chiefly as an index to essential properties.

As we have seen, Pennsylvania Oil, which is made from crude of paraffine base, is superior to all others in lubricating body under heat. It has the highest flash and fire tests and contains the smallest amount of free carbon. Its cold test is about 20° F.

Western crudes are of asphalt base. Their characteristics are loss of viscosity under heat, low flash and fire tests, and usually an excess of free carbon. *Such oils remain limpid at about Zero F.* As it is practically impossible for any one oil to resist extremes of both heat and cold, it is well to remember that oil is used to lubricate; that lubrication is only necessary when the engine is running; and that the engine when running is hot—not cold. Ability to resist heat is therefore of vastly greater importance than ability to resist cold.

The value of the cold test as a means of distinguishing a good oil from an inferior one is obvious. *Never accept an oil of extremely low cold test,* as it invariably indicates deficiency in vitally essential properties.

The zero cold test is considered an advantage by some for winter use on account of convenience in handling. But in reality it is not an important consideration, especially in the Central States, where the winters are not severe. It is easy enough to keep the oil supply in a warm place,

How to Buy Automobile Oils.

In buying oils, do not attempt to base your judgment on one or two properties alone. The various tests and specifications are so co-related and inter-dependent that the full significance of any one test cannot be determined except as it is considered in connection with the others.

Insist on having an oil which will measure up to Mr. Souther's specifications *in every respect.* If you have access to a laboratory in which you can make the tests for these specifications, by all means do so.

But if you cannot satisfy yourself by personal investigation, you can safeguard your car by dealing with people in whom you can place full confidence, and who you know will answer truthfully any and all questions you may ask concerning their oil.

Instructions for Installing and Setting Splitdorf Magnetos

THE instructions given herewith apply to all the Magnetos listed, as follows: Models B, D, F, G, H, L, S, SS, and T.

After bolting the Magneto to the prepared base on the motor, crank it until cylinder No. 1 is exactly on its firing center (i. e., the point of greatest compression). The motor must remain in this position until the balance of the work is finished.

Retard the spark advance mechanism at the steering wheel to its limit and connect it to the spark advance lever on the breaker box of the Magneto, so that if the Magneto shaft revolves in a clock-wise direction looking at the driving end, the breaker box lever will be at its topmost position. If the shaft revolves left-handed the lever should be at the bottom limit, and advanced upward.

As all four-cylinder four-cycle models run at crank shaft speed it is customary to drive either geared direct to the crank shaft, or by means of a universal coupling known as the "Oldham" coupling (Fig. 1). The latter method is very much to be preferred to the former, because the accurate setting and alignment absolutely necessary with

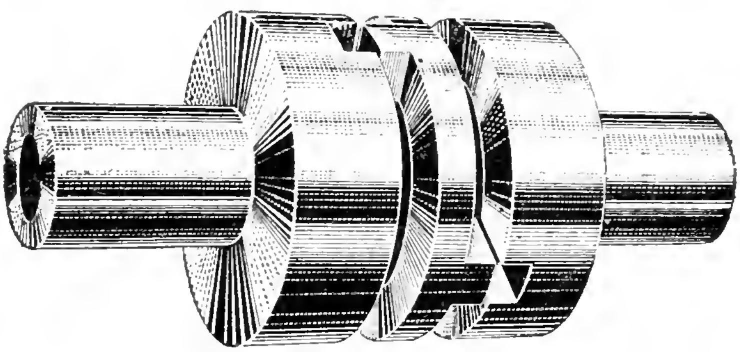


Fig. 1.

the gear directly on the armature shaft, is not essential with the latter method. There is another drive possible, the chain, but on account of the many wearing points, back slack, etc., this should only be used where gear drive is impossible on account of inaccessibility, or where a large number of gears is objectionable.

If the "Oldham" drive is employed, the driving flange is first slotted to fit the "Woodruff" key supplied with the Magneto and then fitted. The other flange of the coupling is left loose on the end of the pump shaft or other shaft used to drive the Magneto and the cross block is slid into place.

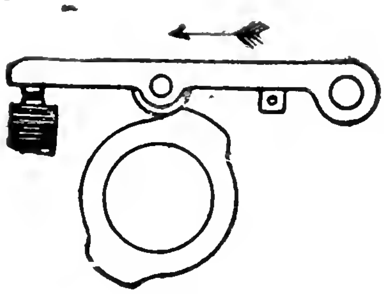


Fig. 2.

Now revolve the armature shaft in its direction of rotation until the oval breaker cam comes in contact with the roller in the breaker bar and just begins to separate the platinum contacts (Fig. 2). The flange of the coupling can then be drilled and reamed for a taper pin and the timing of the Magneto is then permanently effected.

Then connect the terminals on the Magneto to those on the transformer as shown on the wiring diagram.

The wires to the spark plugs in the cylinder should be "stripped" for about one-half inch and the ends pulled into the cups of the distributor, and jammed up into a little ball as illustrated (Fig. 3).

After ascertaining the position of the bronze sector of the distributor (Fig. 4) connect the cup directly over it to the spark plug in cylinder No. 1. Since the direction of rotation of the distributor is always opposite to that of the armature shaft, the wire from the cup next in rotation goes

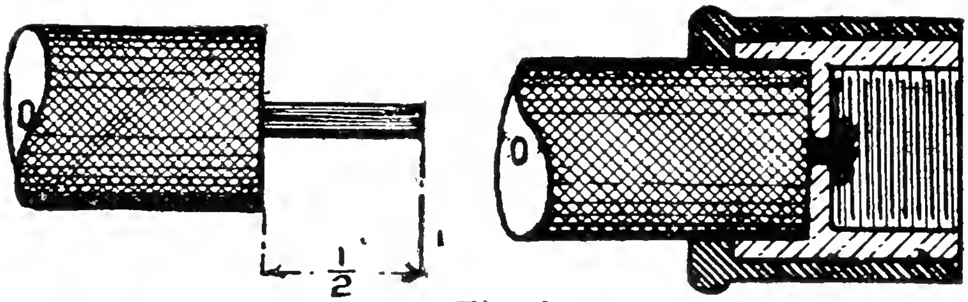


Fig. 3.

to the next cylinder in sequence of firing, and so on until all four are connected. Four-cylinder four-cycle motors always fire either 1 2 4 3 or 1 3 4 2, the latter being the most general rule.

In starting the motor, always retard the spark mechanism to its limit, throw the switch on the transformer to the side marked "Battery" and crank the motor.

If it is desired to start on the Magneto side, ignoring the battery entirely, advance the spark mechanism about one-half or two-thirds of the way and crank as before. No back kick is observed. *Do not drive the motor with the spark retarded, but as far advanced as the engine will permit.*

To change from one direction to the other, remove the breaker box, take out the four screws that hold back plate, then remove back plate and slide armature back; this will bring the two gears out of mesh; hold the driven end of the armature firmly with a pair of gas pliers and remove the little nut. Pull off the cam (Fig. 5) which is keyed on with a Woodruff key, turn the cam over, replace the nut and reset it on the shaft

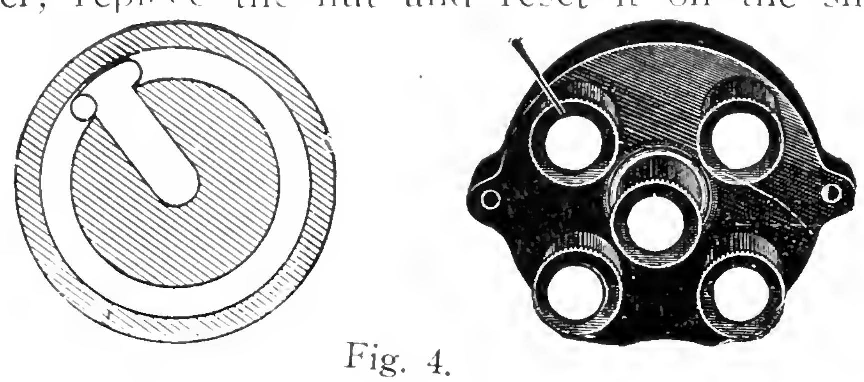


Fig. 4.

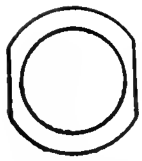


Fig. 5

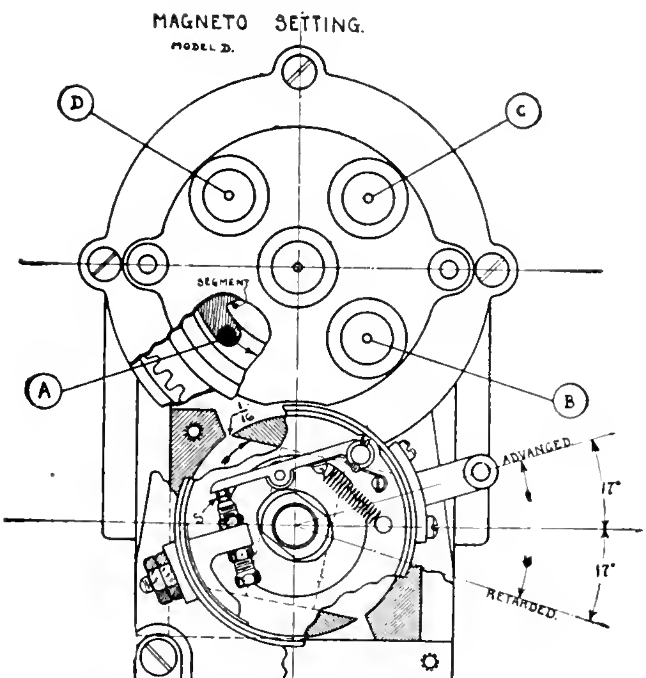
with a prick punch so that it will not jar off. Remove the distributor block and set the armature gear back into mesh so that the position of the sedgment will agree with either Fig. 6 or Fig. 7 according to the direction of rotation.

Remember! This system absolutely requires that both poles of the battery be brought to the transformer. *You must not ground the battery.*

If the platinum contacts after much usage become pitted so that a bad contact results, they can be filed flat with a fine file, taking care not to file off any more than is necessary. Then reset the screw so that the break is not more than .025 of an inch.

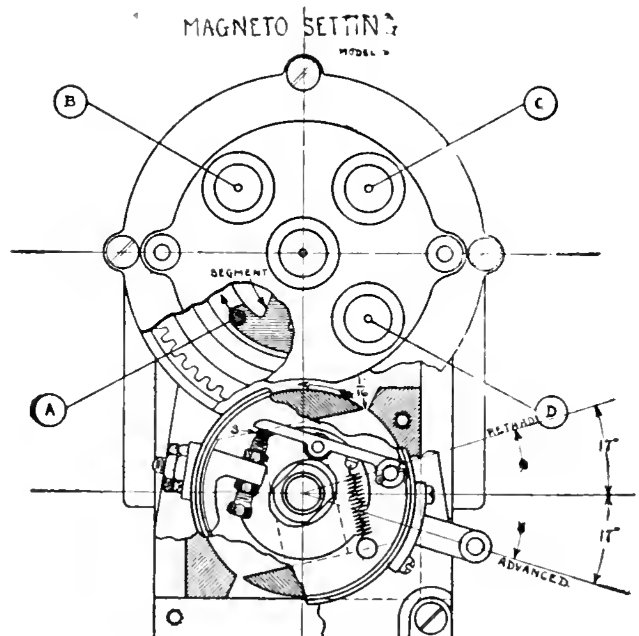
CAUTION.

Do not drive on the coupling. Fit the hole so that it will push on. The size of the shaft is ½ inch, .500, and the hole in the coupling should be at least .501 of an inch.



LEFT HAND MAGNETO, LOOKING AT MACHINE FROM DRIVING END. POINTS(S) ABOUT TO OPEN WHEN ARMATURE CORE LEAVES POLE PIECE, 1/16. SEGMENT JUST UNDER BRUSH

Fig. 6.



RIGHT HAND MAGNETO. LOOKING AT MACHINE FROM DRIVING END. POINTS(S) ABOUT TO OPEN WHEN ARMATURE CORE LEAVES POLE PIECE ABOUT 1/16". SEGMENT JUST UNDER BRUSH.

Fig. 7.

The Mea Magneto

FORMERLY all electricity for igniting the charge in internal combustion engines was generated by means of batteries which depended upon the action of certain chemicals on metals, but for practical purposes in automobile ignition nowadays, electricity is generated by means of a dynamo or magneto. The magneto differs from the dynamo in that permanent magnets are used, while the dynamo employs electro-magnets.

We are to deal here particularly with the magneto that is known as the high-tension type, and are taking as an example of this class for particular study, the Mea magneto, which besides having the same general principles for creating electricity as magnetos of the horseshoe type, it has distinctive features and advantages which the horseshoe type instruments do not possess. In order to get a good understanding of the method of producing electricity by magnetos, it is necessary to review some of the fundamental steps in the way of the most important discoveries.

The magnet gets its name from the country of Magnesia in Thessaly, where the first magnetic ore was supposed to have been discovered by the Greeks. This ore had the property of attracting iron or steel, hence the natural magnets were also called lodestones from the word lead. A piece of soft iron rubbed against a lodestone will itself become magnetized, and it will therefore be seen that a magnet is made by rubbing a piece of iron against another magnet. Before the Mea magneto was introduced, magnets in the shape of horseshoes were used in the construction of all magnetos and many other electrical devices.

Even in the times when little was known about electricity, a certain relation was discovered between electricity and magnetism, and by the experiments of Faraday, Ampere, Davy and Oersted it was discovered that whenever a current of electricity is passed through a conductor there are magnetic lines of force around the conductor ex-

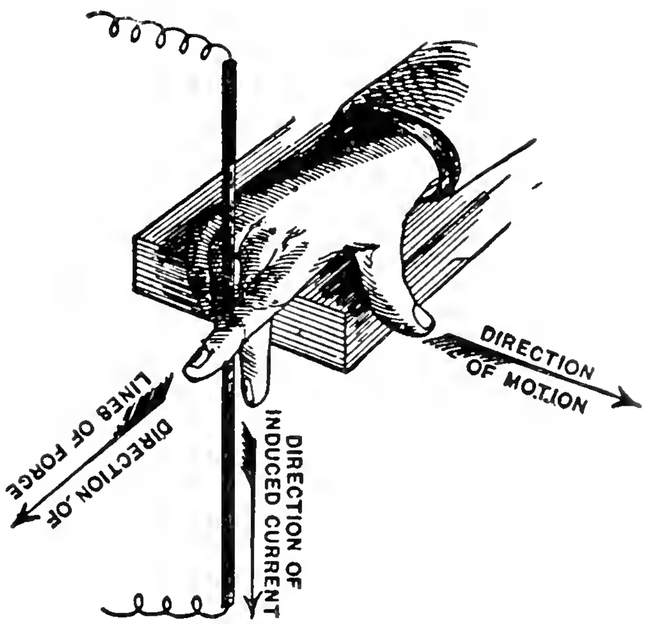
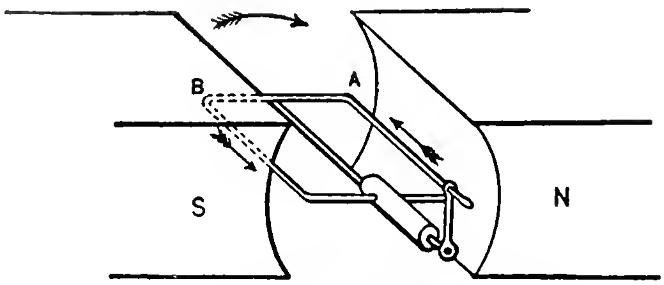


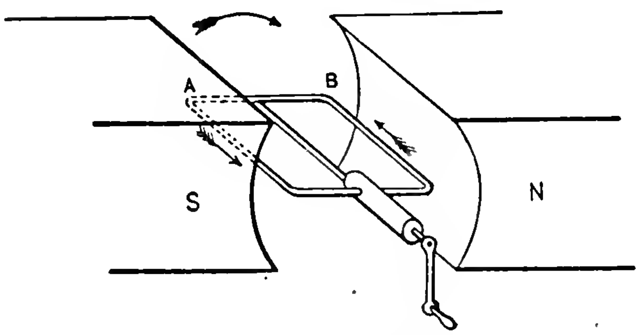
Fig. 1—The hand rule for determining direction of induced current.

actly the same as the lines of force between the poles of a magnet. The space around the conductor which is influenced by this force is called the "magnetic field."

By placing a magnetic needle near a wire through which an electric current is passed it will be noticed that the needle is deflected, tending to point perpendicularly toward the wire. In 1831 Faraday published his discovery of the corollary principle that passing a conductor through a magnetic field so that the conductor cuts through the lines of force, causes an electrical pressure to be induced in the conductor, the direction of the flow of current bearing a fixed relation to the direction in which the conductor is moved in the field. The rule governing these relations can easily be remembered by studying the illustration of the hand. Fig. 2 will illustrate how the direction of the current changes every time the armature moves 180 degrees through the field, producing what is known as an alternating current.



Coil revolved in Magnetic Field.



Coil revolved in Magnetic Field.

Fig. 2—Coil revolved in magnetic field.

The part which is moved through the field is called the "armature" and in a magneto the core of the armature is in the form of an "I." In a high tension magneto there is wound around the core first one coil of wire, which is called the "primary coil," consisting of a comparatively few turns of heavy wire, and on the outside of the primary winding is the secondary winding, consisting of a great many turns of fine wire.

In a low-tension magneto this secondary winding takes the form of a coil which is located outside of the magneto. Without the secondary winding only a current of low voltage can be obtained, and since a high voltage is required to make the current jump the gap in the spark plugs, a secondary winding in some form is necessary. The greater simplicity of the high-tension magneto in this respect is obvious, and in addition to the simplicity, the spark produced by the high-tension magneto is superior for ignition purposes on account of diminished loss of current by resistance in the wires.

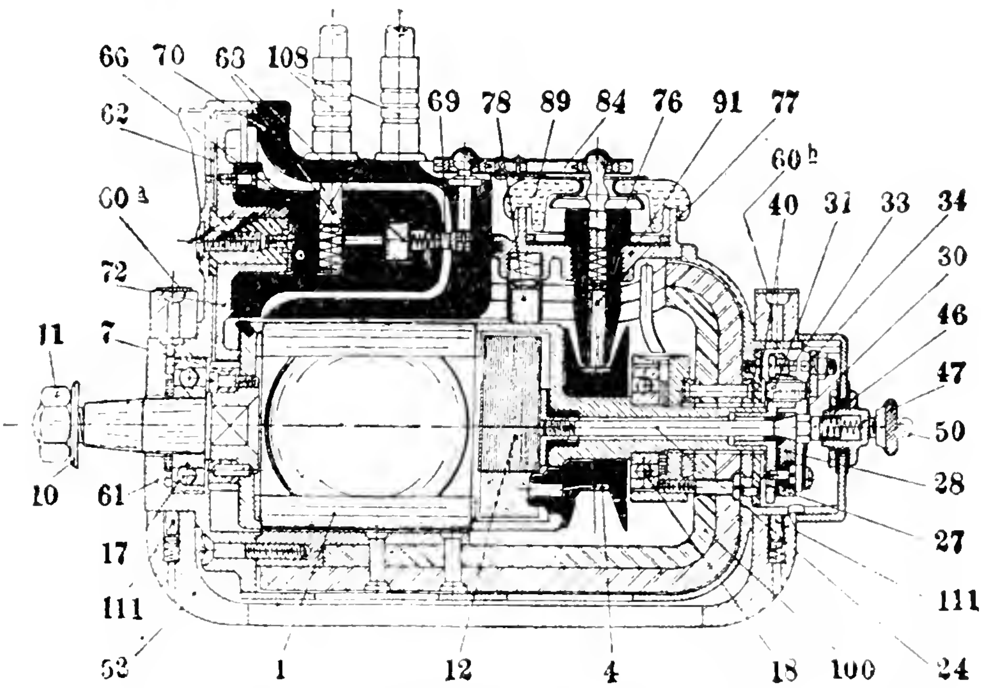


Fig. 3—Cross-section of BH type Mea Magneto.

("Section through magnets in lower half of magnets is taken at right angle to rest in order to show pole piece construction.")

Experiments have led to the discovery that by passing a current through a coil of wire around which a second coil is wound, a current of high voltage is induced in the outside coil *at the moment the primary current* is broken. So the necessity of a device which will break the primary current when a spark is desired in the secondary coil is apparent. This device is called the "breaker."

From the diagram of the Mea magneto shown, the breaker can be seen at the end of the magneto opposite the shaft, and it will be seen that the fibre roller (31), which is actuated by a cam (40), presses the spring (30), carrying with it the platinum point (34), so that the primary current is interrupted between the two platinum points (34 and 33). At the moment when this current is interrupted a spark of sufficient intensity to burn off the ends of the platinum points would be produced if a condenser were not introduced.

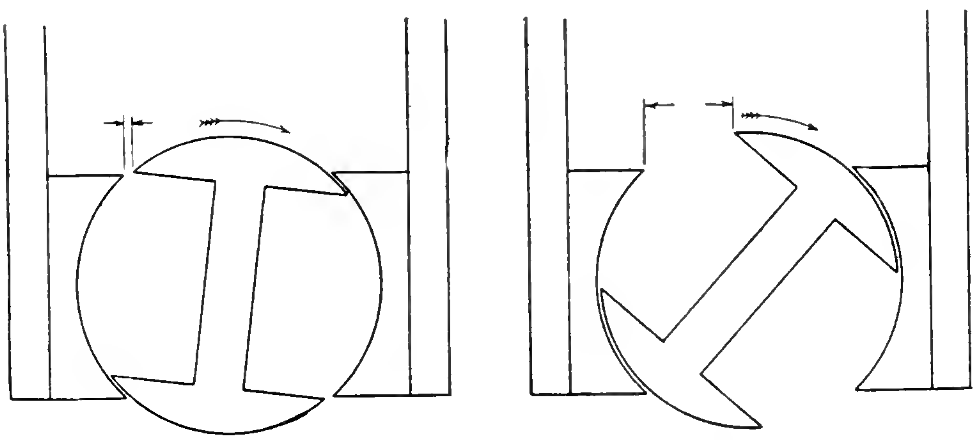


Fig. 4a—Advanced Spark. Fig. 4b—Retarded Spark.

("Horse-shoe type magnetos: Relative position of armature and magnets at the moment of sparking.")

This is indicated by 12 and consists of layers of foil insulated from each other with paper, or mica.

As before stated, when the primary current is interrupted a high-tension current is produced in the secondary coil, which is directly connected to the slip ring (4), and in turn is delivered to the high-tension carbon (77). This carbon is pressed against the slip ring by means of a light spring and the current passes through the carbon and into the knob terminal on top of the high-tension carbon holder. From thence it travels across the high-tension bridge (84) and down into the centre terminal of the distributor body and into the collecting carbon (69). This carbon is connected metallically with the distributing carbons (68), which, as they rotate inside of the distributor body, deliver the high-tension current to the brass segments and up into the cables, which in turn carry the current to the spark plugs. The internal electrode of the spark plugs is insulated and the current jumps from the point of this electrode to ground in the part of the spark plug which is in contact with the cylinders. This is the spark which ignites the gas.

Provision is made for grounding the spark in

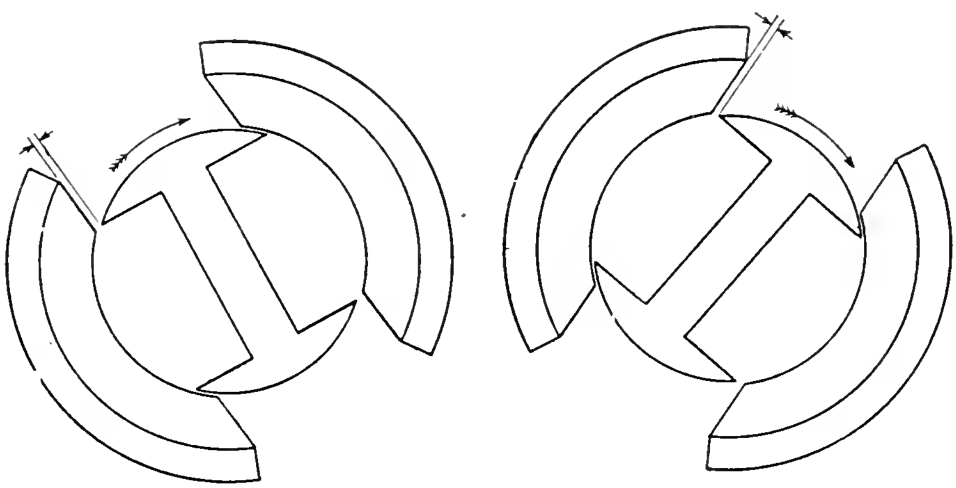


Fig. 5a—Advanced Spark. Fig. 5b—Retarded Spark.

("Mea Magneto: Relative position of armature and magnets at the moment of sparking.")

case there is a broken or improper connection to ground through the spark plugs. The spring leading from the terminal of the high tension carbon holder connects with a brass pin that is set in the center of a mushroom shaped piece of porcelain. This pin is entirely insulated from ground by only a small gap. When the electric pressure in the armature is raised above normal by a break in the natural course of the secondary current, the electricity will jump the gap above referred to and go to ground in the magneto housing. In this way the armature is saved from destruction in case of a broken connection to the spark plugs.

As it is necessary, in order to obtain the highest efficiency in a gas engine, to time the spark so that it will always occur when the piston is at the highest point of its stroke, magnetos have been so constructed that the breaking of the primary spark can be controlled within a certain range.

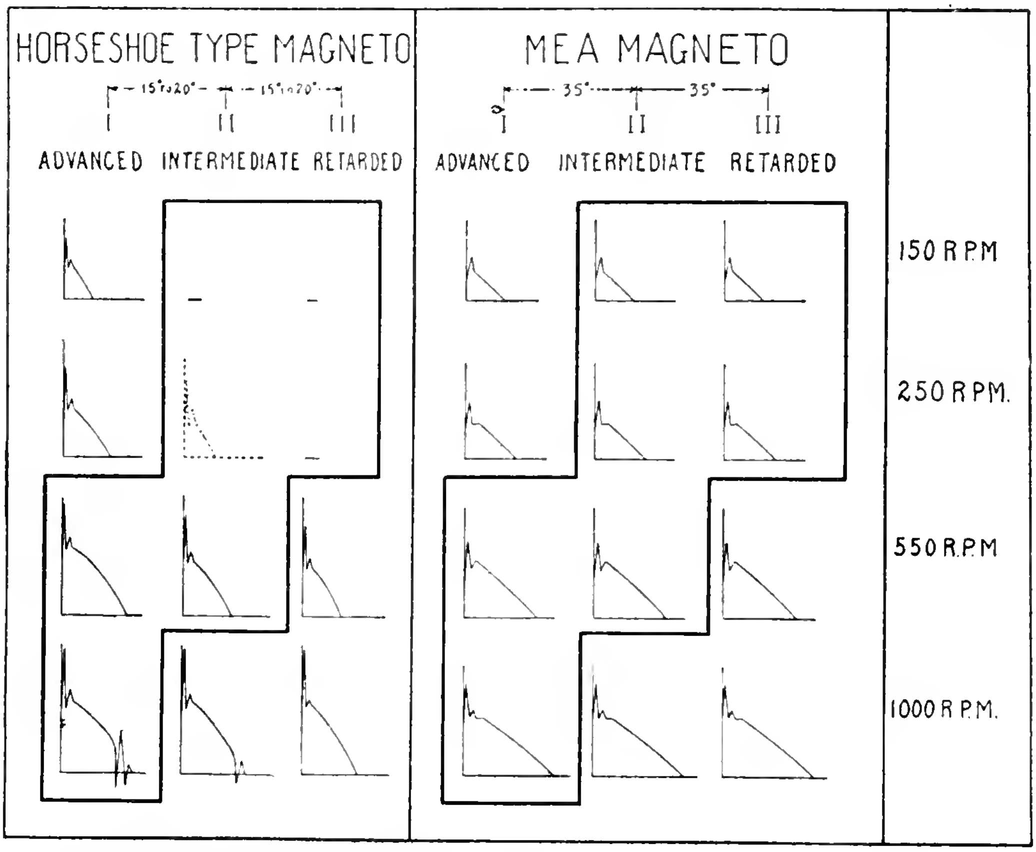


Fig. 6—Oscillograph records of Horse-shoe type and Mea Magneto.

This is accomplished by turning the cam which actuates the breaker forward or backward, so that the break will occur later or earlier, respectively. As it takes an appreciable amount of time for the gas in the cylinder to ignite, it is necessary to light the gas earlier as the speed of the motor increases. The quality of the spark, or, in other words, the heat value, depends, among other factors, particularly upon the position of the armature in relation to the magnetic field at the moment the spark is produced. As the armature in magnetos of this type is in a favorable position for obtaining a spark twice every revolution, the position shown in Fig. 4a half a revolution later (Fig. 4b), two sparks can be obtained per revolution.

There is one position of the armature with relation to the field in which a spark of maximum heat value will be produced, and that is when the pole shoe of the armature has left the pole shoe

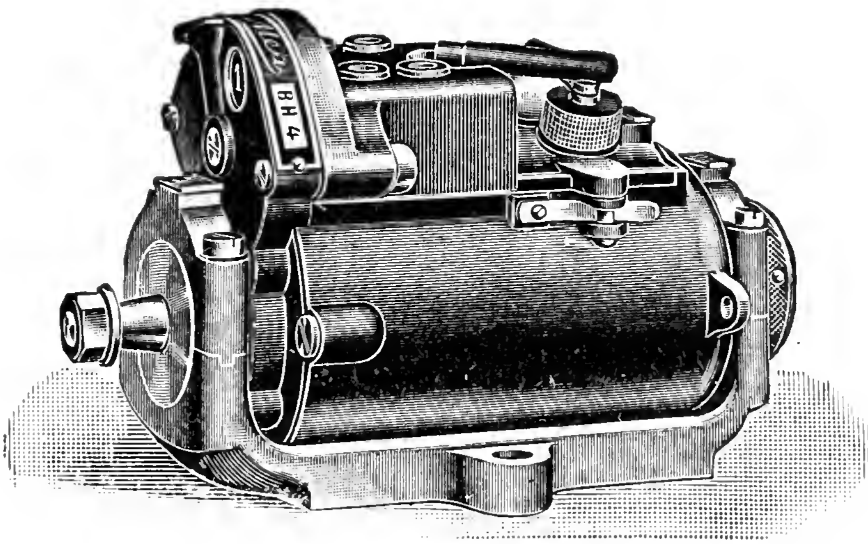


Fig. 7—Type BH-4 Mea Magneto.

of the field a distance of about 1½ mm. If the break of the primary current occurs in any other position, the spark will be considerably weaker. This will be apparent when referring to Figures 4a and 4b, which show in cross-section armature and magnetic field and their relative position at the moment the spark is obtained, on the assumption of a stationary magnetic field of the horseshoe type, 4a showing position with advanced spark, 4b that with retarded spark. It will therefore be seen that the spark is considerably weaker in the retard and in all intermediate position between advance and retard.

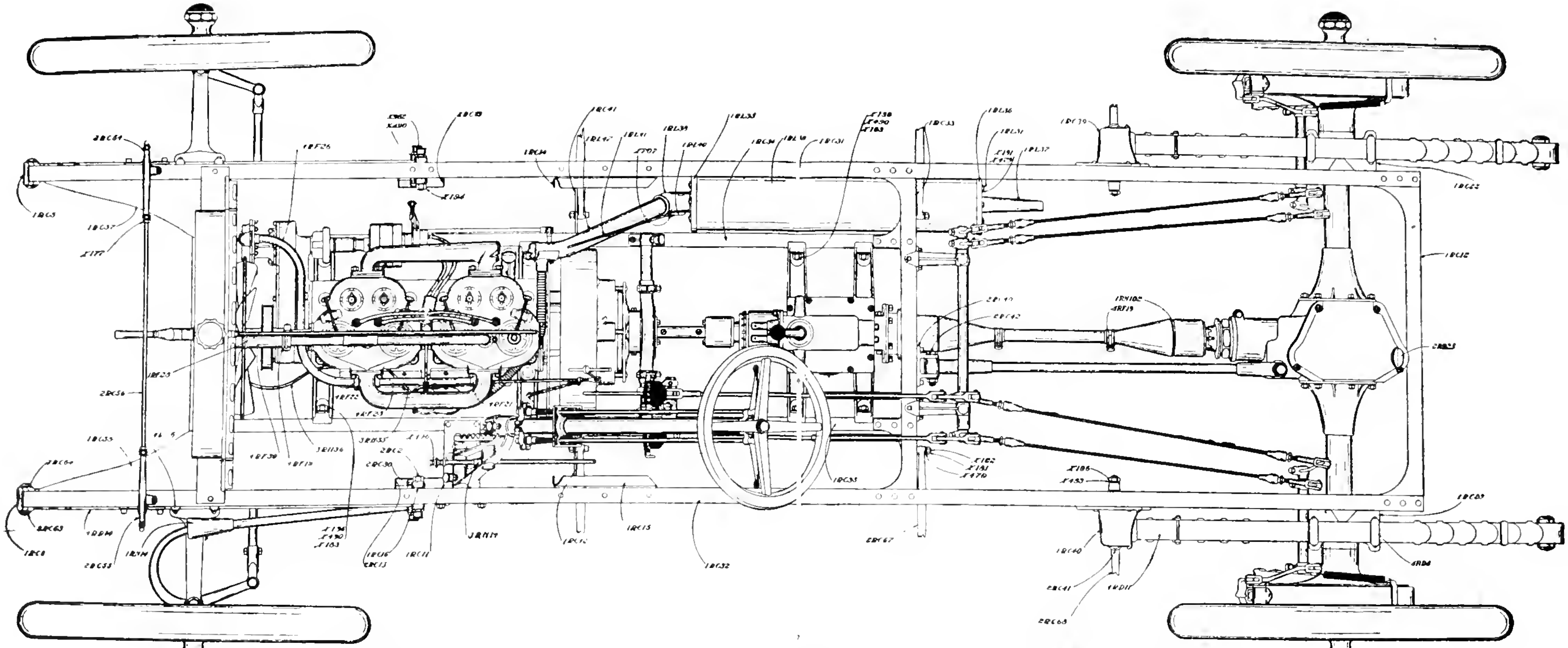
It is in this construction that the Mea magneto is claimed to have a decided advantage. This is accomplished by employing bell-shaped magnets placed horizontally and in the same axis with the armature, instead of the customary horseshoe magnets placed at right angles to the armature. This makes it possible to turn the field together with the armature in advancing and retarding the spark, so that the relative position between the field and armature will always remain the same at the point of breaking. By referring to the cross-sections, Figs. 5a and 5b, and comparing them with Figs. 4a and 4b, which relate to the horseshoe magneto, it will be seen that in the Mea magneto a spark of maximum heat value is always produced, no matter whether the spark is advanced or retarded.

In addition to this, it can be seen that a practically unlimited range of timing is offered, and in the standard types of Mea magnetos this range varies from 45 to 70 degrees.

Oscillograph records of currents developed which were obtained with horseshoe magnetos and with the Mea are shown in Fig. 6. The heavy line encloses the record of sparks which can be used for the operation of motors—i. e., retarded sparks at low speeds and advanced sparks at high speeds. Of course, advanced sparks at low speeds and retarded sparks at high speeds are of no value. It will therefore be seen that the Mea magneto furnishes a good spark in the retard as well as in the advance, the intensity of the spark depending only upon the speed of the motor, and not upon the position of advance and retard.

Since the spark is just as hot in the retard as in the advance, it is possible to start the motor with the spark in full retard with a quarter turn of the crank and without any danger of a backfire. No batteries are required for starting, although the Mea magneto is made in the dual type for those who wish it, the dual instrument having all the distinctive features of an independent type Mea and being provided with a battery breaker for interrupting battery current.

Magnetos are usually best when they are left alone. They require very little oil, as compared with other parts of a gas motor, and only a couple of drops every four or five weeks in each oil hole are required. If more than this is used, the oil gets between the breaker points and burns black, leaving a little film of carbon on the points, which prevents a proper circuit. A quantity of oil will also ruin the armature winding and is likely to cause the fibre roller to wear out. As a rule, if a motor does not work satisfactorily, the cause should be looked for at some other point of equipment other than the magneto, provided the magneto is furnishing a spark regularly.



VIEW OF REO CHASSIS EXPLAINING DIFFERENT PARTS OF AN AUTOMOBILE CHASSIS.

2 RB 25 Oil hole plug for bevel gear housing.
1 RC 5 Front hanger for front spring, right hand.
1 RC 6 Front hanger for front spring, left hand.
1 RC 11 Steering gear support.
1 RC 12 Rear cross frame.
1 RC 14 Toe board support, right hand.
1 RC 15 Toe board support, left hand.
1 RC 16 Hanger block for rear end of front spring.
1 RC 22 Rear hanger for right hand rear spring.
1 RC 23 Rear hanger for left hand rear spring.
1 RC 31 Side frame, right hand.
1 RC 32 Side frame, left hand.
1 RC 33 Center cross frame.
1 RC 34 Motor support, right hand.
1 RC 35 Motor support, left hand.
1 RC 37 Gusset for front end of frame, right hand.
1 RC 38 Gusset for front end of frame, left hand.
1 RC 39 Front hanger for right hand rear spring.
1 RC 40 Front hanger for left hand rear spring.
1 RC 41 Frame brace, right hand.
1 RC 42 Frame brace, left hand.
2 RC 2 Upper rear hanger bolt for front spring.
2 RC 4 Lower rear hanger bolt for front spring.
2 RC 30 Rear hanger link, front spring.
2 RC 40 Supporting bracket for radius rod.
2 RC 42 Bolt for radius rod support bracket.
2 RC 54 Gas lamp bracket, right hand.
2 RC 55 Gas lamp bracket, left hand.
2 RC 56 Stay rod for gas lamp brackets.
2 RC 63 Bolt for front hanger, front spring.
2 RC 64 Nut for front hanger bolt, front spring.
2 RC 67 Step board supports, front and center.
2 RC 68 Step board support, rear.
2 RC 73 Dust guard motor support to side frame, right hand.
2 RC 75 Dust guard motor support to side frame, left hand.
4 RD 4 Clip for rear spring.
4 RD 6 Clip for front spring.
4 RD 11 Rear spring.
4 RD 14 Front spring.
1 RF 28 Stay rod for radiator.
4 RF 19 Clamp for hose connecting cylinder to radiator and drive shaft universal boot on shaft.
4 RF 21 Elbow for cylinder intake water pipe.
4 RF 22 Tee for cylinder intake water pipe.
4 RF 25 Intake water pipe, cylinder to cylinder.
4 RF 26 Intake water pipe, pump to cylinders.
4 RF 30 Hose connecting cylinder to radiator and radiator to pump.
3 RH 14 Protector for gasoline pipe.
3 RH 35 Water inlet pipe for intake heater jacket.
3 RH 36 Water outlet pipe for intake heater jacket.
1 RL 31 Lug for muffler head.
1 RL 35 Front muffler head.
1 RL 36 Rear muffler head.
1 RL 37 Muffler exhaust pipe.
1 RL 38 Body for muffler cut-out.
1 RL 40 Valve shaft for muffler cut-out.
1 RL 41 Link for muffler cut-out.
1 RL 47 Exhaust pipe, motor to muffler.
1 RL 49 Outer tube for muffler.
1 RN 14 Boot for steering connecting rod.
1 RN 101 Boot for drive shaft universal.
1 RN 102 Clamp for drive shaft universal boot to transmission and rear axle.
X 122 Cap screw for front and center step board supports to frame.
X 136 Bolt for motor and transmission to frame.
X 177 Nut for brace rod, gas lamp bracket.
X 181 Nut on muffler head lugs and cap screw for front and center step board supports to frame.
X 183 Nut on bolt, motor and transmission to frame.
X 194 194 Nut for rear hanger bolt front spring.
X 196 Nut for front hanger bolt, rear spring.
X 446 Cut-off valve in gasoline pipe.
X 479 Lock washer on muffler head lugs and cap screw for front and center step board supports to frame.
X 483 Lock washer on front hanger bolt, rear spring.
X 490 Lock washer on bolt for motor and transmission to frame.
X 707 Rod end on muffler cut-out.
X 962 Combination nut and grease cup for rear hanger bolt, front spring.

The Splitdorf Ignition System

IN the description of the Splitdorf Magneto, which we herewith present, we endeavor to explain the principles of construction and method of use in plain words so that it may be easily understood by the lay mind as well as by the experienced engineer.

With this end in view we herewith show cross sectional diagram of their Magneto (Fig. 1). The system used is that having an armature with but one winding, and giving a current of comparatively low tension. The current is discharged through a transformer having a low and a high tension winding somewhat similar to a regular spark coil. This steps the current up to a voltage sufficiently high to enable it to jump the necessary gap between the points of a spark plug in the compressed mixture in the cylinder of the motor.

Looking at the diagram of the Magneto one can almost take in its general construction at a glance. The plain H or shuttle armature is mounted between two annular ball bearings.

One end of the shaft is the driving end and the other is equipped with the breaker cam and the insulation plug which delivers the current generated in the armature to the collector brushes from which it is transmitted to the transformer connection.

From "A" (Fig. 2) the armature current goes through the primary of the transformer, and the circuit being broken at the proper moment, a very high voltage current is induced in the secondary winding of the transformer, and being delivered to the heavily insulated cable D is conducted to the central brush of the distributor whence it is delivered to the spark plugs in the different cylinders in correct sequence.

In addition to using the current from the Magneto, they adapted the transformer to be used as a spark coil by using the breaker mechanism of the Magneto as a circuit breaker to interrupt a current from the battery, which can be switched in for starting purposes or for an emergency. The distributor is used to deliver the current thus gen-

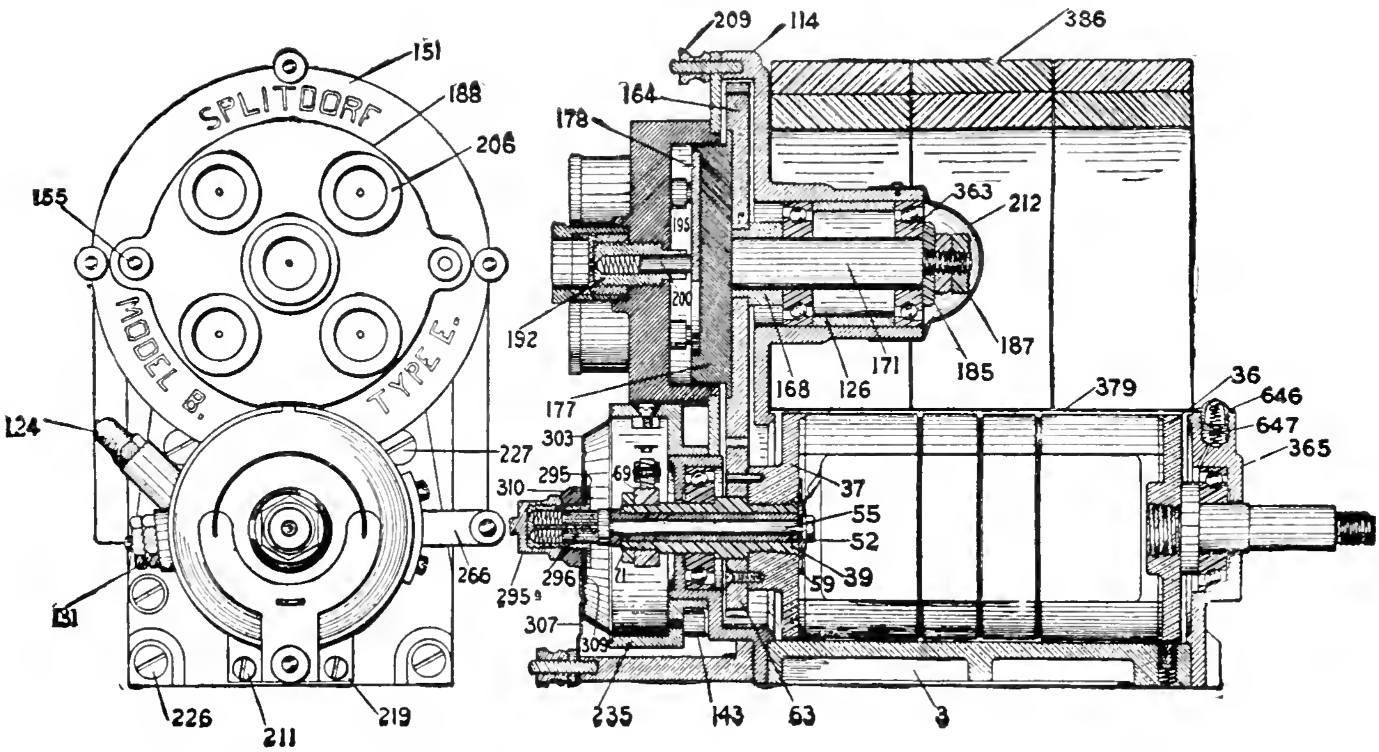


Fig. 1. Diagram of Cross Section of Splitdorf Megneto.

erated to the spark plugs. This gives a dual system with one set of spark plugs, and the simple movement of the switch controls both systems.

A change of style of building automobiles brought about the necessity for devising a transformer which would admit of its being strapped to the frame of the car or to the under side of the foot boards or any other convenient place out of sight. This transformer is in the form of a tube (Fig. 4), with the necessary connections grouped at one end.

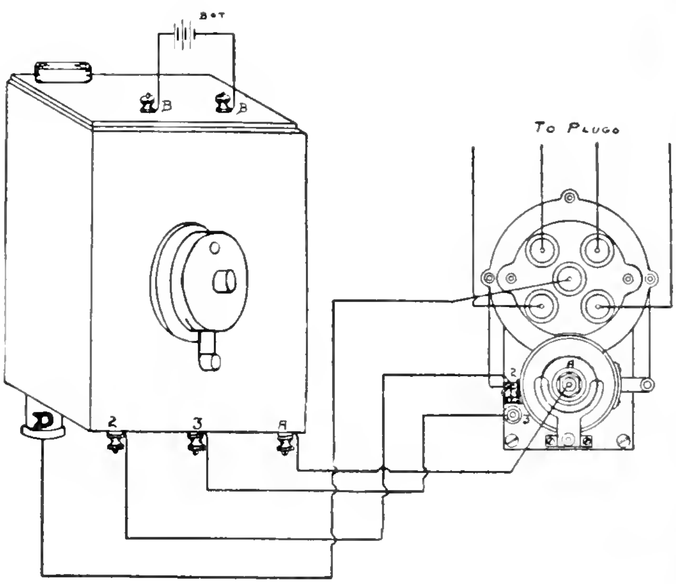


Fig. 2. Wiring Diagram of Splitdorf Magneto and Dash Transformer.

Fig. 4. Tube Transformer.

It is waterproof and oil proof, and is an efficient piece of ignition apparatus. In Fig. 3 is shown a separate wiring diagram for this apparatus, and it is possible to use the device in connection with any model that they make. Of course it is neces-

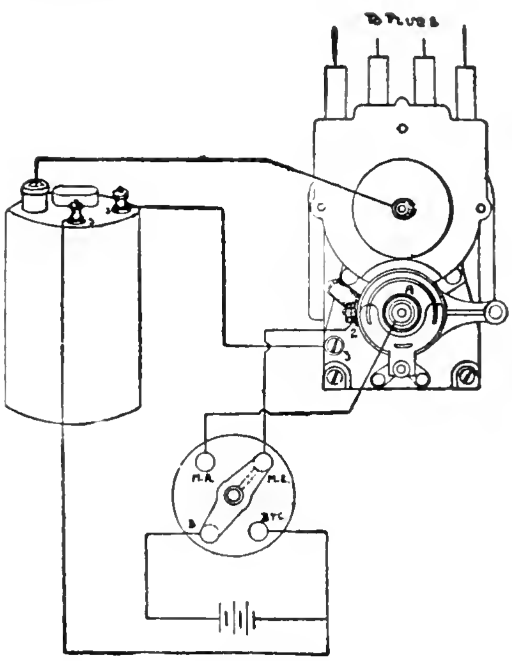


Fig. 3. Wiring Diagram of Splitdorf Magneto and Tube Transformer.

Fig. 5. F Kick Switch.

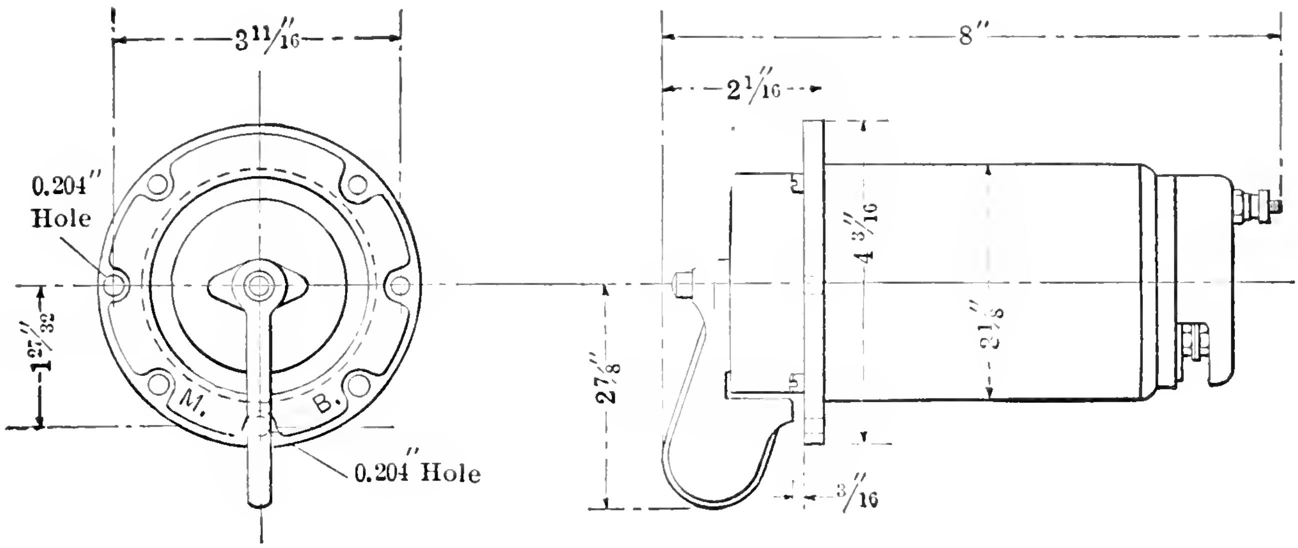
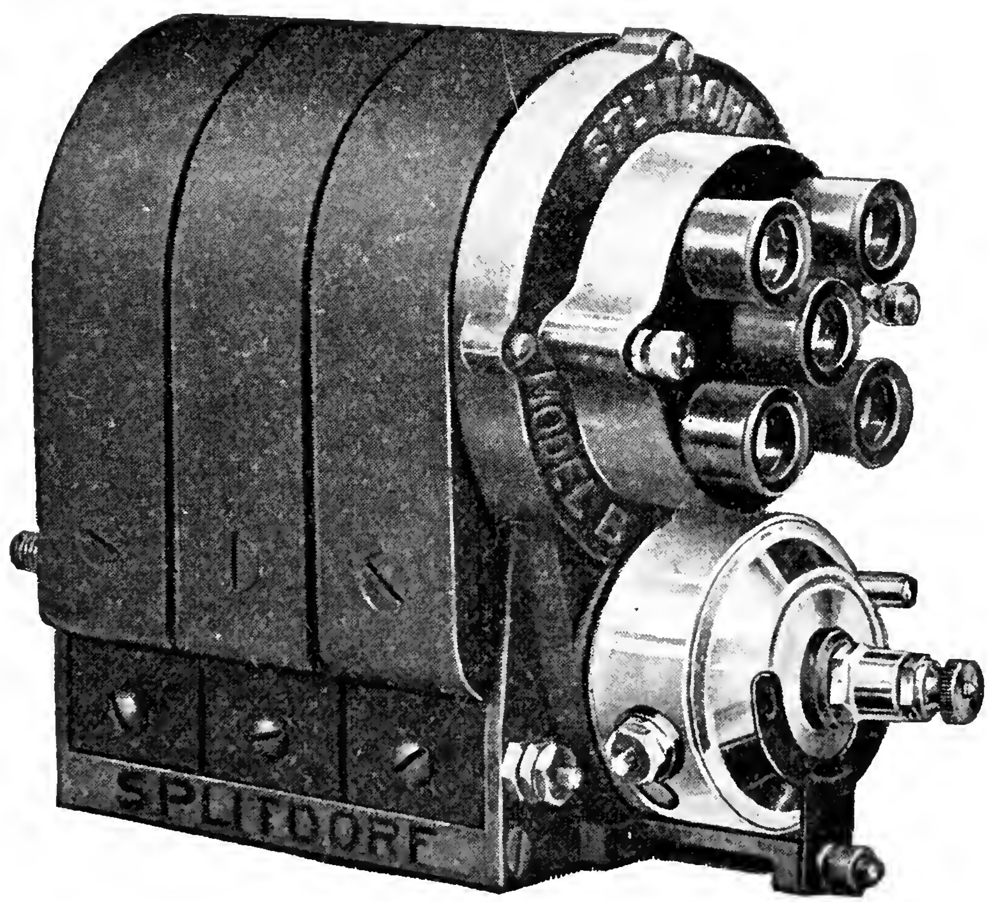


Fig. 6. Diagram of Principal Dimensions of "T S"



Model B Splitdorf Magneto.

sary to use a separate switch on dash for controlling purposes (Fig. 5).

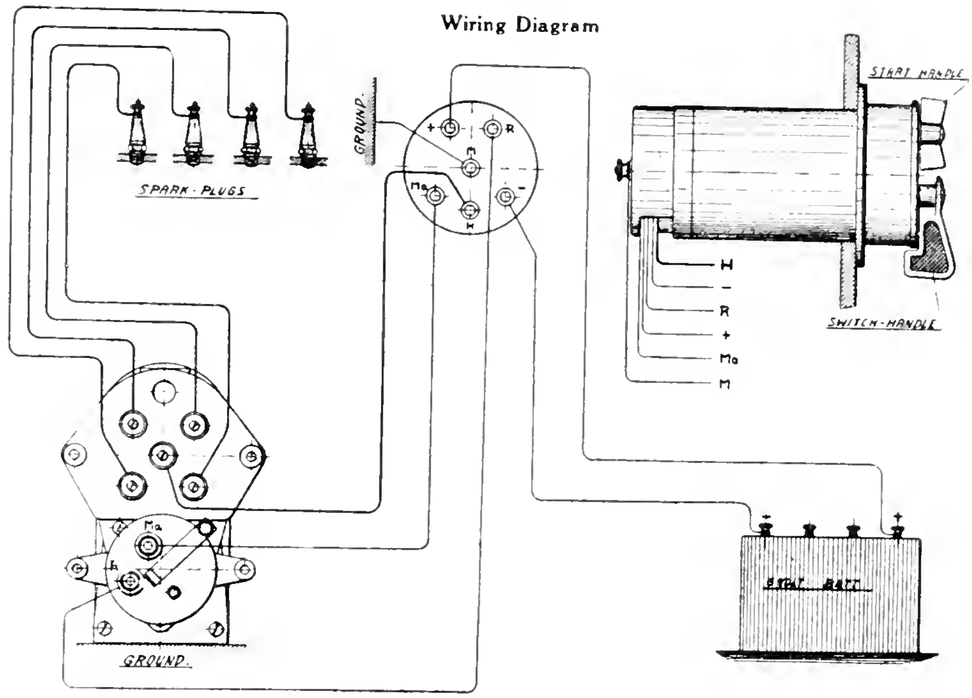
A later development is their new standard "T S" type of transformer. This type particularly does away with the separate switch and still leaves the dash free. This transformer is notable for its ideal firing qualities and general construction. Easily and quickly disassembled, and it is positive in action. Tubular in form, it is set through the dash board and fastened by a flange which forms the base of the switch. All the connections are grouped at the end inside of the dash, and therefore no wires come through the dash and only the face of the switch and its operating lever are visible. All connections are protected from water under the hood by means of a suitable cover. This new construction of the transformer proper has proven very popular, and is easily repaired because its construction is entirely mechanical, no composition being used to insulate the windings.

The Model B Magneto is the straight shaft type for heavy, slow-moving four-cylinder four-cycle motors. Six magnets in three pairs. Can be equipped with the plain tube transformer with separate switch, dash transformer, or as regularly furnished, the "T S B" type, which is strongly recommended.

Eiseman, Magneto, Wiring Diagrams

General wiring diagram.
Wiring diagram Coil D T.
Wiring Diagram Coil D2U.

Wiring Diagram



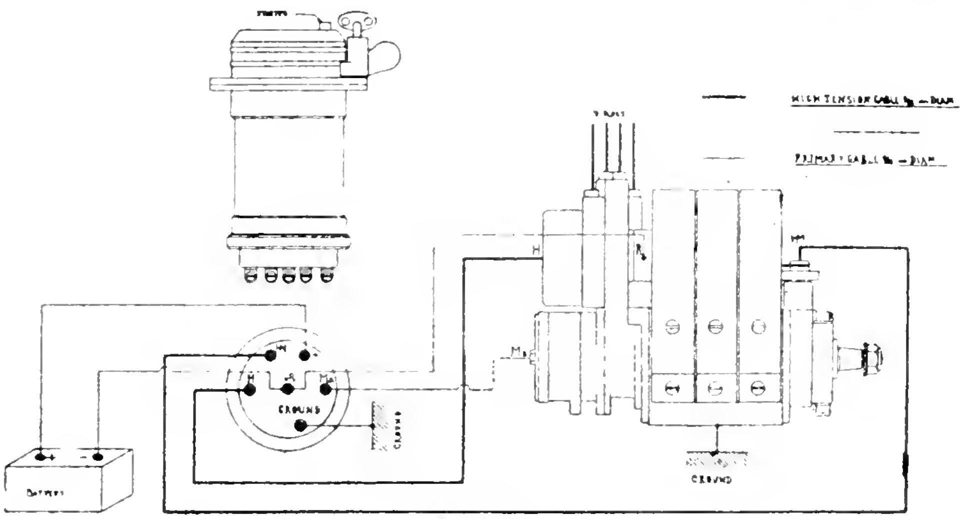


Fig. 5 Wiring Diagram, Coil DT.

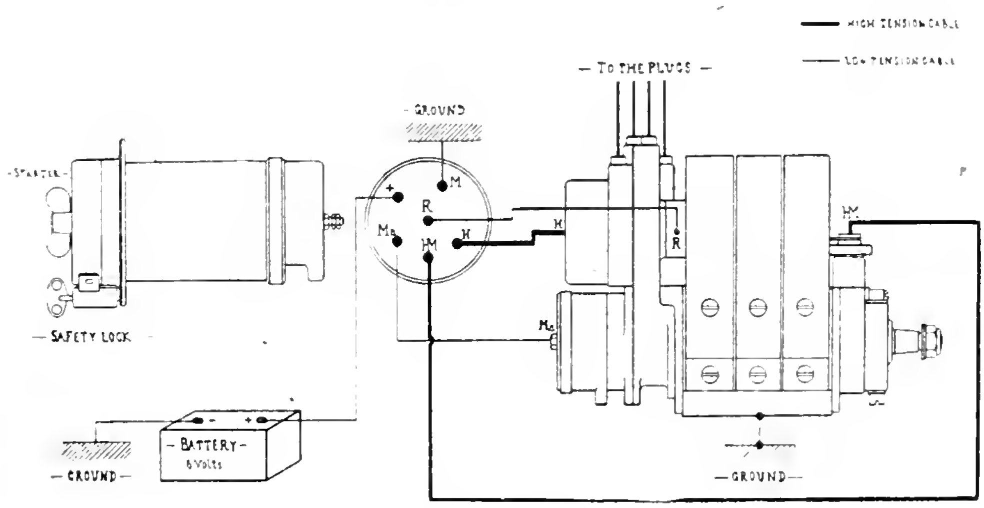


Fig. 4 Wiring Diagram, Coil D2U

The Continental Motor

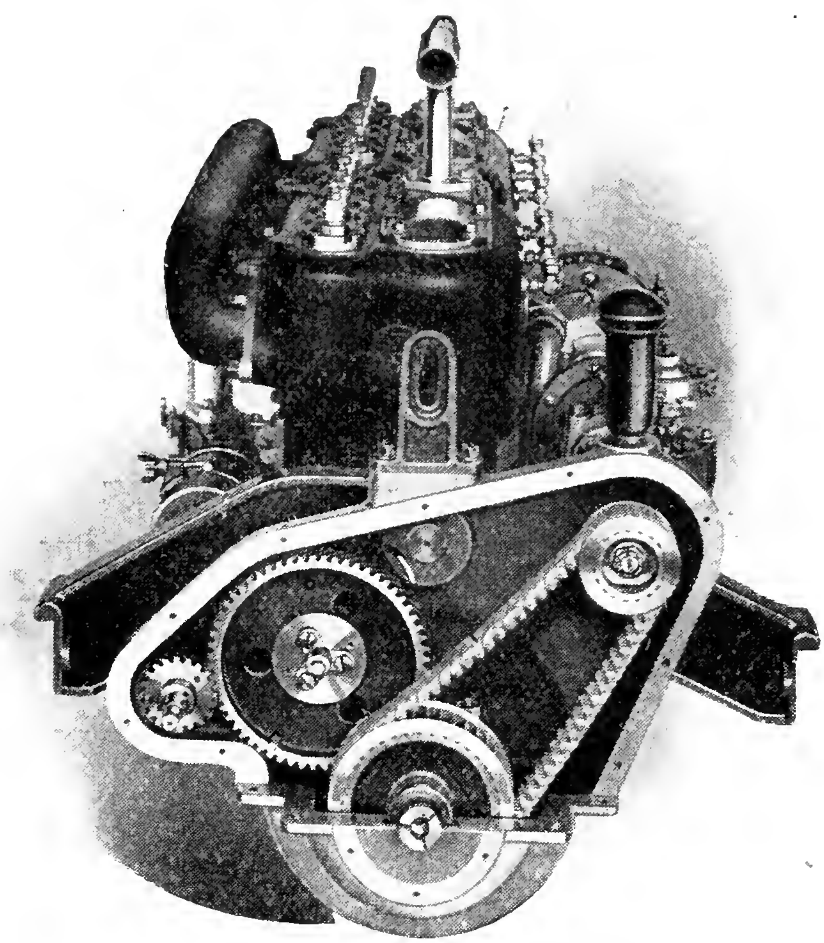
IN order to convey as clear an idea of the Continental Motor as is possible by means of illustrations, four different views are herewith presented, showing the magneto side, the motor valve side and the front and rear of the motor.

Six cylinder vertical "L" head type Continental Motor, unit power plant motor, with enclosed valve mechanism and three point suspension.

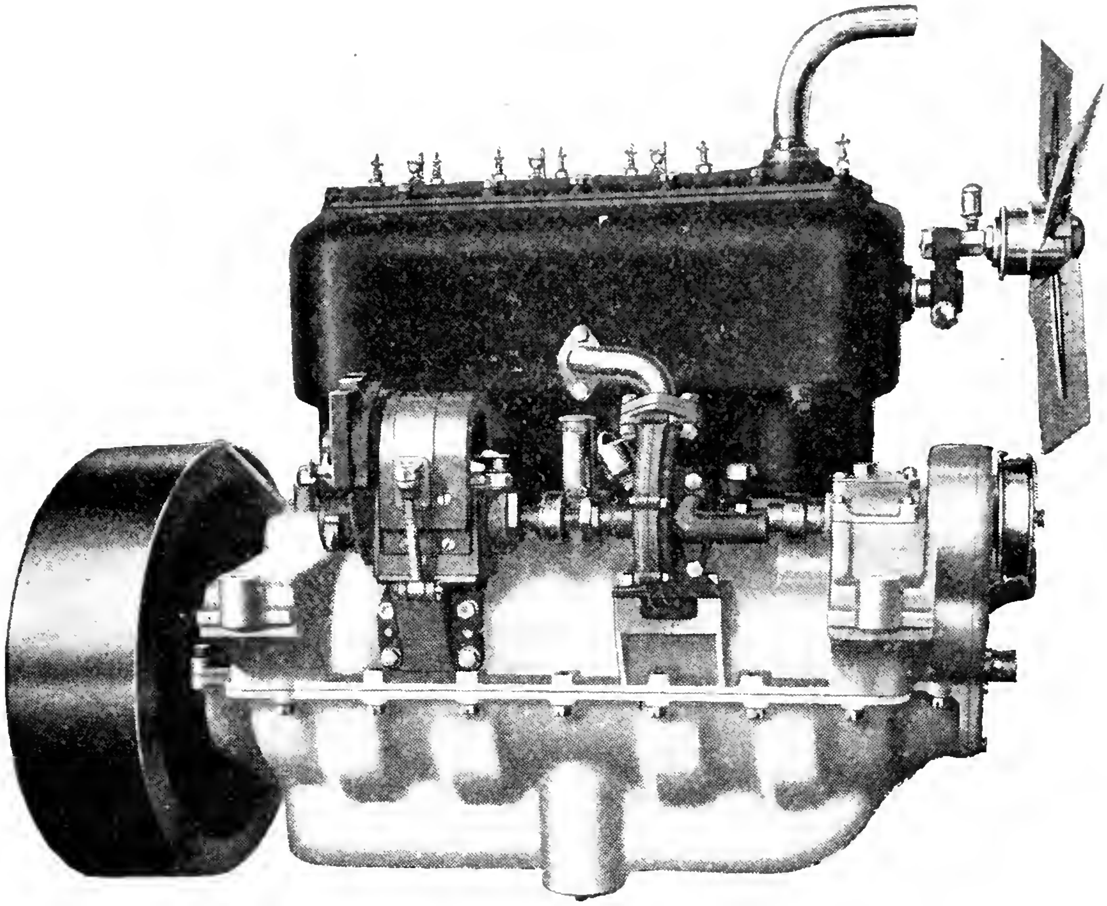
4⅛-inch bore by 5¼-inch stroke.

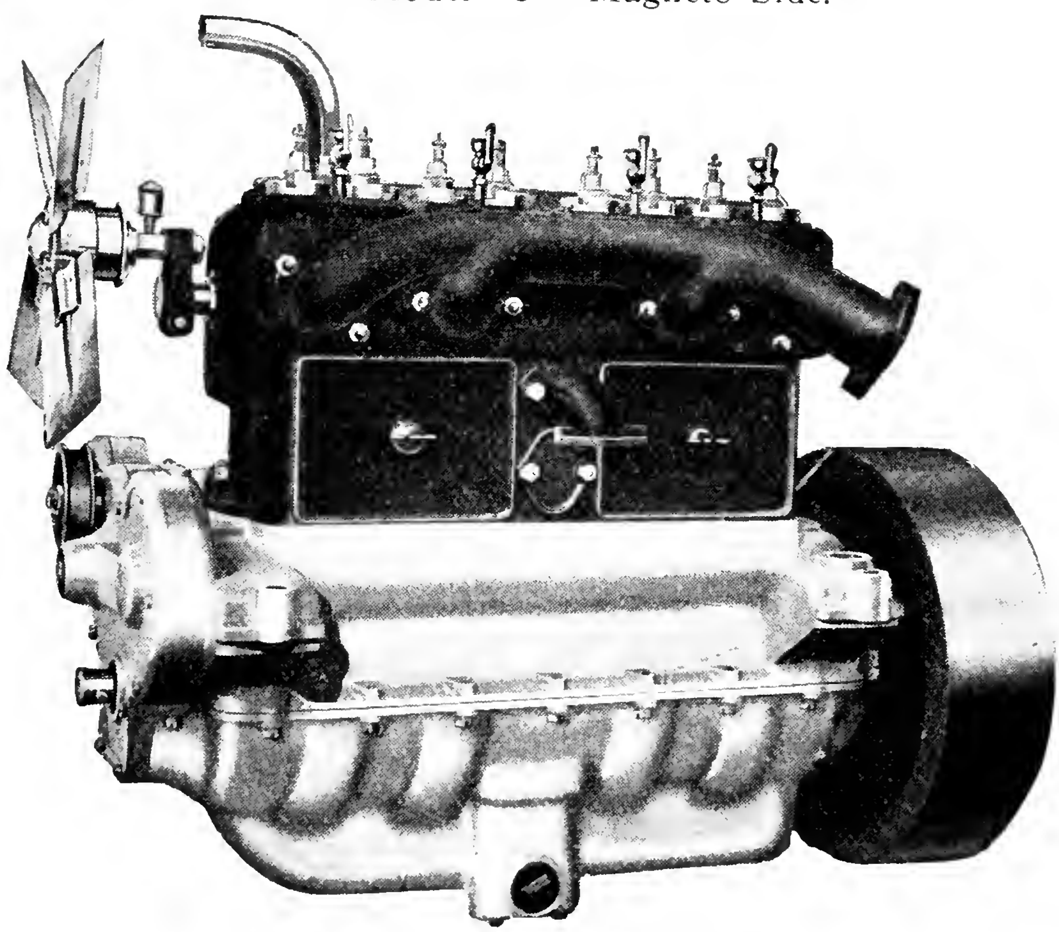
45 H. P. This motor will develop 60 H. P. at approximately 1500 R. P. M.

800 pounds. Flywheel and regular equipment.



Showing Simple and Efficient Silent Chain Drive for Electric Starter and Generator.


Model "C"—Magneto Side.


Model "C"—Motor Valve Side.

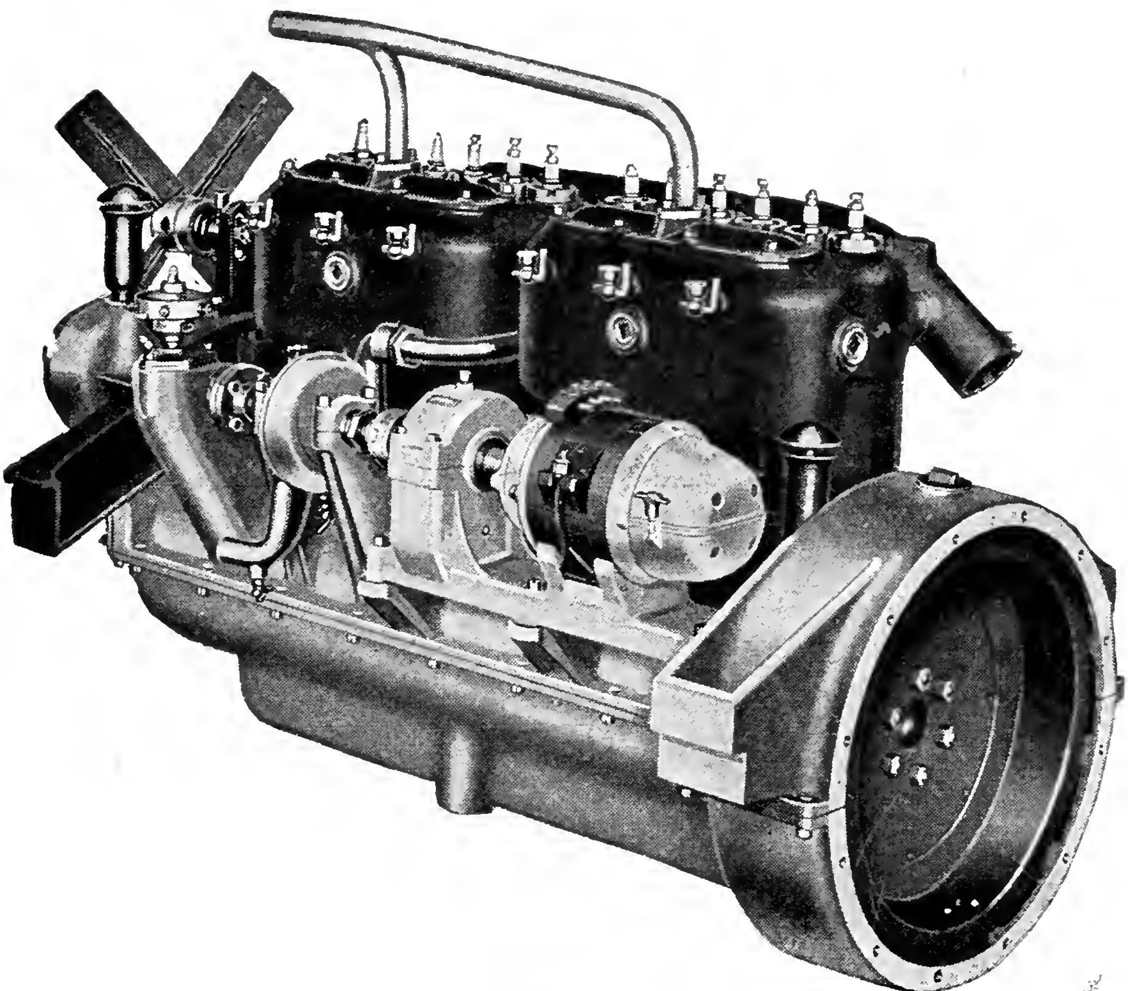
Any standard type of magneto, dynamo or ignition and lighting device may be mounted on this motor. Commutator and drive fitted on special order.

$1\frac{1}{2}$-inch of any standard make.

Forced feed with constant level maintained by positive plunger pump system. Arranged for sight feed on dash if desired.

Centrifugal pump.

This motor is designed for left hand drive and center control, although right hand drive can be satisfactorily used. Crank case is designed to accommodate any type of self starter. Three or four speed transmission and clutch unit can be supplied with motor.



Model 6—C.

Magneto Don'ts.

Don't test your magneto unless you have it completely assembled—i. e., breaker box in place and distributor cover with wires attached.

Don't think it necessary when washing the car to flood the magneto with water. All high tension instruments work better when not flooded with water. This will be thoroughly appreciated by those who have driven with the old type coil ignition.

Don't open the spark plugs nor permit them to burn themselves open more than 1/32 of an inch.

Don't drive the motor with the spark retarded, but as far advanced as possible.

Don't leave your switch turned to battery when car is not in operation.

Don't try to improve the adjustment of the platinum points in the breaker box until they stop breaking.

Don't lessen the efficiency of the magneto by the use of imitation platinum points.

Don't expect your magneto to operate if you permit the frayed ends of your wires to come in contact with each other or the small parts of the instrument.

Don't flood the breaker box when oiling the little roller on the breaker bar. The oil should be applied with a toothpick about once a month.

Don't dissect a magneto to see what makes the wheels go around, unless you are an expert. Manufacturers put the right number of wheels inside when they make it.

Points on the Spark Plug

Don't screw the terminal binding nuts up with pliers, as the hand should be sufficient.

Don't fail to wash the plugs with gasoline, using a stiff brush, and scour the electrodes lightly with fine emery cloth.

Don't forget to remove all particles of emery before replacing plugs.

Don't forget to carry extra plugs, and whenever one is used be sure and replace it.

Don't throw your old plugs or your extra ones in the tool box or locker with a lot of old junk. Keep them in a wooden box, first having greased the threads to prevent rust, and then securely wrap each one in cloth. Porcelains are easily cracked and electrodes easily bent by rough handling.

Don't let a bunch of loose heavy wires drag and pull on your plugs; support them or incase in fibre tubing.

Don't abuse your plugs.

Don't treat them like a nut; treat them like a watch.

Don't fail to examine daily for dirt and breaks.

Don't forget to use kerosene on the threads if the plug sticks.

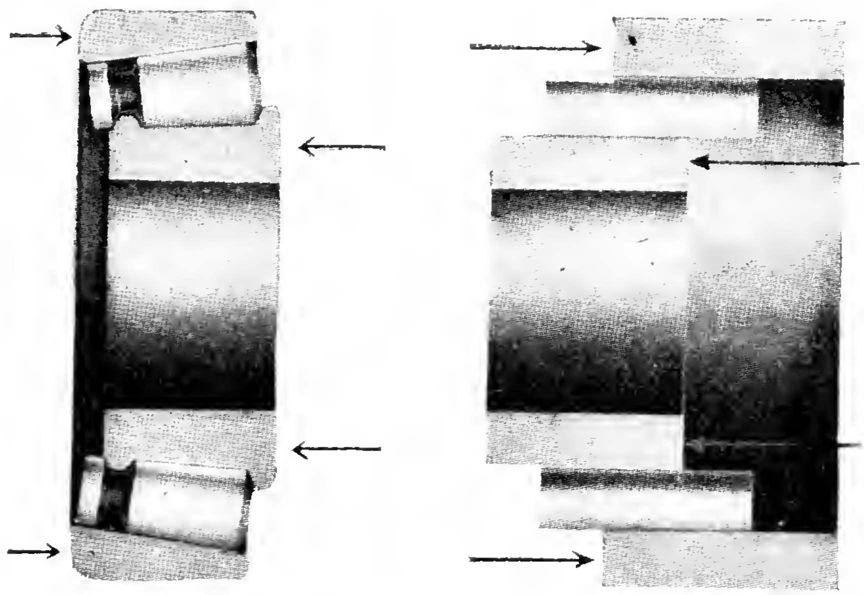
Don't blame the plugs for everything that happens.

Don't buy cheap, unreliable plugs.

How the Timken Bearing Works

THE way in which Timken Roller Bearings operate can best be shown by a concrete example. Glance at the illustration and you will see how these bearings are installed in the front hub of a motor car. (Page 151.)

The cup is firmly pressed into the hub; the cone carrying the rollers and cage is fitted over the axle-spindle. As the wheel turns the rollers revolve between cup and cone.



This construction substitutes rolling-contact for sliding-contact and thus practically does away with friction. To illustrate this principle, take a smooth, round lead pencil or other cylindrical object and place it on your desk, then put a book upon it and move the book back and forth with your hand. Now try moving the book on the desk without any roller and you have a practical example of the advantage of rolling-contact over sliding-contact.

LINE-CONTACT VS. POINT-CONTACT.

The book and pencil also serve to illustrate another advantage of Timken Tapered Roller Bearings:

The advantage of the line-contact of a roller over the point-contact of a ball.

The rollers revolving between cup and cone touch both the cup and the cone in straight lines, extending the whole length of the roller. If they were balls instead of rollers, they would touch only in points.

How Timken Tapered Roller Bearings Meet End-Thrust.

In the diagram the arrows represent the direction in which end-thrust bears upon the cup and the cone of a Timken Bearing and on corresponding parts of a cylindrical-roller bearing.

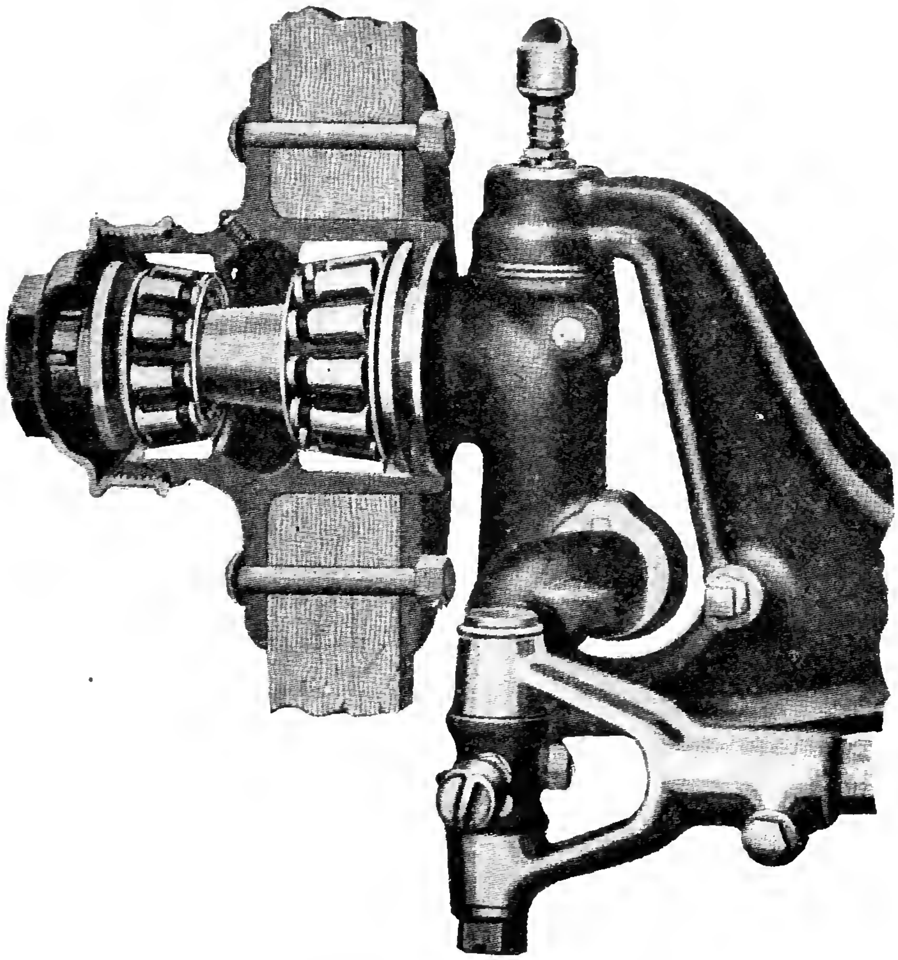
The fact that in a Timken Bearing the parts are tapered makes it impossible for end-force to push the cup and cone apart.

From the diagram you can see, too, that there is absolutely nothing about a cylindrical roller to prevent this very thing from taking place.

To return to our experiment with book and pencil: Instead of rolling the book on the pencil move it sidewise, or along the length of the pencil. It moves easily because the straight roller has no capacity to resist end-thrust.

But, if your pencil were tapered, the book would rise—you would have to *push it up hill.*

In the Timken Roller Bearing this upward motion can't take place because the inner surface of the cup prevents. So the Timken Bearing meets end-thrust.



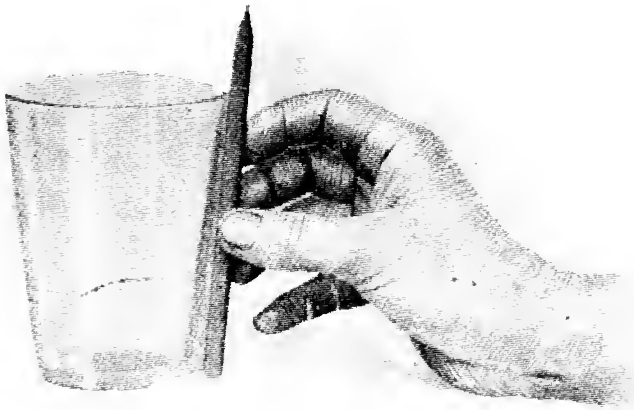
WHY THE CONE HAS TWO RIBS.

As the rollers revolve about the cone, it is of extreme importance that neither of their ends shall travel farther or faster than the other.

The slightest deviation from the true position would destroy the straight line of contact and cause uneven wear.

To get this clearly in mind take a plain, conical, glass tumbler and lay a pencil vertically along its side. You will note uniform contact along the line of the pencil.

The moment, however, that you twist the pencil out of the vertical, you will see that it touches the tumbler only at one point.



Full Point Contact.

We must have a rib on the large edge of the cone in order to keep the tapered rollers from being pressed out from between the cone and cup. The contact between the large ends of the rollers and this rib tends in very slight degree to retard the large end of each roller.

So we must have another rib on the other end of the cone, against which a flange on the small end of the roller presses. This prevents all tendency to twist the roller out of its perfect alignment on the cone.

In a wheel-bearing the load is borne by those rollers which are below the center of the spindle. There is very slight play, almost imperceptible, in the parts of the bearing above the center of the spindle.

Point Contact.

The purpose of the cage is to guide these rollers which are above the center in their proper positions, during their idle period and correctly align them as they enter their working zone.

Bearings Must Do Many Different Things

THE bearings in the wheels carry the whole weight of the car and its load. While doing this they have to meet all the shocks and stresses due to the roughness of the road.

In turning a corner, for example, momentum tends to keep the car on its original course. People riding in the car feel this force pushing them outward along the seat.

This force must be met by the bearings. It is called "end-thrust," and comes in addition to the weight on the bearings.

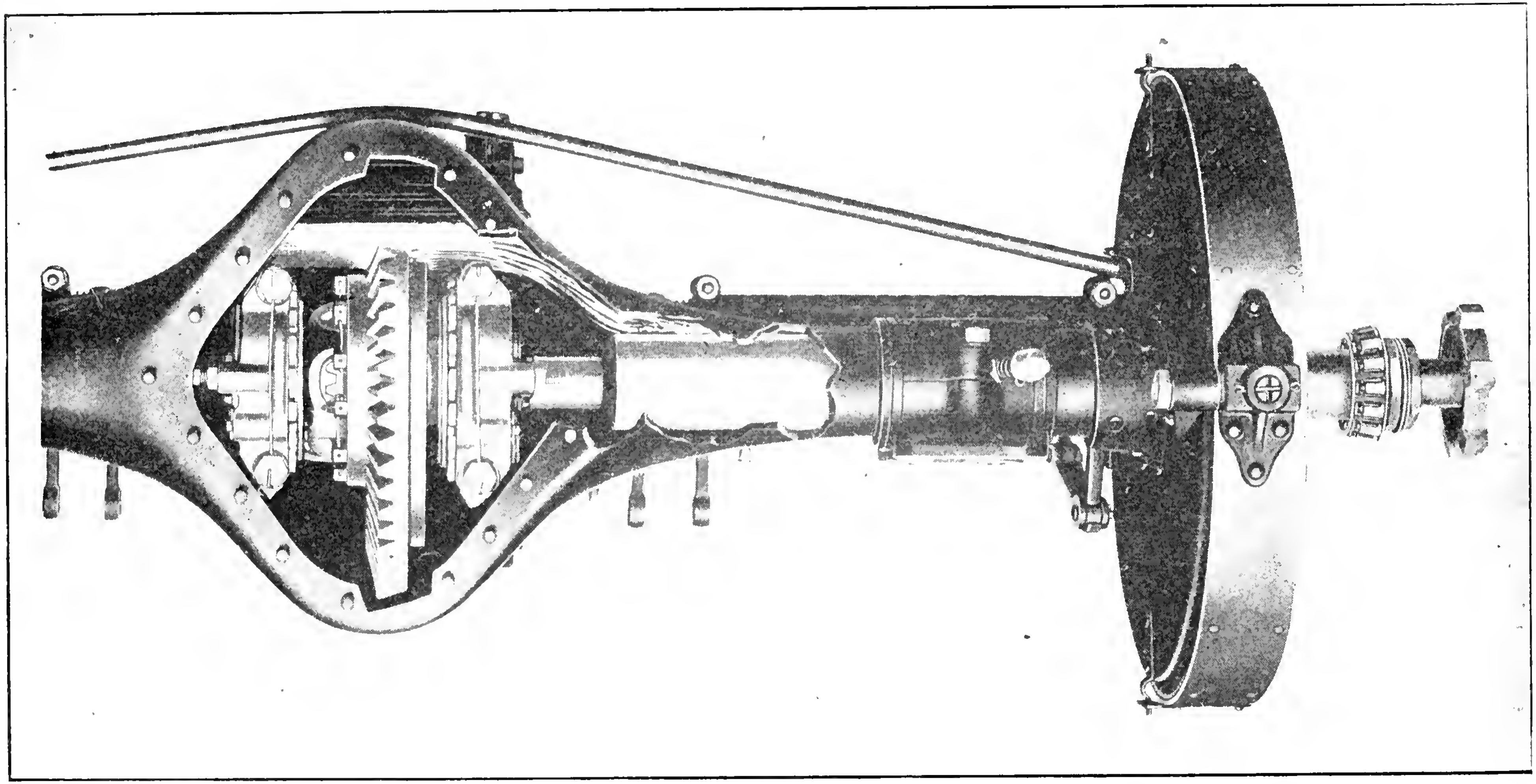
More than half the weight of a heavy touring car or loaded truck is borne by the bearings in its rear wheels. When the car bumps over a stone or drops into a rut, this force is greatly and suddenly increased.

There are other places in the car where great stresses are met by the bearings. For example, power from the engine is transmitted to the rear axle by a tapered gear wheel called the driving pinion. The torsion of this pinion makes it try to climb on the teeth of the gear with which it meshes. The bearings on the pinion-shaft stand all the strain of keeping it from doing this.

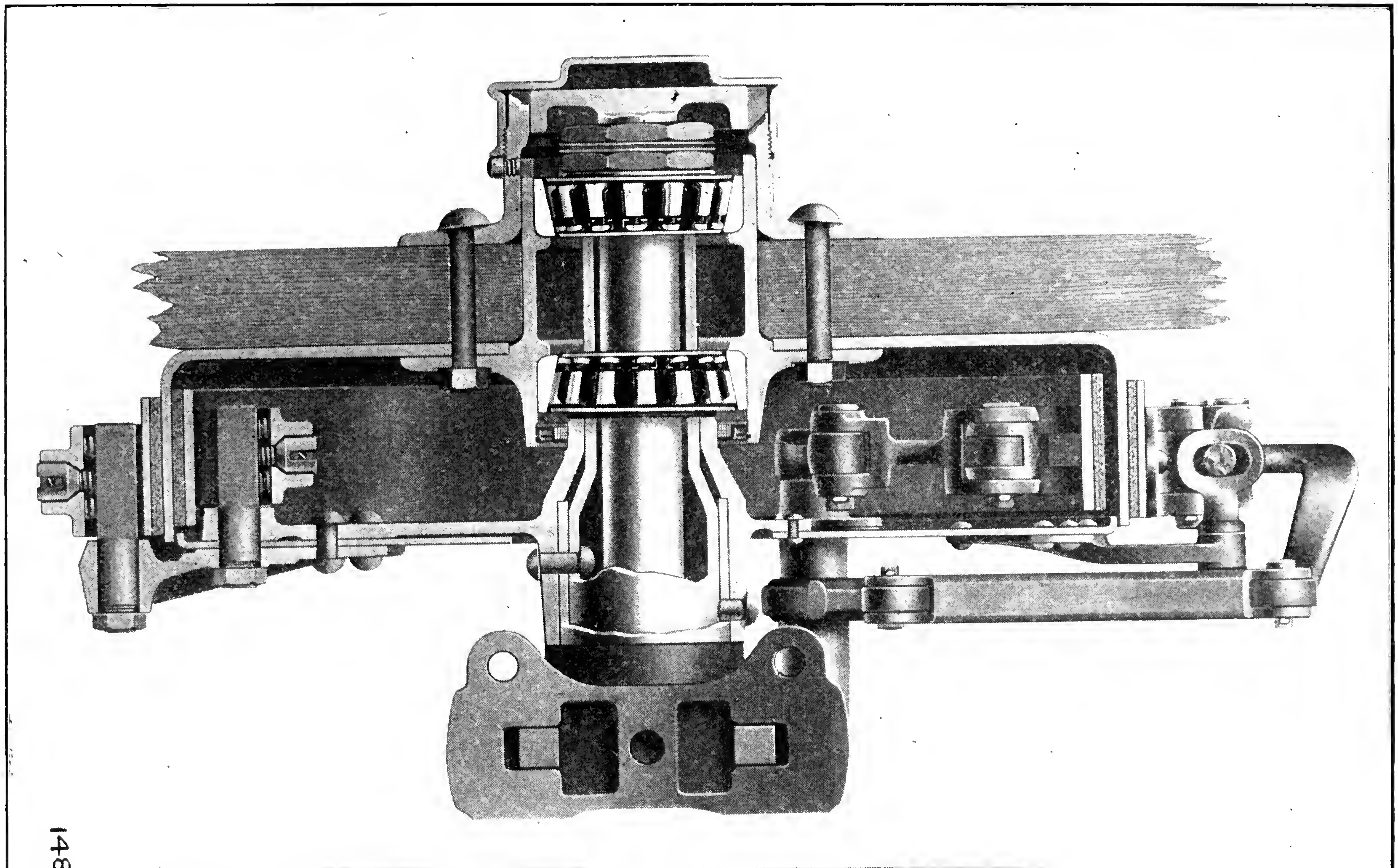
Adjustment of Bearings.

Every time a wheel is removed the cup of the bearing is removed with it, and consequently the bearing must be properly adjusted when the wheel is replaced.

The best method is to turn the bearing up tight, and then revolve the wheel a few times by hand, which overcomes any tendency to "back-lash."



View of Bearings Installed in Rear Axle.



Roller Bearings Installed in Wheel.

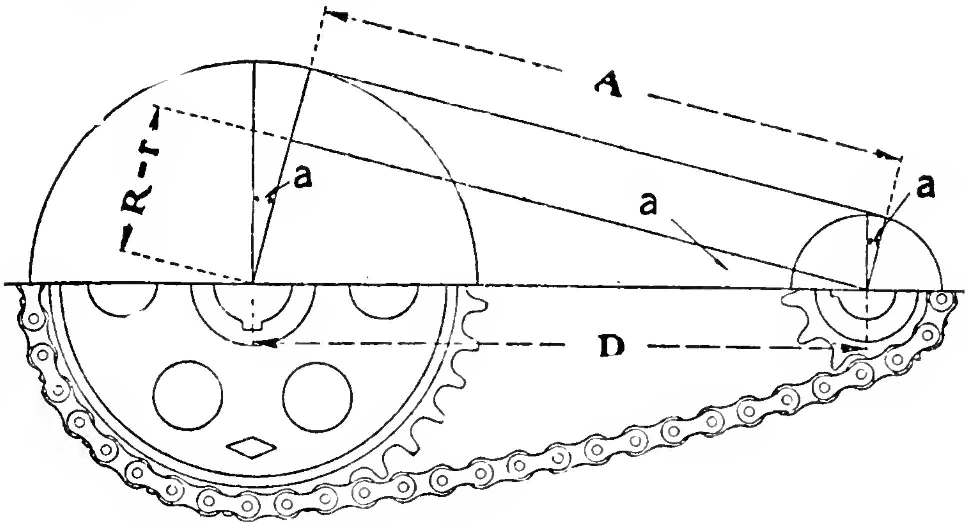
Then back off the adjusting-nut very slightly, so that by grasping the two spokes in a perpendicular line—one above and one below the hub—you begin to feel a very slight shake in the wheel. If this is more than barely perceptible, it is too much, and the adjusting nut should be a little tighter.

When you have it just right, lock it, and the bearings will give the best of service.

Gear-bearings should be turned up to snug fit, but not so tight as to prevent the gears from turning freely.

Formulas, Tables, Measurements, Etc.

FORMULA FOR CALCULATING LENGTH OF CHAIN.



(All Dimensions in Inches.)

D=Distance between centers.
A=Distance between limits of contact.
R=Pitch radius of large sprocket.
r=Pitch radius of small sprocket.
N=Number of teeth on large sprocket.
n=Number of teeth on small sprocket.
P=Pitch of chain and sprockets.
$180° + 2a$=Angle of contact—small sprocket.
$180° - 2a$=Angle of contact—small sprocket.

$$\text{Sin } a = \frac{R - r}{D}$$

$$A = D \cos a$$

Length of chain=L

$$L = \frac{(90+a)\,NP}{180} + \frac{(90-a)\,nP}{180} + 2D \cos a$$

HORSE POWER FORMULAE.

A. L. A. M. Standard, based on a
Piston Speed of 1,000 ft. per minute.

Diameter squared, times number of cylinders, divided by 2.5
Example: Find the H. P. of a 6 cyl. engine, with a bore of 4.5 inches.

4.5 times equals 20.25
20.25 times 6 equals 121.50
Divided by 2.5 equals 48.6 H. P.

TO FIND THE PISTON SPEED.

Revolutions per minute, times stroke in inches, times 2, divided by 12, gives piston speed in feet per minute.

TO FIND THE SURFACE OF A CONE CLUTCH.

Multiply half the width of the face by the circumference of the inner edge plus the circumference of the outer edge.

TO FIND THE AREA OF A BRAKE.

Multiply the width of the face by the circumference; or, multiply the width of the face by the diameter, times 3.1416.

TO ASCERTAIN A GRADE.

Take a stick 10 feet long; rest one end on the road, and hold to level by means of a spirit-level or a bottle nearly filled with water. Measure the vertical distance from the other end of the stick to the road in feet and tenths of a foot; multiply by ten to get the number of feet rise to the 100 feet, or in other words, the per cent of the grade.

WIND RESISTANCE TABLE.

Dating back to the time of Smeaton various formulas have been used for determining the relation between wind pressure and velocity as affecting the stability of buildings and other exposed structures. Smeaton's table, which is largely used at the present day, is as follows:

Miles per Hour	Feet per Second	Pressure per sq. ft. in Pounds	Wind Called
1	1.47	0.005	Hardly perceptible.
2	2.93	0.020	Just perceptible.
3	4.4	0.044	
4	5.87	0.079	Gentle pleasant wind.
5	7.33	0.123	
6	8.8	0.177	
7	10.25	0.241	
8	11.75	0.315	Pleasant brisk gale.
9	13.2	0.400	
10	14.67	0.492	
12	17.6	0.708	
14	20.5	0.964	
15	22.	1.107	
16	23.45	1.25	
18	26.4	1.55	Very brisk.
20	29.34	1.968	
25	36.67	3.075	
30	44.01	4.429	High wind.
35	51.34	6.027	
40	58.68	7.873	Very high storm.
45	66.01	9.963	
50	73.35	12.30	
55	80.7	14.9	
60	88.02	17.71	Great storm.
66	95.4	20.85	
70	102.5	24.1	
75	110.	27.7	Hurricane.
80	117.36	31.49	
100	146.67	49.2	Immense hurricane.

The foregoing table is applicable to automobile work assuming that the machine is moving in still air at the varying rates of speed given in miles per hour. It is generally admitted that the Smeaton formula gives results too high. The formula is $P=00.005\ V^2$.

Other and more recent formulas are those of Martin, $P=0.004\ V^2$, and Dines, $P=0.0029\ V^2$. At a rate of speed of 60 miles an hour these formulas give the following results in pounds per square foot; Smeaton, 18; Martin, 14.4; Dines, 10.44.

In the case of pleasure cars the wind resistance at ordinary rates of speed is so low that it does not greatly influence design, while in the case of racing machines many ingenious forms of construction have been tried out with a view to the reduction of the loss from this source.

POWER REQUIRED TO OVERCOME WIND RESISTANCE (FORREST JONES)

A formula for use in approximating the power required to overcome wind resistance is given as follows:

$$HP=\frac{Pa\ (M\ 5{,}280\ |\ 60)}{33{,}000}=0.96\ PAM$$

In which HP=Horsepower required to overcome wind resistance.
P=Pressure of wind in pounds per square foot.
A=Front area of body in square feet.
M=Speed of car in miles per hour.

Assuming a car with a front area of 10 square feet and a speed of 60 miles per hour, the power required to overcome this wind resistance will be:

$$HP=\frac{13\times 10\ (60\times 5{,}280\ |\ 60)}{33{,}000}=20.8$$

It is not believed that this formula will hold out for all ranges in speed, nor can it be said with certainty that the front area total will be correctly stated if the areas of all the parts without respect to shape or location are figured in on the same basis. In all probability, the most certain way to ascertain the amount of power required to overcome wind resistance is to take a certain car and with suitable instrument under road conditions measure the power required.

THE FOLLOWING TABLE COMPRISES THE MOST POPULAR SIZE TIRES USED.

Metric sizes Millimeters	Approximate Sizes in inches	Metric sizes Millimeters	ApProximate Sizes in inches
650 x 65	26 x 2½	870 x 90	34 x 3½
700 x 65	28 x 2½	910 x 90	36 x 3½
750 x 65	30 x 2½	960 x 90	38 x 3½
800 x 65	32 x 2½	1010 x 90	40 x 3½
830 x 65	33 x 2½	815 x 105	32 x 4
860 x 65	34 x 2½	875 x 105	34 x 4
700 x 85	28 x 3¼	915 x 105	36 x 4
750 x 85	30 x 3¼	820 x 120	32 x 4½–5
800 x 85	32 x 3¼	850 x 120	33 x 4½–5
860 x 85–	34 x 3¼	880 x 120	34 x 4½–5
760 x 90	30 x 3½	920 x 120	36 x 4½–5
810 x 90	32 x 3½	1020 x 120	40 x 4½–5
840 x 90	33 x 3½	1080 x 120	42 x 4½–5

Table of Speed Expressed in Miles Per Hour.

Time for 1 mile Min.	Sec.		Miles per hour	Time for 1 mile Min.	Sec.		Miles per hour
1	0	=	60.00	1	35	=	37.89
1	1	=	59.01	1	36	=	37.50
1	2	=	58.06	1	37	=	37.11
1	3	=	57.14	1	38	=	36.73
1	4	=	56.23	1	39	=	36.36
1	5	=	55.38	1	40	=	36.00
1	6	=	54.54	1	41	=	35.64
1	7	=	53.73	1	42	=	35.29
1	8	=	52.94	1	43	=	34.95
1	9	=	52.17	1	44	=	34.61
1	10	=	51.43	1	45	=	34.28
1	11	=	50.70	1	46	=	33.96
1	12	=	50.00	1	47	=	33.64
1	13	=	49.31	1	48	=	33.33
1	14	=	48.65	1	49	=	33.03
1	15	=	48.00	1	50	=	32.73
1	16	=	47.37	1	51	=	32.43
1	17	=	46.75	1	52	=	32.14
1	18	=	46.15	1	53	=	31.86
1	19	=	45.57	1	54	=	31.58
1	20	=	45.00	1	55	=	31.30
1	21	=	44.44	1	56	=	31.03
1	22	=	43.90	1	57	=	30.77
1	23	=	43.37	1	58	=	30.51
1	24	=	42.86	1	59	=	30.25
1	25	=	42.35	2	0	=	30.00
1	26	=	41.86	2	3	=	29.27
1	27	=	41.38	2	6	=	28.57
1	28	=	40.91	2	9	=	27.91
1	29	=	40.45	2	12	=	27.27
1	30	=	40.00	2	15	=	26.27
1	31	=	39.56	2	18	=	26.08
1	32	=	39.13	2	21	=	25.53
1	33	=	38.71	2	24	=	25.00
1	34	=	38.30	2	27	=	24.49

Formula for Determining Diameters of Sprockets for Roller Chains.

N = Number of teeth in sprocket.
P = Pitch of chain
D = Diameter of roller

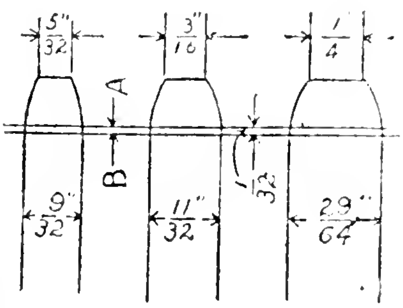
$$a = \frac{180°}{N}$$

$$\text{Pitch Diameter} = \frac{P}{\text{sine } a}$$

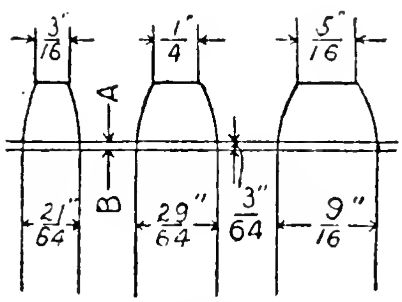
Outside Diameter = Pitch Diameter + D
Bottom Diameter = Pitch Diameter − D

The accompanying drawings show width and shape of sprocket blanks as they should be machined before cutting the teeth to fit (Whitney) chains.

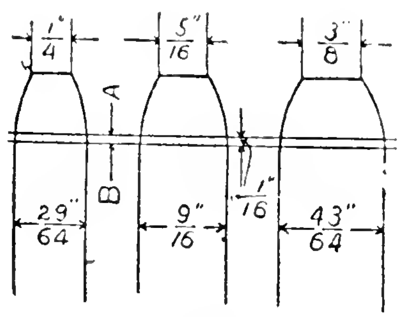
The line "A" indicates pitch line and the line "B" below the pitch line indicates the point at which the clearance curves should start.



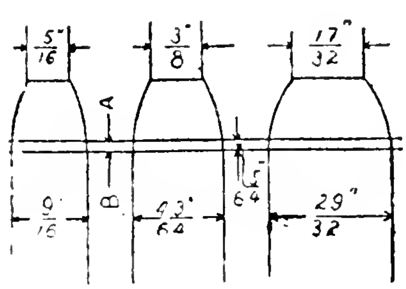
Pitch of Chain	3/4"	3/4"	3/4"
Diameter of Roll	15/32"	15/32"	15/32"
Width of Roll	5/16"	3/8"	1/2"



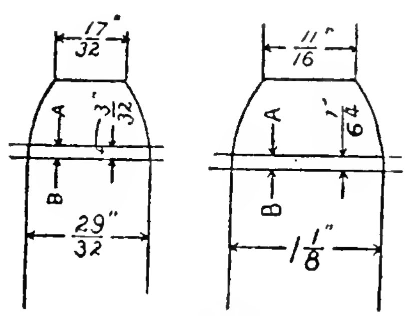
Pitch of Chain	1"	1"	1"
Diameter of Roll	5/8"	5/8"	5/8"
Width of Roll	3/8"	1/2"	5/8"



Pitch of Chain	1 1/4"	1 1/4"	1 1/4"
Diameter of Roll	3/4"	3/4"	3/4"
Width of Roll	1/2"	5/8"	3/4"



Pitch of Chain	1 1/2"	1 1/2"	1 1/2"
Diameter of Roll	7/8"	7/8"	7/8"
Width of Roll	5/8"	3/4"	1"



Pitch of Chain	1 3/4"	2"
Diameter of Roll	1"	1 1/8"
Width of Roll	1"	1 1/4

Electric Wiring Plan and Coil Adjustment.

Things to Know That Save Trouble.

SHORT CIRCUITS. Any battery will be rapidly exhausted if it is allowed to stand on short circuit for any length of time. For this reason care should be taken not to place metal bars, tools, etc., on the battery where they might short circuit it.

When starting a car equipped with a dual system of ignition, the car should be cranked immediately after the switch is turned to the battery side and the magneto switched in at once. This is necessary, because in the majority of such systems the battery is short circuited all the time that the switch is on the battery side.

It is also well to thoroughly examine the switch on any system and to be sure it is free from any short circuits either when the switch is in the off position or on the magneto side. In many cases the battery has been found to be short circuited when the switch was on the magneto side or even in the off position.

Wiring. For primary wiring use about No. 14 gauge wire with approved insulation.

For secondary wiring special heavily insulated high tension wire should be used at all times.

Apparatus should be placed so that the length of the secondary leads shall be reduced to the minimum. These leads should not be placed too close to each other if they are more than 24 inches long.

High tension wires should never be placed so that they are liable to become soaked with oil or water.

Wires should never be left with loose ends exposed. They will cause trouble.

A loose contact will always cause trouble. The wires should be scraped until they are clean and bright after the insulation has been removed and all the joints should be made secure and taped.

Care should be taken that the ground wire makes good contact with the engine frame (not the body frame) in such a position that it is not liable to be broken.

All connections should be inspected regularly for loose or corroded joints.

Spark Plugs. Those that give satisfactory service on battery systems are often destroyed within a short time when used on magneto. Spark gaps about 3/64 inch, or the thickness of a dime, will give good results with batteries.

In replacing spark plugs in hot cylinders, do not screw them in too tightly. They will be hard to remove.

General. Do not operate an ignition system with the secondary wires removed, unless a spark gap is provided through which the secondary may discharge.

Do not take it for granted that the ignition is at fault every time the engine stops or misses.

When using individual dry cells in steel battery box some form of lining should be provided. Ordinary floor matting makes an excellent lining.

When replacing a storage battery with dry cells the interior of the battery box should be thoroughly scrubbed to remove all acid, otherwise the zinc of the battery will be attacked and quickly destroyed. Cases have been known where a number of dry cells have been destroyed within a few days by the acid left in the battery box from a storage battery which was formerly used.

When using individual dry cells care should be exercised in washing the car, so that the batteries and the interior of the battery box are not wet. This is apt to cause leakage of current, which will soon destroy the batteries.

See that the vibrator of your spark coil is adjusted to consume the least amount of current consistent with efficient service. See "Spark Coil Adjustment," Fig. 1.

VIBRATOR COIL ADJUSTMENT.

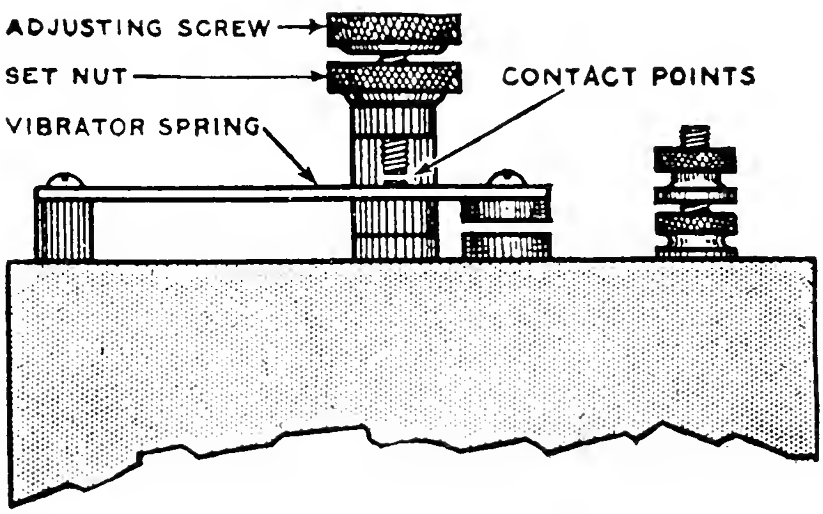


Fig. 1.

The current consumed by any ignition system is affected directly by the adjustment of the vibrator; the heavier the adjustment the greater the current consumption. It is, therefore, extremely, important to adjust the vibrator as lightly as is possible for the engine to start and operate without skipping. Any heavier adjustment not only wastes current, but burns the timer and vibrator contacts unnecessarily.

By observing the following rules, the tension of the vibrator on the spark coils may be adjusted to the minimum rate of battery energy consumption consistent with the proper operation of the engine.

(1) Make certain that the contacts on the spark coils are clean and even, and not too much pitted. (If contact points become deeply pitted or rough, they should be smoothed down with a file.)

(2) See that the spark plugs are clean and free from short circuits.

(3) While the engine is not running, turn the crank until one of the spark coil units is thrown into position in the battery circuit, and its vibrator set in motion.

(4) Lessen the tension on the vibrator by means of the adjusting screw, until the contacts are separated and the vibrator ceases to move; then increase the tension just enough to cause the vibrator to be set in motion again. Secure the adjusting screw.

(5) Proceeding in like manner, adjust the tension of the vibrator of each of the other spark coils to the minimum consumption of battery energy.

(6) Crank the engine. If engine refuses to run, or if it runs in an irregular manner, increase the tension on each vibrator by giving the adjustment screw a very slight turn to the right.

It will be found more economical in the end to use a high-grade spark coil, as the current saved will soon overbalance the increased cost of the coil. Too much emphasis cannot be placed on coil adjustment, for much of the trouble in ignition and short life of the battery can be directly traced to improper coil adjustment.

Causes of Ignition Troubles.

In 99 cases out of 100 the motorist blames the batteries whenever anything goes wrong with his ignition. Experience has proved that the reverse of this is the actual condition.

As a guide to those who may be having ignition trouble we will list a few conditions and show some possible causes for the trouble, independent of the battery.

(*a*) *Whenever the engine fires irregularly, the cause may be due to:*

(1) Broken down insulation on wires.

(2) Carbureter not properly adjusted, causing poor mix.

(3) Cracked spark plug.

(4) A defective connection in some part of the circuit.

(5) Gasoline feed partly choked.

(6) Moisture on spark plugs or water in crank case.

(7) Poor contact in timer.

(8) Spark coil not properly adjusted.

(9) Terminals on coil may be loose or damaged.

(*b*) *When the engine fires regularly, but is weak, the cause may be due to:*

(1) Compensating valve on carbureter not working.

(2) Improper gas mixture.

(3) Insufficient lubrication.

(4) Platinum contacts on coil may need cleaning.

(5) Poor compression caused by loose plugs or valves.

(6) Reduced lift on exhaust valve.

(7) Muffler outlets may be stopped with mud or charred oil.

(8) Vibrator on coil may need adjusting.

(9) Weak spring on inlet valve.

(*c*) *When the engine refuses to start, the cause may be due to:*

(1) Broken or jammed gears.

(2) Dry cylinders.

(3) Battery plug not in position.

(4) Fouled or cracked spark plug.

(5) Gasoline shut off.
(6) Improper gas mixture.
(7) Improper Ignition.
(8) Inlet valve stuck.
(9) Open battery switch.
(10) Poor compression.
(11) Water in cylinder caused by leak from water jacket.
(12) Water in gasoline.

(*d*) *When there is a gradual slowing up of the engine, accompanied by misfiring, the cause may be due to:*
(1) Carbureter may be choked with dirt at jet.
(2) Gasoline tank empty or air-bound.
(3) Gasoline valve partly closed.
(4) Fouled spark plugs, due to over or poor lubrication.

These are not all of the things that may cause your trouble, but serve to show you that there are many angles to the ignition question independent of the battery of whatever make or grade.

To sum up in a few words, here are a few things that may be the direct cause of poor ignition, and each has no connection with battery qualities. (1) Poor or loose connections in the wiring; (2) Poor battery connections; (3) Broken down insulation; (4) Fouled or leaky spark plugs; (5) Broken wires under the insulation somewhere in the circuit; (6) Defective switch; (7) Defective units in good types of coils; (8) Poor coils; (9) Impeded flow of gasoline; (10) Improper adjustment of carbureter; (11) Poor vibrator adjustment; (12) Leaky valves—and many other causes.

Directions for Installing Wires, Switch, Etc., for Auto Lighting.

Anyone should be able to install the switch and connect it to the various lamps and to the battery. The switch proper is mortised into the dashboard, facing the driver. It is held into position by four round-headed brass screws. The white buttons of the switch should be above the black. When the switch is secured in its position in the dashboard, proceed to connect it according to the following diagrams and directions.

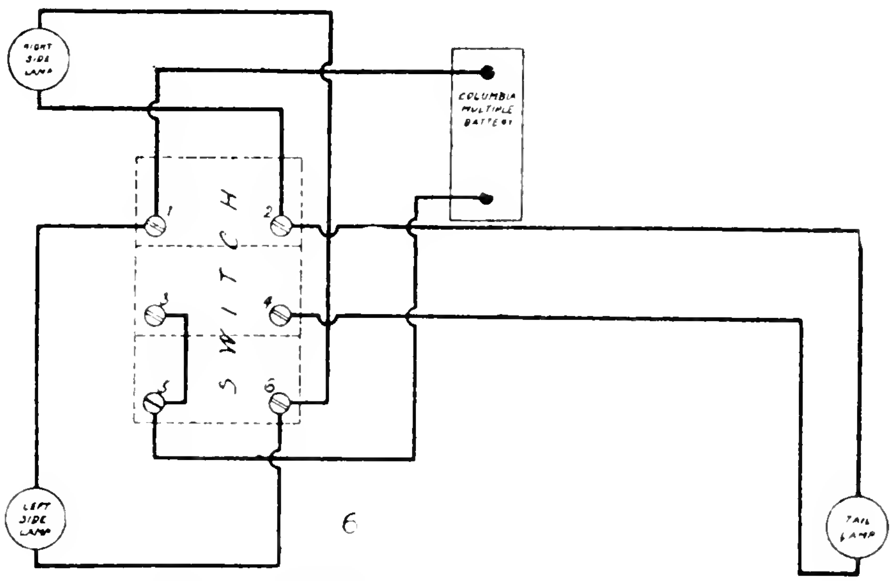


Fig. 2—Wiring Plan for Auto.

The figures shown in Fig. 2 correspond with the same figures shown in Fig. 4. Fig. 4 shows details of the switch, while Fig. 2 is diagrammatic and shows how to make connections.

Refer to Fig. 2 when reading the following directions:

Wires leading from screw No. 1 connect to the battery and to the left side lamp.

Wires leading from screw No. 2 connect to the right side lamp and to the tail lamp.

Wire leading from screw No. 3 connects to screw No. 5 on the switch.

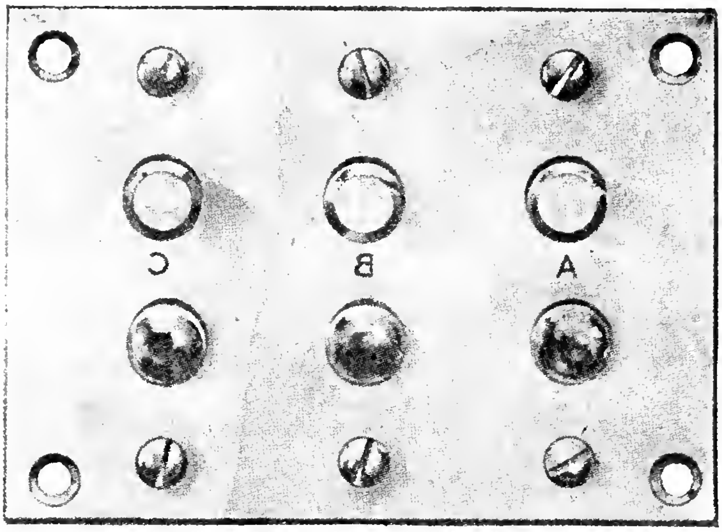


Fig. 3—Front View of Switch.

Wire leading from screw No. 4 connects to the tail lamp.

Wires leading from screw No. 5 connect to screw No. 3 on the switch and to the battery.

Wires leading from screw No. 6 connect to the left side lamp and to the right side lamp.

By referring to Fig. 4 and to the diagram, Fig. 2, and connecting the wires as indicated in the above directions, no one should experience any difficulty.

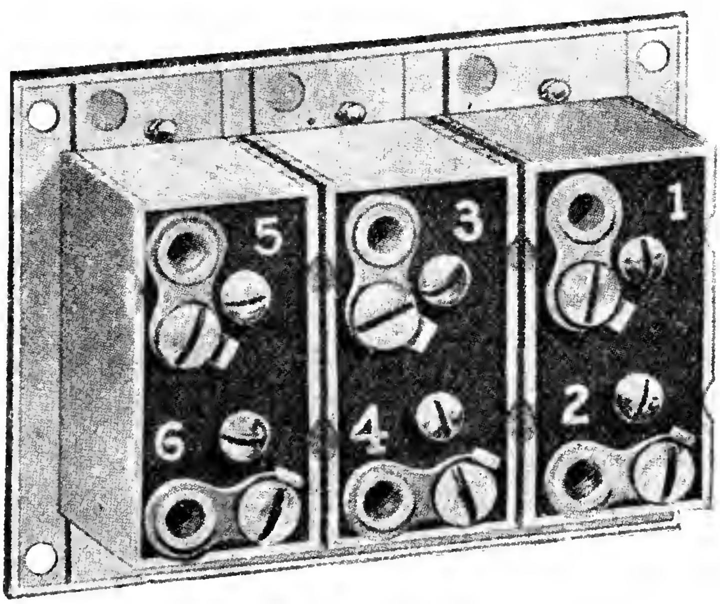


Fig. 4—Rear View of Switch.

Lighting Combinations—Using Three-Gang Auto Switch.

For such a lighting system controlled by the selective system of push button switch, a three-gang switch as shown in Figs. 3 and 4 is recommended.

With this system six different combinations of lighting may be secured by manipulating the push buttons of the switch according to the following directions:

By pushing in button B all lamps burn in series. (Dim light, which use only about one-fifth the amount of current consumed when lamps are on full and bright.)

Note.—This means that the battery's life will be five times as long as when they burn brightly. This is ample light for a car standing at night.

Button C in, lights left side lamp. (Bright light.)

Buttons A and B in, light tail lamp. (Bright light.)

Buttons A and C in, light both side lamps. (Bright light.)

Buttons A, B and C in, light all lamps in multiple. (Bright light.)

It can be seen by these combinations that practically any kind of lighting effects desired can be easily made.

The absolute control which a driver may have over his lamps when using the Three-gang Auto Switch makes the device convenient and serviceable.

Patent Protection

THE value of an invention to the inventor depends largely, if not entirely, upon the measure of protection afforded him by a patent covering the same. The measure of protection depends largely upon the proper preparation and prosecution of the application for the patent by the patent attorney.

In order to obtain a valid United States patent it is necessary that the application for the same be made by the first, original and true inventor or inventors before it has been published for more than two years or been in public use or on sale in this country for more than two years.

Patents are issued for the term of seventeen years and cannot be extended except by special act of Congress, but patents may be reissued at any time within two years from date of issue to correct any "inadvertence, accident or mistake," such as failing to make claims sufficiently broad to amply cover and protect the invention shown and described in the application for the original patent.

Design patents are issued for the terms of three and one-half, seven or fourteen years, as the applicant may elect in his petition for design patent, but after having elected a term, he cannot change it to a longer or shorter term after the application has been allowed.

Procedure.

Before making application for patent, it is desirable that the invention be perfected so that the patent will correctly inform the public how the invention is to be performed or used. The patent attorney and draftsman should have a thorough understanding of the invention by examining the device or a drawing, model, or photograph of the same, together with either written or verbal explanations by the inventor, pointing out the novel features or combinations and the advantages of the same over the prior act.

Precaution.

Inventors in order to establish their dates of priority should always be careful to preserve any original sketches, drawings or models, and date the same at the time they were made, signing their names as inventors, attested by two witnesses, and they should explain the invention thoroughly to such witnesses, who should be persons of integrity and of sufficient intelligence to thoroughly understand and explain the invention if called upon to do so. It is preferable to have witnesses other than a wife and other near relatives. Such precautions greatly assist inventors to establish their rights in case of an interference of two applications for patent in the United States Patent Office or in an infringement suit in the United States Court.

Search.

If there is doubt as to the novelty of the invention, it is often desirable that a preliminary search be made to ascertain what, if any, prior patents may be found to limit or anticipate the invention covered by the proposed application for patent. The cost of such a search is small and may often save the inventor the expense of an application for patent.

Caveat.

The law relating to caveats was repealed June 25, 1910, and the only means now provided by law for protecting an invention is the filing of an application for patent.

Many valuable inventions are forfeited to the public by the inventors because they fail to make the application for patent within two years from the time the invention was first published or put into public use. If an inventor should apply for patent after it has been in public use or published for more than two years, and should bring suit thereon against an infringer, the court, upon proof of such public use or publication, would declare the patent invalid.

A Common Error.

Many people have the erroneous idea that they have a perfect right to use their own invention for more than two years without forfeiting their right to a patent. The only exception to this is that if the use is experimental only, it will not invalidate the patent. But it is unsafe for any public use to occur which extends over a period of more than two years before filing the application.

Patents and Patents.

Patents, like a title to real estate, may be good or bad, depending upon whether the drawings illustrate an operative device and whether the specification correctly describes the same, and particularly whether the claims are of the proper scope. The claims should not be broader than the basis laid for them in the drawings and specification, or so broad as to be met by prior patents or publications. They should not be so narrow as to make it easy for an infringer of the invention to avoid liability for infringement. It is well to have some broad and some narrow claims covering every combination which is properly within the scope of the invention and which does not conflict with prior patents. A patent with such claims affords an ample weapon for the protection of the invention.

A patent may be declared void for other reasons, such as "aggregation," which is a legal term to indicate that claims embody a combination of elements, some of which are not necessarily dependent upon the others for the obtaining of a given result. Such a combination is called an aggregation as distinguished from a true combination. A good illustration of an aggregation is found in the famous Reckendorfer Pencil case, in which the Supreme Court of the United States held the patent invalid because the claim was for the combination of the lead in one end of the wood for writing and the rubber eraser in the other end for erasing the writing, the court holding that the function of each did not modify or change the function of the other and that neither lead nor eraser was dependent upon the other in the performance of their respective functions.

Many people have the mistaken idea that if they receive a document signed by the Commissioner of Patents, bearing a blue ribbon and red seal, that they are amply protected under all circumstances, but it is important to know that unless patents are properly drawn by a competent patent attorney they may be absolutely worthless. On the other hand, if, as above indicated, they are properly prepared, they may afford full protection of the invention and give to the inventor or owner an absolute monopoly of the invention covered thereby, for the term of the patent.

Infringement.

Many good inventions are given to the public by reason of improperly drawn claims which permit an infringer to evade them. If a claim states that an invention consists in the combination of three elements and a person makes the device by using two elements only, he breaks the combination and does not infringe. If he uses the three elements of the combination specified in the claim and adds other elements, he does infringe. If a person uses a combination of elements claimed in another's patent he can only avoid liability by showing that the patent is invalid.

Title to Patents.

A patent will issue to the applicant unless an assignment containing a request that the invention, or a part thereof, issue to an assignee. An assignment will be void as against any subsequent purchaser or mortgagee without notice, not recorded in the Patent Office within three months from its date.

Foreign Patents.

In order to obtain valid foreign patents it is necessary in most countries that the application should be made within one year from the *date of the application* of the United States patent.

Warning.

Some attorneys advertise to obtain a patent covering a simple invention for from $55.00 to $65.00. As a rule an attorney cannot do justice to himself or his client for that amount of money. A simple invention is not necessarily an easy one to protect and does not necessarily involve the least amount of work in securing a patent. A complicated invention involves more work in the drawings, but a simple invention may involve far more work in prosecuting the application to allowance than a complicated one.

The Patent Attorney.

The true worth of every patent lies in the scope and validity of its claims. No one can properly judge of such scope or validity except those who have made a special study of patent laws and the decisions of the courts, and are conservant there-with. This information can be obtained only by years of practical research. It stands to reason, therefore, that you should select some conscientious and reliable attorney to solicit your patent and one who will give your case personal, prompt and efficient attention.

Sale of Patents.

Furthermore, after your patent issues, beware of fakers, and if you have a patent which you wish to dispose of, either manufacture the invention yourself, or in connection with others who may purchase an interest in it, or sell it directly to a company, either for cash or upon a royalty basis. In the latter case you should have your agreement stipulate certain penalties for failure to pay royalties and also give you permission to inspect the books of the company at proper times, in order that you may guard and protect your interests and know that you are receiving your full share of the profits.

Value of Inventions.

Most of the great industries of the country have been founded upon inventions, and most of the great and successful business corporations of the country have become such by reason of the patent protection which was given them by United States patents.

Familiar instances of such industries are the printing press, sewing machines, rubber, steel, type-setting machines, typewriters, automatic shoe machinery, harvesting machines, the telephone and telegraph (including wireless telegraphy), electrical devices, moving pictures, talking machines, stoves and heaters, clocks and watches, photography, adding machines, chemicals, cash registers, washing machines, laundry machinery, machine tools, woodworking machinery, office appliances, elevators, asbestos and roofing products, safes and locks, plumbers' supplies, railway equipment, musical instruments, vehicles, butter and cheese making machinery, agricultural machinery, automobile accessories and engines. In fact, industries upon every hand can properly be included in such a list. Multiplied thousands of inventors have built up handsome fortunes out of inventions which were properly be protected by patents.

Up to November 11, 1913, the United States Government alone had issued 1,078,602 patents. The number of inventions are increasing every year. Each invention makes others necessary, for in the law of patents "it is the last step that wins," and those who would succeed find it necessary to keep step with the onward march of progress as it advances through the evolution of invention.

Aside from this, the material progress and development of the country is due in a large measure not only to the inventive genius of our American people, but also to the liberal spirit of our laws with reference to patent protection—a spirit which has fostered and developed American ingenuity to such a degree that the United States leads all the world in this respect. The great inventors have been and are mostly American. Among these are Franklin, Fulton, Howe, McCormick, Morse, Bell, the Wrights, Westinghouse, Goodyear, Thomas A. Edison, Pullman, Bush, Otis, Gatling, Gibbs, Janney, Rumsey, Bigelow, Corliss, Eads, Campbell, Yale, Sargent, Wm. H. Doane, Joseph L. Hall, Sholes, Bissel, Mergenthaler, Maxim, Eastman, DeForest, Smith, and Dr. Morton. These men are worthy of all honor.

How to Oil an Automobile

PROPER lubrication will save time, repairs, and minimize expenses.

Motor.

Many different types of systems are employed to lubricate the motor. Most manufacturers suggest the oil be changed about every 500 miles. Always keep the oil to the proper level in the crank case. Insufficient oil in the motor is dangerous. It will cut your cylinders and seriously damage your motor. Oil should be kept in a clean tank, and if it contains dirt, should be thoroughly filtered before using.

Every 2,000 to 2,500 miles, the crank case oil reservoir should be drained out and washed thoroughly with gasoline (preferably kerosene oil), and refilled with a fresh supply.

Each 75 to 100 miles of ordinary driving the motor will approximately consume one quart, using slightly more on fast driving.

Use a high-grade cylinder oil, which will give best results.

Valves.

Valve levers, guides and other joints should have a few drops of oil every 100 to 200 miles. In touring or driving consistently oil them more frequently or even every day.

Magneto.

A magneto should be oiled about every 1,000 miles. A thin oil is generally used. Holes and cups are provided. Where the make-and-break mechanism is employed, care should be exercised in oiling around same. Use a toothpick or small piece of wire by dipping into oil and apply.

Magneto or Water Pump Universal Joints.

These joints are to be filled with hard grease and require attention about every 1,000 miles. These joints should be protected from dirt or grit with some sort of slip cover of leather and wired to joint members.

Universal Joints.

If leather boots are used as universal joint dust covers they should be securely fastened in place again after lubricating. A heave grease or mixture of graphite and heavy oil are used. These joints are usually reached by removing the floor boards.

Transmission.

There are a number of standard gear compounds on the market. Whatever is used, the combination should be of such consistency that it will follow the gears when they are in motion. It has been found that a steam engine cylinder oil, sold under the name of "600 W," is a good gear lubricant, especially if mixed with a little flake graphite.

Another good mixture frequently employed is two-thirds ordinary cup grease and one-third gas engine cylinder oil, mixed with a little graphite, which works very well. Fresh oil should be replenished about every 1,000 miles. When you have run 3,000 miles completely remove all old oil, wash out the transmission with kerosene oil and replenish with a fresh lubricant.

Front Axle.

The front axle spindle bolts are usually supplied with grease cups and should be given a turn every 250 miles. To thoroughly lubricate these bolts, jack up car and swing the wheels back and forth, working the grease where friction occurs in the bolts.

Like the spindle bolts, grease cups are generally provided on front axle distance rod and should receive occasional lubrication by turning down the grease cups. If the front wheels are equipped with roller bearings they should be cleaned and repacked with fresh grease about every 2,500 miles.

Steering Gear.

Grease cups are usually placed in the housing of steering gears for shaft, also sector and pinion shaft. These should be given a turn about every 500 miles. If oil cups are attached, oil same frequently. Steering gears usually have adjustments to take up back lash or looseness, and should be kept free from same.

Brake Mechanism.

All brake rod clevis pins and connections should be oiled daily. In the event that brake rod pins are to be removed to make adjustments, you will find that you are well repaid by regular oiling, for these pins rust easily and are almost impossible to remove at times from neglect of oiling.

Springs.

Springs are usually provided with grease cups at both ends and should be screwed down about every 25 miles. The spring shackles should not have any appreciable amount of side play between the ends of springs and their bearings in bracket or chassis of frame, since a small amount of end play will cause a disagreeable rattle in these shackles.

Springs when assembled are lubricated with a mixture of graphite, which is applied to the friction part of the leaves. When the springs become dry they will squeak badly, and this can be remedied by jacking up car and forcing graphite and oil between the leaves while they are partly open. In jacking up the car, place the jack underneath the frame, so as to let the axle hang free, which will spread the spring leaves somewhat.

Clutch, Oil Pump, Fan Bearings, Etc.

In regard to oiling clutch, etc., instructions should be carefully followed concerning the particular make car you operate, and this information is usually supplied by the manufacturer of the car.

EngineTroubles and Causes

TROUBLE HUNTING TABLES

I. MOTOR REFUSES TO START.

Ignition in good order and switch on........	Cylinders have uniform compression.	Carburetor adjustment unchanged and in working order............	Spark timed wrong. Water in gasoline or of poor grade. Gasoline tank empty. Feed pipe clogged.
		Carburetor out of order............	*Carburetor floods*—due to: (1) Leaky float. (2) Needle valve does not seat. (3) Float or mechanism stuck. *Needle Valve* Adjustment changed. *Nozzle clogged*—remove and clean. *Float too low*—allowing only a little gasoline to come out of Nozzle. *Air Valve* Adjustment changed, giving too much air. *Dirt in Air Valve* holding it open, sticky valve stem, etc. *Throttle Valve* out of order—loose on stem.
	Poor compression.	Valve stem sticks. Weak or broken valve springs. Valve (exhaust) leak—regrind. Valve timing wrong.	
Ignition not O. K..	Battery....	*No Spark*......................... *Spark*—Timer out of proper setting.	*Battery in Good Condition*—inspect coil and timer mechanism. Broken or grounded wires. *Old Battery*—replace with new battery.
	Magneto....	*No Spark*—Broken wire distributor dirty, grounded primary wire, water or moisture in parts. *Spark*—Magneto out of time or wired wrong.	

II. MOTOR STARTS AND THEN STOPS.

(1) Water leaks into cylinder.
(2) Grade of gasoline changed or water in tank.
(3) Gasoline used to prime motor used up and adjustment on air valve too light.

III. MOTOR RUNS ON ROAD FAIRLY WELL.

Tests for determining quality of mixture when compression is uniform, spark plugs clean and properly set, magneto or batteries in good order, gasoline supply clean, etc.

Not enough air or too much gasoline.......

(1) Motor speeds up when air valve is pushed open slightly—turn low speed nut down.
(2) Regular missing after pulling slowly on level, motor does not pick up immediately if clutch is disengaged while running—mixture very rich in this case.
(3) After ascending long hill motor does not pick up if clutch is disengaged.
(4) Motor will not pop back in carburetor on suddenly opening throttle.
(5) Motor picks up well on opening throttle in just starting out.

Too much air or not enough gasoline......

(1) Motor hard to start.
(2) Motor speeds up on closing air valve—turn lower adjusting nut up a few notches.
(3) Upon opening throttle car hesitates before picking up speed.
(4) Tendency to pop back in carburator when throttle is opened suddenly.

Warm weather has the effect of not enough air. Cold weather has the effect of too much air.

1. See that clutch is out when starting motor; you may save runaways by observing this.

2. Before cranking engine, turn on battery switch. This will save labor and temper.

3. After cranking motor serveral times, and it does not start, something is wrong, and there is no use in continuing. See "Engine Troubles and Causes."

4. Be sure to retard spark before cranking, as engine may back fire, causing injury.

5. When ascending hills, use plenty of speed, as this prevents pounding, and save trouble of changing clutch to low gear. If engine begins to pound, change at once to low gear.

6. At corners and sharp curves throw out clutch, as this will prevent skidding, which is wearing on tires.

7. Always stop your engine when you leave your car, thus saving batteries, etc.

8. Shut off battery switch when engine is not running, as this will make your batteries last longer.

9. Do not allow motor to run full speed when standing, as this puts extra strain on many parts of engine, causing unecessary wear.

10. The engine should be inspected regularly, thus saving expense and trouble.

11. Poor lubricating oil will cause carbon deposits on combustion chamber walls, piston heads and on points of spark plugs. Carbon on spark plugs may form short circuit, interfering with ignition. If deposit is too great, it will hold enough heat between explosions to cause pre-ignition.

12. Do not turn down lights of an acetylene lamp. Better turn off gas and blow out flame instead of letting it die out. This keeps soot out of the small holes.

13. Back firing in a two-cycle engine is usually caused by a poor gasoline mixture.

14. Have the tires well inflated, as full tires present less wearing surface to the road.

ENGINE TROUBLES AND CAUSES.

The following suggestions may be of assistance in time of trouble to motor car operators:

IRREGULAR ACTION OF ENGINE.

1. Insulation on wires broken.
2. Carburetor improperly adjusted, mixture poor.
3. Spark Plug cracked.
4. Connections defective.
5. Gasoline feed partly stopped.
6. Water in oil case, or moisture on ignition plugs.
7. Contact in timer poor.
8. Spark Coil improperly adjusted.
9. Damaged or loose terminals on coil.

SUDDEN STOPPAGE OF ENGINE.

1. Spark Plug broken.
2. No gasoline supply.
3. Electric circuit disconnected.
4. Wires broken.
5. Spark coil trembler stuck.
6. Terminal loose.
7. Trouble at timer.

INABILITY TO START ENGINE.

1. Gears broken or jammed.
2. Poor gas mixture.
3. Improper ignition.
4. Gasoline contains moisture.
5. Cylinders dry.
6. Gasoline supply shut off.
7. Water in cylinders—if water jacket leaks.
8. Battery plug out of position.
9. Battery switch open.
10. Compression poor.
11. Spark plug cracked or needs cleaning.
12. Inlet valve stuck.

ENGINE MAKES HISSING SOUND.

1. Compression tap open.
2. Spark Plug broken.
3. Exhaust pipe cracked.
4. Exhaust pipe and silencer loosely connected.

CRANK CASE HEATED AND ENGINE WEAK.

1. Piston head cracked.
2. Piston rings may be broken or worn, causing leak of burned gas.

GRADUAL STOPPING OF ENGINE WITH MISFIRING.

1. Carburetor should be cleaned at jet.
2. No gasoline supply.
3. Gasoline valve shut off.
4. Carbon on spa k plugs from poor or over-lubrication.

REGULAR BUT WEAK EXPLOSION.

1. Insufficient lubrication.
2. Gas mixture poor.
3. Muffler outlets stopped with carbonized oil or mud.
4. Carburetor compensating valve not working.
5. Inlet valve has weak spring.
6. Coil vibrator needs adjusting.
7. Cleaning of platinum contacts may be needed.
8. Loose plugs or valves may produce poor compression.
9. Reduced lift on exhaust valve.

CAR RUNNING SLOWLY ALTHOUGH ENGINE IS ALRIGHT.

1. Brakes not entirely released.
2. Clutch has slipped.
3. Clutch springs weak.
4. Clutch leathers may be worn or dry.

KNOCKING IN ENGINE.

1. Mixture too rich.
2. Lubrication poor.
3. Bearings loose or worn.
4. Cylinder on crank case loose—nuts wearing off.
5. Fly wheel on shaft loose.
6. Carbon deposit causing pre-ignition.
7. Spark advanced too far.

EXPLOSIONS IN MUFFLER.

1. Gas mixture too weak.
2. Spark over-retarded.
3. Exhaust valve stuck or does not seat properly.
4. Spark inefficient.
5. Cylinder misses fire and pumps explosive charges into muffler and these ignite when next charge is exhausted.

EXPLOSIONS IN INLET PIPE OR CARBURATOR.

1. Poor gas mixture.
2. Valves not timed correctly.
3. Inlet valve spring defective.
4. Spark over-retarded.
5. Valves leaky.
6. Inlet valve does not close properly.

OVERHEATING CAUSED BY WATER IN RADIATOR BOILING.

1. Spark too far retarded.
2. Valves not timed correctly.
3. Pump defective.
4. Radiator tubes clogged.
5. Muffler clogged.
6. Poor water circulation.
7. Fan not working.
8. Low gear used continuously for a long time.
9. Exhaust throttled.

EXHAUST PIPE BECOMING OVER-HEATED.

1. Use of low gear for too long a time.
2. Exhaust throttled.
3. Muffler clogged.
4. Spark retarded.

SQUEAKING.

1. Improper lubrication at friction points.
2. Brakes not completely released.

Valve Grinding

IF the average car owner only realized the importance of keeping the valves properly seated! Too much emphasis cannot be placed on the necessity of examining them carefully at regular intervals, even though the compression is apparently normal and uniform in each cylinder. The exhaust valves are especially susceptible to corrosion on account of the intense heat of the escaping gases. The seats soon become pitted, the carbon dust and vapor is caught and confined in every little crevice, and in an incredibly short space of time the valves, if neglected, will be covered with a deposit of carbon which will affect the running of the motor to a marked degree. The only remedy is to grind them.

There are several good grinding compounds on the market. It is advisable to use a coarse grade in the first operation and then finish off with a finer one to impart a nicely polished surface. A very good home-made mixture is obtained by making a thin paste of a couple of tablespoonfuls of kerosene, a few drops of oil and enough fine flour emery to thicken the preparation to a consistency where it will not run too freely.

Remember, you must by all means prevent even a minute particle of this grinding abrasive from finding its way into the combustion chambers. Pack a good, generous quantity of waste or rags well soaked in gasoline around the valve seat and take due precaution to leave the inside of the cylinder casting perfectly clean.

Apply a moderate coating of the compound to the bevel face of the valve and return it to its seat. Next rotate valve forward and back until the entire bearing surfaces are polished bright and smooth the full width of the face. If the guide is worn or the stem bent great care must be exercised or the valve will not be "true"—i. e., the bevel face will not be flat, but a trifle convex. The valve should never be turned the whole way round. Oscillate it back and forth a quarter turn at most under light pressure, lifting it up frequently and turning it half way round before seating it again. This method distributes the friction evenly and eliminates the possibility of the emery scoring the bearings. If no valve grinding tool is available, the use of a carpenter's bit stock is advised, as a much smoother movement in thus obtained than by using a screwdriver.

After working up a good clean seat, entirely free from spots or pits, wash the valve, valve seat and guide thoroughly in gasoline. If the stem is rough or gummy, smooth it up with emery cloth, but clean it afterwards before replacing it.

How Six-Cylinder Power Dodges Zero

THE above chart shows the power curve of a four-cylinder motor. This curve starts on the Zero circle, at which point the charge is fired in No. 1 cylinder.

At first the rise is gradual, due to the fact that the explosion's force is partly spent in overcoming compression and the inertia of the moving parts. The power then shoots readily upward, turns and descends again to Zero.

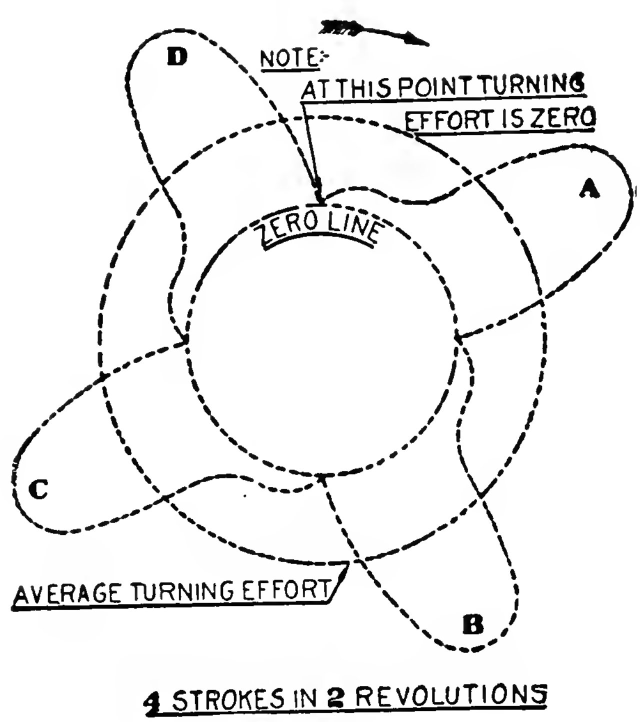


CHART OF "FOUR."

At the precise instant the curve reaches Zero the charge is fired in the second cylinder. Up shoots the curve again. The process is repeated until all four cylinders have fired.

There are two prominent features of this diagram to bear in mind.

There is a point after each power impulse of a four-cylinder motor, in which power is at Zero—nothing.

At Zero, the idle mechanism is suddenly driven to renewed action by a tremendous blow—a blow communicated to the piston, connecting rod, crank shaft and every gear and moving part of the entire car.

Below is a similar chart, showing the power curve of a six-cylinder motor.

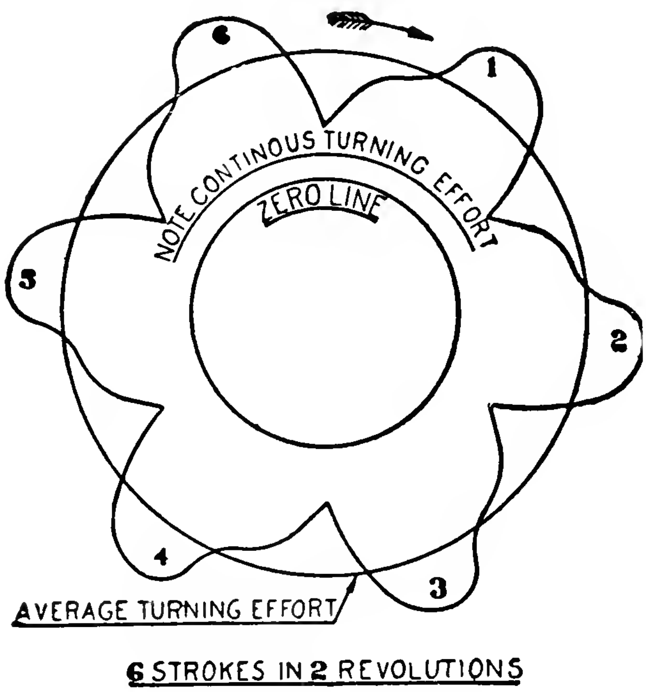


CHART OF "SIX."

The curve, as did the one on the preceding page, begins at the intersection where No. 1 cylinder's charge fires.

Upward rises the force to 1 and then descends until the second cylinder fires. The power rises again and continues the cycle.

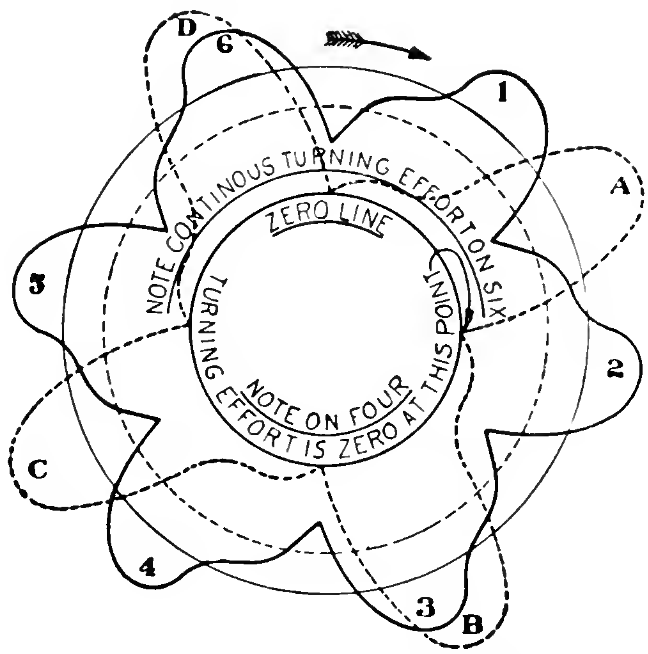
But it never drops to Zero.

At the lowest point the power of the first explosion is still being delivered, nor does it cease until the rising curve of the next power impulse is well on its way.

For a considerable period, both first and second explosions are working together. And the latter part of the second explosion helps speed the third upward curve.

In other words, the motor of the Six is never idle. There is a continuous stream of power flowing through the shafts to the work of driving. In this fact lies the supreme merit of this type of motor.

A comparison can readily be secured by impos-



"Four" and "Six" Combined.

ing on the "Six" chart, the power curve of a "Four" of the same cylinder dimensions and general design. The "Four" curve has been plotted in dotted lines and the impulses designated by letters, instead of numbers.

The most interesting feature is the circle, showing the average power of the two types, the "Six" motor's superiority being so plainly superior as to banish all chance of argument.

A study of this chart also shows conclusively why a six-cylinder motor is so notably free from vibration and its deteriorating effects; why a "Six" will keep pulling on high gear at a speed so slow that a "Four" motor would surely stall; why the "Six" is able to spring almost instantly from three miles an hour to any desired speed, without a change of gear; why a "Six" is more efficient in its ratio of miles to gallons of fuel—why, in short, the American public has so firmly set its seal of approval on a "Six" for all uses where high power and large carrying capacity are the determining influences.

Handy Bits of Information for the Driver and Owner

IN the early days of the sport one of the commonest troubles encountered by the motorist was a broken gasoline pipe. While rarer now, this accident still occurs occasionally, and it is always well to carry a section of rubber tubing with which to make a temporary repair should a pipe break on the road. If the gasoline pipe breaks off short at the union a gas-tight repair can be made by filing the end of the pipe to a cone shape, so that it may be forced into the seating. Next slip over it a piece of rubber tubing, and when the union nut is tightened it expands the rubber inside the union into a form of washer, which will make a perfectly tight temporary job. An additional precaution may be taken by applying a touch of soap around the union at the place where the pipe enters and also on the thread.

It sometimes happens that the bolts securing the fly-wheel to the flange on the crank shaft work a trifle loose, and, as a result, there comes an irregular knock, hard to distinguish from a loose connecting rod big end. This fly-wheel knock will be more noticeable at slow motor speeds, or when the engine is being accelerated or retarded. This is worth remembering when an obscure knock puzzles you to diagnose.

When the float pin is up it indicates that the float chamber has received a supply of gasoline from the tank. If the pin remains down, there is some obstruction in the supply pipe, preventing the flow of the liquid to the carburetor.

Keep Accumulator Terminals Clean.

"Always keep the accumulator terminals scrupulously free from corrosion, or they will gradually become 'eaten away' to such an extent that jolts on rough roads will break them off, and it will then be a matter of great difficulty to effect even a temporary connection," says Emil Grossman. "Thoroughly clean and polish the terminals and protect them from the action of acid by a coating of vaseline."

Careful of New Car.

It requires some self-restraint to forego the pleasure of operating a new car as soon as received, but this should not be done unless the machine has been driven from a responsible agent who guarantees that it is ready for the road. Even then the wise motorist takes a careful look over the car, paying particular attention to the oiling system, the amount of water in the radiator and gasoline in the tank and the adjustment of the brakes. Frequently such an inspection will disclose a lack of oil, water or a slipping brake that might result seriously on the road.

Spark Plug Test Should Be Made Carefully.

To test the spark of a set of exposed sparking plugs, there is need of special clips to grip the plugs, which have a habit of tumbling out of contact, especially when single plugs are being tested with the engine running. There is a risk of straining the magneto or coil if a plug swings by its wire without any earth contact. An ordinary cycle pump clip of the double "U" spring type makes an excellent plug holder. One end may be sprung over any convenient pipe or bolt or stay, and the inverted plug dropped in the empty end.

Care of Garage Floors.

Concrete floors in garages should be painted with a preparation giving them a smooth surface which is easily cleaned and saves the concrete from wear and gritty dust from rising. The floors should be pitched slightly from the center line down to the side walls, both ways, with gutters formed in the concrete along the walls so that washing may be done, if necessary, without moving the cars.

Storage Battery Trouble.

Derangements in a storage battery may be caused through the electrolyte becoming low, completely or partially destroyed or not of specific proper gravity; the plates may be sulphated, there may be sediment in the bottom causing short circuits of the plates, terminals may be corroded, or there may be loose wires or connectors. It is often wise to look at the wiring, as there may be defective insulation, wire broken inside of outer coverings, oil soaked or chafed insulation which always cause short circuiting wherever the wire comes in contact with metal. It is well to re-wire a car at least once a season.

Replacing Spark Plug Nut.

To render easier the replacement of the tiny nuts that hold ignition cables to spark plugs, it is a good plan to remove the top three or four threads with a file; if this is done, the nuts can be put on, even with gloves, merely by dropping them in place and giving them a twirl.

The fuel supply valve should be opened, and after sufficient time has elapsed for the float chamber of the carburetor to fill it should be noted that the float pin is up.

Loss of Motor Power—Its Cause.

When there is loss of power and yet the engine is firing regularly but weak, look for loss of compression at either valves or spark plugs. Of course, this may also be due to the trembler on the coil vibrating too slowly, and this can be obviated by readjusting and trimming the platinum points. Then, again, it may be due to too rich a mixture or flooding of the carburetor. Sometimes the extra air valve on the carburetor refuses to work, and again it may be caused by faulty lubrication. Look for weak springs on the inlet valves, the lift of the exhaust may be reduced or the silencer outlets choaked with dirt carbon or charred oil.

Causes of Ignition Trouble.

Ignition trouble in a car fitted with a high tension magneto may be due to dirty oil, metallic particles or carbon in the distributer. The brushes may not be in contact or the breaker points out of adjustment, worn, dirty or pitted. There may be defective winding, the field magnets weak, the magneto driving gear loose or the magneto out of time.

Bright headlights are absolutely necessary for safe driving at night, but when two cars meet in the night on a narrow road, with headlights dazzling each driver's eyes, great care should be used. There is danger from obstacles on the sides of the roadway and danger from wrong estimate of distance between the cars. Slow down and be safe.

The filler cap should be replaced and care taken that the small hole in the center of the cap is open so that air may be admitted as the fuel is used. This prevents the pressure within the tank becoming less than that of the atmosphere.

Care of Radiator.

Always use the purest water obtainable, and when it is drawn from such as wells, streams, etc., it should be strained through a piece of muslin. Hard water is apt to deposit scales on the walls of the radiator. Flush the radiator about every two months. Care should be exercised not to use any strong chemicals. By dissolving about one-half pound of lye in five gallons of water, and then strain the liquid through a piece of cloth while pouring into the radiator, this will prove a very good cleaner. With the mixture in the radiator start the motor and run about five minutes. Draw it all off again and then fill the radiator with clear soft water.

The radiator should be filled with clean water. As with the fuel, the same care should be taken with the water, to see that it is free from any foreign matter; the latter may clog the restricted passages of the radiator and impair its efficiency.

Among the minor motoring ills there is none much more annoying than having trouble with the terminals of an old storage battery. A method of curing this leaky condition is to wrap rubber insulating tape about the terminal pillars. This, in itself, makes a first-rate repair, but by applying a hot iron instrument a perfect union may be induced between the gutta percha of the cell and the rubber of the tape.

Because an electric motor or dynamo is completely enclosed, so that it is impossible for dust and dirt to work in from the outside, it does not follow that the interior will be free from dust. On the contrary, the gradual wear of the brushes and the slower wear of the commutator produce a dust that is more or less abrasive and also is a good conductor of electricity.

Spark plug adjustment will clear up magneto troubles, nine times out of ten. If the points on the plugs are adjusted right the gap will be such that the current can readily jump the gaps and ignite the charge. Often the car will run all right on the battery and yet when switched onto the magneto there is trouble, and the blame is laid onto the magneto, when a mere changing of the spark plug gap is all that is needed. Some magneto manufacturers provide a fine gauge for spark plug gaps, while others advise a gap varying from one-fortieth to a sixty-fourth of an inch. Many use a worn thin ten-cent piece as a gauge, but the best way is to experiment around these figures until the proper gap has been effected, and then always keep the gaps at this figure. It is important, however, to make sure that the gap on all four plugs is uniform, otherwise the motor will work with a jerk.

It often happens that the enamel on the hood becomes blistered through the too ardent attentions of the exhaust pipe. An asbestos shield fitted inside the hood and about an inch from it, will prevent this most unsightly trouble. Two arms should be secured onto the inside of the hood at the strategic position and to these a sheet of asbestos is attached. A similar attachment will prevent the exhaust pipe charring the woodwork of the dash.

After filling the radiator it is advisable to turn the engine over several times to allow the water to circulate through the cooling system and any air pockets that may have formed; this will be indicated by a lowering of the water level in the radiator, in which case more water should be added. If the car be driven in winter, a good non-freezing solution should be used.

To test the spark of a set of exposed sparking plugs, there is need of special clips to grip the plugs, which have a habit of tumbling out of contact, especially when single plugs are being tested with the engine running. There is a risk of straining the magneto or coil if a plug swings by its wire without any earth contact. An ordinary cycle pump clip of the double "U" spring type makes an excellent plug holder. One end may be sprung over any convenient pipe or bolt or stay, and the inverted plug dropped in the empty end.

In making a joint leak-proof it is not only wise to use a suitable gasket, but also to place felt washers underneath the iron washers of the retaining bolts. This gives an elastic hold that will allow for expansion and contraction and may keep the threads of an over-tight bolt from stripping. The common corn and bunion plasters made of white felt make good felt washers that are convenient to obtain.

It is often necessary for the motor car owner who does his own repairing to hammer a polished service, which would be absolutely ruined by a steel or wooden hammer. Rubber mallets can be bought for just this sort of work at almost any supply store, or at a pinch a pad may be made from several thicknesses of old rubber, which will prevent marring the polished surface.

Ignition trouble in a car fitted with a high tension magneto may be due to dirty oil, metallic particles, or carbon in the distributor. The brushes may not be in contact, or the breaker points out of adjustment, worn, dirty or pitted. There may be defective winding, the field magnets weak, the magneto driving gear loose, or the magneto out of time.

When preparing for a long run both the gasoline and water tanks should be tested. The amount of fuel and water in the tanks and radiators may be determined in some automobiles by glass gauge tubes fixed to the fuel and water tanks showing the level of the liquids at a glance. In others it is a simple matter to test the level by inserting a stick in the filling hole and noting the height to which the liquid rises on it; the fuel level may be tested in this way if the stick be withdrawn quickly and examined before evaporation takes place.

Gasoline should be strained to guard against the carbureter passages becoming clogged by foreign matter that may be contained in the fuel. A chamois skin or wire netting having a very fine mesh may be used as a filter.

Be Cautious of the Cold Weather.

The only really effective method of safeguarding the motor is by the use of some liquid or solution with a lower freezing point than water. At the first glance this method would appear to be an easy matter, but there are many things to be taken into consideration.

The majority of the non-freezing liquids react chemically with metals, and if harmless solutions are used, loss of water through evaporation raises the density of the solution above the point of precipation, thereby clogging the radiator air cells.

The most reliable solution is alcohol and water, as alcohol does not act upon the metals of the radiator nor upon rubber.

A 25 per cent solution of alcohol will not freeze at zero Fahrenheit. Thirty per cent should be used for negative 7 degrees; 35 per cent for negative 15 degrees, and 40 per cent for negative 22 degrees.

There is one objection to alcohol, and that is that it evaporates very readily. There are two methods of overcoming this fault. One is by the addition of glycerine—a solution of 15 per cent alcohol and 15 per cent glycerine will stand a temperature of negative 10 degrees Fahrenheit. The only function of glycerine is to prevent the evaporation of alcohol.

The second method is to cover the overflow outlet with a "safety valve." A piece of rubber tubing over the pipe and tied at the free end acts admirably, as too great pressure will blow the tube off instead of damaging the cooling system by excess pressure.

Grain alcohol is better than wood alcohol, for even wood alcohol has a corrosive effect on copper and brass, as it forms formic acid in the pressure of superheated air.

Another good mixture is a saturated solution of calcium chloride—eight pounds of the crystals to one gallon of water. This should be used diluted one half and with the addition of a cupful of milk (calcium carbonate), as this neutralizes the acidity of the calcium chloride solution. Salt solutions may also be used, but great care should be exercised to keep these latter solutions at the proper density.

It should be remembered that about half the normal radiation area is sufficient at freezing temperatures.

How to Avoid Blow-Outs

NO doubt every motorist has had the experience of the so-called "blow-out." This experience affects all in the same way. It is nothing but an exasperation, and although a blow-out can often be repaired, the motorist cannot help preferring never to have had it in the first place.

Today the importance of the automobile tire industry has fostered an improvement of the tire as now manufactured, to the point that the motorist who cares can, by a few simple precautions, protect himself from the blow-out bugaboo.

A blow-out is due to one of a few simple causes, which if given the necessary attention can be easily avoided. To prevent the blow-out we seek the cause and eliminate it. Accordingly, we will show and explain briefly the different causes of blow-outs.

The amount of air in a tire is just as important as the tire that contains it. Improper inflation renders a tire susceptible to blow-outs, just as proper inflation prevents this annoyance. This is the reason:

The body of the tire is of fabric; several plies are used and the mass, after being thoroughly impregnated with rubber is vulcanized into an integral whole—the tire. Over the body is a layer of rubber—the tread.

What happens when a round stone, a brick, a car track, or any blunt object is encountered? If the tire is improperly inflated the internal air pressure not offering sufficient resistance, the object will sink into the tire, forcing it inward at this one place. The tread comes into actual contact, but its elasticity allows it to adapt its shape so that it usually suffers no injury, unless the object be sharp and cuts it. But the effect on the fabric is more serious. It isn't elastic; it can't stretch; consequently, if the object sinks in far enough to produce enough strain, it must break.

Naturally, that ply of fabric receiving the greatest strain is the inside one, for it undergoes the greatest distortion, and for this reason it is the first to break. Seldom, indeed, is any shock violent enough to break every ply of fabric and cause an immediate blow-out. Most always it is only the inside ply that is fractured at the time. As this isn't apparent, the tire usually continues to give service, but the broken edges of the inside fabric chafe the other plies. The natural bending of the tire finally breaks the remaining plies, and then the tube forces its way through, resulting in a blow-out.

This is the first warning the motorist receives that something is wrong. He didn't know the fabric was broken some time before. He sees nothing but the immediate conditions, and doesn't realize that his misfortune is something he could have prevented if he had only known how.

The reason the inside ply of fabric broke in the first place, was the result of improper air pressure. This permitted the object on the road surface to sink in and stretch the fabric at one place to the breaking point. Had the pressure been of the proper amount it would not have been possible for the object to have made such an impression. The internal air pressure would have offered the proper resistance, and the shock instead of being localized would have been distributed all over the tire, and so absorbed without injury.

Hence the remedy: Use the air gauge, and carry the proper air pressure—twenty pounds for every inch of width.

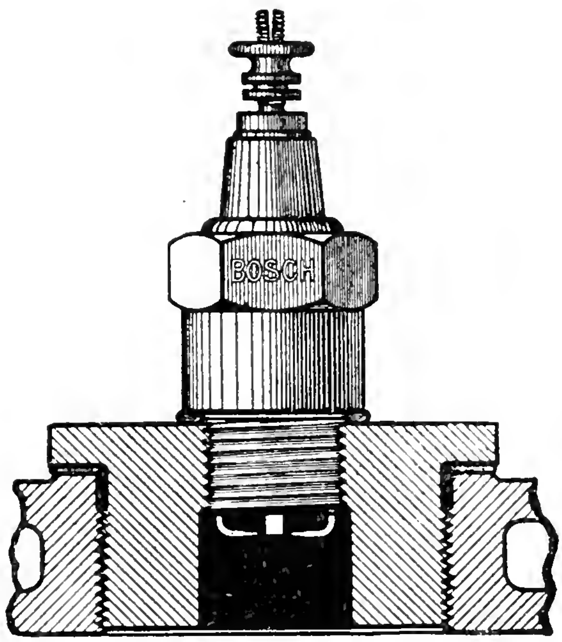
Again, the tread has received a cut. Various foreign substances from the road surface are forced through the cut by the motion of the tire. As a result, these impurities have a tendency to spread, separating the tread and fabric. This opening of the tread lays the fabric bare to road wear and the action of sand and moisture. The latter rapidly rots the fabric, weakening it until the pressure can no longer be sustained, and then the same aforesaid fatality occurs.

For this the remedy is repair gum. Cuts repaired in time will grow no worse, and so these consequences are avoided.

In conclusion, there are two important causes of blow-outs—under inflation, which results in the breaking of the plies of fabric, and neglected tread cuts. Avoiding these by means of a pressure gauge and a can of repair gum, the motorist will be able to avoid the trouble to which they lead—the blow-out.

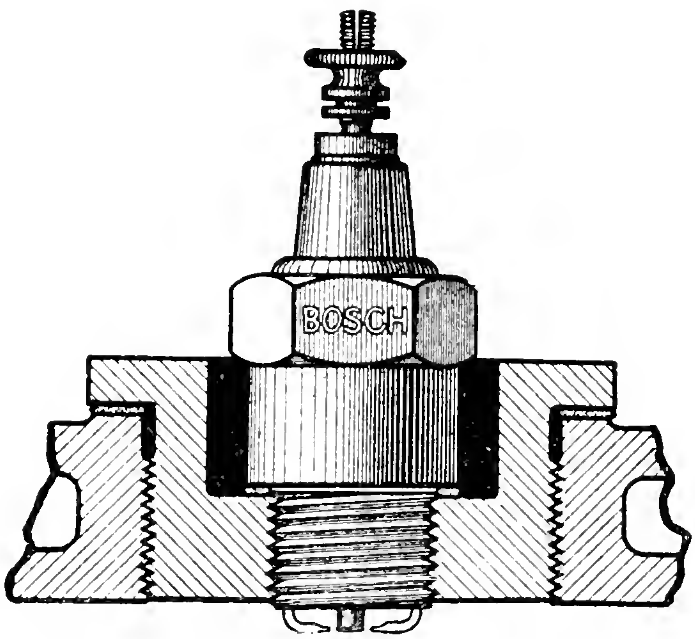
Position of Spark Plug Means Much.

THE best and most scientifically constructed spark plug will not give the most satisfactory results in an engine if its location is not correct and if it is not set in the cylinder in the proper manner. In order that an engine may run efficiently the time required for the spread of the



The Disadvantage of Thick Valve Caps.
Out of the Path of Gas.

flame through the charge of mixture should be as brief as possible, and to secure this end the spark plug gap should be located within the combustion space and not in a pocket or recess. If the plug is so located that its points are placed in a recess or hole that communicates with the combustion space, as will be the case with a short plug set in a thick valve cap, dead gas will accumulate about the electrodes and cause missing and slow combustion. In such cases a decided improvement in the efficiency of the engine will result if the cap is bored out in such a manner as to permit the plug to set further down in the valve cap; the points of the spark plug will then project into the combustion space. The spark then comes into direct contact with the clean and fresh mixture and the flame will spread with maximum rapidity.



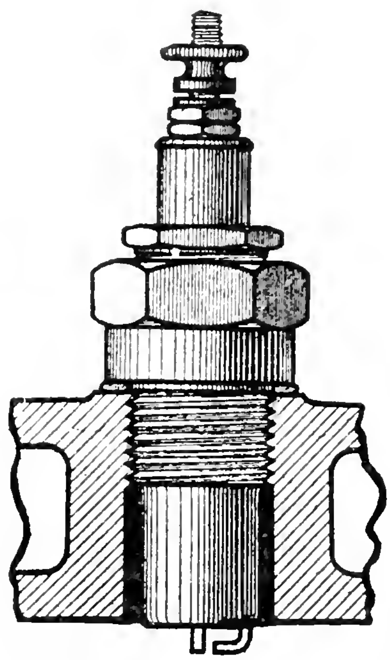
An excellent Spark Plug Location when set in the Valve Cap.

This setting is indicated in the accompanying illustration.

It follows also that the spark plug should preferably be located in the immediate neighborhood of the intake valve in such a manner that it will be surrounded by the fresh gas that enters during the inlet stroke. If the plug is located on the exhaust side there is a liability that dead gas will collect around the points and cause missing and inefficiency.

Plugs Should Be Located so as to Cool Electrode Points.

In order to get the best results the plugs should be so set in the cylinder that cooled metal is in close proximity to the sparking points, as in this manner possible overheating of the spark plug will be eliminated. A plug that is not properly cooled will overheat and the electrode points are

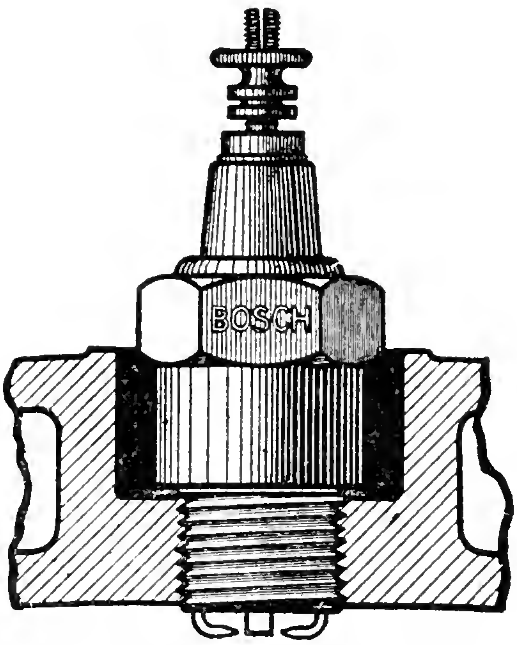


Undesirable Plug Design
and Cylinder Location.

liable to become incandescent, thus causing pre-ignition.

In certain plug designs the electrodes project for a very considerable distance below the threaded portion of the spark plug, and even if the metal of this plug is heavy enough to prevent its becoming incandescent, it will certainly become heated to such a degree that the electrodes will warp, thus altering the size of the gap.

If, on the contrary, the desired length of plug is made up by extending the barrel, or that portion above the thread, the metal of the electrodes will be adjacent to the cooled metal of the engine and the heat will be readily transferred. On many engines the plug is set in the cylinder wall in such a manner that it must project through the water jacket, and extension plugs are required on



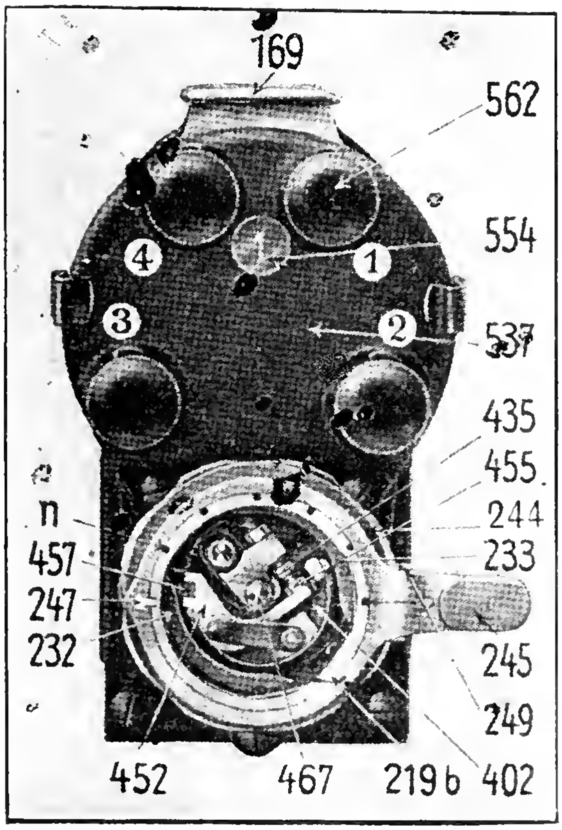
The Proper Plug Location when set through the Water Jacket.

such engines in order to prevent the pocketing of the gases. Considerably better results will be attained on engines of this type if the spark plug hole is made large enough to permit the thread to be cut at its very bottom, as shown in the sketch, for in that manner the plugs will be properly cooled.

The Bosch Magneto

THE Bosch magneto types "ZR4" and "ZR6", produce a high tension or jump spark current, this current being generated in the winding of the rotating armature without the use of a separate induction coil.

Two ignition sparks are produced during each revolution of the armature, and these are transmitted to the proper cylinders by means of the



high tension distributor which is integral with the magneto. Once during each half revolution of the armature, the primary circuit is broken, and the abrupt interruption of the primary current results in the production of the high tension current in the secondary winding.

The variation in ignition timing is effected on the magneto itself, the arrangement permitting the interruption of the primary current to occur earlier or later in the revolution. A special construction results in the production of the ignition spark at as low a speed in the full retard position as in the full advance, which greatly facilitates starting, and permits the motor to be operated with the spark lever in the full retard position.

INSTALLATION OF THE MAGNETO.

Magneto Speed.

The Bosch magnetos "ZR4" and "ZR6" produce two high tension sparks during each revolution of the armature, and as proper engine operation requires the sparks to occur when the crank shaft is in a certain definite position, it is essential that the armature be driven in a fixed relation to the crank shaft. The "ZR4" magneto is designed for a four-cylinder engine, being driven at crank shaft speed for a four-cycle engine, and at twice crank shaft speed for a two-cycle engine.

The "ZR6" magneto is designed for a six-cylinder engine and must be driven at 1½ engine speed for a four-cycle motor and 3 times engine or crank shaft speed for a two-cycle motor.

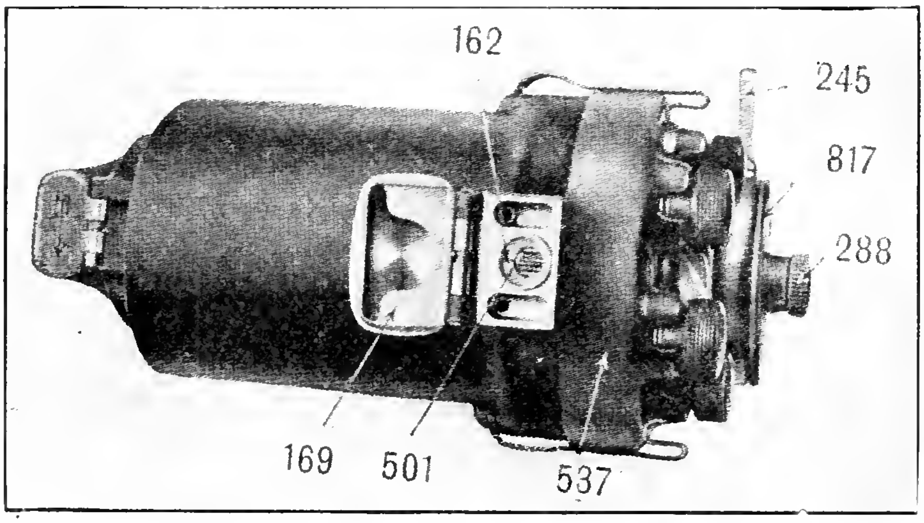
Driving Methods.

Lost motion and play should be eliminated in the magneto drive, and it is always advisable to drive the magneto through gears. The magneto may be driven by chain and sprockets if gears cannot be fitted, but the arrangement should be such that the chain will run with as little slack as possible, and at the same time without placing undue side strains on the armature bearings. The necessity for preventing slippage prohibits driving the magneto by belt or by friction.

Magneto Setting.

The first step in setting a "ZR" magneto is to bring one of the pistons of the engine—preferably the piston in cylinder No. 1—to the firing position. This is done by bringing the piston to top dead center of the compression stroke and then turning the fly-wheel backward until the piston has moved down from 6 to 13 mm (¼ to ½ inch), or in other words, until the crank shaft has been turned backwards from 22° to 34°.

The magneto armature must then be turned until the figure "1" appears at sight hole 554,



which is in the face of the distributor plate. Oil well cover 169 is then to be lifted and the distributor gear will be seen through sight hole 162.

The armature is then to be further turned until the marked distributor tooth registers with the marks on the side of the sight hole, and with the armature held in that position, the magneto drive is to be connected, great care being taken that the position of the armature is not disturbed.

The exact location of the piston for the firing position may be determined by experiment or by inquiry from the manufacturers, but in the great generality of cases it will be within the limits named above.

Should the firing position be given in degrees, the movement of the piston corresponding with any given number of degrees, may be determined by reference to the diagram (see diagram of piston travel in inches).

CABLE CONNECTIONS.

Before the magneto can be connected with the spark plugs, the firing order of the engine should be determined, and in the case of four-cylinder four-cycle engines, the firing order must be either 1, 3, 4, 2 or 1, 2, 4, 3. The firing order may be determined by cranking the engine slowly and observing the order in which the inlet or exhaust valves operate, this order of operation being identical with the firing order.

When the figure 1 appears through peep-hole 554 in the distributor disk, the distributor is making contact with terminal No. 1, and this terminal should therefore be connected to the spark plug of cylinder 1. Bearing in mind that the rotation of the distributor is opposite to the direction of rotation of the armature, the next distributor contact that will be made should be connected to the spark plug of the cylinder that is next to fire. The third and fourth terminals of the distributor should be connected to the remaining spark plugs according to the firing order, and these connections will be facilitated by a study of the wiring diagrams. When the connections are made, the apparatus is ready for operation.

CARE AND MAINTENANCE.

Care of the Interrupter.

Among the most important parts of the magneto is the interrupter, and it is advisable to inspect it from time to time. The inspection of the interrupter requires the removal of cover 817, which is secured to the interrupter housing by means of a spring ring that permits it to be snapped on and off. The interrupter lever 452 (451) should be moved for assurance that it is free on its pivot, and a test should be made of the distance between the platinum points. When the lever is depressed by one of the steel segments 232 and 233, the distance between the platinum points should not exceed 0.4 millimeters. This distance may be adjusted by the movement of platinum screw 435.

Should it be necessary to replace one of the platinum screws or to attach a spare part, the interrupter may be more completely exposed by turning lock ring 244 a quarter of a turn to the right or to the left and removing it and the interrupter housing. The interrupter itself may be removed by unscrewing interrupter screw 467.

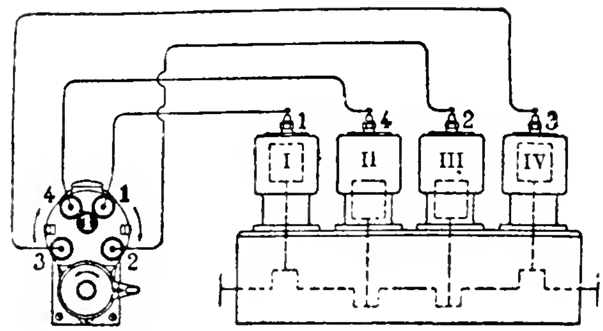
When replacing the interrupter, care must be taken that the key on the interrupter disk fits exactly into the keyway on the armature shaft, and care must also be exercised when replacing the interrupter housing.

Lock ring 244 should be turned so that one of the marks on its circumference is opposite the mark on the magneto end plate, and the housing and ring may then be pushed into position. The lock ring may then be rotated a quarter of a turn to the right or to the left until the lock pins catch in the recesses provided for them.

Care of the Distributor Parts.

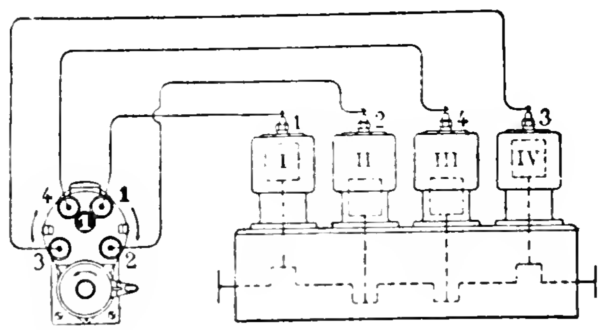
Distributor plate 537 should be removed occasionally for inspection as to the presence of the carbon dust that wears off the carbon brushes. This dust may form a connection between the distributor segments, and in consequence cause a spark to occur in the wrong cylinder. Carbon dust that has collected, on the distributor should be wiped out with a cloth, the cloth being moist-

Magneto running clockwise
Firing Sequence
I, III, IV, II.



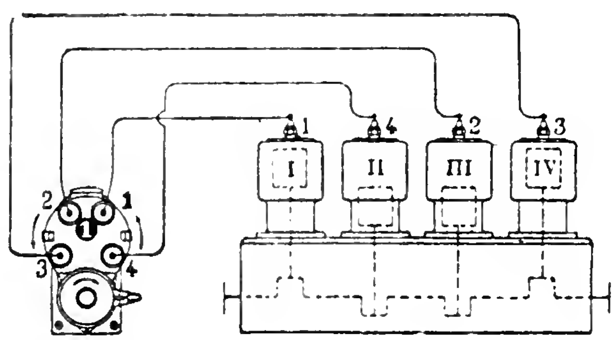
View of Distributor End

Magneto running clockwise
Firing Sequence
I, II, IV, III.



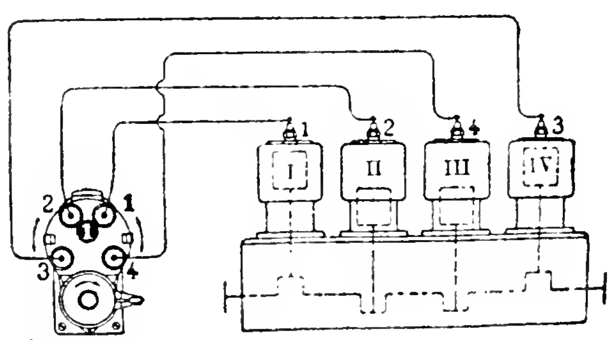
View of Distributor End

Magnete running anti-clockwise
Firing Sequence
I. III, IV, II.



View of Distributor End

Magneto running anti-clockwise
Firing Sequence
I, II, IV, III.



View of Distributor End

ened with gasoline should the carbon have become caked. After cleaning with gasoline, the inside of the plate should be given a very light film of oil to prevent excessive wear of the brush and the distributor plate.

Oiling the Magneto.

The over oiling of the magneto should be guarded against in order to prevent the entrance of oil to the interrupter parts. Each of the oil holes is to be given a few drops of fine machine oil every two weeks or every 1,000 miles. *The interrupter is designed to work without lubrication*, and the presence of oil on the platinum points will give unsatisfactory results, inasmuch as it will cause sparking at the points and possible misfiring.

Cutting off the Ignition.

To cut off the ignition the primary current must be grounded, which will prevent the breaking of the circuit by the opening of the interrupter, and consequently prevent the production of the secondary current. The primary current may be grounded by making a connection between the grounding nut 288 and the engine ground, this circuit usually including a switch. One terminal of the switch is connected to the engine or frame, the other terminal leading to ground nut 288. When the switch is open, the magneto will produce a spark, but the closing of the switch will ground the primary circuit and will prevent the production of the ignition spark.

SAFETY SPARK GAP.

In order to protect the insulation of the armature and all other parts from injury due to excessive voltage, a safety spark gap is provided to permit the passage of the current to ground without injury. The current will pass across the safety spark gap in case a high tension cable is disconnected, if the spark gap is too great, or if for any other reason the spark plug circuit is open. Discharges should not be permitted to pass through the safety spark gap for any great length of time, however. This should be particularly guarded against if the motor is operated on a second or auxiliary ignition system. When the motor is operated on such a system, the magneto should be grounded in order to prevent the production of high voltage current.

DETECTION OF FAULTS.

In case of defective ignition, it must be determined whether the fault is in the magneto or in the plugs. It may be pointed out that in general, when only one cylinder misses, the fault is almost invariably in the plug.

The more common defects of spark plugs are as follows:

1st. Short-circuit at the spark gap due to small metallic beads which are melted by the heat of the intense spark and form a conducting connection between the electrodes. This defect is easily ascertained, and may be remedied by removing the metallic beads.

2nd. If the gap between the spark plug electrodes is too great, the spark will jump across the safety gap on the magneto. In such a case, when the plug is unscrewed from the cylinder the spark will jump across the electrodes of the plug and not across the safety spark gap. This does not signify that the distance between the electrodes is correct, for it must be borne in mind that open air has a lower resistance than the compressed air or gas existing in an engine cylinder. The distance between the electrodes when under compression in the cylinders must, therefore, be less than is required in the open air. The correct gap should be approximately 0.5 to 0.6 mm.

3rd. Fouling of the plug. The danger of fouling is reduced to a minimum in the new Bosch plug. If fouling should occur, the parts exposed to the burning gases may very readily be cleaned by removing the plugs from the cylinder. This exposes the steatite core, and it may be cleaned with gasoline.

The spark plug cables must be tested, and special attention should be paid to ascertaining that the insulation is not injured in any way. The metal terminals of the cables must not come into contact with any metal parts of the motor or with any metal parts of the magneto, except the proper binding nuts.

Ignition Fails Suddenly.

A sudden failure of ignition indicates a short-circuit in the low tension cable, either through a defect in the cable, through a faulty connection of the switch or through the presence of dirt or moisture. This may be tested by removing the grounding cable from binding nut 288 on the magneto and endeavoring to start the engine on the magneto. If the engine runs with this wire disconnected, but stops when the wire is connected, it may be determined that there is a fault in insulation or other defect through which the low tension current escapes through ground. It is also advisable to examine the carbon distributor brush 553 to ascertain if it is in good condition, and this brush may be exposed by removing distributor plate 537.

Irregular Firing.

Irregular firing is usually caused by the improper working of the interrupter, and this part should be examined. It should be seen that the interrupter lever moves freely on its pivot; that the center screw 467 is properly tightened; and also that the steel segments 232 and 233, as well as the two platinum screws 435 and 455, are properly secured in position. Furthermore, the platinum points should be inspected for the correctness of their adjustment, and they should be so set that they are 0.4 millimeters apart when the interrupted lever is depressed by one of the segments. The platinum points should be clean, flat and true to one another, and any oil, grease, or dirt that is deposited on them should be removed. If they are uneven or in bad condition—*but only then*—they may be trued by means of a fine flat file. If the interrupter lever does not move freely on its pivot, as is occasionally the case, particularly with new magnetos, the hole through the fibre bushing that forms the bearing may be reamed out. This work should be very carefully performed, however, and excessive reaming should be carefully guarded against.

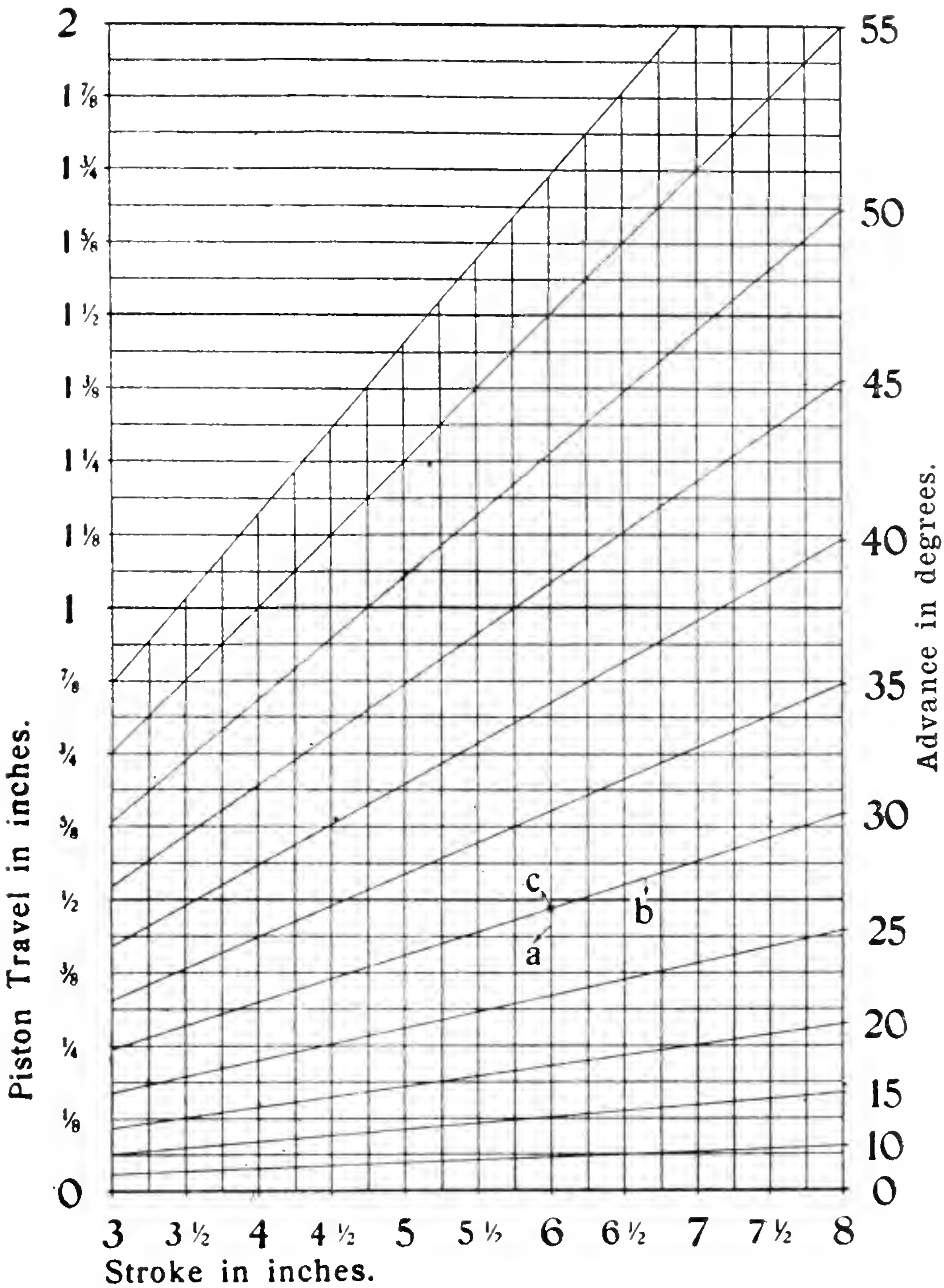
If this examination of the magneto has not led to the discovery of the defect, and it is absolutely impossible to start the motor, the timing of the magneto to the engine should be carefully verified. If it is found to be correct, the magneto should be returned to the company.

DETERMINING THE ADVANCE.

The relation of the piston travel to the rotation of the crank shaft depends on the stroke and the length of the connecting rod.

The piston travel of an engine is easily determined, and the determining of the rotation of the crank shaft in degrees, corresponding to any desired piston travel, may be ascertained from the accompanying diagram. In this diagram the relation between the crank and the connecting rod length is as 1 :4.5. In the diagram the vertical lines

Diagram.



2
1 7/8
1 3/4
1 5/8
1 1/2
1 3/8
1 1/4
1 1/8
1
7/8
3/4
5/8
1/2
3/8
1/4
1/8
0
Piston Travel in inches.
55
50
45
40
35
30
25
20
15
10
0
Advance in degrees.
c
b
a
3
3 1/2
4
4 1/2
5
5 1/2
6
6 1/2
7
7 1/2
8
Stroke in inches.

numbered at the bottom give the stroke of the engine in inches, the rotation of the crank shaft in degrees being indicated by the slanting lines and the figure at the right. The figures on the left, and the horizontal lines indicate the piston travel in inches. As an example in the use of the diagram, it may be desired to find the piston travel for an advance of 30° on a motor of 6 inches stroke. The vertical line for the desired stroke may be identified by the figures at the bottom of the diagram, and this vertical line may be followed upward until it cuts the diagonal line indicating the desired number of degrees, which is 30° in the present case. The horizontal line nearest this point should be followed to the left, and in the present instance it will be seen to indicate about ½″. This figure of ½ indicates the advance in inches corresponding to a rotation of 30° of the crank shaft.

The Burning Question

HOW can the fuel cost of motor car service be reduced? Gasoline cost is already so great as to be a serious economy factor. It is safe to say that every single motorist existent keenly desires to reduce his motor fuel bills.

How is this cost to be made smaller?

Crude petroleum, as it comes from the oil well in various quarters of the earth's surface, varies greatly in heat-giving elements, some varieties containing more heat units than others, but kerosene and gasoline, pound for pound, are of nearly equal value as heat producers, and the best crude petroleum for internal combustion motors is not so very much inferior to kerosene or gasoline. The crude petroleum can be had at from 3 cents a gallon to 5 or 6 cents. Kerosene is worth 5 cents to 6 cents in carload lots, and gasoline somewhere around 20 cents per gallon, in the United States, to 75 cents per gallon in London.

Obviously, the motorist can save in fuel costs by using either kerosene or crude petroleum.

The best source of information as to the mechanical requirements of successful use of crude petroleum and kerosene is the largest and most successful manufacturer of oil burning engines in the world, which distinction belongs beyond question to the Rumely Traction Engine Building Company, of Laporte, Ind., U. S. A., working the motor inventions of John A. Secor, and Mr. Secor's nephew, William H. Higgins.

John A. Secor was born in New York City in 1847. About 1893 he turned his mind to the consideration of power production by burning liquid fuels, and his hands to the construction of internal combustion motors, to such good purpose that the Secor Kerosene Engine, under perfect governor control, showing not more than one-half of one per cent speed variation full load all on or all off as quickly as an electric resistance switch could be handled, was completed and on exhibition in New York City in 1900,—too early for the world's appreciation.

Business considerations led him, in 1908, to consider most flattering proposals from the Italian Naval Department to apply his oil engines to Italian torpedo boat propulsion. Immediately, however, he received a wholly unexpected proposal from the M. Rumely Company, of Laporte, Ind., to undertake the application of his new motor to the Rumely Farm Tractor, which he accepted.

THE OIL TRACTORS.

Secor favors the fewest number of cylinders possible, and decided on single cylinder motor for low power and double cylinder for high-powered tractors.

An approximation to the horizontal cylinder type of motor was used, giving sure drainage of cylinder to crank-box. The cylinders were inclined at a 10 degree angle to horizontal, crank-box ends low.

The mechanically operated intake valves are placed on top of the cylindrical compression space and the exhaust valves on the bottom of same, both these being 45 degree angle poppet valves.

The "Tangye" form of motor frame was adopted, with integral cam shaft bearings all enclosed in a crank-box with a readily removed cover, affording access. The individual cylinders, having applied cylinder heads, are bolted to the crank-box end, thus obtaining a very readily assembled and disassembled construction of the fewest individual units, all important moving parts enclosed.

Ignition is by a leather cased Bosch low tension magneto, with starting battery and make and break spark plugs.

The Higgins carburetor was already at hand, supplying the motor with gasoline, kerosene, and

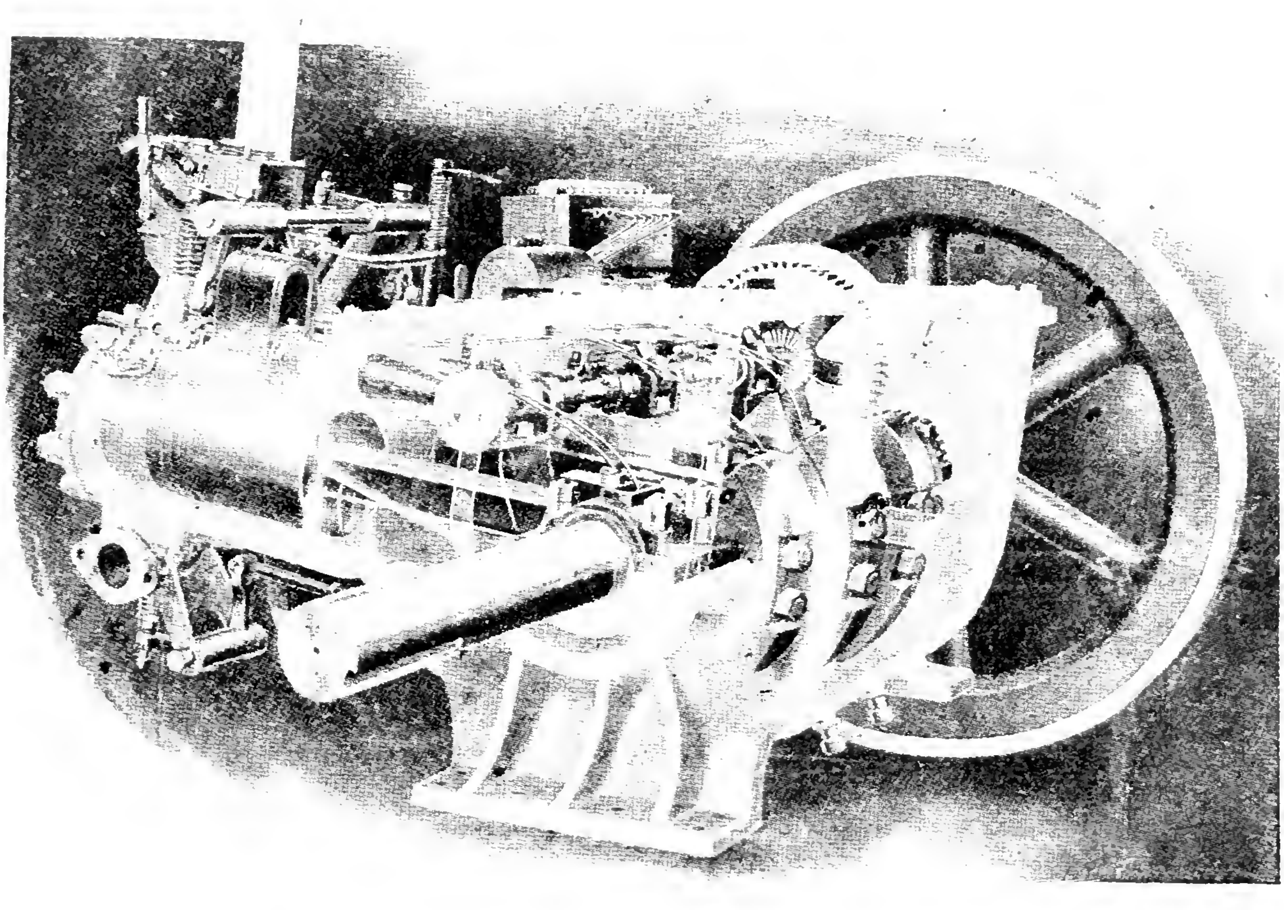


Fig. 1. Secor Kerosene Motor Construction.

water under governor control. Secor placed the first Rumely "Oil-Pull" Farm Tractor, twin cylinders, 45 b. h. p., on the road in March, 1909. This Oil-Pull Tractor has been continued to the present day with only very minor improvements.

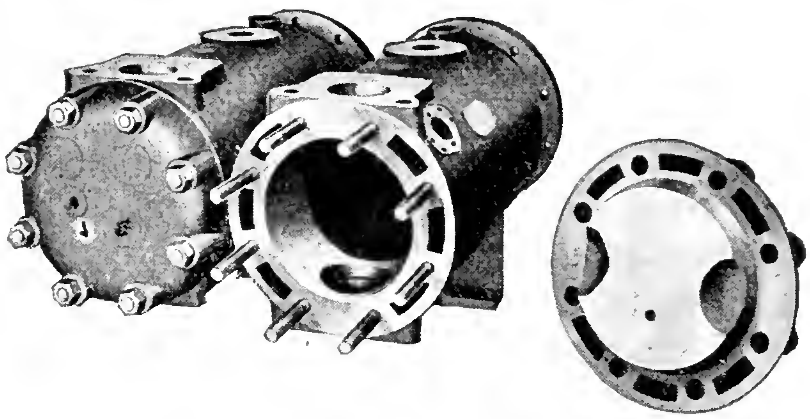


Fig. 2. Secor Kerosene Motor-Cylinder Construction.

PARTICULARS OF SECOR MOTOR.

Cylinders (small engine), bore 9½ in.; stroke, 12 in.
Intake valve port diameter, 3⅜ in.
Exhaust valve port diameter, 3⅜ in.
Con. Rod, C. to C, 2½ in.; stroke, 30 in.
Cam shaft diameter, 1 13-16 in.
Crank shaft, wrist and journal diameters: Wrist, 4½ in.; journals, 4 7-16 in.
Cylinders, large bore, 10 in.; piston stroke, 12 in.
Intake valve port diameter, 3⅜ in.
Exhaust valve port diameter, 3⅜ in.
Crank wrist diameter, 4½ in.
Journals, 4 7/16 in.
All crank shaft wrists are 4½ in. long.

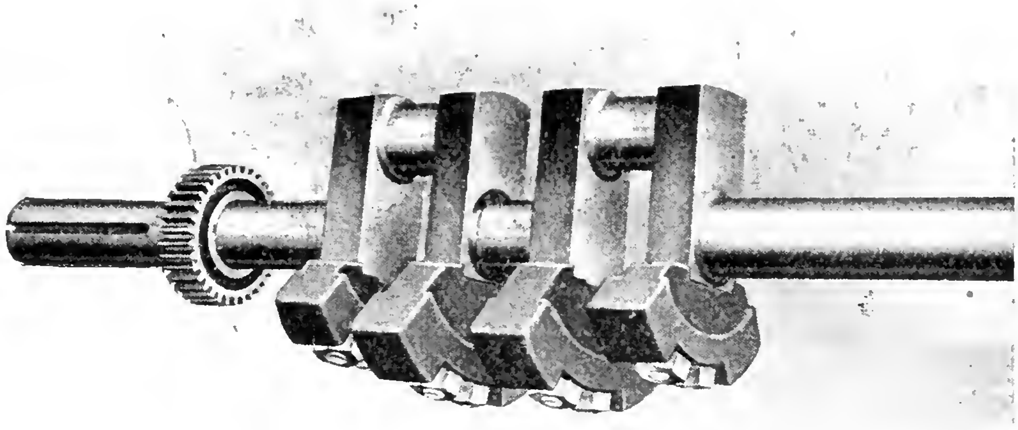


Fig. 3. Crankshaft of Secor Two-Cylinder Motor. The gray iron counterbalance weights are bolted on as shown.

The piston pins are all 2¾ in. diameter, are all solid, case hardened and ground, are fixed in the pistons and turn in the rod ends length of rod and pin bearing 5½ in. in all rods.

The ratio of compression space cubic content to piston displacement cubic content is 30 per cent.

The maximum power for each small cylinder is 30; for large, 35 b. h. p. or say 70 b. h. p. for large twin cylinder motors.

Crank shaft constant speed 375 r. p. m.

THE SECOR CRANK SHAFTS.

Some of the crank shafts are drop forged to rough crank shapes, while some are shaped by cutting from the solid.

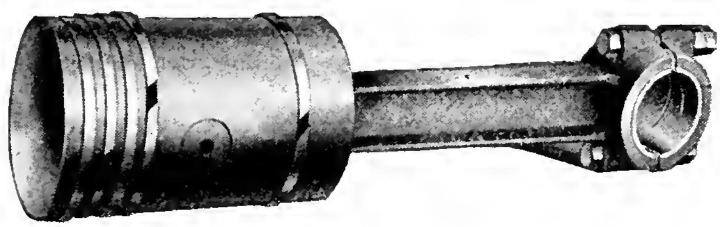


Fig. 4. Piston and Connecting Rod Assembly of Secor Motor.

All crank shafts are "heat treated," or annealed. The preference is for great tenacity and twisting before breaking; test specimens must show 75,000 to 85,000 lbs. tensile strength per sq. in., and 20 per cent elongation in, 8 in. test piece length before breaking. The factor of safety is about 10.

SECOR MOTOR COOLING.

The cylinder jackets and radiator are filled, not with water, usual practice, but with cooling oils, known as "Zero Black," "Polar" and "Arctic Ice Machine," used instead of water to obviate freezing dangers.

DRIVING WHEELS.

The driving wheels of the Oil-Pull Farm Tractors are either 64, 70 or 80 in. diameter, and the gear reduction ratios give respectively, 1 9-10 m. p. h. for large tractor forward and backward the same; and for the smaller tractors 2½ miles forward and back, with 4 miles high speed forward.

THE HIGGINS CARBURETOR.

All of Secor's practice to date is constant crank shaft r. p. m. with butterfly governor control, and

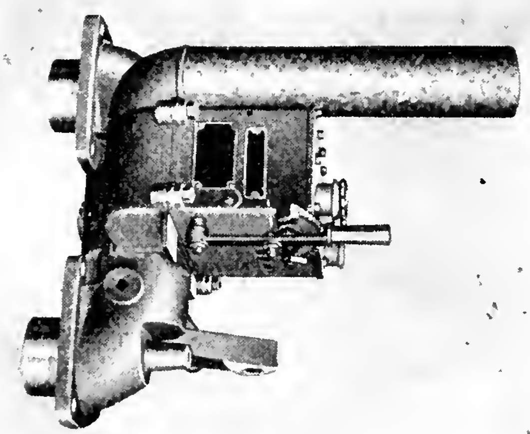


Fig. 5. Higgins gasoline, kerosene and water-supplying carburetor. Complete assembly, ready to go on cylinders of two-cylinder Secor Motor.

the entire Rumely Tractor practice has been with the Higgins carburetor, which consists of three overhead chambers (Fig. 5), two supplied by mechanically operated plunger pumps to varying fluid levels fixed by overflow pipe heights, one of these automatic pump supplied chambers containing water and the other containing kerosene, and the fluid level being lower in the water chamber and higher in the kerosene chamber. The third overhead chamber is hand pump supplied with a sufficient quantity for one starting, about one-half pint of gasoline, the fluid level being higher than the kerosene level. (See right hand of Fig. 10.)

The gasoline chamber being sufficiently filled, piston suction on gasoline delivery duct S, draws the gasoline up past the gasoline needle valve for starting charge adjustment, and delivers this suc-

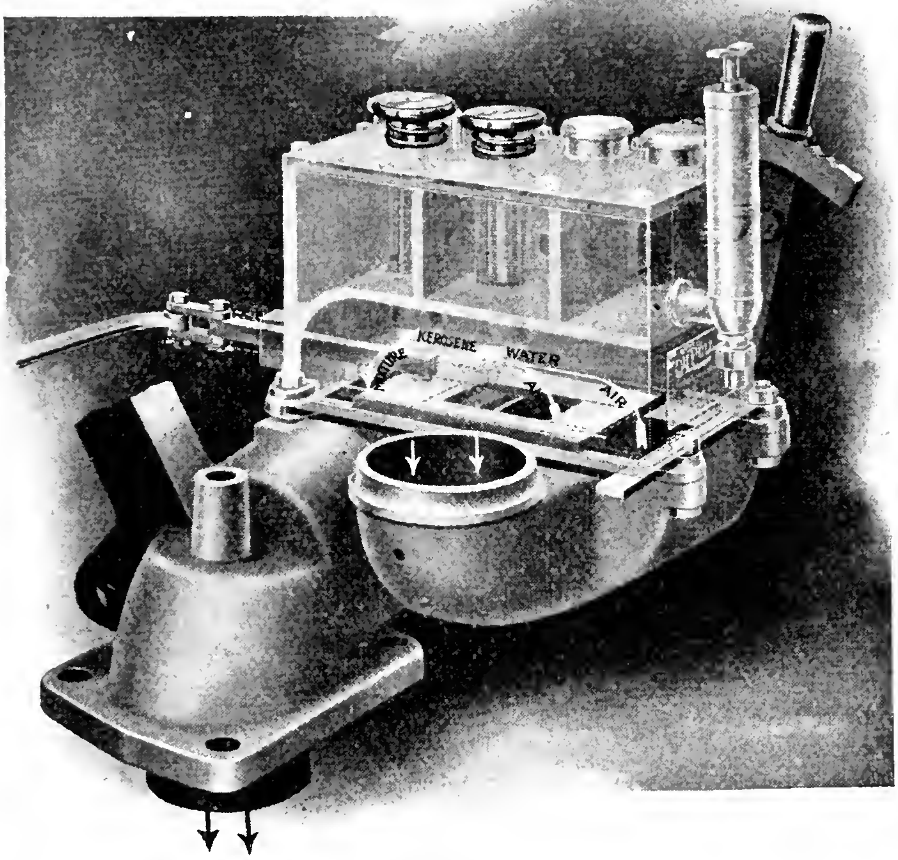


Fig. 6. Ideal view of Higgins Carburetor as applied to *Secor Motor.*

tion drawn gasoline to the mixing chamber and motor intake. This starting needle valve adjustment is made by the tester at the factory and never changed thereafter. All the gasoline hand pumped into the gasoline chamber is used in one starting, and must be renewed when the motor is again to be started.

When the motor is stopped in the field the kerosene and water needle valves, Fig. 10, are hand closed, and remain closed until the motor has started and runs about to speed on gasoline, when the kerosene needle valve is opened to the factory tester's mark on the head, and spring friction retained; the fixed index is not shown in the cut.

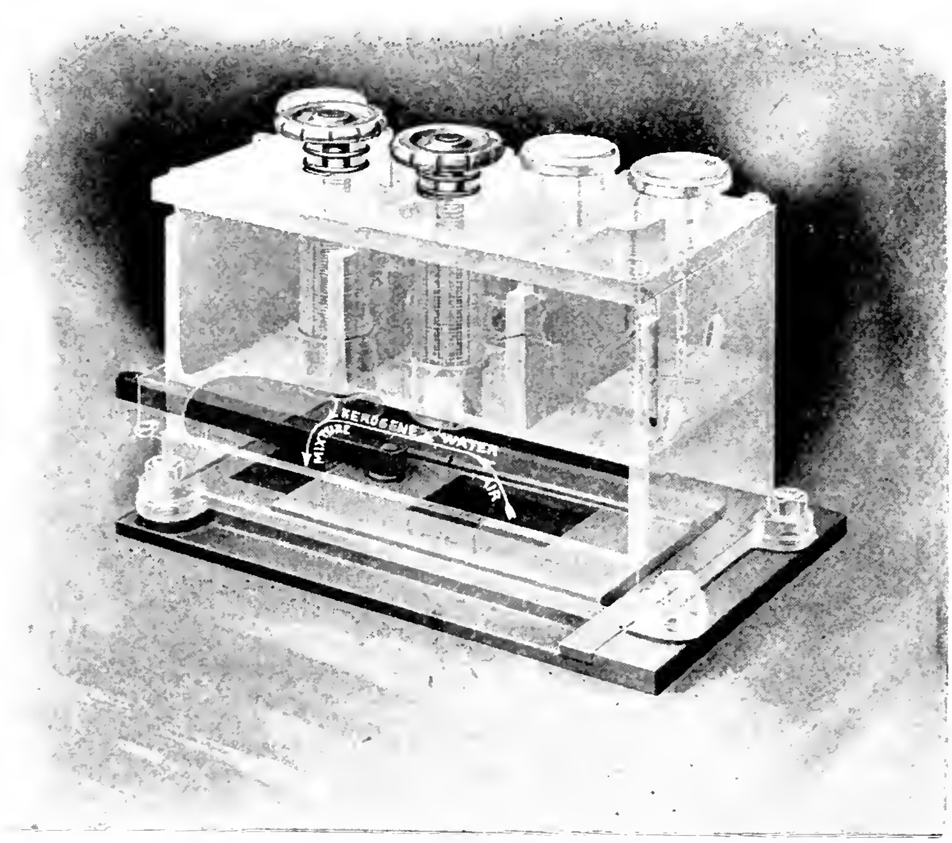


Fig. 7. Phantom view of Higgins Carburetor. This view shows the needle valves and ports to motor which are more or less opened and closed by a butterfly governor action to make the mixture suit the motor power and speed. The needle valves are adjusted by the tester at the factory, and need never be touched again.

Because of some gasoline fuel supply the first few working strokes made after opening the kerosene needle valve to place, will have too much fuel and give a smoky exhaust until the gascline is used up. Then the motor runs sweetly at fixed speed.

The water needle valve is opened to the adjuster's mark as soon as the motor begins to warm up, which leaves the motor free to take water when the motor load automatically increases the piston suction in the mixing chamber sufficiently to lift the water up to the two small delivery holes, H2, Fig. 10, and deliver the water overflow to the carburetor mixing chamber. The water intake is thus made dependent on the motor

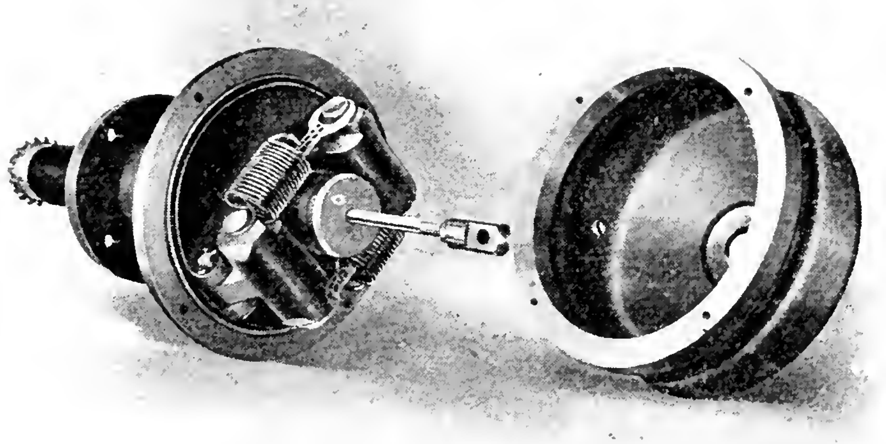


Fig. 8. Secor Kerosene Motor Butterfly Governor and casing—Governor runs in oil.

load, so that the motor takes water when it needs water, and at no other time.

The water is forced by the pump through a water delivery pipe coil about the exhaust pipe, so that it is always delivered warm to the carburetor water chamber, simply to prevent water freezing in cold weather.

Water admission begins at about half power and increases to full power, the maximum volume of water admission being about the same as the maximum volume of liquid fuel admission.

EFFECT OF USING WATER.

The effect of the water admission to the cylinder is to reduce cylinder heat, delay combustion and reduce the maximum cylinder pressure, while increasing mean effective pressure, or in other words, "fattening" the indicator diagram. Water admission to the cylinder makes for both fuel economy and motor durability, and is as desirable in the automobile motor as in the farm tractor engine.

For air port adjustments, see Fig. 9, diagrammatic horizontal section of the mixing chamber below the fuel and water chambers. The carburetor takes air through the middle and right port, marked "Air inlet," and delivers mixture downward through the left port, marked "Mixture to Engine."

The effective areas of these three ports are affected by two sliding valves—one at the right marked "Adjusting plate," which is hand adjusted to a fixed position by the factory tester and retained by screw pinching. The top surface of this hand adjusted slide is flush with the governor actuated flat sliding valve seat, so that this governor actuated valve, marked "GV," can also vary the effective area of the two air intake ports, and of the mixture exit port to the cylinder.

The valve "GV," is shown in Fig. 9 at about half power position, and is moved by the governor to the right when the motor speed is too low, closing the right air port, and opening the middle air intake port and the left, mixing-delivery-to-motor port, thus giving the motor a larger charge volume and consequently increasing the motor power.

When the motor develops too great power and runs above normal speed in the slightest degree the governor pulls the slide, GV, to the left, which gives the mixing chamber more air, thus decreasing mixing chamber suction and so de-

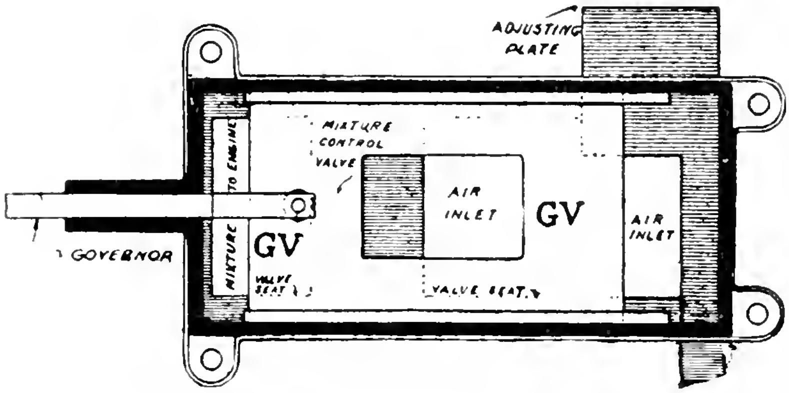


Fig. 9. Diagrammatic plan of Higgins Carburetor Mixture Control Valve—Governor Actuated.

creasing charge richness and also decreasing the effective area of the mixture port opening to the engine, and effectively and instantly reducing the motor power so long as the motor runs at all above its normal speed.

The use of the right hand adjusting plate is to vary the right hand air intake port area, so that the mixture will be of correct fuel richness. Moving the adjusting plate to open the right hand port decreases the mixture richness, while moving the adjusting plate to close this air intake port gives more suction in the mixing chamber, and thus increases the mixture richness.

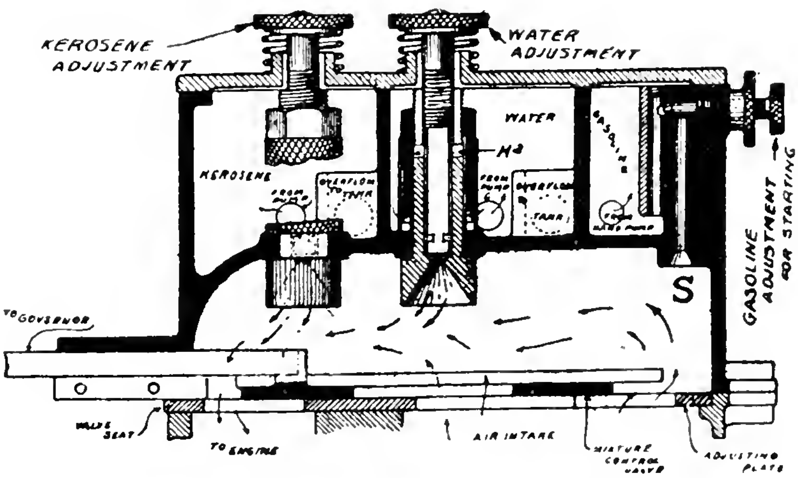


Fig. 10. Longitudinal section of Higgins Carburetor, showing handling of kerosene, gasoline and water, and permanent adjustment means.

The motor start is made by operator putting his body weight on fly wheel arms. A compression release is supplied. As soon as the motor starts on gasoline the operator opens the kerosene needle valve to its index mark, with the result of a very few working strokes made with too much fuel and, of course, smoky exhaust, which speedily ceases and the motor then begins to run sweetly at fixed speed and holds this speed until overloaded.

FACTORY STARTING AND TESTING.

The carburetor air intake is piped as high as may be under the cab roof to avoid dust, but is not screened against dust entrance.

The time required to start the motor and make it ready for work is about 45 seconds, average. The weight of the complete carburetor assembly, same for all motors, is about 43 lbs.

GOVERNOR AND VARIABLE SPEED.

The Secor governor is bevel gear driven from the cam shaft, and inclined 10 degrees to the horizontal, same speed as crank shaft.

The integral steel castings bell crank governor arm is 3¾ lbs. weight, 3 in. from pin eye center to over the cylinder bob, and 2¼ radius from pin eye center to collar lever center, with coil spring at each end of bobs, springs calibrated to hooking into different holes.

The governor spring's tension fixes the motor speed.

While it is correct to say that the motor runs at a fixed speed, this speed is graduated by a latched lever, notched quadrant and spring so arranged as to augment the governor bobs spring effect and thus vary the motor speed from 300 to 425 r. p. m., each lever setting giving a fixed speed of its own.

FUELS.

Although using kerosene as a regular practice the motor works perfectly well with gasoline, or with the lately introduced "Motor Spirit," selling at about three cents less than gasoline. This "Motor Spirit" also works perfectly well in any gasoline motor.

MR. SECOR'S OPINION AS TO KEROSENE FOR AUTOMOBILES.

As the world's leading expert in kerosene motors, Mr. Secor's opinion as to the successful use of kerosene at 5 cents or 6 cents per gallon vs. gasoline at 20 cents or more per gallon,—these two fuels not varying much in contained heat units,—are deeply interesting to all motorists at this moment.

These opinions are here expressed in the form of question and reply as giving Mr. Secor's views in more specific detail than otherwise readily obtainable. The following questions were answered by John A. Secor:

Can the internal combustion motor show as much flexibility, that is to say, as low a speed and power and as high a speed and power, when burning kerosene as when burning gasoline for fuel?

My experience shows that it can.

Can the internal combustion motor, adapted to kerosene or crude petroleum for fuel, be durable and reliable when made as light in weight as a gasoline motor showing equal maximum brake horse-power?

It can.

Then, in your opinion, is it practicable to substitute kerosene and crude petroleum motors for gasoline motors for driving motor cars?

At present, I know of no reason why this cannot be done.

Which fuel, kerosene or gasoline, demands the more costly motor construction to be flexible, efficient and entirely reliable and satisfactory in motor car driving?

I believe there need be no material difference in the production cost of the motors adapted to burn kerosene and those adapted to burn gasoline.

Then, in your opinion, there is absolutely no mechanical or operative objection to the use of kerosene and crude oil burning internal combustion motors for motor car driving?

I know of none.

Is electrical ignition satisfactory for kerosene motors?

Absolutely so.

In your present large practice with kerosene motors, does magneto current ignition give reliable and satisfactory results?

The results with magneto current ignition in my present practice are reliable and in every way satisfactory.

Do you use jump spark or make-and-break spark plugs with your kerosene and crude petroleum motors?

Make-and-break spark plugs exclusively, "Meteor Metal" contacts.

How does the make-and-break spark plug compare with the jump spark plug in the points of first cost, certainty of ignition, frequency of cleaning required and total upkeep cost for equal hours of actual running time, say for a year?

The first cost of make-and-break spark plugs need not exceed the first cost of high quality jump spark plugs. The make-and-break mechanism, however, makes the prime installation cost of the make-and-break spark greater than that of the jump spark plug.

In point of certainty of ignition in actual use, I believe the jump spark is not to be compared with the make-and-break spark, no matter what fuel is used.

As to the frequency of spark plug cleaning required. I now show you this make-and-break spark plug is the precise condition in which it was removed from one of my kerosene tractors after 2,033 hours of running with no cleaning, and, as you can see, it is still in serviceable condition, and to all appearances equal to another 2,000 hours of duty without having anything at all done to it.

For extended service, and counting the delays caused by jump spark ignition failure, and the actual time cost of jump spark plug cleaning, the make-and-break spark is by far the more economical installation. In my own practice I have successfully used the jump spark plug, but at the cost of frequent delays for spark points cleaning, and of a much more costly grade of crank box oil. In the case of this plug I am showing you the crank case oil cost about 11 cents per gallon, whereas if jump spark had been used the crank box oil would have cost not less than 35 cents per gallon. In fact, it is economy to use nothing but the very best grades of crank box oil with jump spark ignition, as dirty points are the most frequent cause of motor delay. No more low priced crank box oil than of high priced is required for equal service. The only advantage gained by the use of high priced crank box oil is less soot production, hence less spark plug cleaning demanded.

In your opinion, does a kerosene or crude oil burning automobile motor demand the presence of water inside the cylinder to obtain the best results in points of motor flexibility and fuel economy with crude oil and particularly, is it needful to use water in the cylinder to avoid sooting or in other words, to insure perfect combustion of crude oil fuel in an internal combustion motor?

While in some rare instances it may be economy to use crude petroleum fuel, kerosene is, generally speaking, the lowest cost and most all round economical liquid fuel for small internal combustion motors, and my own extended experience fully warrants the statement that from about half power upward a gradually increasing addition of water to the cylinder charge is of very great value in reducing heat and delaying combustion, and thus giving less initial pressure with increased mean effective pressure on the piston, and also aiding in perfect combustion.

Would you advise placing a governor on an automobile motor?

I certainly would. The governor can be fitted with the same motor speed varying device we use on the tractor motors and so give any motor speed whatever within range of the motor possibilities, with absolute certainty of instant motor speed change from the driver's seat. The governor, in my opinion, can be made small, light, low cost, and durable without difficulty, and will add to motor control reliability without any offsetting drawbacks whatever.

Useful Tire Information

The Changing of Tires.

SEE that your jack is set firmly and is perpendicular. Do not place it against the truss rods, but under the axle or under the spring bolts, where it cannot damage the machine.

After removing dust cap, remove valve plunger to hasten the deflation of the tube. Don't leave the dust cap, valve cap and plunger lying on the ground, but put them in your pocket or some place where they will be handy when you want them. Always have a few new valve plungers with you, as many a slow leak originates in a bad plunger.

A Three-in-One tool is a most valuable accessory. While you can remove the valve plunger by inverting the valve cap, the tool is handier and also enables you to remedy battered threads both inside and outside the valve. After deflating, turn the wheel until the valve is down, and push the valve stem into the case. Pull the tire toward you, so as to loosen the back bead, beginning at the top. The front bead will slip off readily enough, but the back one will sometimes stick. In that event reach into the case and pull the valve stem out. You will then have no trouble.

On Proper Inflation.

There is no one thing more important in the care of tires than to keep them inflated properly. A good rule is to allow the tires to show no depression under the weight of the car when standing on a level floor. A daily test of the air pressure is necessary if the bad results of under-inflation are to be avoided.

Punctures.

A punctured inner tube can often be repaired without removing the tire entirely from the rim. If the location is known, expose enough of the tube to insert a *Permanent Puncture Plug,* or you can apply a self-curing patch, first cleaning the point of application with sandpaper and benzine.

If a tire leaks it may not always be from a puncture. Test your valve first. This is easily done by moistening the valve cap washer before screwing down. If there is a leak small bubbles of air will be seen issuing from around the edges of the cap.

Pinched Tubes.

Ninety per cent of tube troubles are due to pinching, from improper application of the tires to the rim. Either a flap gets misplaced, a tire tool gets jammed against the tube or the beads of the case catch it at some place where it is creased. The result may be merely a pin-hole puncture or the pinch may be large enough to blow the casing off the rim. Practically all instances of a tube letting go inside the case, without outside evidences of injury, are due to this cause, or to a bruise break in the fabric pinching the tube.

When a tube is put in a case it should be lightly inflated and the hand slipped around inside the case to feel that there are no wrinkles. The flap, if any, should be put in position in the same way. After the case is on and before final inflation, the bead should be raised all around with a tire tool to allow the tube to escape into place if the beads are pinching it anywhere. See that the lugs, if used, move freely up and down and the valve stem likewise. Attention to these particulars will prevent subsequent trouble.

Many tire experts agree that more than half of the number of tire troubles are due directly or indirectly to underinflation. As it is, in the case of the pneumatic tire, not the rubber but the air which carries, suspends and cushions the weight of the vehicle—everything, of course, depends on having as much air as possible in the tire tube, without approaching the breaking point of the rubber at the weakest place of the tube. Every molecule of air which can be safely held in place in the tube helps to do the work for which the tire is employed. Incidentally, it keeps tube and casing in the most desirable form, for which they are designed, and holding them rigidly, offers stones, nails and other road sundries such resistance as is needed to make the impact harmless.

Water Injurious to Tires.

When water works its way beneath the tread and breaker strip and into the carcass of a tire premature deterioration is certain to follow.

When a tire is completed it is free from moisture on the inside and it remains so as long as the tread is in condition to perform its full duties. However, small cuts, caused by sharp objects in the roadway, are very apt to appear, even in a new tire, and through these openings water eventually finds its way to the tire carcass. In time this produces separation of the individual plies of fabric of which the carcass is made up, and the tire rapidly goes to pieces. Breaks in the tread also admit sand and dirt, which cause fabric separation.

When a motorist discovers one or more small cuts in the tread of a tire he should close them at once. There are several special preparations for this purpose which can be easily applied after the cut has been thoroughly washed out. The expense amounts to practically nothing and the saving is bound to be great.

Tire Pointers.

Air costs nothing; tires are expensive.

More tires give out from insufficient inflation than anything else. Remember that it is the air in the tube that carries the load and cushions the road.

Avoid sudden application of the brake.

If one side of a tire shows more wear than another, turn it around.

Running on a tire flat, even a short distance, is sure to be costly.

Better run on the rim, very slowly and carefully, if imperatively necessary, and the distance is very short, than on a flat tire.

Keep grease and oil away from your tires and tubes always. They destroy rubber.

DATE DUE

Engelman, Roy Albert, 1889-
Engelman's autocraft; being an instructive study of the automobile; its care and management; how to drive; locating troubles and repairing them; with chapters exploiting some of the latest devices used in automobile construction. By Roy A. Engelman. Cincinnati, O., The American chauffeur publishing co., 1914.
viii, 257 p. illus. 20 cm.