FIRST AID TO THE CAR

HAROLD WHITING SLAUSON

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OR

HIGHWAY HINTS AND HELPS

Guide to Road-side Repairs and Improvised Replacements

BY

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THE AUTHOR.

INTRODUCTION

THIS book is made necessary because the old adage, "It is the unexpected that always happens," applies more truly to motoring than to any other form of sport or business.

A man may understand the mechanical design and construction of his car perfectly, and yet be confronted with a roadside accident which will tax all his knowledge and power of imagination before he can arrive at even the simplest temporary solution.

The following pages are not to be considered as a substitute for the instruction book. That should be studied thoroughly, for it contains the essentials of construction, operation, and care which must be mastered before roadside repairs can be attempted. This book, therefore, is rather a supplement to the instruction book and in it the author has attempted to treat in a practical and elementary way of those accidents which may happen even to the best-regulated car, together with a brief outline of the cause of such an accident and its temporary or permanent cure.

The chapter headings are in the form of a diagnosis, so that the symptom as exhibited will serve as an index for the portion of the book covering the trouble in question.

The "family tree" chart, preceding the majority of chapters, serves as a paragraph index of the succeeding pages, indicating the various parts and other troubles which are discussed under the corresponding headings. The author has attempted to make the contents of this book self-finding, without the use of an elaborate index, employing merely the symptom of the car trouble and its probable source as the key to the location of the pages discussing the cause of the difficulty and its remedy.

H. W. S.

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CHAPTER I

TOOLS AND SPARE-PART EQUIPMENT

ACCIDENTS don't "just happen." They occur from some very definite cause. The next best thing to preventing them, by the use of the utmost care in driving and inspection of the car, is to have the remedy always at hand. If you start on an extended trip without a spare spark plug, and find that one or more of your cylinders begin to miss, you deserve to be compelled to pay a goodly sum for a tow to the nearest garage.

On the other hand, the average motorist cannot make of his car a traveling repair and supply shop. Personal luggage occupies considerable space on an extended trip, although the use of running-board carriers solves this problem to a great extent. However, there are certain tools and equipment which, if carried in

every car, will reduce roadside grief by fully 90 per cent. The remaining 10 per cent are accidents so serious that we must cheerfully pay our fee to the wrecking car.

A complete set of wrenches, screw drivers, cold chisels, files, spanners, and the like, to fit every nut, bolt, or screw on the car, should be a regular part of the traveling equipment and should never be taken from the car except when absolutely necessary. As indicated in Chapter XIII, "The Private Garage and Its Equipment," duplicates of all of these tools should be available in the private garage itself, so that there will be no danger of a mistake which may result in the absence of a vital car tool when most needed. Thousands of dollars' worth of tools are lost each year by the careless motorists, who will leave a valuable wrench, screw driver, or other tool on the running boards of their cars and will forget to remove them when they drive out of the garage.

We may classify the necessary tools and equipment, in addition to the regular role or kit supplied with the car, by the purposes which each is to serve. For the

Tires

you may need one or more spare shoes, mounted on the rim and inflated; two additional spare tubes; a small roadside vulcanizing kit with

equipment, or a set of self-vulcanizing tube patches; an inside and an outside blow-out patch; a box of spare valve insides; a half dozen valve caps; a wire-wheel hub wrench or special lug wrench, depending upon whether wire or wooden wheels are used; a box of talc or powdered mica, and a sturdy and reliable jack. This last should have been furnished with the car, but too often such a class of equipment is inferior in construction and should be replaced by one of more satisfactory design and make.

For the emergency in which

Power or Traction

other than that furnished to the wheels is required, you will need a set of tire chains, a few "mud hooks" or separate pieces of chain which can be wrapped around the wheel, a long rope or towing cable, a spade, if you expect to travel through snow, mud, or sand, and a complete outfit either of overalls or old dusters and gauntlets.

For the

Care and Upkeep

of the car and engine during the trip you will need a can of cup grease, an adequate supply of cylinder oil, a well-filled squirt can or oiler, a grease can, plenty of soft cotton rags or waste, and a can of greaseless car polish or other

harmless chemical for removing mud stains, tar spots, and the like. For the

Engine

be sure to have three or four new spark plugs of the right size and type, a gasket to fit the detachable cylinder head, a small can of putty, and a bottle of shellac for carburetor trouble, a length of rubber hose for emergency feed supply, testing, and the like, a spare valve or so (exhaust and intake valves on the modern car are now made interchangeable), and extra nuts and bolts of the kind which will fit the engine and its attachments.

Separate from the engine, and yet functioning closely with it, is the

Radiator and Cooling System.

Trouble with this part will necessitate the use of a can of radiator cement, an extra fan belt, a length or so of radiator hose of the size used on your car, and hose clamps to fit the same.

The

Electrical System

embraces an important part of the car, and should include a battery tester or hydrometer, lengths of high-tension and low-tension wire, one or more additional contact points for the breaker arm, a spare coil, a roll of tire tape for insulating or adhesive purposes, additional light bulbs of the type and size used in the head

lights, dash light, and tail light (be sure to note whether these are of the double- or single-contact type), and an electric circuit tester. This may consist of a small dash light mounted in a double-contact socket and attached to two wires, each of which should be provided with a bare terminal. When these bare terminals are placed in various portions of the circuit, the lighting of the lamp, or its failure to light, will determine the condition of the electric circuit as described in some of the succeeding chapters.

In addition to the above-mentioned specific tools and supplies for special purposes, a goodly amount of emergency equipment should be carried, the use of which may be general. This should include several sizes of cord or rope, a ball of tarred cord known in ship terms as marlin, boxes of odd sizes of screws, nuts, and bolts, a box of cotter pins, a coil or two of copper wire and another of annealed stovepipe wire, several short lengths of assorted strap iron, and one or two pieces of gas pipe which will accommodate the handle of a heavy wrench and which may be used to increase leverage in the removal of recalcitrant nuts or the straightening of fenders or running boards.

A small vise, which may be clamped to the running board, may prove useful. If room can

be spared, a small acetylene tank of the motorcycle size, with a length of flexible rubber tubing, and a small blowpipe, will also prove useful for heating small parts, soldering, and the like.

Many modern cars are provided with compartments in one of the front side doors especially intended to accommodate the tools of the most-used variety. Such tools should, of course, be in the most accessible position, and the advantage of this location lies in the fact that the front seat does not need to be removed in order to make minor adjustments of the engine, to replace spark plugs, and the like. Tire chains should be carried in a bag and placed under the seat, together with the tire pump, jack, rim wrench, and other similar accessories. Here, too, should be found room for some of the additional equipment specified in this chapter. The overflow may be carried under the back seat, but it is well to store here only those tools which will probably be needed less frequently than the others. The back seat is usually used for the accommodation of guests or touring luggage, and the compartment under the seat is thereby rendered less accessible than the front seat. Some tool boxes may be placed on the running board, but as a rule it is generally better to reserve this space for such suitcases

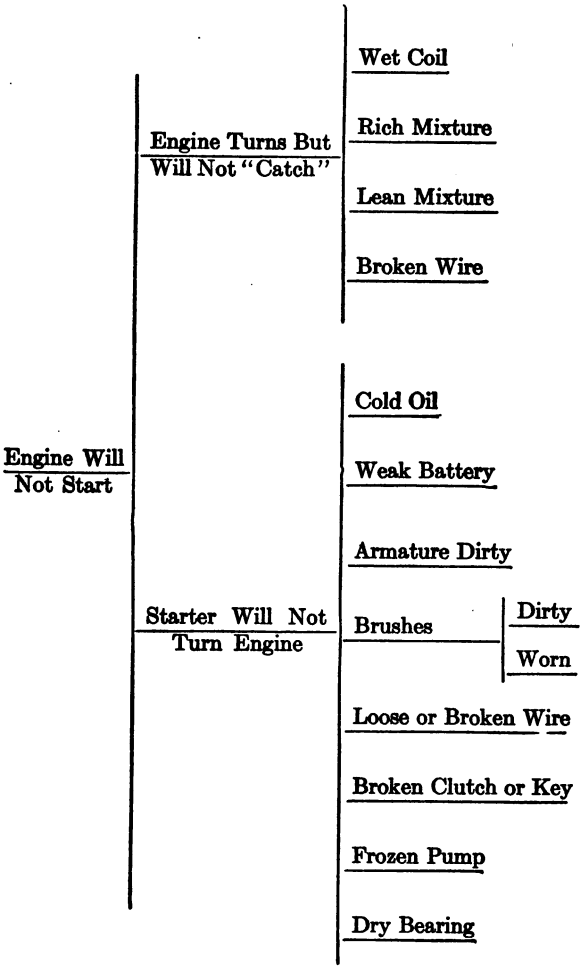
and other traveling paraphernalia as cannot be accommodated in the body of the car itself.

Spare tubes should be rolled tightly and carried in waterproof leather bags especially provided for the purpose.

One of the most important of the many outfits which should be carried by every motorist is a first-aid kit, consisting of small rolls of lint, bandages, plaster, and the better known emergency drugs and medicines, such as iodine, peroxide, and other healing and cleansing agencies. The occasion for the use of such equipment may arise from a variety of accidents; from skinned knuckles from a slippery wrench, to serious lacerations due to an overturned car or collision.

Last, but not least, in the list of touring equipment, should be mentioned complete insurance policies to cover damage by fire or collision, loss by theft, and to protect against payment of heavy damage suits due for injury sustained by another person or his property. A fire-insurance policy will demonstrate the value of an approved chemical fire extinguisher as a part of the equipment.

How and Why of Chapter II
When the Engine Will Not Start



CHAPTER II

WHEN THE ENGINE WILL NOT START

THIS chapter should be considered as distinct from Chapter III, "When the Engine Stops," for it frequently happens that an engine which has apparently been running perfectly as long as its power is required, will fail to start after a rest of only a few moments' duration. This refusal of the engine to start may be indicated in two ways, either by the failure of the starter to turn the engine over, or, if the starter operates properly, the failure of the engine to "catch" and run of its own accord.

If the

STARTER WILL NOT SPIN THE ENGINE

we may look for mechanical or electrical troubles, depending upon whether or not the engine can be turned by hand with ease. If there is no response to the starter when the starting pedal or button is pushed, the trouble may be mechanical and due to a

Dry Bearing,

which, strange as it may seem, may not have asserted itself during the previous operation of

the engine. Occasionally a starting-motor bearing or a piston may become overheated, due to a tight adjustment or lack of oil or grease, and yet will not seize until the engine has been at rest for some time. If the difficulty is due to a seized piston, the same course should be taken as recommended in Chapter III, "When the Engine Stops." If the difficulty can be laid to a starting-motor bearing, the grease cup supplying this should be removed, the passageways cleaned out thoroughly, and plenty of kerosene and lubricating oil injected into the opening.

If the engine has been standing idle out of doors, and the weather is very cold, the inability of the starting motor to crank the engine, even with the help of a strong battery, may be due to a

Frozen Pump.

Remember that the water in the lower portions of the cooling system is colder than that at the top. An unprotected radiator offers a large cooling area, and as the pump is frequently located at the front of the engine, where it will receive many of the cold blasts of winter, the formation of ice at this point, if there is insufficient alcohol in the radiator, prevents the rotation of the engine or any of its parts, inasmuch as the pump shaft is geared directly to the crank shaft. Open the drain cock on the

pump housing, and if water will not flow out even when a wire is inserted through the opening, you may be sure that this is the difficulty. Do not try to start the engine until hot water or the application of heat in any form has served to thaw every particle of ice in the pump housing. If your starting motor is strong enough, continued use of the starting button may impart so severe a strain to the pump that one of the vanes or a key on the driving shaft may be broken.

If the starting motor turns without moving the engine, there is obviously some breakage in the connection between the starting motor and the engine. This may be due to a

Broken Clutch or Key

which allows the starting motor to revolve without turning the gear or sprocket, which communicates power to the engine. If what is known as the Bendix drive is used, in which the starting-motor pinion meshes with the teeth on the fly wheel automatically only when current is applied to the starter, the operation of this mechanism should be observed, either by removing the floor boards or through the opening between the engine and the dash under the hood. If the small starting pinion does not draw in automatically when current is applied, push it in with the hand, applying leverage if

necessary. If it offers material resistance, you may find that it is jammed or stuck with gummed oil; otherwise the difficulty is electrical and will be found within the windings of the starter itself. In either event, use the hand crank for starting the engine, and wait until you reach a competent electrical repair man before having this difficulty adjusted, unless you can loosen the gummed oil yourself.

If there is no response to the starting motor when the pedal or button is pushed, and the starter makes no effort to turn the engine over, you may usually confine your efforts in the search for the trouble to but two places. The most probable source will be a

Loose or Broken Wire

leading from the battery to the starter and starting switch. This wiring system is the simplest of any on the car and may be recognized by the large, heavily insulated cable used to carry the excessive current frequently required by the starter. Battery connections especially are prone to go wrong, owing to the "sulphating" of the cells and the deposit of the greenish-white substance on the battery terminals. The terminal clamps should be loosened, and cleaned thoroughly with ammonia, or, if none is available, the lead posts and wire terminals should be scraped clean with a dull knife. The appli-

cation of vaseline will prevent the formation of this obnoxious material. Be sure to tighten the battery connections as much as possible. Examine the switch, motor, and "ground" terminals, and make sure that all such screws are tight.

The other probable reason for the failure of the starting motor to turn will be

Worn or Dirty Brushes.

These are heavy pieces of carbon which are inserted in the brush holders, and which make contact with the armature as the latter revolves. The current generated by the revolving armature is picked up by these brushes and transmitted to the armature of the electrical system. In the case of the motor, the current is led to the armature by means of these brushes, and it is consequently through them that the starter receives its power. Continued sparking will eventually burn or wear them, and they will need to be renewed occasionally.

If the starter is of the type which is operated by means of a pedal (instead of an electric button) the cover at the end of the starting motor may be removed, and the clamping device which brings the brushes against the armature when the pedal is pushed, may be pressed with a screw driver. If this added pressure serves to start the engine, you may be certain

that new brushes are needed or that the armature has become so dirty as to prevent satisfactory electrical contact. A piece of fine sandpaper may be passed around the armature, and moved gently in a circumferential direction to free the surface from the accumulated grease and dirt. When installing new brushes, remember that the exact curvature of the armature must be obtained, so that perfect contact will be made throughout the entire width of the face. This can be done by placing a small piece of sandpaper around the armature and holding the brush in such a manner that it will always extend in a radial direction from the armature, and will be worn to a groove of the proper curvature.

Remember that the ammeter showing the charge and discharge of the battery is not connected with the starter. You can easily tell, however, whether current is passing through the starter or not, by observing the effect on the dash light or on the head light when the starter button is pressed. If these lights grow dim, the current is passing through the starter, and it is unnecessary to look for a broken wire. The failure of the engine to start under these conditions will be due to the same causes as may prevent the starter from turning it over except at a very slow and sluggish speed.

The most probable cause of this difficulty will be a

Weak Battery.

Remember that the starter represents a tremendous drain on the battery and that from twenty to thirty times the length of time during which the starter button is pressed is required to replace the energy thus consumed. Your ammeter may show that the generator charges the battery at ten or twelve amperes, but the discharge when the starter is operating may amount to two or three hundred amperes. Thus a car which is used only for short trips will soon require more current for the starter than will be replaced by the generator. The remedy is to use the starter less, run the car more, or remove the battery and have it charged at the local service station. A short circuit will cause a discharge of the battery, but this is usually avoided by the use of fuses in the lighting and horn circuit. There is no fuse in the ignition circuit, however, and if the engine is left with the switch in place, the current may escape from the battery.

Cold Weather

requires a battery to be in the best of condition. Oil rapidly congeals at low temperatures and becomes heavy and sticky. The oil thus left on the walls of the cylinders and pistons will,

therefore, offer considerable resistance to cranking, and if the battery is not well charged, great power will be necessary to turn the engine over with adequate speed to permit ignition. So much current is required for cranking the engine that the battery cannot supply enough to furnish a fat, hot spark at the spark plugs. It is better to crank the engine by hand under these conditions, and allow all of the current from the battery to be used for ignition. Filling the radiator and entire cooling system, in fact, with hot water, not only helps to vaporize the gasoline, but warms the oil and makes cranking and starting doubly easy.

FAILURE OF THE ENGINE TO CATCH after continued use of the starter will doubtless be due to some action of the elements (cold or dampness) if the engine had previously been running satisfactorily. If, however, the engine has been tampered with, we may look for a

Broken Wire

and may test each spark plug for the passage of current by means of a screw driver, as used in the manner described in Chapter IV, "When the Engine Misses." Remember that the starter turns the engine over slowly, and that you must wait two complete revolutions of the flywheel before a spark will be repeated at any one cylinder.

Cold weather may affect the mixture. Remember that a

Lean Mixture

will not explode in a cold engine, and that for starting you must use the button adjustment, which chokes the air intake and increases the suction of the carburetor, or you must prime the cylinders with raw gasoline through the pet cocks, the spark-plug openings, or through the device especially provided for such purpose, found on some cars. The throttle should also be nearly closed when starting a cold engine. If the engine refuses to start, make sure that the choke lever, or other dash control, is properly connected through its linkages, wires or rods, with the small lever on the carburetor or intake pipe. Occasionally a set screw, holding one of these connections in place, will become loose, and will allow the dash adjustments to be moved without a corresponding action at the carburetor. A

Rich Mixture

will sometimes prevent immediate starting of the engine. This is especially true if the choke is pulled out and the engine raced in order to leave a rich mixture in the cylinders previous to an expected wait of considerable duration in cold weather. If, through some unforeseen circumstance, this wait is cut down to only a few

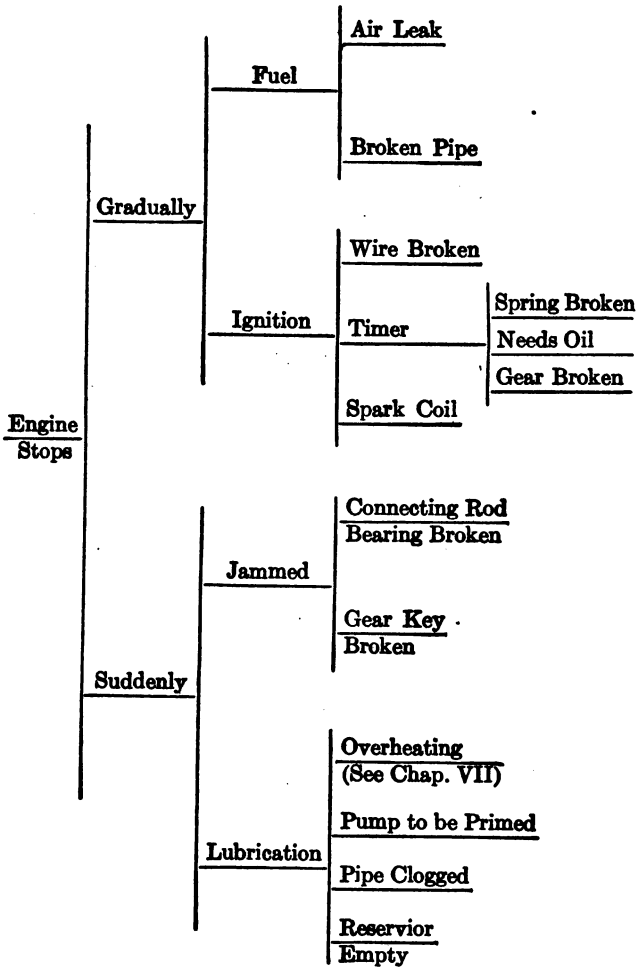
moments, the initial charge in the cylinder will be so rich as to be unignitable. Under these conditions the choke or other dash adjustment should be opened, and set as in ordinary hot-motor running.

A car which has been recently washed, or which has been left in the rain for a considerable length of time, may suffer from a

Soaked Coil.

A coil into which the least suspicion of dampness has penetrated will give only a weak spark, and will cause the cylinders to fire intermittently, if at all. The coil may be dried out by leaving it in a warm place. This condition may also, eventually, cure itself, although some time is required to accomplish this.

When the Engine Stops



CHAPTER III

WHEN THE ENGINE STOPS

AN internal-combustion engine will stop dead (as distinguished from missing or losing power) only from one of two causes—either when the resistance cannot be overcome by the power generated, or from an entire absence of some one of the power-producing functions.

A SUDDEN STOP

is dangerous, as it may result in the breakage of a vital part of the engine or other mechanism of the car. Such a stop can be produced only by

Inadequate Lubrication.

A broken part or piece of foreign metal which has jammed in the mechanism.

Remember, a stop from either cause requires *instant attention.*

As soon as anything seems to be wrong with the engine throw out the clutch so that the added momentum of the car will not turn the engine over when it should be brought to a stop.

If the engine revolves for a turn or so, under

its own impetus, or if the starter or hand crank can move it easily, the cause will be found under the difficulties described in the latter sections of this chapter dealing with the engine which stops, due to *lack of power.*

Otherwise the most frequent cause of such sudden stopping will be trouble with the

Lubricating System.

Inspect the oil reservoir to make sure that there is an adequate supply. When did you last clean it and the crank case with kerosene and renew the oil? Oil easily loses its lubricating qualities, and worn-out oil is as bad as none at all.

If the difficulty is due to lubrication troubles the pistons will have become unduly hot, will have expanded in the cylinders, and will have seized or gripped the walls so that they cannot move freely up and down. The engine must be allowed to cool. Inject copious quantities of kerosene, if available, into the spark-plug openings of each cylinder. Insert the hand crank at the projecting end of the crank shaft and try to turn the engine over by hand. If kerosene is not available, use lubricating oil in the cylinders.

As the engine cools and the lubricant works its way down between the piston and cylinder, you will gradually be able to get some results from your tugs at the hand crank. When the

engine is finally freed, so that it turns over with comparative ease, try the starter with the ignition cut off to determine whether there are any unusual internal sounds from the engine which might indicate damage to the crank shaft or connecting-rod bearing.

If the engine revolves freely with no unusual sounds, no damage has been done, and it is only necessary to find the cause of the lack of lubrication, which may be a

Clogged Oil Pipe.

Start the engine slowly under its own power and watch the oil-pressure gauge, sight feed, or "tickler" on the dash. If these do not indicate a flow of oil, disconnect the main oil pipe between the indicator and pump and blow through it by means of the rubber tubing which should be a part of the emergency equipment of every motorist. The oil reservoir or other portion of the lubricating system should have a strainer, and you should know its location and how to get at it. Examine this and clean thoroughly.

If all portions of the oil feed are clear the oil pump may need

Priming.

First, however, remove the check valve if the pump is of the plunger type. Clean this and its seat thoroughly and increase the tension of

the spring slightly by stretching it with the fingers. Pour in a few teaspoonfuls of oil and replace the check-valve cover. Run the engine slowly, until oil is discharged at the disconnected end of the pump leading to the gauge.

If the gauge or sight feed indicates that the lubricant is feeding properly, the sudden stopping of the engine may be due to

Overheating.

(For complete details of this trouble see Chapter VII, entitled, "When the Engine Overheats.") Do not neglect to remedy this trouble, although if adequate time is given for the motor to cool it may be driven slowly and carefully for a short distance if you will be sure to stop as soon as the slightest evidence of labor or knocking, due to overheating, again asserts itself.

If the engine has stopped with a dull thud or thump and cannot be turned by the hand crank, the difficulty is more serious and is probably due to a

Jammed Crank Shaft.

A bolt may have dropped off of one of the connecting-rod bearings and become wedged between the crank arm and the top of the crank case. The connecting rod may have been broken and become wedged in the cylinder. A nut, key, or other part may have broken off and become wedged in the forward train of gears.

Such difficulties, as a rule, will require the facilities of a garage, and the car should be towed to the nearest service station. However, the removal of the oil pan or the forward gear case will determine the extent of the difficulty, and the installation of a new key or a bolt and nut for the big end of the connecting-rod bearing will overcome the trouble, if no other breakages have occurred. Roadside repairs of burned-out bearings have been made, but the lack of facilities renders such work exceedingly difficult, and both time and money will be saved if the car can be towed to the nearest repair shop.

If the engine

TURNS EASILY

by hand immediately after stopping, you need look for trouble only in one of two systems—ignition and the fuel. If the

Explosions Stop Suddenly

look for a loose connection or an actual break in the wire from battery to coil, from coil to distributor or condenser, or the electric connection with the frame used as the ground. Difficulty with the other parts of the ignition system will make the engine miss without stopping suddenly. (See Chapter IV, "When the Engine Misses.")

If the breakage is found in a high-tension wire the entire length should be renewed, or

if no extra lengths are available it should be spliced and the connection covered with many layers of insulating tape. A high-tension wire may be determined by its greater diameter and heavy cover.

A broken connection in a low-tension wire (which need be no heavier than the ordinary door-bell wire) can be repaired more easily, but should be protected with two or three coverings of insulating tape. To trace the ignition difficulty the short-circuit tester described in Chapter I should be used. The engine should be turned over so that the sparking points of the timer or circuit breaker are left in contact, and you may then find the wires at which no current flows. Do not use the electric lamp as a tester for the high-tension circuit, as the presence of a high voltage will be indicated by sparks flying from the high-tension wire when ignition is made, or from a screw driver which may be used as a temporary means for conducting the current.

If the main high-tension and low-tension ignition wires are in good condition the difficulty may lie in the

Spark Coil,

which will occasionally burn out or loosen internally through undue heat or vibration. The windings of the coil are securely embedded in

wax or other substance and cannot be repaired by the amateur. The spare coil should be installed. If the wiring and coils are in satisfactory condition look at the

Timer or Circuit Breaker.

Remove the cover and turn the engine slowly by hand. The contact points should come together and separate two, three, four, or six times with each revolution of the crank, depending upon whether the engine is of the four-, six-, eight-, or twelve-cylinder type. (In some of the eight- and twelve-cylinder engines a separate ignition unit is used for each "block." In this case treat each block as a separate engine.)

Note the slight motion of the breaker arm which tends to make and break contact. If this does not move, the contact-making

Spring

may be broken. This can temporarily be replaced by a thin piece of spring steel or, in an extreme case, by a flexible spring wire, such as a hairpin, wound around the post and pressing against the arms with sufficient strength to make contact when necessary.

If the

Breaker Arm

does not move easily when touched with the finger, a drop of oil on the post on which it is mounted may be all that is needed.

If the spindle carrying the circuit-breaker cam or

Rotor Does Not Turn

the difficulty is mechanical and is due either to stripped gear teeth or to the loss or breakage of the key which holds the timer driving gear in place. The former difficulty can only be remedied by the use of a new timer gear. In the latter case, however, a nail or other small piece of steel, filed to the proper size, may be driven into the opening formed by the slot in the shaft and the keyway in the gear.

Difficulty due to the

Fuel Supply

will not cause the engine to stop suddenly, and is, therefore, treated in detail in Chapter IV, "When the Engine Misses."

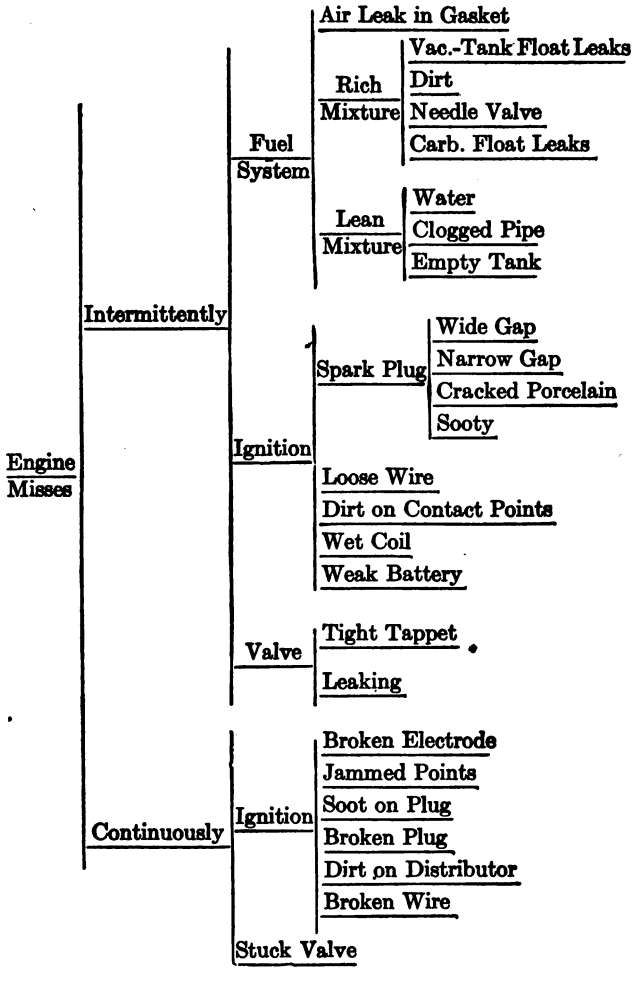
However, a sudden stoppage of explosions accompanied by a peculiar

Sucking or Hissing Noise

will indicate that the gasket between carburetor and manifold has been blown out and that the engine is receiving too much outside air through the leak thus formed. This produces a lean or rare mixture which will not fire in any cylinder. In this case the carburetor should be removed and both surfaces against which the gasket rests should be thoroughly cleaned. A piece of wrapping paper should then be placed on

one surface or the other and the outline of the carburetor should be tapped gently with the small ball end of a light machinist's hammer. This will cut the gasket to the proper shape. Apply shellac to both surfaces and to the paper gasket thus cut. Clamp the carburetor firmly in place and allow a few minutes for the shellac to dry.

When the Engine Misses



CHAPTER IV

WHEN THE ENGINE MISSES

A "MISSING ENGINE" is one having one or more cylinders in which explosions do not occur. A gasoline engine can operate "idle" on but one half or one third of its cylinders, but it is difficult to obtain sufficient pulling power even for low-gear running under these conditions. When an engine has one or more missing cylinders we can eliminate all parts which apply to the engine as a whole, and restrict our searches to those which affect each cylinder separately. The three main systems which are duplicated in each cylinder are:

Valve system,
Ignition system,
Carbureting or fuel-feeding system.

There are two ways in which one or more missing cylinders will be evidenced:

Consistent missing in one or more cylinders.
Intermittent or spasmodic missing in one or more cylinders.

The spasmodic miss is more difficult to find

than is that which asserts itself constantly, for we cannot literally "pin it down" and make it misbehave when the hood is raised and when we are ready to look for the trouble. On the other hand, cylinders which will fail to fire when the engine is idling, as well as when it is pulling under a load, furnish a much more simple solution of the difficulty.

When the engine

MISSES CONTINUOUSLY

it is first necessary to locate the offending cylinder or cylinders. If the engine is provided with pet cocks or relief cocks, these may be opened in turn to determine those through which no sound of escaping explosions can be heard. Such cylinders are dead and are the ones which are causing the difficulty. If your engine has no relief cocks, hold the end of a screw driver against the cylinder head, and bring the steel shank against the top terminal of each spark plug in succession. Do this when the engine is throttled, and no reduction in speed will indicate that the cylinder in question is functioning, for this short-circuits the ignition and cuts out the spark. Cutting out a dead cylinder will, of course, have no effect on the operation of the engine, and in this way it is comparatively simple to find which cylinders are failing to do their work. In the case of a multicylinder

engine, in which the short-circuiting of one plug will not have a sufficiently marked effect on the speed of the engine to determine the condition of that cylinder, it is well to remove the high-tension wire from half or a third of the spark plugs, and test at first only those which are connected. It is evident that the effect of cutting out one cylinder from among three or four will be more marked than if one cylinder is short-circuited from among six, eight, or a dozen.

If the difficulty is due to a

Stuck Valve

you can test it by noting the loss of compression in the cylinder when the engine is turned over by the hand crank. Remember that in the four-cycle engine, as used on all automobiles, two complete turns of the hand crank must be made before all the cylinders will have reached their compression stroke. A valve which is stuck will remain open, and where the trouble lies with the exhaust or the intake valve, the difference in compression can be felt easily. If your engine has a relief cock in each cylinder, these may be opened, and the difference in sound of the escaping air will determine which cylinder is forcing its compression through an open exhaust or intake valve. A valve will stick due to overheating or a lack of lubrication between the stem and valve guides. The

injection of a few drops of kerosene or oil squirted on the end of the valve stem may serve to loosen the grip of the guide after the valve has been allowed to cool. Use the valve tool, which should be a part of the tool kit of every car, to remove the valve spring by the method shown in your instruction book. Then, by means of a screw driver, gradually pry the valve loose until it is absolutely free. The next time you have the cylinder head off of the engine to grind the valves, dress down, with fine emery paper, any of those which may have become stuck, and apply a little dry graphite to the stems.

Nine times out of ten, however, the cause of regular missing in one or more cylinders of an automobile engine will be found in the

Ignition System.

If there is a brilliant spark at each plug when the screw driver is held within an eighth of an inch of the terminal (instead of directly against it, as described in a preceding paragraph of this chapter), you may be sure that the wires, timer, distributor, coil, and battery are functioning properly. If there is no spark at one plug, look for a

Broken Wire

from that plug to the distributor; or for

Dirt on the Distributor

which may short-circuit the current intended for the cylinder in question.

If there is a spark at the plug terminal of the offending cylinder, you will need

A New Plug.

However, if you have been foolish enough to start on your trip without an extra spark plug, remove the damaged one and examine it for

Oil or Soot.

The hollow space surrounding the central electrode or interior projecting sparking point should be scraped clean. The electrode or wire point, across which the spark jumps, should also be kept clean and set at a distance of about the thickness of a worn ten-cent piece. If the

Points are Jammed

together, no spark will occur at the proper space inside the cylinder, as a free-and-easy path will be furnished and the current will have no occasion to jump the intervening air space.

A Broken Electrode

cannot be repaired and it will be necessary for you to leave the plug in place and "limp" to the nearest supply store, where you should lay in an adequate stock of spare spark plugs.

A SPASMODIC OR INTERMITTENT MISS

of the engine is more difficult to determine, as it may occur only when the engine is pulling up heavy grades or when it is speeding on a level. The trouble can be due to the same three systems as indicated in the first page of this chap-

ter, but the original source will be somewhat different. For example, we have shown how a valve which is stuck will cause that cylinder to miss regularly and continuously, but a

Leaking Valve

may cause a cylinder to miss only at wide-open throttle or when the engine is pulling through deep sand or up a hill. A leaking valve will be caused by an accumulation of carbon or pit marks, due to excessive running without grinding. Valve grinding is a home or public-garage operation, and cannot be performed on the road. However, the valve can be cleaned somewhat by injecting kerosene into the air opening of the carburetor, when the car is at rest and the engine speeded up. This will serve to soften the carbon and may temporarily provide a seat which will hold compression and explosion pressure.

A leaking valve may also be caused by a

Tight Tappet.

The desire for a quiet engine often induces some repair men to set the nuts at the ends of the push rods and tappets too close together. This keeps the tappet roller or other form of cam follower continually against the cam surface, and when the engine is warmed, and the metal expands, the valve stem will lengthen sufficiently to prevent actual seating of the

valve. The nuts between the valve stem and tappet should be turned back, so that there is a space between the two surfaces for the insertion of a thin piece of cardboard not quite as thick as an ordinary visiting card. This should be done, of course, when the valve is in a closed position. A clattering valve is better than one which is quiet at the expense of lost compression.

The

Ignition System

is the basis of many mysterious and elusive misses or skips in the cylinder. The spark occurs at the gap in the spark plug, because it dislikes to jump an air space. The resistance offered by this air space increases as the compression in the cylinder increases. This compression in the cylinder increases as the volume of air to be compressed grows larger, and the engine sucks in more air as the throttle is opened. Consequently, pressure and resistance to the passage of the spark grow greater as the throttle is opened for high-speed travel, for pulling up a hill, for running through sand, or other heavy going.

Therefore a

Weak Battery

which may furnish sufficient current for a spark at low speeds or idling of the engine, will be

inadequate for the purpose at high speeds. The remedy is to have the battery charged at the nearest service station; or in an emergency to insert half a dozen dry cells in connection with the battery and limit the use of the horn and lights until a fully charged battery can be obtained. Do not try to run with the battery disconnected, relying on the current for the spark produced by the generator. It will burn out the windings of the latter.

A Wet Coil

which has been dampened from exposure to the rain or through washing of the car, will occasionally give trouble, although it is more probable that the difficulty will first evidence itself in a difficulty in starting the car, as described in Chapter II, "When the Engine Will Not Start." This will make a weak spark in all of the cylinders, and will cause the engine to miss at moderate loads. A spare coil should be installed until the wet one can be thoroughly dried out in the sun or in a warm place near the stove, and care should be taken to prevent a recurrence of the difficulty by covering the coil with oilcloth or a rubber "apron." If the engine has been run far enough to become well warmed, and no spare coil is on hand, the original coil may be removed and placed on top of the engine, where it will dry out more quickly than if it is left in

its cooler position on the dash or wherever it may be placed under the hood.

If your car has been run several thousand miles without attention to the timer, the intermittent skip or miss in the engine will doubtless be caused by

Dirty or Pitted Contact Points.

These are made of platinum or tungsten steel, and are in the form of very small buttons, which constitute the contact points of the circuit breaker in the timer. These should be kept clean and smooth with emery paper, and should be so finished that their surfaces will come together at all points. They should also be set so that their maximum separation is slightly less than that of the spark-plug points, but nearly all cars are equipped with a gauge of some kind, by which this setting may be tested. A fine file may be drawn between these points when they are pressed together with the fingers. Be sure to remove all particles of metal with a gasoline-soaked cloth. If the contact points are badly pitted, or are uneven, due to excessive sparking or arcing, new ones should be installed at the first opportunity.

A Loose Wire

leading to one spark plug will make that one cylinder miss. A loose wire from the coil, battery switch, or timer will cause all cylinders to

miss at once for one or two revolutions until the vibration of the engine makes connection. All the connections should be tried with the fingers, to make sure that the terminals or binding posts have an adequate grip at the ends of the wires. Remember that whenever the ammeter on the dash shows a passage of current when the engine is turned over, there is no trouble with connections between the battery switch and timer. This refers only to moving the engine by hand.

After a spasmodic miss has been found to exist in one of the cylinders, and it is seen that the high-tension wire leading from distributor to that spark plug is properly attached, we may lay the difficulty almost certainly to the

Spark Plug,

which, although not functioning properly, may merely need cleaning. The accumulation of

Soot

on the spark plug which does not quite bridge the gap will reduce the efficiency of the spark and cause that cylinder to miss at high speeds or other conditions of wide-open throttle. Soak the plug in kerosene and use a dull knife blade to scrape off all of the carbon from the points as well as inside the shell. Do not be too sure of a plug which will show a good spark when laid on the cylinder head with a high-tension

wire attached and the engine turned over by hand or by the starter. Remember that the low pressure of the outside air does not offer the maximum resistance to the passage of the spark, and that there may be a

Cracked Porcelain

which will permit the current to leak through when the plug is screwed in place in the cylinder head. If the plug is of the type having an outside electrode in the form of a wire, this can be bent away from the central electrode to a distance of one quarter of an inch or more. If the engine is then started when the spark plug is laid on the cylinder head with the high-tension wire connected, a spark across the greater space will indicate that the plug is in good condition.

The sound of a spark, however, if not noted at the point between the electrodes, will indicate a cracked porcelain or a broken electrode inside the shell, in which case a new plug must be secured in order to obtain satisfactory results.

Intermittent missing at slow or idling speeds in a certain cylinder can very often be attributed to a

Narrow Spark-plug Gap.

A hotter spark is required to fire the mixture at low speed than is the case at high speed. The narrow gap naturally forms a short spark, which does not furnish the quality of ignition

necessary to explode poor mixtures at slow speeds. Consequently, there is a close relation at this point between spark-plug adjustment and carburetor adjustment. Spark-plug points on a battery ignition system should be set at a distance equal to the thickness of a worn ten-cent piece, or slightly greater if the battery is in good condition. The points on plugs used with a magneto in the ignition system should be set according to the gauge furnished by the magneto or car manufacturer.

Missing at high speeds or wide throttle openings when the car is pulling up a hill or through sand or mud, may indicate a

Wide Spark-plug Gap.

Remember that the greater the distance the spark must jump, the greater the resistance offered to its passage. Also that the higher the compression in the cylinder the greater is this resistance, and that with wide-open throttle the cylinder compression is at its maximum. Bend the sparking points closer together if missing occurs at high speeds, especially if the battery or other portions of the ignition system are not in the best of condition.

The

Fuel System

may contribute very largely to intermittent missing of various cylinders. A deviation by

only a small percentage in the proper ratio of fuel to air may cause all the difference between smooth and irregular running.

Irregular running, accompanied by back-firing or popping through the carburetor, may be caused by a

Weak Mixture

which can often be remedied by a proper adjustment of the carburetor—opening the needle valve or other means of controlling the flow of fuel.

An

Empty Fuel Tank or Clogged Fuel Pipe

will, as a rule, produce continuous missing, which rapidly becomes worse, until the engine finally stops. However, a partial clogging of the fuel line or of the strainer will cause the engine to miss when it is running at high speed or with wide-open throttle, when the maximum amount of fuel is required. If the engine is then slowed down and runs properly under these conditions, and also for a while after it is again speeded up, we can positively lay the condition to a stoppage of the fuel line, which permits the float chamber of the carburetor to fill when the demands upon it are small, as in slow running, and which is then rapidly emptied when the engine speed is increased. Nearly all cars are provided not only with a fine screen or

strainer in the fuel line, but also with a water trap, into which water will settle by reason of its greater gravity. This water trap should be drained frequently, for

Water in the Gasoline

will cause irregular running similar to that occasioned by a partial stoppage in the fuel pipe.

Irregular running, accompanied by a choking smell and black smoke, especially at moderate speeds, indicates a

Rich Mixture.

The carburetor may be adjusted to reduce the amount of gasoline passing through the needle valve, or, if the carburetor has a tendency to drip gasoline, the float chamber should be drained to remove any particles of dirt which may have accumulated in the float valve. Continued flooding of the carburetor may indicate a

Leaking Carburetor Float.

If the float is of the hollow type, this may be removed, and the gasoline which has entered driven out by the application of heat. The boiling point of gasoline is less than that of water, and consequently, if the float can be submerged in a small quantity of boiling water, the gasoline will be driven out. The small hole constituting the float leak can be observed at the same time, and may be plugged by means of a bit of solder. A temporary repair may be

made with a piece of gum, wax, shellac, or other substance not soluble in gasoline.

Continued and aggravated evidence of a rich mixture which cannot be cured by any of these methods, almost certainly indicates a

Leaking Vacuum-tank Float

if the car is provided with this type of fuel supply. When the float of the vacuum tank leaks it fails to rise when the fuel level in the main chamber has reached the proper height, and the gasoline will continue to flow from the supply tank. The suction exerted by the engine will not be shut off under these conditions, with the result that more gasoline is sucked into the intake manifold of the engine and each cylinder is supplied with a surfeit of fuel. The vacuum tank cover should be removed, taking care, during this operation, not to damage the gasket. A new float should be installed or the old one repaired in much the same manner as that described in connection with a leaking carburetor float.

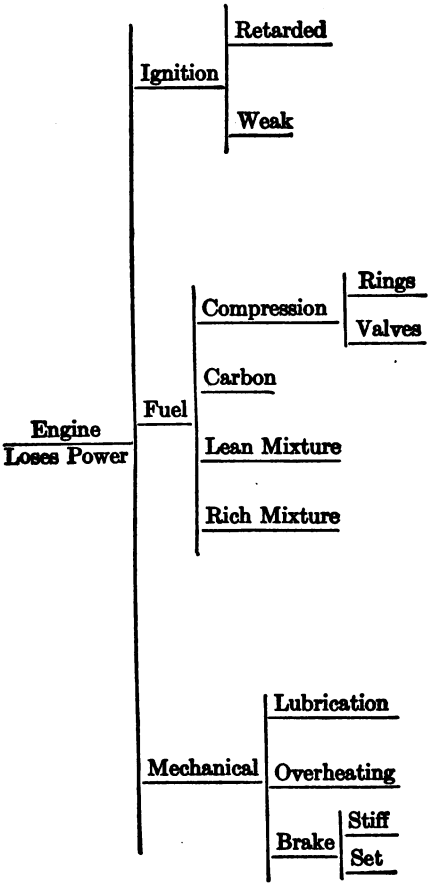
Uncertain and occasional missing of explosions, which produces a "bucking" or jerking of the engine, and which is not due to faults in the ignition system as already described, can frequently be traced to an

Air Leak

in the intake pipe or manifold. This air leak may not be noticeable at certain speeds, but as

soon as the suction is increased through closing the throttle, enough air may enter the defective gasket or other aperture to dilute the mixture to the missing point. If a new gasket is needed, the torn pieces should be scraped clean from both surfaces, and a new one cut out of heavy wrapping paper and applied as described in Chapter III, "When the Engine Stops." Remember that shellac makes the best "cement" for a gasket which is to hold gasoline or air pressure and is not subjected to heat.

How and Why of Chapter V
When the Engine Loses Power



CHAPTER V

WHEN THE ENGINE LOSES POWER

WHEN all cylinders fire evenly without skipping, we may look for trouble external to the individual cylinders. This difficulty may be

MECHANICAL

and entirely foreign to the engine itself. If the engine seems sluggish and unresponsive, look first to see if the

Emergency Brake

is released. You may be an experienced driver, and yet the best of us will frequently drive for miles with the emergency brake set for the last stop.

The

Foot Brake

may also be stiff and fail to release itself.

An

Overheated Engine

will soon lose power, as described in Chapter VII, "When the Engine Overheats." The cause of the overheating should be determined, how-

ever, long before it begins to affect the power developed by the engine, otherwise you may suffer from a burned-out bearing.

The lack of the proper

Lubricant,

however, in the engine itself, or in a transmission or rear-axle bearing, will produce the same effect as though the car were being constantly driven up a moderate grade.

Difficulty in the

FUEL SYSTEM

may often produce a loss of power evenly distributed over all cylinders. An obstruction in the fuel line will cause various cylinders to miss intermittently, but a

Rich Mixture,

inasmuch as it burns slowly, will not offer the "snap" furnished by a mixture composed of the proper combination of gasoline, vapor, and air.

A Lean Mixture

may help to produce the same effect, although it will, as a rule, be accompanied by popping and explosions through the carburetor.

Carbon

in the cylinders will cause an engine to lose power, and will also be accompanied by a pronounced knock when the throttle is opened under load or when the spark is advanced. (See

Chapter VI, "When the Engine Knocks.") The effect of carbon will not be noticed until the engine has become thoroughly warm after several miles of operation.

Another principal cause for a loss of power is a

Compression Leak.

The power developed by an explosion is largely dependent upon the amount to which the charge is compressed previous to ignition. If the valves or piston rings are not tight, they will furnish an easy means of escape for the compressed charge, with the result that the following explosion will be greatly reduced in intensity and effectiveness. If the difficulty is due to the

Valves,

they should be ground and reseated at the first opportunity, although this is not a roadside job.

If the loss of compression is due to

Leaking Rings,

they should be replaced by an expert at a garage. A temporary remedy of this trouble can sometimes be obtained by the use of copious quantities of kerosene fed into the intake opening of the carburetor when the engine is speeded up. This will serve to loosen any gummed oil and carbon which may have settled

in the piston-ring grooves. The piston rings are dependent upon their elasticity and springiness for their efficiency, which causes them to expand and grip all portions of the cylinder walls. After the gummed oil has been cleaned out by the use of kerosene it is well to use a heavier grade of oil for a while, in the hope that the greater body will help to seal the space between the rings and the cylinder walls through which the compression and the force of explosions escapes.

The

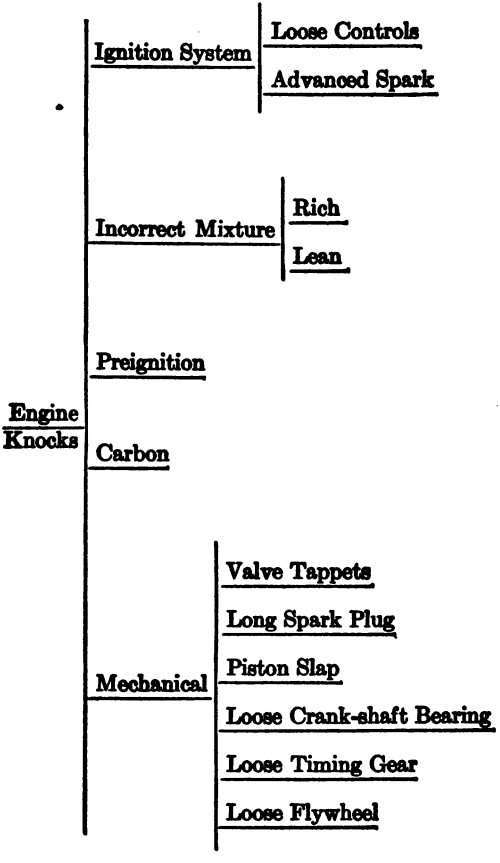
IGNITION SYSTEM

may occasionally be responsible for a loss of power in all of the cylinders, although when the engine is well warmed a spark which will just ignite the mixture will perform its work almost as well as though it were considerably hotter and fatter. In other words, it is only under more severe conditions of operation, such as cold, idling, heavy pulling, and the like, that a weak spark will assert itself. A

Retarded Spark,

of course, occurs as the piston is on its downward stroke, in which case much of the effectiveness of the explosion is lost. This produces a loss of power and causes eventual overheating, as described in Chapter VII, "When the Engine Overheats." If the spark is retarded,

even though the spark lever is pushed toward its extreme limit of advance, look for a lost or broken connection in the linkage which should transmit the movement of the spark lever from the steering post to the timer.


Engine Knocks
Ignition System
Loose Controls
Advanced Spark
Incorrect Mixture
Rich
Lean
Preignition
Carbon
Mechanical
Valve Tappets
Long Spark Plug
Piston Slap
Loose Crank-shaft Bearing
Loose Timing Gear
Loose Flywheel

CHAPTER VI

WHEN THE ENGINE KNOCKS

REMEMBER this, *a knock or other similar abnormal sound represents wear.* Such a sound may also be the result of wear, but, nevertheless, it means more wear as long as the conditions producing it continue.

As a rule, a knock in a gasoline motor can emanate from but two sources—

overheating or
detonation (preignition).

However, we may divide the contributing causes of knocking into the four following:

mechanical,
overheating,
fuel,
ignition.

The

MECHANICAL

type of knock is, as a rule, due either to overheating or to an overload applied to some part not able to withstand such a load. For exam-

ple, a frequent cause of a mysterious knock may be due to a

Loose Flywheel

in which case overheating has not as yet taken place, but the load imposed by the flywheel has been too great for the key, nut, squared shaft, or other means of holding the flywheel in place. A flywheel represents so heavy a mass that the retaining means must be exceptionally tight. You cannot test the nut or key with your fingers or even a moderate-sized wrench. A heavy wrench, supplemented by a long length of pipe into which the handle is inserted, must be used to make sure that the nut is sufficiently tight.

A similar but less violent knock may be caused by a

Loose Timing Gear,

in which the key or other retaining means has been worn. Unless such a sound is aggravated, however, you will be able to drive the car for some time, until an expert repair man can remove the gear case and fit a new key or other retaining device.

The ability to locate a sound is important if we would determine its cause. If the engine knocks when not in gear, it may be advisable to listen and determine whether the sound comes from the front or rear part, or from the upper

or lower portions. A device sometimes employed by garage men is useful for this purpose, and consists of a metal diaphragm similar to a telephone receiver, in the center of which a long, slender steel rod is attached at one end. On moving the other end of this steel rod around the various parts of the engine, and holding the ear close to the cup-shaped diaphragm, the source of the sound may be located through the same magnifying principle as that employed in the physician's stethoscope.

A mechanical thump or knock when the engine is pulling, and which does not disappear when the remedies suggested under the

Fuel

and

Ignition

headings are applied, is certain to be due to a

Loose Crank-shaft Bearing.

The engine may be run slowly under these conditions if the knock is not pronounced, but the indication of trouble should not be overlooked, and the bearings should be repaired or taken up at the first opportunity. There is no roadside remedy other than the assurance that the crank-case oil is clean and of the proper quality and quantity.

Many mysterious knocks emanate from the cylinders, and may be due to a

Piston Slap,

produced through the accumulation of carbon or faulty ignition or carburetion, as mentioned under those headings in this chapter. However, use of the wrong type of

Spark Plug

in certain kinds of engines may interfere with the free movement of the piston. If the spark-plug opening is placed so near the point reached by the top of the stroke of the piston that a long spark plug will interfere with the movement of the latter, a pronounced knock will be heard unless the proper type of plug is employed.

Many so-called engine knocks are due to the

Valve Tappets.

This is not actually a knock, however, but is a click produced as the cam revolves and raises the valve. While such a sound indicates wear, it is not serious, and it is far better to have the tappets loosely adjusted, so that such a sound is produced, rather than to have them absolutely tight and run the risk of preventing an absolute seating of the valve when the engine is warm and all metal parts are expanded.

A frequent cause of knocking is

OVERHEATING.

The reasons for overheating are fully discussed in Chapter VII, "When the Engine Overheats." A piece of metal which is overheated expands

beyond its normal amount. For example: if the piston expands unduly, it will grip the walls of the cylinder more tightly, and require greater effort to move it. The slightest looseness of the connecting-rod bearing will assert itself with a pound or thump whenever the connecting rod endeavors to pull or push the tight-fitting piston.

A companion to overheating is

CARBON

trouble, which, through the formation of projecting points becoming incandescent after incessant explosions, causes

PREIGNITION

of the mixture. Preignition is an explosion which occurs prematurely in the cylinder before the piston has reached the top of its stroke. The violent downward thrust imparted to the piston when it is already traveling upward produces an impact transmitted through the connecting rods that results in a violent knock. A badly carbonized engine may be cleaned partially on the road, although the most thorough method consists in the removal of the cylinder head and scraping the surface carefully. Many garages have oxygen tanks, by means of which the carbon can be burned out. Carbon is inflammable when its combustion is supported by oxygen. Consequently, the carbon will burn,

and when it is all consumed the flame will be extinguished of its own accord, because oxygen itself is not combustible, but is only a supporter of combustion. When the carbon is burned out of the cylinders the cooling system should be filled with water, and the pistons brought to the top of the stroke, so that the minimum amount of cylinder surface will be exposed to the flame.

Running a small stream of water through the air opening of the carburetor when the engine is idling with a fairly wide-open throttle, will loosen small quantities of carbon. A quart mixture of four parts of kerosene to one part of lubricating oil poured into the carburetor in a small stream, in the same manner, will also loosen the carbon and, at the same time, help to lubricate the valve stems.

There are several excellent carbon-removing chemicals on the market which, when properly used, produce satisfactory results. One of the best known of these should be poured through the spark plug or pet-cock opening in each cylinder. One to two ounces is the proper dose for each, depending upon the amount of carbon which has collected. The engine should then be turned over, with the spark shut off, for a few times, and then left to rest for three or four hours. At the end of this time the motor should

be primed, the carburetor adjustment set for a rich mixture, and the engine started in the usual manner. Fumes from the carbon remover are not explosive, and consequently several revolutions of the starter will be required before the liquid will be removed. Best results are obtained if the liquid is introduced when the engine is warm, but not hot, as too much heat will evaporate the carbon remover before it has a chance to attack its enemy in the most effective manner.

Of course any condition that produces carbon is indirectly, at least, a cause of a knock in the engine. A direct cause of a knock, as well as carbon accumulation, however, is an

INCORRECT MIXTURE.

A Lean Mixture

may be so highly explosive that the heat due to the compression will ignite the mixture before the piston has reached the top of its stroke, in which case the same piston slap or knock will be produced as occurs because of preignition. A

Rich Mixture

produces carbon, but may also be the direct cause of a knock because of its chemical property and ability to produce sudden detonation. The remedy for such knocks naturally lies in the proper adjustment of the carburetor.

The principal cause of an engine knock, however, is to be found in the

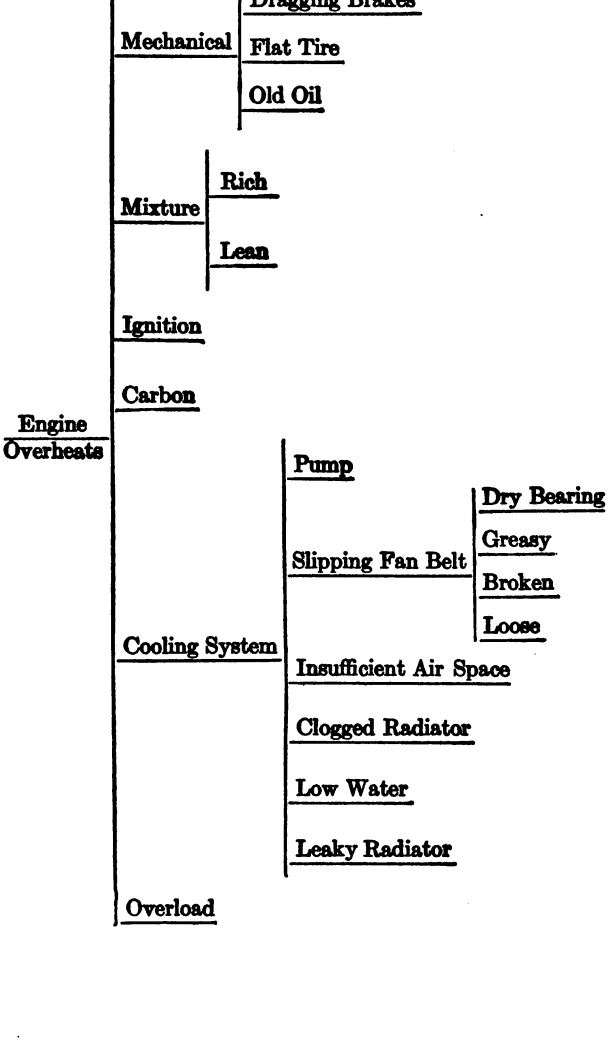
IGNITION SYSTEM,

and is due to an

Advanced Spark,

which causes the ignition to occur prematurely before the piston has reached the top of its stroke. The majority of modern motor cars are provided with automatic control within certain ranges of spark advance. This control produces a spark at the proper time, regardless of the speed of the engine, although such a spark may be advanced or retarded beyond the normal ranges, by means of the hand control on the steering wheel. The best remedy for a knock of this kind is the movement of the spark lever in the direction which retards the time of ignition. If this has no effect on the knock, make sure that the linkages and connections, by means of which the movement is transmitted from the spark lever to the timer, are intact and properly adjusted.

When the Engine Overheats



CHAPTER VII

WHEN THE ENGINE OVERHEATS

THE gasoline engine is primarily a heat engine. The heat generated by each explosion expands the gas, and thus forces each piston downward, producing the impulse which turns the crank shaft. Within certain limits the more of this heat that we can conserve the higher will be the efficiency of the engine. Lubricants and metals, however, can only withstand a limited amount of heat, the former breaking down and losing its lubricating properties under excessive temperatures, and the other expanding unduly and possibly losing some of its metallic characteristics. Consequently, some means must be provided for dissipating the excess heat generated in the cylinders of a gasoline engine. This heat is intense, and frequently reaches the melting point of iron, and, were it not for the means provided for disposing of the heat, our engines would become red-hot.

Air is the primary means used for disposing of the heat of a gasoline engine, and the difference between the water- and the air-cooled engine lies only in the method of transferring this heat to the air. In the first type, the heat from the engine is transmitted to water, which is pumped or circulated through the radiator, composed of a greater air surface than is offered by the engine itself. The air passing through this large cooling surface (known as the radiator) is then returned to the engine, where it again absorbs heat. In the case of the air-cooled engine, the radiating surface is formed directly on the cylinder walls of the engine and a strong blast of air forced directly across this surface. Some types of air-cooled engines employ no fans, and consequently all difficulties of the cooling system due to water circulation or defects in the pump, fan belt, or radiator, may be eliminated when dealing with certain types of cars.

A water-cooled car might safely be run at temperatures which would boil the water in the radiator, were it not for the fact that this very condition so exhausts the water that temperatures dangerously high will soon be reached. Therefore, boiling water is merely an indication that serious difficulties will soon be encountered.

The best-designed cooling system may occasionally give symptoms of overheating. When all parts are not in good condition, this trouble can only be due to an

OVERLOAD

on the motor, in which a greater amount of heat is generated in the cylinders than can be disposed of by the air as it passes through the radiator. The amount of heat generated in a gasoline-engine cylinder is dependent upon the amount of gas exploded, and consequently the wider we open the throttle the greater is the amount of heat to be disposed. On level roads this wide throttle opening means a greater speed, and as this results in a greater cooling effect on the radiator, conditions are equalized. When traveling up a long hill, however, or running through deep sand, the engine is working hard at a time when the cooling effect is reduced to a minimum. Consequently, do not be worried if the water in your cooling system occasionally boils after climbing long, steep hills, or pulling through sandy or muddy roads on low gear with a well-loaded tonneau. Keep the water in the cooling system at its normal level through frequent replenishment, if necessary, and "take things easy."

Inasmuch as water is the usual medium used

to transmit the heat of the engine to the radiator, the radiator and all parts of the

COOLING SYSTEM

must be kept filled. A

Leaky Radiator

is conducive to overheating, for a small amount of water will heat more quickly than will a greater amount. The radiator may leak through exposure to cold, in which case the expansion of the ice may crack a tube or series of cells; to vibration arising from high-speed travel over rough roads; to a puncture caused by collision with another object; or from rust. The permanent repair of a leaking radiator should be made by an expert who is familiar with radiator construction, and who can solder the leaks properly. The most satisfactory temporary repair, however, may be made by means of some one of the better known chemical radiator compounds, which should be poured into the radiator when the engine is running. A solution is formed which mixes with the water as it drips through the leak, and which, upon contact with the air, immediately solidifies. Such a repair may last for months, or even years, and a can of such radiator cement should be a part of the equipment of every motorist.

In the case of the thermo-siphon system of water cooling, in which no pump is used, but

which depends on the natural tendency of heated water to rise,

Low Water

will cause overheating, owing to the reduction of the speed of circulation. The water in the radiator and tank should be kept above the opening through which the upper pipe discharges the heated water. If this opening is uncovered, the siphon action will cease or be materially reduced. The thermo-siphon system of water cooling uses large hose connections in order to reduce the resistance to circulation to a minimum.

Rust from the water jackets will eventually accumulate, as well as impurities and lime from hard water. These substances will coat the interior passages of the radiator and may eventually clog them so that the flow of water is greatly restricted. A

Clogged Radiator

should be drained, and then filled with a solution of about five pounds of washing soda dissolved in boiling water. The engine should then be run so that this compound will be circulated through all the passages. If the radiator is then drained and again filled with clean water, the entire cooling system will be cleared of obstruction. Use great care when filling the radiator with the soda solution, for it will attack

paint and dull the finish of radiator and bonnet if any is spilled.

Remember that the eventual cooling of the engine is entirely dependent upon the speed with which the air passes through the heated water and over the engine. Any obstruction in the passage of this air will reduce the cooling effect, and consequently

Insufficient Air Space

will cause overheating almost as quickly as will an insufficient amount of water. The tendency to cover radiators partially or entirely, during cold weather, is frequently conducive to overheating if the air obstruction is not removed—especially during a long run at fairly high speeds and wide throttle opening. An engine having a tendency to overheat in warm weather may sometimes be helped by opening or removing the motor bonnet. This affords a more ready circulation of the air and may indicate that the designer has failed to put a sufficient number of openings in the side of the bonnet, or has not left a large enough space between the engine pan and floor boards of the car, through which the air may leave the engine compartment after passing through the radiator.

The rapid passage of the air through the radiator is facilitated by the fan, which is usually

driven by a belt passing over a pulley at the front of the engine. A

Slipping Fan Belt

will reduce the amount of air forced through the radiator. This may be caused by a

Looseness of the Fan Belt.

Nearly all cars are provided with some means whereby the fan belt may be tightened through raising or lowering the fan bracket. Some are mounted on a crank or arm, which may be swung upward or downward after loosening the clamping nut, while others are placed in a slot. A

Broken Fan Belt

must be replaced with a new length, which should always be a part of every motorist's equipment. Repairing an old fan belt is an unsatisfactory job. Before starting on an extended trip, be sure you know how a fan belt should be applied to your engine. If you purchase one intended for your particular make, you may be able to slip it over the fan and both pulleys when the former is moved down to its lowest adjustment position. If the endless type will not fit over your fan, you should carry a length which may be "threaded" around both pulleys, and which can then be clamped in place by means of belt-lacing or some one of the special adjustments available at any acces-

sory store. In cutting a leather belt to the proper length, be sure that the fan is moved to its lowest position, so that plenty of room for tightening will be provided. A

Greasy Fan Belt

will slip easily, and should be cleaned with gasoline. The source of the grease leakage should be found and remedied.

A belt will slip, even though it may be provided with sufficient gripping power, if the

Fan Bearing

is dry. A grease cup or oil hole is generally provided, by which the fan belt may be lubricated. Inasmuch as the fan revolves at high speed, this bearing should be well oiled or greased, for if it runs dry it will turn hard and the belt will be unable to do its work. In this connection, remember that a fan which is too tightly adjusted will run dry more quickly than one in which the belt tension is correct.

The majority of cooling systems employ a

Pump

to assist in the circulation of the water through the radiator and engine jackets. A broken pump-shaft key or gear will render the pump inactive when the engine runs, and circulation of the cooling water will become so sluggish that but little cooling effect is produced. The same effect will be observed to a less extent if

one or more of the pump vanes or paddles are broken. The effect of the pump can sometimes be felt if the upper hose connecting the cylinder jacket with the top portion of the radiator is grasped firmly, or, rather, pinched tightly between the hands. The throbbing of the water as the engine runs will indicate that the pump is operating properly. It is never necessary to prime the water pump, because it is so located at the lower portion of the system that it is always surrounded by water.

CARBON

serves as an excellent insulator and prevents the ready passage of the heat from the piston and cylinder walls to the water jackets. This may sometimes produce the peculiar condition of an engine overheated internally, in which the water does not boil. Eventually, however, the heat will pass through the layer of carbon and will be absorbed by the water in greater quantities than can be dispelled by the radiator. For the cause and remedy of carbon troubles see Chapter VI, "When the Engine Knocks."

A frequent cause of the overheating of an engine is a

RETARDED SPARK.

If the spark does not occur until the piston is well started on its downward stroke, a large

area of the cylinder wall is exposed to the action of the flame. The resulting explosion is weak, and it is exerted after the point of highest compression, and the energy of the gas, which should be developed in the form of power, is wasted as excess heat. Consequently, an engine which overheats from this cause will be logey. The obvious remedy is the adjustment of the spark, so that it will occur at the top of the stroke or slightly before, depending upon the speed at which the engine is to be operated. Occasionally the linkages connecting the spark lever on the steering post with the retarding mechanism will become loose, with the result that the movement of the spark lever has no effect on the spark timing. The time of the occurrence of the spark may be noted by placing a spark plug on its side at the top of the cylinder head with the wire well connected, and observing the position of the piston when the spark occurs. The engine should be cranked slowly by hand by an assistant, and the position of the piston may be determined by inserting a screw driver or long rod through the spark-plug opening, and noting its change in position as the piston rises or descends.

INCORRECT MIXTURES

will have somewhat the same effect as a retarded

spark. A mixture which is too rich or too lean is slow burning, and a

Raw Flame

still exists in the cylinders at the time that the piston has completed its stroke and the exhaust valve is opened. The mixture should be regulated, so that when coasting down a hill with the throttle closed and the engine in high gear, a slight puffing noise may be heard at the muffler. This indicates a mixture slightly leaner than might produce the best running, but one which is economical and which, when the engine is thoroughly warmed, will produce satisfactory average results. Any

MECHANICAL DIFFICULTY

which may interfere with the ease of motion of the car produces the same effect as climbing a hill, traveling through sand, or any other resistance of motion.

The most common trouble of this sort is

Dragging Brakes.

One brake or the other may be adjusted too tight for ordinary running. Such a condition may be determined by feeling of the brake drums and noting whether one or the other is unduly hot after a moderate speed on a level not calling for extensive use of the brakes. The releasing mechanism actuated by a spring on

the brake rods or within the brake drums, may require lubrication. A

Flat Tire

may have somewhat the same effect, although it is quite probable that such a difficulty would be brought to your attention either through your own sensation or from the warning of a passing motorist before the engine would be given an opportunity to overheat from this cause. You may well realize that a flat tire produces resistance to the motion of a car, however, if you try to push a car under these conditions even on a smooth garage floor.

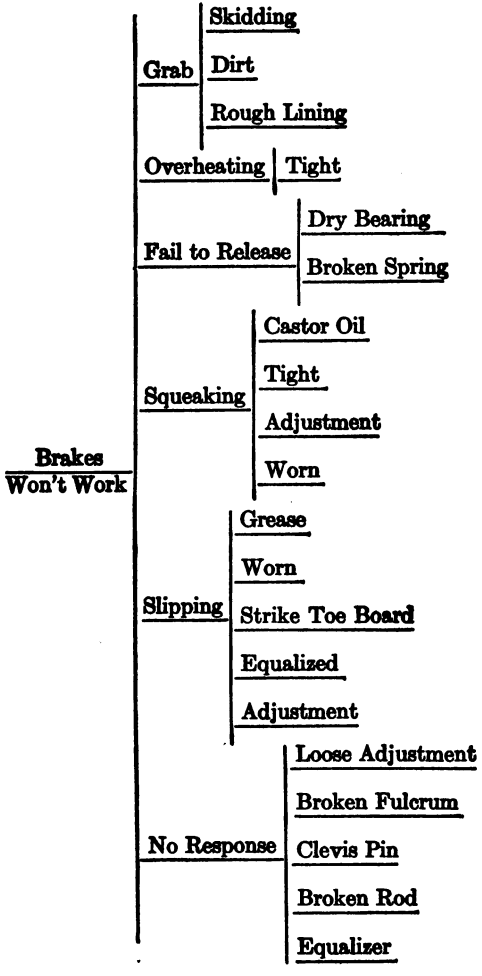
The crank shaft and connecting-rod bearings of an engine represent a source of heat, for they transmit the entire energy developed in the cylinders. A lubricant of the proper quality will carry this excess heat away. A lack of oil, or use of

Old Oil

which has outlived its usefulness, will allow the bearings to become unduly hot, and this heat will soon be transmitted to the cooling system. The good of the engine will demand a cleaning of the oiling system and a replenishment of fresh oil of the proper quality at the earliest opportunity. In the meantime, under these conditions, you should run as cautiously as possible, giving the engine ample time to cool. While it

is not the intention of this book to serve as sponsor for any particular type of accessory not furnished as regular equipment on all cars, this chapter can only emphasize the absolute necessity for some type of temperature indicator by means of which the temperature of the cooling water and its approach to the boiling point may be observed from the driver's seat.

When the Brakes Won't Work



CHAPTER VIII

WHEN THE BRAKES WON'T WORK

BRAKES depend for their operation solely upon the generation of friction, as friction is a resistance to all motion. The amount of friction developed depends upon the pressure between the two surfaces, the size of those surfaces, and their nature. The brake drum, which is attached to the wheel or propeller shaft, and revolves with them, is of cast iron. The stationary surfaces which may be expanded or contracted to grip the inner or outer surfaces of the brake drum are of metal, usually covered with some type of heatproof fabric. Occasionally we find brakes in which the metal is moved into direct contact with the brake drum, but this type of metal-to-metal brake is more popular on foreign cars than on those of American make.

When the brakes

FAIL TO HOLD

a thorough examination should be made immediately to determine the cause of the trouble,

for the operation of a car under these conditions is criminally dangerous. If

NO RESISTANCE

is offered to the pressure of the foot other than that which might be created by the pedal spring, you may be sure that one of the operating rods or connecting linkages is broken. The

Brake Equalizer

is a device intended to equalize the pressure exerted upon each brake regardless of its adjustment within certain limits. It operates on the "whiffletree" action of the horse-drawn vehicle. The brake-pedal rod is attached to the center of another rod placed at right angles to it. From either end of this transverse rod the linkage passes to the proper brake. A

Broken Link or Rod

on either brake will effect the operation of the other if an equalizer is used. Occasionally a

Clevis Pin,

which is the short, stubby pin passing through the eye and yoke of connecting-brake rods, may drop out. A repair may be effected temporarily by the use of a heavy nail or other piece of iron filed to the proper size to fit the holes in the clevis yoke and eye. Some positive means should be used for retaining this makeshift pin in place. If no small drill is available by which a hole may be made for a cotter pin, a turn or

so of wire may be employed. A ridge or groove should be filed around the end of the projecting pin, and fairly heavy copper or iron wire wound within this, and the ends twisted together tightly to form a projection which will not pass through the eye in the clevis if pressure is exerted to withdraw the pin.

All brakes must have some rigid and substantial means of adjustment to the axle housing or other non-revolving part of the rear end. This point of attachment receives the full shock of braking resistance, for its firm anchorage prevents the revolution of the brake band with the drum when the former is brought into contact with the latter. In other words, the two are gripped together to revolve as a mass, were it not for the secure attachment of the brake band at its fulcrum. Inasmuch as the brake band cannot revolve, a tendency is exerted to prevent the brake drum and wheel also from revolving. Thus a

Broken Fulcrum

will allow the brake band to turn slightly, and loosen the tightening effect of the brake linkages and rods. Depending upon the point at which breakage occurs, a repair may be effected sometimes by the use of a nut and bolt of the proper size. If the breakage is in the casting of the brake drum, a new part will be needed.

The car provided with an equalizer will be brakeless under these conditions, unless some means is used to secure the ineffective brake rod in place, so that the non-operating end of the equalizer will be held in the same position as though both brakes were working. This may be done by removing the clevis pin at the rear end of the rod near the defective brake, and lashing it in place by means of heavy wire or rope to some portion of the springs or rear axle. The sole object of this is to prevent movement of this portion of the brake at the expense of the brake-operating linkage at the other wheel. If an equalizer is not used, these precautions need not be taken, but the remaining brake must do double service and must be adjusted accordingly. Also, the emergency brake should be used more frequently to avoid the dangerous skidding effect obtained when only one brake is in commission.

If neither brake operates, the difficulty will be found in a broken rod or loose connection forward of the equalizer or transverse rod, which communicates the motion to each side of the car. One person should watch the brake band on either side, while the driver presses the brake pedal to determine whether there is any motion whatever communicated to either brake band.

If both brake bands move without retarding the car, a

Tighter Adjustment

is necessary. There are several points where such adjustment may be made which will vary with different designs of cars, and these will be described under separate headings in this chapter.

Brakes which slip will not bring the car to a stop as quickly as may sometimes be necessary, and consequently are a source of great danger.

SLIPPING BRAKES

are brakes which do not grip the entire drum surface with sufficient pressure, or which are covered with grease or other slippery material which serves to reduce the friction that should be generated by a certain amount of pressure. If the brakes slip they may need a

Tight Adjustment,

which may be obtained by screwing together the nuts which secure the end of the brake band. The smaller the opening between the two ends of the brake band, the greater will be the pressure on the brake drum for a given movement of the pedal. When released, the brake bands should allow freedom for the brake drum to turn. Adjustment also may be provided at the back of the brake, which serves to equalize the pressure in all directions. The adjusting nut

at this point should be so moved that the space between the brake band and the drum is the same at the top as at the bottom, otherwise the brake will grip more tightly at one point than at the other, and will not only wear more quickly, but will prove less effective for stopping the car.

Brakes should be

Adjusted Equally

so that the stopping effect is approximately the same on each wheel. This may be accomplished by jacking up both rear wheels, and with the transmission in first speed allow the engine to turn the wheels over slowly. If the brake is applied and one wheel slows down perceptibly, while the other turns faster, you may safely assume that the brake at the free wheel requires tightening.

If the brake pedal

Strikes the Toe Board

the necessary adjustment will be found at the clevises rather than at the brake bands themselves. It will be necessary to shorten the rods, either at the pedal or at the points where they join the brake arm. An adjustment is usually provided for this purpose which, after the clevis pin is removed, allows the yoke to be screwed farther on to the threaded end of the rod. Lock nuts are provided, so that the clevis eye or yoke will remain tightly in place after the

proper adjustment has been secured. If the screw adjustment is dirty or rusty, a few drops of kerosene should be applied to the threads. Some cars are provided with a double adjustment, by which the length of the rod may be changed without removing the clevis pin. Such are constructed with a two-way thread, in which the motion of a long nut brings the two ends together or forces them apart. Two lock nuts are provided in such designs, and both of these should be tightened hard against the adjusting nut after the proper distance has been obtained. A brake should be adjusted so that when its full effect is applied at the pedal there will still remain an inch or so of space between the pedal arm and the end of the slot in the toe board.

Another case of slipping is occasioned by

Worn Brake Linings,

which indicate the necessity for garage attention. Modern brake linings of good quality should give service down to the last eighth of an inch or so in thickness. If the wear has been unequalized, however, and such linings are worn through in some places, the effective braking area is greatly reduced. Worn or burned-out brakes should be replaced at the first opportunity.

Grease,

as the enemy of friction, is also an enemy of good braking effect. Grease from the differen-

tial may work its way along the live axle, through the felt retainers, and on to the brake drum. This is a difficulty especially noticeable at the right wheel, which, because of the American custom of keeping to the right, and of the high crown and low ditches of our country roads, is the point toward which excess grease will flow. When an excess amount of grease reaches one wheel or the other, the wheel should be removed and the drum and braking surface wiped clean. At this time a new felt retaining washer should also be installed in the outside bearing. If it is inadvisable to go to this time and trouble, an ample injection of kerosene on the brake lining may serve to cut the grease, so that a temporary braking effect can be secured. Fuller's earth may also be applied in small quantities to absorb and thus dry the excess grease, but the condition creating the excess grease should be remedied at the first opportunity.

SQUEAKING BRAKES

may be effective as a means of stopping the car, but they are unpleasant to occupants as well as all others within earshot. A brake which squeaks may be

Worn,

in which case the renewal of the fabric will prove to be the most effective remedy. Wear

may have been unequally distributed, so that a portion of the lining has worn through to the band, in which case the contact of the two metals will produce the annoying sound. Also, a brake lining which, although properly adjusted, has been worn through, will squeak because the heads of the rivets have become exposed and are held in contact with the metal drum when the brake is applied. Rivets should be of copper, which is softer than the iron of the brake drum, so that the latter will not be cut. Naturally, the renewal of the rivets is a much simpler matter than is the replacement of the entire brake drum.

An unequal

Adjustment

may also cause a brake to squeak. The pressure should be uniform throughout the entire length of the lining. Some brakes are provided with an adjustment at the side of the band opposite to the operating mechanism. The brake band is held loosely anchored at this point, and an adjustment for an up and down position is provided by means of a long screw and a spring. By moving the screw up or down, the amount of space, or "play," near the upper and lower halves of the brake may be evenly distributed. When the brake is released there should be as much freedom of motion at the upper half as

at the lower. Adjustment of both brakes should be such that the point of a screw driver can be inserted between the lining and the drum when the brake is released.

A brake which is set too

Tight

under normal running conditions may squeak when it is applied. Such a difficulty will also assert itself through overheating at the brake band.

A brake which squeaks without any apparent cause may sometimes be treated with a few drops of

Castor Oil.

This will not injure the brake lining and may serve to lubricate the "high spots" or other portions which are conducive to the unequalized friction which produces the squeak.

A brake which

WILL NOT RELEASE

when the foot is removed from the pedal produces undue friction, which will act as a drag on the car. This trouble can, as a rule, be attributed to a

Broken Spring

either at the forward end of the linkages or at the brake mechanism in the vicinity of the drum. If the spring is broken a wire may be used to hold it in place until a new one can be

secured. If, however, the springs are in good condition, the difficulty will be due to a

Dry Bearing

at one of the operating points of the brake linkage. Oil holes are provided at the fulcrum points for the brake pedal, and other lubricating means at the bearings through which the main crank arm passes. This crank arm is what serves to bring the two portions of the brake band together when the brake pedal is depressed. The pressure at this point is great, and lubrication should be adequate. If poor oil or grease has been used, or the oil hole has become stopped so that no lubricant reaches the bearing, it will become hard and dry and move with such difficulty that the strength of the spring will be insufficient to release the brake. The remedy lies in freeing the oil hole and the use of a few spoonfuls of kerosene, after which plenty of fresh lubricant should be applied.

OVERHEATING

of the brake is caused by applying the brake under severe conditions of downhill travel. A brake which overheats when it is not in use, however, indicates a

Tight Adjustment.

The brake should be sufficiently free, so that the upper and lower portions of the brake band

may be moved with the fingers when the pedal is not depressed.

Water may sometimes be used to cool the brake, although modern linings of the best quality are not seriously affected by heat, as asbestos enters largely into their construction.

Both brakes should be used alternately when descending a long hill. If both are applied at the same time, the brakes clamp the drum tightly on both sides, with but little chance for the heat that is generated to escape. But if the outer or foot brake is used first, and then the emergency brake, one may be cooling somewhat while the other is in use. However, a hill sufficiently steep or long to result in overheating the brakes requires the use of the engine as a brake in second or low gear, with spark retarded and the throttle closed.

Brakes should operate smoothly, quietly, and gradually. A brake which

GRIPS

may cause the wheels to slide despite the efforts of the driver to apply the brake gently. Gripping is caused by a

Rough Brake Lining,

which has been incorrectly applied, so that certain high spots will grip the brake drum before the remainder of the lining is brought into contact with the brake-drum surface.

Dirt

also will cause the brakes to grip unevenly. Here, too, the application of a few drops of castor oil will help to equalize the action.

Skidding

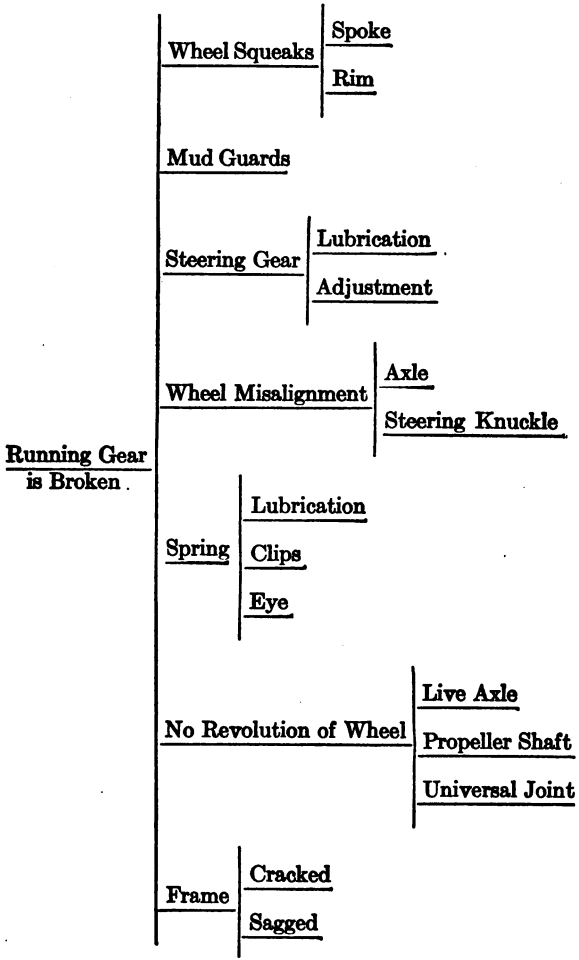
is frequently caused by the uneven action of the brakes. The wheel on which the brake is applied the hardest will slow down, and the car will turn upon this as a pivot. When this occurs, the brake should be released until the wheels can resume their normal course. Then a gradual application of the brake will bring the car to a stop.

Many cars are designed with a

PROPELLER-SHAFT BRAKE

operated by the foot, and the usual type of emergency brake operated by the hand. The directions which have been given for individual rear-wheel service brakes apply to the adjustment and treatment of the propeller-shaft brake, as the principle of operation of the two is the same.

When the Running Gear is Broken



CHAPTER IX

WHEN THE RUNNING GEAR IS BROKEN

THE running gear may be considered as the entire chassis, exclusive of the engine. This will, therefore, include the wheels, the springs, the frame, the axles, the steering gear, and the means of power transmission from engine to rear axle.

The frame is the foundation on which the car is built. It carries the engine, body and load, and also serves to "tie" the front and rear axles together. A

SAGGED FRAME

will not necessarily prevent the operation of the car, for although certain parts of the running gear may be thrown out of line, this is a condition which prevails every time that the car is run over rough or uneven roads. The repair of a sagged frame is a blacksmith's job, in which the application of heat at the proper point, and pressure exerted at the ends in the opposite direction to that applied at the point

of the bend, will serve to straighten the frame without danger of rupture.

However, a

Cracked Frame

is more serious, for it may eventually result in an actual break, which would not only put the car out of commission, but in so doing may irreparably damage parts of the running gear and body. A cracked or broken frame may be repaired temporarily by means of an iron plate or heavy wooden block, which must be driven in between the extending flanges of the channel section after the frame has been brought to its normal alignment, by means of pressure applied by the jack at the proper point. The iron plate or block of wood should be wedged in as tightly as possible in order to prevent loosening, as the frame weaves or fluctuates when the car is driven over a rough road. If a drill is available it is better to screw the plate or block of wood in place by means of rivets or bolts passing through the repair piece and the frame at either side of the crack. Unfortunately, so far as the ease of such repairs is concerned, the inside of the channel section of the frame generally faces inward, with the result that the plate or wooden block must be applied from the inside of the car, under the floor board. The removal of the floor boards or the application of the repair

piece from the under side of the car may sometimes solve the difficulty created by this inaccessibility.

With the transmission and clutch engaged, the revolution of the engine without a corresponding motion at the rear wheels may indicate a

Broken Universal Joint.

If this universal joint is of the "spider" type, the broken projecting arm may sometimes be replaced by means of a piece of steel rod cut and filed to fit the opening. The construction of a universal joint, however, is a matter of proper materials and accurate workmanship, and the car should not be run long under these conditions without the installation of a new joint.

Another reason for the refusal of the wheels to turn is a

Broken Propeller Shaft,

which condition will, of course, be obvious at the first glance under the car. It is far better that a new shaft should be installed, but, in case of an emergency, a temporary repair may sometimes be made by slipping a close-fitting piece of heavy iron pipe over the two broken ends and holding this in place by means of several pins driven through holes drilled in both sides of the pipe and through the shaft. Re-

member that the entire "shearing" stress of the power transmitted to the rear wheels is carried by these pins, and they should, therefore, either be made of exceptional strength, or a sufficient number used to distribute the load.

Another difficulty which will prevent the rotation of the wheels is a

Broken Live Axle.

If the rear axle is of the semi-floating type, this will permit the wheel to come off, inasmuch as the wheel itself is mounted on the extending end of the axle. If the rear axle is of the full-floating type, any apparent breakage can be observed from an inspection. The removal of the few nuts, however, which hold each live axle in place on the hub of the wheel, and the withdrawal of the live axle from either side, will quickly determine its condition. A breakage in a driving axle will serve to transmit all of the power from the engine to the point of least resistance, which, of course, is the broken end which can revolve without turning the wheel. The unbroken axle will not turn because the action of the differential transmits the power only to this point of least resistance.

In certain types of rear-drive construction, in which a certain means of holding the rear axle to the frame is used, a break in the propeller

shaft may be productive of serious consequences. This is due to the fact that the axle will be allowed to turn forward slightly, with the result that neither the foot nor the emergency brake can close sufficiently to obtain their full braking effect. This means that a car so constructed, which suffers from a broken propeller shaft, will be impossible to control, so far as checking its speed by means of the brakes and engine is concerned.

One of the most frequent accidents to the touring automobilist is a

BROKEN SPRING

caused, usually, by the sudden impact with a depression or obstruction in the road. Automobile springs are made of alloy steel, which permits of great flexibility and strength without brittleness. This means more or less delicate heat treating, and consequently the repair of a broken spring is a blacksmith's or forge shop's job. As a rule, it is better to replace the broken leaf with a new part, which can be obtained at almost any service station. A spring breakage is not particularly serious, as evidenced by the number of owners who may drive their cars for many miles before they are aware of the fact that a spring leaf has been ruptured. Springs are composed of layers of leaves of increasingly greater length, held together at the central point by

means of the spring clips which tie the bundle of leaves to the axles. A breakage at the

Spring Eye

can best be remedied by the replacement of the entire long-spring member at the first opportunity. Such a breakage, however, will generally permit of a displacement of the body of the car by but an inch or two, and will not interfere seriously with the operation of the car. If the displacement of the car due to this breakage is excessive, the frame may be jacked up and a block of wood inserted between the horn or other member to which the spring is attached, and the broken leaf. The remaining portion of the spring will then rest against the block of wood, which, of course, should be lashed in place firmly to prevent its loss when the car is driven over rough roads.

If the break occurs nearer the center, or in one of the several leaves, one of the many forms of spring clamps now available at any accessory store may be employed. The object of such a clamp is not so much to carry some of the weight borne by the spring as it is to prevent their undue separation on the recoil. The longer leaves of the spring are fastened together at their ends, so that this separation will not become excessive, for it is an important fact to remember that practically every spring breakage occurs on

the upward rebound of the car when such thrust is borne by the spring leaves individually. When the body of the car is depressed, due to the sudden flattening of the springs, the support given by each leaf is collective. In using a spring clamp, you should remember that the leaves must be allowed to slide as they are depressed, and return to normal, and that any clamp which serves to hold two or more leaves tightly together will absolutely fail of its purpose. For this reason an excellent temporary spring repair may be made by winding the broken portions tightly together by means of wire or heavy cord. This will prevent the separation of the leaves and yet will permit the necessary sliding motion between each.

Inasmuch as springs depend largely upon individual sliding motion for their flexibility, the adjoining surface should be kept clean and well oiled. Rust and dirt will soon accumulate, and it is well to separate the leaves occasionally by means of some of the tools prepared for that purpose, and insert copious quantities of graphite grease. This will gradually work its way throughout the length of the sliding surface, and will prevent the formation of rust. Other preparations are in the form of light oils, which penetrate all surfaces easily, and which, when applied to the edges of the spring leaves, will

work their way into the sliding portions. Protective coverings, which contain oil-soaked felt, and which may be wrapped around the entire spring, make an excellent combination to prevent the entrance of dust and to keep the spring leaves permanently lubricated. Other systems of spring lubrication, which are suitable for almost any car, consist of small oiled-felt pads which can be clamped to the outer end of the spring and from which oil will flow by means of capillary attraction; and strips of self-lubricating material which may be placed between each leaf in the assembly of the spring. The

Spring Clips

should be tightened frequently. These are the U-shaped pieces which surround the bundle of spring leaves on three sides, and the ends of which project through holes made in the spring seat of the axle or frame. The nuts on the ends of these spring clips should be tightened occasionally, especially within the first three or four thousand miles in the case of a new car. The continued action of the spring will greatly compress the leaves, and if the looseness thus produced is not taken up, spring breakage will be more frequent.

WHEEL MISALIGNMENT

will produce undue wear on the tires, although it will by no means prevent the operation of the

car—in fact, unless the misalignment of the wheels is decided, the owner may not be aware of the existence of any such condition until he may note that one tire is wearing faster than the others. Wheel misalignment is generally produced by a shock or collision, which may have bent the frame or moved the axles slightly at the spring seat. Continued operation of the car may also produce a distorted frame.

Front wheels are designed to tilt inward at the bottom somewhat, so that they do not revolve in a vertical plane. This tilting, or camber, as it is sometimes called, is designed to bring the point of application of the load on the road directly under the steering-knuckle point at which the wheel is pivoted. This reduces the leverage required for steering, and is the secret of the easy control of many of our heaviest cars. A sudden blow or collision may tend to bend the steering knuckle. This will result in hard steering and undue tire wear, but the remedy is easily accomplished by a blacksmith with his heating appliances and bending tools applied at the steering knuckle.

Another cause of wheel misalignment will be found in a

Bent Steering Knuckle,

which is the pivot on which the front wheels turn to direct the course of the car. The front

wheels of a car should "toe in" slightly, to take care of the tendency to spread when the car is driven forward at full speed. The wheels should be set so that the distance between the rims at the front should be about three eighths of an inch less when the car is at rest than the distance measured at the rear.

If the wheels do not toe in the proper amount they can be easily adjusted by lengthening or shortening the tie rod which connects the two steering arms, and which keeps the wheels in two nearly parallel planes. An adjustment is provided whereby the steering arms of the wheels may be brought closer together or forced farther apart.

Another cause of misaligned wheels is a

Bent Axle.

The front axle may be straightened by the application of heat at the bent portion, and a leverage exerted by means of a rod driven through the eyes of the steering-knuckle yoke.

The rear axle of the average car is of the hollow type, and cannot be bent, as the tubular type of construction is exceedingly rigid.

Reports of automobile accidents almost invariably state that "the steering gear failed to work." This is hardly probable, for the

STEERING GEAR,

as a rule, gives less trouble than any other part of the car. However, it may turn hard, due, as

a rule, to a lack of adequate lubrication. The steering housing, in which the worm gear or other method of transmitting the power from the steering wheel to the rods is housed, should be kept filled with grease. The ball-and-socket ends, in which the arm from the steering wheel operates, and the smaller end, in which the steering arm is inserted, should also be supplied with plenty of grease. The grease or oil cups located at the steering-knuckle pins should not only be well filled and screwed down tight in the case of the former type of lubricating system, but the channels should also be kept free from obstructions.

A steering gear in which there is

Too Much Play

indicates wear. Some steering gears are provided with two or three different positions on which the steering hub may be set, so that when one point is worn a new surface may be brought into use.

MUD GUARDS,

although unimportant so far as the actual operation of the car is concerned, are susceptible to damage because they are the first parts to be struck in the event of a front, side, or rear collision. They are generally made of pressed steel or aluminum, and if bent out of shape can at least be brought back out of contact with the

wheels by a strong, steady pull in the opposite direction. As a rule, mud guards are held in place by means of bolts or screws. In case of a bad dent they should be removed before any attempt is made to straighten them.

An annoying, but by no means serious trouble, with many modern cars, is the tendency to produce the sound known as a

RIM SQUEAK.

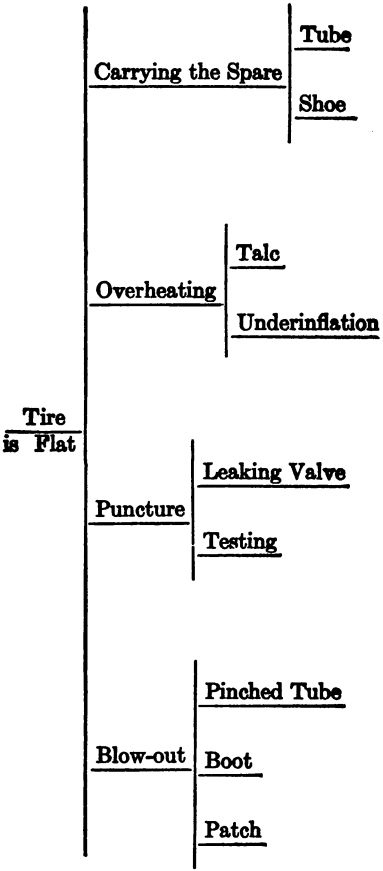
This is because the rim, on which the tire is mounted, does not rest evenly at all of its points of contact on the wheel. These points of contact are known as lugs, and by means of their wedge shape can be forced in between the rim and wheel with varying degrees of pressure. When applying a spare tire all lugs should be tightened partially before any one is tightened to its full extent. This will distribute the pressure equally. After the rim has been worn, the thickness of the lug may be insufficient to give adequate support, with the result that a squeak or click will be produced at each revolution of the wheel. Oversize lugs are available which will overcome this difficulty. A temporary remedy for a rim squeak may be made by inserting a wad of leather or double thickness of tire tubing between the lug and the rim. When the lug is then screwed into place, the pressure will be equally distributed.

Many so-called rim squeaks are due to a

LOOSE SPOKE

in a wooden wheel. Wooden wheels are assembled and glued together. This glue may dry out, with the result that one or more spokes will move slightly in their sockets. Sometimes a thorough drenching with water will serve to swell the wood and tighten the spoke. In the event of the failure of this treatment to remedy the difficulty, a preparation may be obtained which will serve somewhat the same purpose as the original glue, and when dry will fill the space in which the squeak occurred.

How and Why of Chapter X
When the Tire is Flat



CHAPTER X

WHEN THE TIRE IS FLAT

A TIRE will become flat from but one cause —the inability of the tube to retain air. The possible reasons for such inability of the tube to retain air, however, are many and various.

A sudden loss of the air, accompanied by a loud report, indicates a

BLOW-OUT.

If you are wise, and are well provided with spare tires, you will remove the injured tire and replace it with one of these spares, for a blown-out tire should not be used until it can be repaired by an expert. Remember that every foot that the car is driven on a flat tire will wreak infinite damage to shoe and tube, and may amount to an additional cost as high as twenty dollars to thirty dollars a mile. At the first opportunity take the shoe to an expert repair man, where it can be left for a day or so, and can be provided with a new section or patch, which should be vulcanized and cured properly.

The tube may not be beyond repair, although a severe blow-out will rupture the tube beyond the point where it is advisable to patch it. Save the tube, however, as the excellent rubber of which it is made can be applied to many a useful purpose.

If you have no spare tire already mounted on a rim, and find it necessary to use the one which has blown out, a

Blow-out Patch,

which should be a part of every emergency equipment, may be used. This is a series of layers of fabric vulcanized together, which, when properly applied, serves to reinforce the shoe at the ruptured point. The ordinary type of blow-out patch should be applied inside of the shoe, over the ruptured portion. The patch should be allowed to extend over the bead or clinch of the tube on either side, so that when the tube is inflated the ends of the patch will be gripped firmly between the tire bead and the retaining edges of the rim. Another type of blow-out protector is known as a

Boot,

which entirely surrounds the tire and rim of the wheel, and is laced in position. In lieu of either a blow-out patch or a boot, a section of old shoe may be used, and strapped firmly in place by means of cord or other binding material.

A blow-out is usually caused by a previous rupture of the fabric or cords in the tire. This rupture may not be apparent from an outside inspection, as the rubber tread is flexible and will not necessarily indicate any breaks in the structure of the supporting fabric or cord. The high pressure carried upon the tire, however, increased through the reaction of the blows struck when traveling over a rough road, will cause the ruptured fabric to blow apart in due course. The clincher type of tire, which is stretched over the edges of the rim, will sometimes blow off of the rim, due to the absence of the strands of wire embedded in the bead which are now employed in all types of the quick-detachable clincher, and straight-side clincher used on split rims.

A blow-out may be caused by a

Pinched Tube,

which will be occasioned by improper insertion of the tube in the shoe or the careless application of the flap. The flap is used in tires above the four-inch size to prevent direct contact of the tube with the more or less rough and rusty surface of the rim. When the tube is put in the shoe, it should be smooth all around, and then inflated slightly, so that it will retain its normal shape. The flap should then be inserted between the tube and the inside of the bead of

the shoe, and drawn tight and smooth. It is better to use a tube slightly smaller than the shoe than to use one which is too large, as the latter will wrinkle. For example, a four-inch tube can be stretched to four and a half inches in cross section without great immediate damage, but to install one of four and a half inches cross section in a four-inch shoe will cause wrinkling. Likewise, a tube which is too great in its ring diameter, will wrinkle, but on the other hand it is inadvisable to install one which must be stretched over the rim. Remember that the ring diameter of a $34 \times 4\frac{1}{2}$-inch tube is less than the ring diameter of a 34×4-inch tube, for we subtract twice the diameter of the cross section from the larger measurement of the tire to obtain the ring diameter. Thus a $34 \times 4\frac{1}{2}$-inch tube would have a 25-inch inside or ring diameter $[34 = (2 \times 4\frac{1}{2})]$. A 34×4-inch tube would have a 26-inch inside or ring diameter $[34 = (2 \times 4)]$.

A leak from which the air escapes more slowly than in the case of a blow-out is known as a

PUNCTURE,

and is less serious than a blow-out in that the tube only is damaged. However, a punctured tire should not be used, for it can be easily ruined if run when flat. The quickest remedy is the replacement of the punctured tire with

a spare; but if no spare is available, a roadside repair of the damaged tube may sometimes be made by means of the portable vulcanizing kit, which may be obtained at any accessory store. These kits operate on the principle of the application of the proper degree of heat to the cemented patch. In lieu of such an outfit, mechanically treated "self-vulcanizing" patches may be obtained, which will produce a more or less permanent repair without the application of heat.

Before the repaired tube or a new tube is inserted in the shoe, the inside of the latter should be examined thoroughly for the cause of the puncture. Inasmuch as it is not the function of the shoe itself to retain air, small holes caused by the entrance of a nail, tack, wire or other sharp piece of metal need not be repaired unless the rubber tread has been loosened from the surface of the tire. If the offending piece which produced the puncture is not removed, however, each tube which is used will eventually lose its air. Sometimes a small nail will work its way into a new tire, and yet will not puncture the inside of the casing for several months. This is especially true if the nail is shorter than the thickness of the tire when new, or if it enters at an angle, so that the point at first does not penetrate the inner layer of the fabric. When examining the shoe

for the cause of the puncture, the inside should be wiped clean and the beads forced apart so that a thorough inspection can be made. Wipe the inside with a piece of waste or a silk cloth. You will then quickly find the location of any projecting nail point or other cause of the puncture. The tube may be tested for a slow leak by inflation to fair pressure and then immersion in water. The leak will assert itself by the formation of bubbles at the point where the air escapes. Sometimes a tube will leak slowly, and yet the rubber itself will be in perfect condition. Such a condition may be due to a

Leaky Valve,

in which case the remedy is simple. The valve may be tested by applying a drop or so of saliva from the mouth to the point at which the air-hose screws when the tire is to be inflated. The formation of bubbles at this point will indicate a leaky valve. This should be replaced by a new "inside," which should be a part of the equipment of every motorist. The slotted end of the valve cap forms a special wrench, which, when inserted in the end of the valve, and turned to the left, will remove the defective valve "inside." The removal of this valve "inside" will cause the complete deflation of the tire. Remember, however, that air may be retained even in a leaky valve, if the valve

cap is in good condition and is screwed firmly in place. Dependence on the valve cap, however, is only a makeshift, for the valve "inside," which represents the point of greatest wear, should be sufficient for the purpose.

Heat is an enemy of vulcanized rubber; consequently it is advisable to keep tires as cool as possible. Temperatures due to traveling over sun-baked roads are not serious, but the heat generated by the friction, due to the continued bending of the side walls of a tire which is not properly inflated, will soon cause a blow-out or other rupture. Therefore, the primary cause of

OVERHEATING

is insufficient inflation. Do not be afraid of the increase in pressure due to the expansion of the air on a hot day. This is slight, and will not amount, in the ordinary tire, to more than three or four pounds. Therefore, tires should be inflated as hard on a hot day as on a cold day. One result of an overheated tire is a partial vulcanization of the rubber tube to the inner fabric of the shoe. This will cause the tube to stick tightly, so that it cannot be removed without tearing, or other serious damage. The best remedy is the use of

Talc or Powdered Mica.

This should be sprinkled freely in the shoe before the tube is inserted. Then after you have in-

flated the tube sufficiently so that it will hold its shape, slide it around inside of the shoe by means of the valve stem, in order to distribute the powder thoroughly. Avoid the use of an

Excess of Talc

or other lubricant, however, inasmuch as an oversupply will accumulate in the form of lumps and ridges, which may eventually puncture the tube.

Don't ever travel without an adequate supply of spare tubes and spare shoes. Tire trouble, however, seems so frequently to be a matter of luck that even the most cautious motorist will sometimes find himself with his supply of spare tubes exhausted, and no supply station available within several miles. We have already pointed out that a shoe will be ruined if run when flat. On the other hand, the operation of the car on a bare rim will dent the latter and will also prove very annoying to the occupants of the car. It is possible in an emergency of this kind to fill the shoe with grass, hay, cotton waste, or other similar substance which can be forced tightly into the casing before the shoe is mounted on the rim. Such stuffing is, of course, a makeshift at best, but it will serve to retain the shape of the shoe partially, and will reduce the damage which would otherwise result were the car run with an absolutely empty shoe.

Sorry is the plight of the motorist who finds himself stranded by the countryside with no spare shoe of any kind. The defective shoe may, of course, be used unless it is necessary to cut this up for blow-out patches for use on another tire. In lieu of any shoe whatsoever, however, rope may be wound around the rim to produce a certain cushioning effect between the metal or the rim and the hard road surface. Makeshifts such as these, however, are not to be encouraged, and represent a lack of foresight unworthy of the modern American motorist.

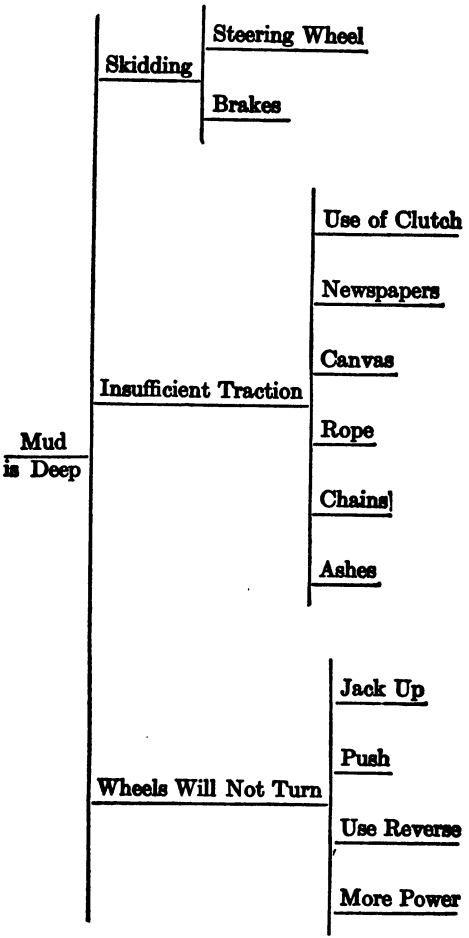
Inasmuch as the spare tire plays so important a part in the equipment of the motorist, it is well to remember a few

HINTS FOR CARRYING THE SPARE TIRE.

It is often said that a tire will deteriorate as quickly from age when unused as from wear when in constant service. This is true if the spare tire is not protected. The enemies of the rubber of which the shoe is made are dampness, heat, and light. Consequently, the spare tire should be covered by a well-fitting, waterproof casing, which will help to keep it cool and which will naturally keep out sunlight and moisture. It should be inflated to the normal pressure and tested as frequently as the tires which are on all four wheels. A tire which is used occasionally may last longer than one

which is idle for a year or more, owing to the "massaging" and life-giving properties of the compression and expansion due to contact with the surface of the road. Spare tubes should be deflated by removing the valve stem and rolling them tightly. Then after the valve stem has been replaced they will be perfectly flat and flexible, and may be folded into the proper shape to fit the lightproof bags provided for the purpose. In lieu of such a bag, oiled paper makes a satisfactory wrapping.

When the Mud is Deep



CHAPTER XI

WHEN THE MUD IS DEEP

MUD, sand, and snow are obstacles to the smooth operation of every car, and yet, except on our hard-surfaced roadways, one or another of them is with us always. All three offer their resistance to motion because their consistency is such that the wheels sink down and produce the same effect as though the car were continually driven up a stiff grade, with the exception that in this instance the grade is pushed aside as the wheels plow through the loose road surface. This resistance either prevents the revolution of the wheels, or causes them to spin without forward motion on the part of the car.

When the

WHEELS WILL NOT TURN

the trouble is primarily due to a lack of power developed by the engine. This

Lack of Power

may be caused by the imperfect adjustment of the engine or the improper use of the clutch.

The clutch should be engaged gradually as the throttle is opened, so that a sudden load will not be applied to the engine. If the car cannot be moved forward under these conditions, try throwing the transmission in

Reverse.

It frequently happens that a car can be backed out of a mudhole, snowdrift, or the like, through the tracks made by it when entering. Then through the judicious use of the clutch and throttle, the car may be given sufficient momentum to carry it through the point of greatest resistance. Remember that the difference between the power required to move the car through mud or snow, and that actually developed, may be very slight. Therefore the additional power furnished by a

Push

will sometimes suffice to move the car over the peak of its difficulty. This is especially true if the car is allowed to rock back and forth, gathering momentum each time that the power is applied and the push given at the proper instant. Each time the car may rise farther out of the mudhole, and as it settles back when the power is released, it will move farther in the other direction, without the use of the reverse.

If these methods fail, one or the other wheel should be

Jacked Up

by the use of the jack, a fence rail, heavy timber, or the like. Then a heavy plank should be forced under the wheel thus raised so that a hard surface will be furnished on which the wheel may travel. The plank also furnishes a somewhat gentle slope over which the wheel may climb out of the abrupt hole in the mud. In lieu of the plank placed under the wheel, the hole may be filled with stones, bricks, ashes, or other hard or compact substances, which will furnish a foundation on which the wheel may rest when the jack is removed. Avoid sharp stones or small pieces of brick, which may cut the tread of the tire if the wheel should spin.

A car possessed with ample power will generally become stalled in mud, snow, or sand through the absence of

SUFFICIENT TRACTION,

which means that the friction between the tires and road surface will give way and permit spinning before the car will be moved. Do not allow the wheels to spin unnecessarily, for this will only serve to dig the hole in the mud, snow, or sand the deeper, and your difficulties will be increased.

A smooth surface will slip where a rough surface will ofttimes offer sufficient traction. This rough surface may be provided either by the road or by the tire. The former may be furnished by the use of

Ashes

or other gritty material, although such a procedure is necessarily hard on the tread of the tire. The best method is to apply

Chains

to the wheels before the mudhole or snowdrift is reached. It is rather difficult to apply the ordinary tire chain if the wheel has settled down into a mudhole or snowdrift. Short lengths of chain or

Rope

may be wound around the tire between the spokes to furnish temporary ridges, which should supply sufficient traction.

If no material is available which can be wrapped around the tire,

Canvas or Burlap

or even an old duster may be pushed down in front of the mired wheel to furnish a better support for the tire and to prevent the wheel from literally digging its own grave. In lieu of such material, branches or twigs will produce a friction-forming surface which will not be as

hard on the tread of the tire as will ashes, stones, or brick. Even old

Newspapers

can be stuffed under the revolving tire and made to furnish traction.

Remember that the secret of the extrication of a car from a mudhole or snow bank is to maintain traction. As soon as traction is lost, the wheels spin. The power from the engine must be absorbed in some manner, preferably by the movement of the car. If the power is applied more suddenly than can be absorbed by the difficult motion of the car, the wheels will start to spin. Therefore, the clutch should be engaged very gradually, and power applied only as the forward motion of the car increases. A delicate

Clutch Foot

will do more toward removing mud and sand difficulties than will all the makeshift appliances available for such purposes.

Akin to mud, snow, and sand driving, and yet more dangerous than all three combined, is car operation on a slippery surface when

SKIDDING

is threatened. Skidding is due to a lack of traction, and, as has been pointed out in a previous chapter, is caused by the tendency of one wheel to slide on a slippery surface when

the brakes are applied, while the other has still sufficient traction to prevent slipping. This causes unequal pull on the rear of the car, which produces the tendency of the car to turn upon the driving wheel as a pivot.

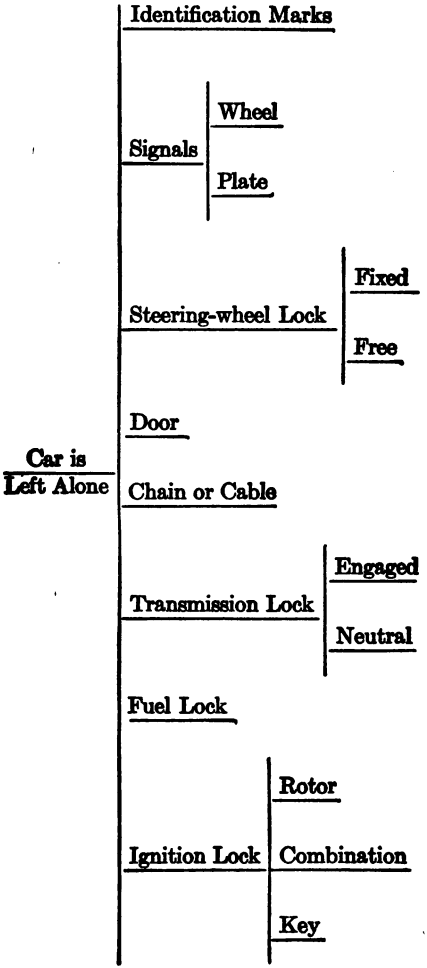
Brakes

should be applied very carefully in all slippery weather, and as soon as the tendency to skid is felt, the brakes should be released until the car resumes its proper direction. The

Steering Wheel

should be moved quickly to turn the wheels in the direction in which the car should travel, and it will often be found that the continued application and release of the foot brake and emergency brake will serve to bring the car to a safe stop more quickly than will the gradual application of these brakes on a slippery surface.

When the Car is Left Alone



CHAPTER XII

WHEN THE CAR IS LEFT ALONE

REMEMBER that every thief who steals a motor car probably knows more about its mechanism and internal construction than you do yourself. The theft of automobiles is highly organized, and amounts in value to a sum almost as great as that paid annually for repairs and overhauling. There are few locks which cannot be operated by the clever thief. Every car, when it leaves the factory, is provided with an

IGNITION LOCK,

which prevents the operation of the switch making the electrical connection through which the current supplying the spark passes. The large number of cars in use, and this common means of locking them, has placed the thief on his guard, so that he is now supplied with master or skeleton keys which will fit almost any of the locks as used on the popular cars.

Combination Locks,

such as can be installed, are effective when set, so far as picking or other means used is concerned, but if the driver forgets the combina-

tion himself, he will be in a serious situation. Furthermore, the expert thief can make short circuits or other connections under the dash or under the hood in such a manner that the switch is not needed in order to supply ignition current. Of course, such an operation requires time, and if the owner of the car is not to be absent for an extended period the ordinary ignition lock, as supplied with the machine. will prove fairly effective.

An excellent supplement to an easily picked ignition lock is the removal of some vital part of the ignition system. Nearly all distributors or timers are provided with a removable head, from which the

Rotor

or armature of the timer may be removed. It is not to be supposed that thieves will be provided with such ignition parts for all makes of cars, and as no short circuit can be made which will enable the engine to be operated without this vital part, this forms a most effective means of combating car theft.

Fuel is as necessary for the operation of the gas car as is ignition, and consequently a

FUEL LOCK

is also effective. This lock may be concealed in some part of the fuel line known only to the owner of the car, and consequently even the

thief who may have ample time at his disposal may be puzzled as to the location of the seeming obstruction in the gasoline pipe. The gasoline which is left in the float chamber of the carburetor and vacuum fuel system, however, may be sufficient to run the car a mile or so. In this case the owner whose car is provided with a fuel lock will need to search a rather extended area before he can find his car, which by this time will probably have been abandoned and the owner anathematized as one who does not know how to keep his car in proper running condition.

The car may be provided with a lock which will prevent the use of the

TRANSMISSION LEVER,

and in this case, although the engine may be started, its power cannot be communicated to the rear wheel. This lock may also be so applied as to hold the transmission in gear, in which case the engine, of course, cannot be started unless the clutch is released, and even then, if the transmission were left in reverse, the car could only be operated in that direction. This, therefore, is one of the most effective means of car protection.

Ignition, fuel, and transmission locks, however, possess one fault in common, and that is the inability to prevent the theft of the car by towing. This is a favorite and most effective

method with many organized bands of thieves, who, by means of the so-called "repair car" and personal disguise in overalls, pretend to be garage men sent by some repair shop to tow the supposedly disabled car to the garage for overhauling. Consequently, any car in which the driver's seat may be occupied, and in which the wheels are free to turn, can be stolen in this manner.

Such a method of theft can be forestalled by the use of a

HEAVY CHAIN OR WIRE CABLE

passing around the rim of one of the wheels and through the spring or other part of the running gear of the car, and attached at the loose ends by a padlock. Thieves have been known to saw or cut light chains or cables, but if sufficiently heavy and tough material is used, a considerable amount of time will be required—and this presupposes parking in a lonely and unfrequented part of the city not patrolled by police officers or detectives, who would be quick to discover any unlawful tampering with a stationary car.

Another effective means to prevent the theft of the car by the towing means is to supply the driver's compartment of a

CLOSED CAR

with a lock which will prevent access to the steering wheel. A car which cannot be steered

or its speed controlled by means of the brake, cannot be towed.

The objection to both of these methods of car protection, however, lies in the fact that wire, chain, or cable, and the inaccessibility of the emergency brake, render the car incapable of motion, and in case of emergency, such as fire or other conditions, it may be necessary to push the car away from a point of danger or congestion. The owner who may try to overcome this objection by leaving his sedan doors locked and the emergency brake released, may find himself in trouble if the car is resting on a slight down-grade, for the owner is responsible for any damage created by his car, whether it be attended or not.

The most effective type of lock which will prevent the operation of the car under its own power, and one which will absolutely eliminate the possibility of towing, and yet will enable it to be pushed a short distance away from a scene of congestion or danger, is a

STEERING-WHEEL LOCK,

which is of two types. One of these makes the wheel

Fixed,

and prevents its operation by means of an arm attached to the dashboard and clamped to one of the spokes, or by means of a pin secured to

the post and held in a hole drilled in the steering rod, which passes through the post and turns with the wheel. The other type of steering-wheel lock is that which is known as the

Free

type, and serves to disconnect the steering wheel from the rod which transmits the steering movement through the post to the gear and wheels. A car which cannot be steered cannot be run, and, consequently, both of these means are exceedingly effective.

Several types of

SIGNALS

have been devised which announce the theft of a car, either by prominently displayed signs or operation under abnormal conditions. The first of these may be in the form of a padlocked sign attached to the fender, which states that if this car is operated it is a stolen car, and the other more popular method may be the use of a heavy, specially prepared lock which surrounds the tire and rim of one of the wheels and which revolves with the wheel. The projecting end of this lock forms an obstruction over which the wheel must turn at each revolution. This will serve to reduce the speed of the car, and therefore the continued action of its constant bumping and thumping will announce to any observer that the car is operated without the con-

sent of the owner, who, of course, possesses the key. This is an excellent type of lock, in that it is simple, cannot be tampered with, and yet permits of the removal of the car for a short distance.

IDENTIFICATION MARKS

are an important means of recovering a stolen car. The object of the thief, when he is once successful in securing a car, is to disguise it so that the owner cannot prove that it is his property. The location of factory numbers is known by the average thief, and these are easily removed. Bodies, and even engines, may be dismantled, and their place taken by those of a different type. The use of secret identification marks made by means of a prick punch on the inside of gasoline tank covers, hub caps, and other parts of the frame or running gear, known only to the owner, may often serve to identify the stolen car and will go far toward convicting the thief.

CHAPTER XIII

PRIVATE-GARAGE DESIGN AND EQUIPMENT

THE properly designed and equipped garage is the home of the car which will have no roadside trouble. Every roadside accident can be used as a lesson for additional care at the garage, which would have rendered unnecessary such a repair on the road—barring collisions and similar accidents, of course.

If the garage is a

Part of the House,

its design, size, location, and shape will be largely affected by the architecture and other conditions affecting the house itself. If, however, the garage is

Detached,

it should be made of ample size to accommodate

Two Cars,

for even though the owner may not be lucky enough to be the possessor of a second automobile for local work, accommodations for the

frequent guest car will be afforded. If conditions permit, the garage should be

Wide

rather than deep, so that two cars can be placed alongside each other, and either car moved in or out without disturbing the other. For such conditions the garage should be at least twenty feet wide, and of sufficient depth to leave plenty of room for the work bench, spare parts, and all garage equipment, when both cars are in place. In order to permit the movement of one car without disturbing the other, the

Doors

should be of ample width, preferably of the folding or sliding type. The swinging doors are objectionable, because of their liability to blow shut unless held open by a hook or one of the patented devices which will keep them in place, and also because of the accumulation of ice or snow which may need to be cut away before they may be swung open.

Plenty of light is necessary for the proper care of the car. Daylight is better than electric light, and consequently the garage should be provided with ample

Window Space

on all four sides, if possible, and also directly over the work bench. A skylight is a luxury afforded by but few private garages, and yet

it is a valuable adjunct if the owner expects to make all of his own minor repairs and to keep the car spick and span by means of paint and varnish.

In northern latitudes some form of

Heating System

should be installed. Separate garage outfits which burn coal or gas, and are acceptable to the fire underwriters, can be obtained. If, however, the garage is placed sufficiently near the house, underground pipes may be used to connect the two buildings with the main heating plant. In lieu of either of these systems small kerosene heaters, which supply warmth directly to the radiator and engine of the car, may be obtained, and used to prevent the freezing of the water in extreme weather.

Water

is indispensable in connection with the care of the car. If the garage is at some distance from the house, cold water only can be used, but if conditions warrant, a hot-water connection will prove most valuable, although hot water should never be used on the varnish of the car itself. The cold-water tap should be of the type to which a hose may be attached, and if hot water is available a sink with a stopper should also be provided. Incidentally, if feasible, this sink

should be made of sufficient size to permit of the testing of tire tubes.

The

Floor

should be, preferably, of concrete, with a drain in the center from which small gutters radiate. A concrete floor is furthermore advantageous in that grease, oil, and dirt can easily be removed. The objection to the concrete floor is that it furnishes no opportunity for a

Pit

in which the owner may stand when he desires to work underneath the car. If a pit is to be used, a wooden floor is the only type of covering available. The pit should be lined with wood and provided with a heavy wooden cover. The depth of the pit should be such that the head and shoulders of a man, when standing erect, will project above the floor level. If a wooden floor is to be used, a zinc or tin

Oil Pan

should be employed to place under the car and catch the drops of oil and grease which drip from every machine. The oil-soaked floor not only looks dirty and unattractive, but is a fire menace.

If a concrete floor is to be used, the cross beams supporting the roof should be reinforced and a

Chain Hoist

installed, so that the front or rear portion of the car may be raised for under-body repairs. This hoist is also useful for removing the engine or other heavy parts.

In lieu of either of these means for reaching the under side of the car, an inclined runway, consisting of two tracks supported on short, heavy timbers, may be built. The car may be run on this under its own power, and the increased head room thus afforded can be used to good advantage by the man who must work under the car.

However, the simplest and least expensive means for reaching the under side of the car is to jack up the front or rear axle, depending upon the part that is to be repaired or examined, and to use a creeper or cradle, which is a small latticework affair mounted on casters, on which the repair man may lie on his back and move himself around to any position under the car.

Ample light is a necessity for any repair job. Probably most of the owner's work on the car must be done at night, and consequently provision for

Electric Lights

should be made. One of these should be placed over the work bench, and one or two more at

the sides, where illumination can be distributed generally. A

Trouble Light

is a necessity. This is a light attached to the end of a long, flexible cord, which permits of the illumination of any part of the car. The light is placed in a wire cage provided with a hook, thus protecting the bulb from breakage and enabling it to be attached to any part of the car where illumination is needed. A flexible shade, to prevent the direct rays of the light from striking the eyes of the repair man, may also be included. Such lights are available in the form of a spring-wound reel with an automatic catch. The light on the cord may be pulled out to any desired length, and when the work is completed the wire will be automatically rewound on the reel.

The

Work Bench

is one of the most important parts of the garage equipment. It should be constructed of heavy material, so that bulky parts may be clamped in the vise and such heavy work as engine removal and valve grinding can be undertaken. Various

Supplies

may be kept under the work bench, and this forms a convenient location for the storage of

oil and grease cans, empty cans for greasy waste and rags and polishing materials, and other bulky supplies or tools used in the garage.

The best equipment for the garage includes a sunken

Gasoline Tank,

which should be attached to a measuring pump similar to those used by roadside filling stations. Such tanks and pumps which will meet the requirements of fire underwriters are available, and the quantity in which fuel can be bought will permit a material saving to be made in each gallon of gasoline so used.

Oil Pumps

also are available in which smaller quantities of oil may be kept and measured out for use in the engine, transmission, or differential. Such outfits are hardly worth while unless two cars are to be supplied.

The most important part of the proper equipment of a garage is the

Tools

which will be used on the car. The completeness of such an outfit, of course, varies, but it is advisable for all of those which are used as a part of the equipment of the car itself to be duplicated in the garage. This may seem like doubling an investment, but it is well worth while, for tools which are taken out of the car

may not always be returned to their proper place and may even be left on the running board, where they will surely be lost.

Among the tools which should be a part of every completely equipped garage are an electric emery wheel or grinder, an electric portable drill, a hand drill with a set of drills of various sizes, a heavy work-bench vise capable of rigidly supporting such bulky parts as steering-gear posts and assemblages and the like, a complete set of wrenches, screw drivers of various sizes and weights, files (flat, three-cornered, and round), pliers and wire cutters, assorted sizes of cold chisels, taps and dies for cutting and cleaning standard and automobile-size threads, and tools for removing the valves and grinding them, including a hand-operated grinder, special wrenches, and a valve lifter for compressing the valve spring previous to the removal of the pin which holds it in place.

Judgment must be used in the selection of the proper amount and size of special tools, and no definite rules can be given. However, the selection may be increased as the occasion arises, but it is especially advisable to begin the collection with a complete supply of wrenches. There should be at least two adjustable "monkey wrenches," two adjustable Westcott with the S-shaped handle and mov-

able jaws at the end, three sizes of Stillson or pipe wrenches, half a dozen solid-end wrenches which will fit twelve different sizes of nuts, and a set of socket wrenches which fit over hexagonal or square nuts, and which are operated by a ratchet handle applied through an extension shaft or a universal joint for the nut which is especially difficult of access.

The need for special tools may not be apparent at first, when the car is new, but continued use will loosen certain nuts and make the removal of others necessary, which the owner never before realized existed on his car. Nuts must be kept tight, and continual inspection is the price of that freedom of mind possessed by the owner of the car who knows that he will never encounter roadside trouble from any preventable cause.

DICTIONARY OF AUTOMOBILE TERMS

A

ABRADE: To cut or scrape with a blunt instrument or granular material. Valve grinding is an abrasion equally distributed throughout the entire valve and seat surface.

ABRASIVE: Any granular material which, under the influence of friction, will cut or wear away a metal surface. Powdered glass, emery dust, and particles of flint or other hard stones are the most common forms of abrasives in use.

ACCELERATION: The rate of increase in speed, often known as "pick up" when applied to a car. The ability to accelerate from one speed to another speed in a given length of time is a popular measure of the performance ability of a car.

ACCELERATOR: A pedal, generally operated by the toe of the right foot, which controls the throttle opening through a spring and linkage. The usual means by which the speed of nearly all makes of gasoline-driven cars is controlled.

ACCESSORY: An attachment or appliance not inherently a part of the car itself and not absolutely essential to the starting and stopping of a car. In its broader sense, any actually or supposedly useful article not regularly furnished as a part of the complete equipment by the car manufacturer.

ACCUMULATOR: A term formerly applied to the cells of a storage battery for the reason that the battery "accumulates" current fed to it from an outside source.

ACETYLENE: A pungent gas formerly used in the head lights of automobiles. Now employed extensively as a fuel for the flame used in welding broken parts. Acetylene gas can be produced by the emersion of calcium carbide in water.

ACID: A chemical opposite in its action to an alkali which, as a rule, possesses the power of disintegrating or eating away portions of a large number of metals. Sulphuric acid and water form the liquid in the storage battery which acts upon the plates and enables the cells to store their charge of current.

ACTION: The process occurring in the storage battery when the cells are being charged or discharged.

ADAPTER: A base or socket designed to permit of the attachment of an electric bulb to an acetylene or kerosene head or tail light. Any kind of device which will adapt one type of electric-light bulb to another type of socket.

ADVANCE: To cause the spark in the cylinder to occur earlier. The levers and linkage by which the setting of the timer is controlled.

ALCOHOL: A hydrocarbon liquid, made by the distillation of grains, fruits, or vegetables; suitable as a fuel for the generation of intense heat and, owing to its low freezing point and affinity for water, is often used in the radiator to prevent freezing. GRAIN and WOOD ALCOHOL indicate the materials from which alcohol is obtained—DENATURED alcohol is grain alcohol treated in such a manner as to render it unfit for human consumption.

ALIGNMENT: A condition in which two bodies are in the same line. In the case of revolving objects the axes of rotation must occupy the same straight line in order to be in alignment.

ALLOWANCE: A variation in measurement necessary to take care of the expansion and contraction of adjoining parts subject to different conditions of heat.

ALLOY: A metal formed by the union of some chemical with iron or other metallic element to change its nature

and obtain a desired hardness, toughness or other characteristic.

ALUMINUM: An exceedingly light metal entering largely into the construction of many automobiles. Once a very rare metal, but now obtainable by an electric converting process from a large portion of the earth's surface.

AMMETER: An instrument indicating the number of amperes flowing to or from a generator or storage battery.

AMPERE: The measure of electric quantity. An ampere "HOUR" is one ampere flowing for one hour. The capacity of a storage battery is stated in terms of ampere hours—one of 100 hours' capacity, for example, will deliver 100 amperes for one hour, one ampere for 100 hours or other multiples of this quantity.

ANCHOR: To hold a piece rigidly in place at its base. The body may be said to be anchored to the frame at the point at which the bolts pass through.

ANGLE IRON: An iron bar or strap used as a bracket to support another member. The majority of running boards are held in place by brackets in the form of angle irons.

ANNEAL: A form of slow heat treatment and cooling which serves to prevent distortion in metal pieces when machining. Many cylinders and cylinder blocks are ANNEALED after having been bored and ground.

ANNULAR: A ring-shaped piece; an ANNULAR BALL BEARING is a bearing having the balls placed between two rings. An ANNULAR GEAR is the larger gear in the internal-drive type of transmission in which the teeth are cut on the inside of the ring-shaped piece.

ANVIL: A heavy block of hardened iron on which hot metal pieces may be shaped and hammered.

APRON: A sheet of fabric or metal attached to the car to serve as a protection from oil, mud, water, or other foreign substance.

ARBOR: A short steel shaft on which work may be mounted for machining on a lathe or other revolving tool.

ARC: Any portion of the circumference of a circle. The flame caused by the escape of electric current into or across an air gap; also the flame caused by burning particles subjected to electric heat. Poor contact between the brushes and the commutator of a generator will cause an arcing, due to the heat which ignites small particles of carbon.

ARM: A fixed or movable projection. When fixed it may serve as a support for the part to which it is attached; when movable it may serve as a lever.

ARMATURE: The smaller portion of the two principal parts of a dynamo, generator, or electric motor. As a rule it is the revolving portion and consists of a bundle of wires surrounding a serrated iron core and mounted on a shaft. In some types of electrical instruments, notably the larger sizes of dynamos, the ARMATURE may remain stationary and the larger part, known as the field, may revolve. Also the vibrating portion of an electric bell or buzzer.

AUTOMOBILE: A self-propelled vehicle, either steam, internal combustion, or electric, which may be steered and controlled by the driver

AUXILIARATOR: An incorrect term applied by the ignorant to the accelerator.

AXLE: A fixed or movable shaft on which a wheel or cylinder may revolve. The LIVE AXLE is the shaft within the rear axle which transmits the power but does not carry the load. The DEAD AXLE is the solid piece or the housing which supports the load, but which does not transmit the power. LIVE AXLES may be divided into FULL FLOATING, THREE-QUARTER and SEMI-FLOATING, designated by the location of the bearings and the part that each type plays in supporting the wheel.

B

BABBITT: A white metal used as a lining for bearings. It is poured into the bearing boxes while hot and thus conforms absolutely to the shape of the shaft revolving in it.

It is somewhat softer than the bearing boxes and its boiling point is lower, thus causing it to melt when a bearing becomes overheated, before further damage is done to the remainder of the box.

BACKFIRE: An explosion occurring in a cylinder, either after or before its appointed time. When the inlet valve is opened this allows the flame of the explosion to fire back through the carburetor, occasionally resulting in a serious fire, usually caused by too lean a mixture when starting.

BACKKICK: An explosion occurring before a piston has reached the top of its stroke, thus causing the engine to revolve for a portion of a turn in the reversed direction. When an engine is cranked by hand, a backkick may wrench the crank out of the driver's grasp and strike his arm or wrist on the return. A backkick can best be avoided by making certain that the spark is fully retarded whenever the engine is to be cranked without the starter.

BACKLASH: Play or lost motion existing between a pair or a train of gears or links.

BACK PRESSURE: A resistance to the expulsion of the exhaust gas. A dirty or improperly designed muffler will create back-pressure which will interfere somewhat with the efficiency of the engine.

BAFFLE: To deflect a gas or liquid by interposition of metal sheets or plates. BAFFLE-PLATES are found in a muffler to break up the gases and reduce the sound of the explosion; also used in large gasoline tanks to prevent the sloshing of the fuel as a mass. BAFFLES may also be used at the bottom of the cylinder and in the crank case to prevent the oil from being splashed in undesirable quantities.

BAKE: A heat-treating or drying process applied by artificial means to fenders, bonnets, radiators, and other enameled portions to impart a permanent hardness to the colors and enamels employed.

BALANCE: The relation of the distribution of weight. A part may be in balance under various conditions, such as

balance of rest, balance of motion, the balance of linear measurement, and the balance of a mass considered in its three dimensions. The term "BALANCE" is also applied to the distribution of weight throughout a car and affects its ability to "hold the road" at various speeds. COUNTERBALANCE: A weight added to a part ordinarily out of balance to bring it into balance.

BALL: The spherical portion of a ball bearing. A BALL JOINT is employed at the steering connections to take up play and give a flexibility of operation.

BAND: A flexible piece of fabric or metal usually partially surrounding some portion with which it is necessary for it to make permanent or intermittent contact. The BRAKE BAND is the flexible portion of the outside brake to which the lining is attached and which enables the latter to grip the drum when the brakes are applied.

BANK: The sloping portion of a roadway or track at a turn, designed to overcome the centrifugal forces striving to turn the car over toward the outer edge of the curve.

BASE: A portion on which a part rests or to which it is anchored. The lower portion of an electric lamp.

BATTERY: A source of electric energy; also a term applied to a number of machines of the same kind, such as battery of drill presses, a battery of gear cutters, and the like. A DRY BATTERY is a small cell generating a moderate amount of electric current through electric action, and is suitable, in company with three or five additional batteries, as an emergency source for current for ignition. STORAGE BATTERY is the type usually employed on the average car for starting, lighting, and igniting and obtains its current from an outside source. It is an electric storage reservoir.

BAUMÉ: A system of determining and stating the comparative specific gravity of various liquids.

BEAD: The two portions forming the inside circumference of the tire casing. Therefore, the portion of the tire which is gripped by the rim.

BEARING: A stationary or movable part in which another part revolves at a different speed; also applied to the assembly of parts employed to absorb friction at a certain point. Can also be applied to the friction surface between two sliding parts, as between a piston and its cylinder.

BED: The foundation or support on which a part or assembly of parts rests.

BELT: An endless fabric or rubber piece surrounding two pulleys and intended to transfer motion from one to the other by means of friction.

BENZINE: A liquid akin to gasoline, obtained from the distillation of petroleum; somewhat more volatile and inflammable than naphtha.

BENZOL: A hydrocarbon liquid obtainable from coal tar and suitable for use as a fuel in internal-combustion engines.

BEVEL: An angle at the edge of a flat surface. BEVEL GEAR: a gear which transmits its motion at an angle to its own axis by means of teeth cut on a beveled edge.

BINDING POST: The brass terminals of a battery, switch, spark plug, or other electric instrument to which the ends of wires are to be clamped.

BITE: The grip obtained by a cutting or grinding tool; also the generation of friction in a clutch or brake to the point where the two parts move or remain stationary as a unit; applied in the latter sense to a clutch or a brake.

BLISTER: A separation of the rubber on the tread of a tire from its underlying fabric, caused by the admission of sand, water, or other foreign substance through a hole cut in the tread. Also the separation of paint or varnish from a surface to which it is applied.

BLOC: A group of cylinders cast in a unit.

BLOOM: The grayish discoloration appearing on bodies and other highly varnished surfaces, caused by dampness or an imperfection in the varnish.

BLOW-OUT: An explosion of the tire, outer casing as well as tube, caused by a sudden rupture of the fabric or re-

lease of the grip between rim and bead. Caused either by imperfection in manufacture, by inattention to cuts and stone bruises, or by operation when insufficiently inflated.

BODY: That portion of the car mounted on the frame at the rear of the engine bonnet. The entire structure used for accommodating passengers and all other movable loads.

BOLT: A cylindrical piece of metal threaded at one end and provided with a nut or screw-shaped head at the other. Used to hold two or more pieces firmly together.

BONNET: The sheet-metal covering for the engine extending from the radiator to the driver's compartment.

BOOT: A leather or heavy canvas piece laced over tire and rim of wheel to strengthen a weak portion of the tire or to repair a blow-out temporarily. Also a leather stocking laced over a connection such as found in universal joint and steering control intersections. In this latter case it serves to prevent the entrance of dirt into the lubricated portions of the joints.

BORE: The measurement of the diameter of the piston or the interior of the cylinder. The power of two engines of identical construction should vary as the square of the bore.

BOSS: An enlarged portion of a casting or other metallic piece intended to add strength or to provide for a greater bearing surface on another part than that which is otherwise allowed by the ordinary size of the part in question.

BOW: The supports over which the material for the top is stretched and which, when the latter is folded, encircle the rear seat. BOW SEPARATORS are the clamps which, when the top is folded, hold the bows in their proper relation to each other and prevent rubbing and chafing.

BRACKET: A piece connected with or attached to one part for the purpose of supporting another.

BRAKE: A mechanical friction device intended to prevent or retard the movement of another part.

BRAZE: To fuse or "weld" brass or bronze parts by the

application of heat, similar in principle to soldering tin parts.

BREATHER: The connection between the crank case and the outside air which serves to equalize the pressure, no matter in what position the various pistons may be at any portion of the stroke.

BRONZE: An alloy consisting of varying proportions of copper, tin, and zinc, somewhat harder than brass.

BRUSH: A small piece, usually of carbon, used to gather the electric current from the revolving armature of an electric generator; also used to transfer the current from the battery or from the fields to the armature when the instrument is used as a motor.

B. T. U.: British Thermal Unit. The standard of heat value. A B. T. U. is the heat energy required to raise one pound of water one degree in temperature. The heat value of gasoline is about 19,000 B. T. U.'s per pound.

BUCKLE: To bend or distort, due to excessive strain.

BUFF: To polish by means of friction with a leather or other comparatively soft material on which a polishing preparation may be used. Usually accomplished by means of a rapidly revolving wheel to which the necessary material is attached.

BULB: The glass, filament, and base of an electric light.

BUMPER: An attachment to the front or rear of a car.

BURNISH: To polish or grind down by means of friction applied by a coarser material than that used in buffing.

BURR: A roughened surface or projection left in a piece of metal by a file or other cutting tool.

BUSH: To insert a thin piece of metal in a bearing to reduce its size and thus take up lost motion. A BUSHING is the part thus inserted. This is the method employed to take up noise and lost motion in steering connections, brake-rod pins, and spring shackles.

BUTTERFLY: A circular or other symmetrical valve mounted on a diameter or other line dividing it equally, used to control the flow of gas or liquids. This arrangement serves to balance the valve so that the tendency of

the gas or liquid to strike it on one side, serving to close it, is exactly counterbalanced by the portion of the liquid or gas striking it on the other side, tending to hold it open. A term also applied to a wing or thumb nut.

BY-PASS: A supplementary route or short cut through which gas or liquid may be forced when it is not desired to circulate it through the entire system.

C

CABLE: A braided wire rope sometimes used in place of brake rods to connect the brake pedal or lever with the operating mechanism at the drum. Also a term applied to the high-capacity wires conveying the electric current to the starter and to the spark plugs.

CALCIUM CARBIDE: A chemical used in the production of acetylene gas. Acetylene is given off when water comes in contact with the carbide.

CALCIUM CHLORIDE: The chlorine salt of calcium sometimes used to mix with the radiator water to reduce the freezing point.

CALIBRATE: To determine the accuracy of a measuring or recording instrument provided with a scale, such as a thermometer, gauge, or a ruler.

CALIPER: An instrument similar to a compass in shape, the opposite points of which may be set to register the diameter of any circle, or the distance between any other points within its range. A caliper is generally of two kinds, known as an "inside" and "outside" caliper, and designed, as the name implies, for measuring the inside or outside diameter of shafts or circular openings.

CALORIE: A measure of heat; a heat unit based on the metric system of measurement.

CAM: An unsymmetrically-shaped revolving piece which serves to transform its rotary motion to reciprocating motion; used to open the valves of a gasoline engine at the proper time and for the proper duration. CAM FOLLOWER or CAM ROLLER: the portion of the reciprocating piece in contact with the surface of the cam and

operated by it. CAM SHAFT: The shaft on which the cam, or series of cams, is mounted and from which such cams derive their rotating power.

CANVAS: A term sometimes erroneously applied to the cotton-fabric layers which, with rubber, form the entire construction of the outer casing of a tire.

CAPACITY: When applied to a storage battery it is generally measured in ampere hours or the number of hours during which one ampere can be given off from a battery, when fully charged, at its normal voltage.

CAPILLARY: Pertaining to hairs. CAPILLARY ATTRACTION is the natural law which causes a liquid to rise above its own level when an absorbent material is immersed in it.

CAP-SCREW: A threaded bolt having a nut-shaped head.

CARBON: A chemical element found in varying proportions in all fuels. When combined with the proper proportion of oxygen it becomes inflammable. In its free or excess state it can become the black, annoying soot or cokelike deposit found in the combustion chambers of gasoline or kerosene engines.

CARBURETE: To mix with air.

CARBURETOR: A mechanical device which atomizes the liquid fuel and mixes it with the proper proportion of air for combustion in the engine cylinder.

CARCASS: The body or "bonework" of a tire casing or shoe consisting, as a rule, of layers of fabric embedded in rubber, on the outer layer of which the thicker rubber, known as the tread, is mounted.

CARDAN JOINT: Commonly known as universal joint. A joint which admits of the transmission of power at an angle to its axis. A flexible joint necessary wherever one body is liable to move in relation to another which is driving it.

CASEHARDEN: A form of heat treatment which imparts an exceedingly hard surface to a metal body without affecting the entire structure. Gears are casehardened in

order to impart an exceedingly hard wearing surface without destroying the toughness and tenacity of the material of which they are composed.

CASING: The "shoe" or outer covering of a tire which contains the inner tube and which supplies the necessary strength to enable the tube to retain its proper inflation pressure.

CAST: To mold.

CASTELLATED: A form of nut having slots or castellations cut across the top at each face to accommodate the ends of a cotter pin which will hold the nut in place.

CASTING: A part made by pouring molten metal into a mold or impression of the desired shape; usually applied to iron and steel parts produced in this manner, as opposed to the forging and machining or shaping methods of production.

CASTOR: A design which so distributes the application of weight that the front wheels are naturally kept in a position to move directly forward in a straight line. This term is obtained from the shape of a furniture caster which is so swiveled that it will move in the direction in which it is pushed. CASTOR OIL: The oil of the castor bean, occasionally used as a high-grade cylinder and bearing lubricant in racing-automobile engines.

CELL: One unit of a dry or storage battery. Also the small apertures in the cellular or honeycomb type of radiator.

CELLULAR: A type of radiator composed of small cells through which the air passes to increase the cooling effect upon water. Opposed to the tubular type, which consists of flutes or vanes on a series of tubes.

CEMENT: An adhesive material used to repair tire tubes and outer casings. Another type of cement is sometimes used in radiators to stop small leaks.

CHAIN: A flexible metal belt used to drive the rear axle of some trucks. SILENT CHAIN: A form of power chain used to drive cam shafts, water pumps, and other portions of an engine. This is so arranged that wear or

lost motion is automatically taken up by the position of a series of adjoining teeth, thus eliminating all objectionable noise. NON-SKID CHAIN: A pair of circumferential chains connected by cross links which entirely surround a tire and are intended to give the latter a more perfect grip on slippery roads.

CHANNEL: A groove cut in a metal part intended to convey oil or other liquid in the proper direction. CHANNEL BEAM: An iron or steel beam of a trough-shaped section, largely employed in the construction of automobile and truck frames.

CHARGE: The act of supplying electric current to a storage battery, either from generator on the car or from an outside source. CHARGING RATE: The rate, expressed in amperes, at which current is supplied to the storage battery. This seldom exceeds from 15 to 18 amperes in the ordinary automobile system.

CHASSIS: The portion of the car below the floor of the body. The complete car with the exception of the body, dash, motor bonnet, running boards, and fenders.

CHATTER: A violent vibrating motion imparted to a revolving piece, caused, as a rule, by excessive concentrated friction applied at an unsupported point. This condition occurs in a lathe when the cutting tool is fed in too rapidly. The rear axle or a propeller shaft might also chatter if a bearing requires lubrication and becomes overheated.

CHAUFFEUR: A person employed by the owner to drive a passenger car or truck.

CHECK VALVE: A valve admitting of the flow of air, gas, or liquid in one direction, but preventing its return in the other. A necessary part of all air pumps, inner tubes, vacuum fuel feed systems, and other parts requiring automatic prevention of a return of the air or liquid.

CHEEK: A portion of the crank shaft, sometimes known as the crank arm, which connects the crank pin with the main portion.

CHOKE: To cut off or reduce the flow of air, gas, or liquid.

A term largely applied to reducing the amount of air admitted to a carburetor to facilitate starting in cold weather. The throttling of the air increases the suction applied to the gasoline, with the result that an exceedingly rich mixture reaches the combustion chamber.

CHROME: One of the chemical elements largely used as an alloy with steel to impart to it properties of great toughness and strength. Usually used in conjunction with other elements, in which case the steel is designated by those alloys used, such as chrome nickel steel, chrome vanadium steel, and the like.

CIRCUIT: A complete course by which a fluid or gas may be returned to its point of origin. Usually applied to the battery and electric parts of a car. For example, the lighting circuit is the collection of wires, lamps, switches, and the like through which the current supplied to the lights must pass before it can again reach the negative pole of the battery. CIRCUIT BREAKER: A device which automatically opens or breaks the electric circuit when the current becomes greater than the system is designed to carry. Such a device is intended to overcome the danger of burned-out lamps and other delicate parts when a short circuit is formed.

CIRCULATION: The movement in which gas, oil, water, or gasoline is conveyed from one point to others in the system and returned to its point of origin, to be used over again.

CLAMP: A mechanical device usually provided with a thumb- or hand-screw which enables one object to be securely fastened to another by means of pressure exerted by the aforementioned screw.

CLASH: To engage gears without a sufficient release of the clutch or reduction in the speed of the engine or car. A term also applied to a system of gear changing in which one gear is brought "face on" to its neighbor by means of a motion perpendicular to its axis.

CLEARANCE: A space allowed between two moving parts to insure perfect freedom of motion, such as the

space existing between the teeth of gears in mesh, and between a valve stem and its push rod, or between a piston and the top of its cylinder head.

CLEVIS: The forked end of a rod by means of which it is attached to an operating mechanism. CLEVIS PIN: The pin or bolt passing through the eyes of the yoke and serving as the joint or connection between the two portions of the mechanism.

CLIMB: A term applied to a chain or belt when it becomes unseated and "rides" on the teeth of the sprocket or the flanges of the pulley.

CLINCH: To anchor or secure a hold by a hook-shaped piece embedded in the material to be secured. Especially applied to nails or soft rivets when the ends are to be bent over.

CLINCHER: A type of tire having a hook-shaped bead which fits snugly into grooves formed in the rim to which the tire is to be secured.

CLUTCH: A mechanism by which one part may be separated from, or connected with, another at will. A necessary part of every gasoline-engine-driven car to enable the engine to be operated while the car is at a standstill and to disconneet or engage the power when a shift of the transmission is desired.

COAST: To travel from the force of momentum or gravity without brakes engaged and without the assistance of the engine.

COCO MAT: A form of fiber foot mat used on the floor boards of the tonneau or on the running board to protect the interior of the car.

COIL: A collection of turns of wire used in the ignition system to bring the voltage of the current from that supplied by the battery to the twelve or fifteen thousand volts necessary to furnish the electric spark under the most adverse conditions. COIL SPRING: A circular collection of turns of spring wire arranged to bring a spring action, either on expansion or tension. This is the usual form of spring used on all valves, clutches, brake rods, and the like.

COKE: The pure carbon residue remaining after the more highly inflammable portions of gasoline or oil have been burned off. A heavy black gummy mass which eventually becomes the carbon of the engine cylinders.

COLD CHISEL: A hardened steel chisel designed to be used for cutting iron and other metals without preheating.

COLD TEST: A test applied to oil or other lubricant to determine its viscosity or thickness at decreasing temperatures.

COLLAR: A flange or enlargement of a shaft or other projection, intended either to increase the strength or for the attachment of another part.

COMBUSTION: The act of burning. COMBUSTION CHAMBER: The entire volume of the cylinder, including piston displacement and clearance space in which the gas is burned. COMBUSTION ENGINE: Usually known as internal-combustion engine; a term applied to all gasoline, kerosene, alcohol, and fuel-oil engines in which power is derived from the explosion or burning of an inflammable charge within the cylinder itself.

COMMUTATOR: A collection of copper segments mounted on the armature of a direct-current dynamo or generator from which the current is collected, or on to which the current is led. This is the device which changes the alternating current, formed by all dynamos, into the direct type.

COMPARTMENT: A space or division in a car in which passengers or luggage may be carried. The rear compartment of a touring car is usually known as the tonneau.

COMPASS: An instrument, consisting of two legs of equal length, joined at one end and used for describing circles of various sizes.

COMPENSATING GEAR: A name sometimes applied to the differential.

COMPOUND: Composed of two or more parts. A name applied to a chemical mixture used to repair cuts or bruises in a tire; also the material, plastic when hot, used to seal battery cells and render them water-tight.

In engine design a term applied to the two stages of expansion or compression of gas or liquids. A COMPOUND STEAM ENGINE employs two cylinders for the expansion of the same steam. A COMPOUND AIR PUMP employs two cylinders for the successive compression of the air.

COMPRESSION: The pressure of a gas or liquid caused by a reduction in the volume of the space in which it is contained. COMPRESSION SPACE or COMPRESSION VOLUME: The clearance above a piston at the top of its stroke into which the combustible charge is compressed before ignition.

CONDENSE: To change from a gaseous to the liquid state, through the application of cold or through a reduction in pressure.

CONDENSER: A device intended to supply a cold effect upon gases, so that they may be returned to the liquid state. Employed on steam engines to transform the exhaust steam into water, and thus reduce the "back pressure." Employed on motor cars to return the steam from a boiling radiator to its liquid state and to recover such alcohol as may be boiled out, due to the excessive heat of the cooling system. A term also applied to a portion of an induction coil which increases the ability of the latter to transform the current to a higher voltage.

CONDUCTOR: A metal or other substance offering a low resistance to the flow of electric current.

CONE: A type of clutch having a piece shaped like the truncated base of a cone which engages with a similar recess in the flywheel of the engine. The cone is usually covered with leather, asbestos fabric, or other material which will furnish a substantial grip when the parts are being held firmly together, and will enable the two to revolve as a unit. Also the cone-shaped portion of certain types of tapered bearings.

CONNECTING ROD: The piece connecting the piston with the crank shaft, and which serves to transform the

reciprocating motion of the former into the necessary rotating motion of the latter.

CONNECTION: A method of attaching an electric conductor to the part to which the current is to be led.

CONTACT: The state of touching. A condition arising when two electrically charged bodies are so close that current of low voltage can pass from one to the other. CONTACT POINT: The platinum or other hard-metal point which ultimately makes and breaks the ignition circuit. Used on the timer to determine the exact instant at which the spark usually occurs.

CONTROL: The lever and pedals used to change the speed of the engine or car or to shift the gears; also a designated point in a race, endurance run, or reliability contest at which the entrants must stop and report within an appointed time.

CONTROLLER: A lever connected with a switch which varies the speed of electric motors.

COPPER: One of the metallic elements largely used in the manufacture of electrical instruments because of its low resistance to the passage of electric current.

CORE: The interior part of a coil or magnet around which the wires are wound; also a molded pattern of baked clay or a similar substance used in castings. The coremaker's art is brought to its highest point of perfection in preparing the mold for the intricate water jacket placed on the modern type of bloc-cast engine cylinder.

CORK INSERT: Cork projections employed in clutch facings and brake linings to produce more perfect friction absorption.

COTTER PIN: A split, flexible pin inserted through a hole in a shaft, bolt, or nut to hold another piece in place.

COUNTERBALANCE: The application of a weight to a revolving part to balance another weight applied to another portion of the same part. Usually applied to crank shafts to compensate for the weight of the crank throws and connecting rods.

COUNTERSHAFT: A shaft placed parallel with another

and driven by it at a different speed. This is the shaft from which low and second speeds are obtained in the average transmission boxes.

COUPÉ: An inclosed car of the runabout type.

COUPLING: A joint connecting two moving or stationary objects, having their axes extended in the same direction. The point at which one shaft joins another; also the piece by which sections of hose or pipe are connected to one another.

COWL: The successor to the dashboard of olden times. The curved portion of the sides of the body, where the motor bonnet of the modern car joins the front compartment and where the back of the front seats merges into the tonneau.

CRACK: To refine gasoline or other hydrocarbons further by the additional application of heat. Carbon is formed in the gasoline engine by the cracking process of the heat of combustion when applied to the more or less impure grades of present-day gasoline.

CREEP: To change location gradually. A term applied to a tire not locked to the rim with sufficient security; also applied to tire chains when their relative position on the tire is constantly changed.

CREEPER: A low, bedlike affair, mounted on castors, which a repairman may use for examining and repairing the underside of the car.

CRYSTALLIZATION: A fracture of a metal part caused by continual vibration or an accumulation of jars and strains.

CUP: A rounded depression similar to a cup in shape. To wear or cut out in the shape of the bottom of a cup.

CUP GREASE: A lubricating grease of a certain definite consistency intended to be placed in grease cups and forced into the portions to be lubricated as the cups are screwed down.

CUT-OFF: An automatic electric device which prevents the current from the battery from flowing through the

generator when the car is traveling at a slower speed than that at which the dynamo will produce current.

CUT-OUT: When applied to an electric device, synonymous with the above. More usually a valve in the exhaust pipe, forward of the muffler, which allows the exhaust gas to pass directly into the outside air without entering the muffler.

CYCLE: A succession of events which eventually are regularly repeated. The cycle of the average automobile engine consists of four strokes as follows: ignition or expansion, exhaust or scavenging, suction, and compression.

CYLINDER: The casting, including water jackets, in which the piston moves and explosions take place. When made with a detachable head, the cylinder consists only of the tube and valve seats, if they are located at the side.

CYLINDER HEAD: The portion of the cylinder above the combustion chamber.

D

DAMPEN: To soften or absorb a violent action, such as to dampen a spring or excessive vibration. May be accomplished by means of a counterspring or friction device.

DASH: Sometimes known as DASHBOARD. Formerly the board at the front of the driver's compartment corresponding to the dashboard of a horse-drawn vehicle. This design has now been eliminated by blending the motor bonnet with the front of the driver's compartment. The modern form of dash is merely the board on which the instruments and gauges are placed in plain view of the driver.

DASHPOT: An air cylinder and plunger used to control the action of a valve in a carburetor, steam engine, cylinder, or other mechanism.

DEAD CENTER: The point at which the motion of a piston or connecting rod can have no rotating effect on the crank or flywheel. This condition occurs at two points, such as the extreme upper and lower positions of the piston.

DEADEN: To muffle or reduce a sound by restricting the vibration.

DECARBONIZE: To remove the carbon from an engine cylinder by means of chemicals, heat, or mechanical methods.

DECELERATE: The opposite of accelerate; to reduce speed.

DECLUTCH: To release the clutch by pressure on the pedal.

DEFLATE: To remove or reduce the air pressure of a tire or other flexible air-containing body.

DEFLECT: To divert from a straight path, applied in an automobile to the incoming or exhaust gases when they are forced against a beveled plate or by deflecting. Applied to rays emanating from head lights when they pass through certain forms of lenses which bend the rays downward away from the eyes of oncoming drivers.

DENATURE: To render unfit for human consumption. The process applied to alcohol to render it unsuitable as a beverage.

DEPRECIATION: The rate at which an automobile or part decreases in market value.

DETERIORATION: The decrease in the actual service ability of parts as it affects the mechanical or chemical efficiency. An automobile may DEPRECIATE in value, due to the output of improved models, even though it has not DETERIORATED in its ability to perform the work for which it was intended.

DIAPHRAGM: A thin disk of metal, rubber, or leather used to transmit sound waves, as in a horn or telephone transmitter, or to control or indicate variations in gas or liquid pressures, as in barometrical instruments, carburetors, pumps, and the like.

DIE: A piece of metal cut or shaped in the form of a mold for the article to be produced. The impression of the die upon the object to be shaped is made through a series of blows or through continued pressure upon the metal or other substance when softened through the application of

heat. DIE CASTING: A casting made from dies which have been cut in a harder material than the sand into which the ordinary castings are usually poured.

DIFFERENTIAL: The mechanism at the rear wheels of a car which enables one to turn at a slower or faster speed than the other and which is in operation whenever the car deviates from a straight line.

DIFFUSE: To spread around; the opposite of concentrate. Applied to those head-light lenses which increase the area over which focused light would otherwise be spread. The area of illumination is increased at the expense of intensity.

DIM: To reduce the intensity of a head light through the interposition of a semi-opaque substance or through a reduction in the amount of light produced by the use of a smaller bulb or by the diminution of the current applied.

DIRECT: To aim or focus a light upon a given point. DIRECT DRIVE: The "speed" or "gear" of a transmission system which unites the two shafts so that they drive as a unit, and the power is transferred to the differential without the interposition of another gear. Also applied to such systems as exert the power directly at the rear axle or at each driving wheel.

DISCHARGE: To empty, when applied to a battery; the flow of current from the positive to the negative pole.

DISCHARGE RATE: The number of amperes or amount of current which flows from a battery during a given operation.

DISH: To arrange a wheel so that the rim and hub do not lie in the same plane and so that the spokes, therefore, leave the hub at a slight angle from a perpendicular with the axle. A form of construction of some wheels to provide for driving thrusts and their strains.

DISINTEGRATE: To melt away or fall apart from the action of time, heat, chemicals, or the weather.

DISK: A thin circular piece of metal, fabric, or other material which will retain its shape. DISK CLUTCH: A clutch composed of a series of metal or fabric-covered disks

which are pressed together when the clutch is engaged.
DISK WHEEL: A type of automobile wheel composed of one or more solid disks on which the rim rests. The rim replaces the spokes of the wheels.
DISSOCIATE: A chemical term applied to the action which causes one element of a compound to leave another and enter into a different form.
DISTANCE ROD: The rod or arm used to form a positive connection between the rear axle and frame to cause the former to hold its proper relation with the latter, regardless of the driving strains which may be applied.
DISTILL: To give off larger elements by means of the application of heat. Gasoline is obtained by a form of distillation in which the lighter liquids from the petroleum arise in the form of vapors and are condensed.
DISTRIBUTOR: An electrical device by means of which the current is "sorted" and directed to the proper cylinders of an automobile engine.
DIVIDERS: A draftsman's compass with an accurate adjustment used for obtaining measurements, describing circles and other geometric operations.
DOWEL PIN: A small pin or projection on one surface, fitting into another surface, serving to hold the two pieces in exactly the proper relation to each other.
DRAG: A term applied to a binding clutch or brake band which does not release properly.
DRAG LINK: The rod connecting the steering arm with the yoke of the front wheel and which serves to communicate the motion of the former to the latter, so that the car may be steered.
DRAIN COCK: A valve or cock, placed at a low point in the oil, fuel, or cooling system for the purpose of draining the contents of the tank, reservoir, or radiator.
DRIFT PIN: A tapered pin, used for lining holes in two pieces which are to be held together by a screw or bolt.
DRILL: To cut a hole by means of pressure and rotation of a special form of tool. The name also applied to a

metal tool having a cutting edge designed to make holes in a metal or other hard material.

DRIVE: The method of transmitting power from the engine to the rear wheels.

DROP-FORGE: To shape a heated piece of metal by means of successive blows of a steam hammer which contains a die which will stamp the piece to the desired shape.

DRY BATTERY: A form of battery cell used for emergency ignition which obtains its current from the chemical action of its elements in the form of a paste instead of a liquid.

DUST CAP: The cover which screws down over a tire valve stem to protect the latter from dust, mud, and water.

DYNAMO: A machine for generating electric current.

DYNAMOMETER: A mechanical device for the absorption and measurement of power produced by an engine or motor. This is the only method by which the actual brake horse power developed by an engine can be determined.

E

ECCENTRIC: Two circles, one within the other, having different centers; also a circular projection, mounted on a shaft or stud, machined from a different center than that from which the shaft itself is turned.

EFFICIENCY: The ability to perform work without loss of material or energy other than that required to perform that particular work. Generally expressed in terms of percentages; thus a transmission 90 per cent efficient means that 10 per cent of the power is lost and that only 90 per cent is delivered in useful work.

ELASTIC LIMIT: The tension in pounds per square inch at which a material will lose its power to resume its normal length after such strains. The point at which its elasticity becomes strained.

ELBOW: A connection which enables a pipe line to be changed to another direction.

ELECTROLYTE: The liquid in which the plates of a storage battery are immersed.

ELEMENT: A chemical term applied to the eighty natural gases or solids which are distinct in themselves and are united with no other gases or materials. A term also applied to an assemblage of plates and connections in a battery forming either the negative or the positive units.

ELLIPTIC: Having the form of an ellipse. SEMI, THREE-QUARTER, and FULL ELLIPTIC SPRINGS designate the number of sections of springs supporting each portion of the car.

EMERGENCY BRAKE: The brake which supplements the foot or service brake and which is generally provided with a ratchet, so that it may be used to hold the car on a grade without the assistance of the driver. The emergency brake is generally applied by a hand lever, and usually acts on the inside of the brake drum.

E. M. F.: An abbreviation meaning Electro Motive Force, the voltage or pressure of an electric battery or generator.

ENAMEL: A glossy pigment or form of paint applied to fenders, motor bonnets, and other steel portions of the car. To apply enamel.

EN BLOC: A French term implying an engine casting in which all cylinders are formed in the same piece.

END POINT: The temperature at which the distillation of a certain fuel or other volatile liquid ceases.

END THRUST: The force applied in a lateral direction on a revolving shaft and usually caused by the reaction of the transmission of the power carried by that shaft.

ENDURANCE RUN: A contest based not so much upon speed as upon the ability to withstand whatever ordinary obstacles are encountered during the course of the run. Penalties are exacted for delays due to mechanical failures.

ENERGY: The ability to perform work.

ENGAGE: A term applied to the release of the clutch

or the movement of gears, so that two or more come in contact with each other.

ENVELOPE: The covering used to inclose the top when folded.

EQUALIZER: A mechanical arrangement providing for equal distribution of power from a single rod to two or more other rods; used extensively in motor-car brake systems to insure the same braking effect on each wheel.

EQUIPMENT: The fittings ordinarily included in the purchase price of a car, but which are not absolutely essential to its operation.

EXHAUST: The gas given off after the completion of the power stroke. It consists of carbon dioxide (CO_2) and the poisonous carbon monoxide (CO), as well as water vapor. EXHAUST HORN: A horn operated by the exhaust gases from the engine. EXHAUST PORT: The opening of a two-cycle engine through which the exhaust gases pass when uncovered by the piston. EXHAUST VALVE: The valve controlling the exit of the exhaust gases from the engine cylinders into the exhaust manifold and pipe.

EXPANSION: An increase in size due to the effect of heat, moisture, or other physical condition. EXPANSION JOINT: The space provided between two adjoining pieces of material to allow for an increase in size.

EYE: A hole formed in the flattened end of a rod; usually used as the portion connected with the "yoke" of another rod, such as a brake connection, throttle lever, and the like.

EYELET: A small hole in a fabric or other material, usually bound with brass.

F

FABRIC: A woven material of almost any kind used for a variety of purposes. Specifically, the closely woven cotten layers which, when separated by rubber, form the carcass of the tire. The fabric is the "skeleton" or bones of the tire which take the strains and enable the casing to carry its load.

FACTOR OF SAFETY: A figure expressing the amount of overload which a given piece or material is designed to withstand.

FAN: A rotating piece used to draw a blast of air through the radiator or engine.

FASTENER: Snaps or other devices used to hold curtains, slip covers, and envelopes in place.

FAT: A term applied to a thick, efficient spark.

FATIGUE: A condition reached by metals and other materials when they have been subjected to continued stresses and strains beyond their endurance.

FEED: The manner in which a regular supply of fuel, lubricant, or gas is caused to reach its destination. FORCE FEED: The system by which lubricant is positively forced to the proper bearings by means of a pump. GRAVITY FEED: The system by which fuel reaches the exhaust merely through the action of gravity. PRESSURE FEED: The system by which the fuel is fed to the carburetor by means of air pressure. VACUUM FEED: The system by which fuel reaches the carburetor by means of vacuum or suction created by the engine on the air space in the main tank.

FELT: A wool material used for packing and to produce grease-, oil-, and dust-tight joints.

FENDER: The guards covering each wheel of an automobile serving to prevent mud, dust, and water from reaching the interior of the car.

FIELD: An area of electrical or magnetic activity. The fields of a dynamo or generator are the ends of the stationary magnets in close proximity to which the armature revolves. It is the cutting of the magnetic lines of force emanating from the fields that causes the electric current to be generated and collected at the armature.

FIERCE: A term applied to a clutch which is violent in its action.

FILAMENT: The hairlike wires contained in an electric light through which the current passes and the incandescence of which produces the illumination.

FILE: A roughened piece of hard steel used to smooth metals.

FILLER BOARD: The sheet-metal piece filling the space between the inside edge of the running board and the frame.

FILTER: To strain gasoline, oil, or air by forcing it through paper, cloth, or a fine-mesh screen.

FIN: Thin blade used for increasing the surface and thus providing for air cooling.

FINAL DRIVE: The system employed for transmitting the power from the driving shaft to the rear axle and wheels.

FINGER: A trigger or other lever used in certain mechanisms.

FINISH: The nature of a surface. The final machining operation.

FIRING ORDER: The order in which ignition takes place in the cylinders of a gasoline engine.

FIT: FORCE FIT: Two pieces so designed that pressure is required to fit the one into the other. RUNNING FIT: Two pieces so designed that the one will slide freely over the other with as little lost motion between the two as possible.

FIXED SPARK: A system whereby the spark is caused to occur slightly after the "dead center" of the explosion stroke and which provides no means for automatic or manual control.

FLAME: The blue or yellowish color formed by the ignition of the charge in the cylinder.

FLANGE: A circular projection extending from the circumference of a shaft or other circular piece; used as a guide or a stop.

FLASH POINT: The temperature at which oil, when heated, gives off an inflammable gas.

FLEXIBILITY: A term applied to the performance of a car which indicates its speed range on high gear and its ability to accelerate rapidly without shifting gears.

FLOATING AXLE: The method by which the live axle shaft is mounted in the rear axle bearing. (See Axle.)

FLOATING BATTERY: A certain method of wiring a battery in multiple with the generator and current-consuming systems.

FLOOD: To cause an oversupply of gasoline to reach the carburetor through the depression of the float regulating the check valve, or through the accumulation of dirt which prevents a proper action. Also applied to a two-cycle engine when the lower portion becomes filled with raw gasoline, thus producing an overly rich mixture which will not ignite.

FLUTES: A series of longitudinal or concentric projections.

FLYWHEEL: A large iron wheel mounted on the end of a shaft which serves to store and deliver energy and thus equalize intermittent impulses.

FOOTBOARD: The board on the floor of the driver's compartment through which the control levers extend.

FOOT REST: The rod or rail in the rear of a car on which the occupants of the tonneau may place their feet.

FORE DOOR: Doors placed at the entrance to the front, or driver's, compartment.

FORGE: A method of treating iron and steel, when heated to the proper temperature, by means of repeated blows with a hand or power hammer.

FOUR-CYCLE: The type of engine in almost universal use in the automobile. This consists of four distinct strokes in each cylinder between each explosion.

FOUR-WHEEL DRIVE: A transmission system used successfully on trucks which applies power to the front wheels as well as to the rear.

FRAME: The portion of steel on which the engine, transmission, and body are mounted and which in turn rests upon the four springs of the two axles.

FREEZE: To cause a bearing to seize through overloading or lack of lubricant.

FRICTION: The resistance encountered when one body

is slid over another in contact with it. COEFFICIENT OF FRICTION: A figure determining the relative friction generated by different bodies.

FUEL: A liquid or gas capable of producing an explosive charge in an internal-combustion engine. Also the liquid or gas used to produce the fire in the boiler of a steam engine.

FUSE: To blend metals by means of heat. A short piece of wire which will break down or "burn out" when subjected to an abnormal flow of electric current. Such a fuse is used to protect delicate and expensive systems, should a short circuit be formed.

FUSIBLE PLUG: A plug made of a metal or alloy having a low melting point which is used in steam boilers as a safety device when the water in the boiler reaches too low a level.

G

GALLON: The unit of measurement used in this country when purchasing fuel, and consisting of four of our standard quarts. IMPERIAL GALLON is the unit used in Canada, and is 25 per cent larger in that it contains five of our quarts.

GALLOP: The "regularly" irregular sound of explosion caused through a periodic missing of certain cylinders in an engine due to the use of too rich a mixture or other conditions which cause certain cylinders to fire regularly.

GALVANIZE: To coat iron with zinc or other metal by means of an electrolytic action. Usually applied to tanks and other receptacles exposed to the action of rust.

GAP: The distance between the sparking point or electrodes of a spark plug. Also the maximum distance between the platinum contact points of the circuit breaker or interrupter.

GARAGE: A public or private building used for the storage of one or more automobiles.

GAS: A term improperly applied to gasoline. Gasoline

does not become a "gas" until it reaches the carburetor, and is there vaporized.

GASKET: Paper, copper, asbestos or other material cut in the proper shape and used between two flat surfaces to prevent the escape of oil, water, or gas. GASKETS are used on all transmission and differential case covers and on those engines having a detachable cylinder head. The material of which the gasket is composed is softer than the two surfaces to be clamped together and thus fills all minute inequalities in those surfaces and forms a tight joint.

GASOLINE: A fuel which, when vaporized and mixed with the proper amount of air, forms the motive power of the majority of the automobiles in use. It is a product of petroleum obtained by distillation carried through a certain point.

GATE: The series of slots through which the gear-shift lever is moved and which controls the sections into which it may be slipped. The usual form of gear gate is known as the "H" gate, through its similarity to that letter in shape and construction.

GAUGE: An instrument for determining pressures or quantities by means of the movement of a pointer over a circular or linear scale. Also the width of tread between the wheels of a car.

GEAR: A toothed wheel used to change the direction or ratio of rotary motion. Also an assembly of various parts forming a unit used for the same purpose as the transmission. GEAR BOX: The container for housing the speed gears of a gasoline-driven car; also called GEAR CASE. GEAR SET: The collection of gears and shafts mounted in the case which constitute the change-speed element of a gasoline-engine-driven car.

GENERATOR: A device for producing electric current or gas. Most commonly, the dynamo used in all cars provided with electric starting and lighting systems which serves to keep the battery supplied with the proper amount of current.

GIVE: The unsupported spring or sag of a part or an assemblage of parts when a load is suddenly applied.
GLYCERINE: A heavy liquid sometimes used in the cooling system to prevent the freezing of the radiator water in cold weather.
GOVERNOR: A mechanical device which automatically limits the speed of the engine to a predetermined number of revolutions through its control of the throttle position.
GRAB: The sudden application of load or power due to a sudden release of the clutch or to a harsh condition of the clutch surface.
GRADE: A roadway or other surface extending at an angle from the horizontal, sometimes measured in degrees made by this angle with the horizontal. The American method of determining grade, however, is in percentage given as the ratio of the vertical distance to the horizontal distance traveled. Thus a 20-per-cent grade is one in which a 20-foot elevation is obtained for every 100 feet of travel in a horizontal direction. By the English method of determining, this would be termed a "one in five" grade.
GRAPHITE: A finely flaked or pulverized form of carbon used as a lubricant to fill the pores of metal surface sliding in contact with one another.
GRAVITY: The attraction of the earth which causes bodies to fall downward. GRAVITY FEED: The fuel system by means of which the gasoline reaches the carburetor from a tank placed higher either on the dash or under the front seat of the car.
GREASE: A lubricant of a higher consistency than an oil. Grease is generally non-flowing except under high heat or under pressure. GREASE CUP: The grease container applied to spring bolts, steering knuckles, and other portions of a car requiring a constant pressure of lubricant at the joints in question.
GREEN: The condition of a paint or varnish before it has properly "set" or hardened.
GRID: The gridiron shape of battery plates, so formed for the purpose of combining light weight with a surface

to which the negative and positive elements may be applied.

GRIND: To reduce size or remove roughness by means of abrasion. Also the noise produced by worn or imperfectly adjusted gears.

GRIP: The indentation, projection, or other irregular surface in a tire provided for the purpose of obtaining a more positive contact with the roadway.

GROMMETT: A brass-bound circular opening in a canvas or other flexible material used for the support of a hook or rope and to prevent tearing of the fabric.

GROUND: The use of the frame or other metal portion of the car as the return for electric current in certain lighting systems. These are known as "one way" systems. Also the point at which the battery is connected with the frame to form the "ground" return.

GROUP: The collection of all parts of a similar shape serving the same purpose. For example, the negative group of a cell is the collection of all of the negative plates of that cell which are joined together at a common terminal.

GUARD: A sheet of metal used to protect a person or his clothing from revolving parts of machinery or from flying particles of metal and the like. MUD GUARD: The fenders placed over the front and rear wheels to catch the particles of mud, stones, and dirt thrown off by centrifugal force.

GUDGEON PIN: Almost obsolete term sometimes applied to the wrist pin of a connecting rod.

GUIDE: A ridge or hole formed for the purpose of controlling the direction of movement of a piece. VALVE GUIDE: The opening in the cylinder through which the valve stem passes and which serves to cause the valve to return to a perfect seat.

GUM: A term often applied to pure rubber out of which the best quality of tires and tubes are made. Also a specially treated rubber material used for repairing cuts and bruises in tires. The condition reached by an oil or

other lubricant when heat or age has evaporated the lighter elements, leaving only a sticky mass which will not flow.

GUSSET PLATE: A reinforced plate used at the junction of a cross member with the side members of a frame to strengthen this portion and to prevent "weaving."

H

HACK SAW: A specially tempered saw designed for cutting metals or other substances harder than wood.

HAIR: The material used in stuffing the best automobile upholstery.

HALF-TIME SHAFT: A cam shaft or other shaft of an engine driven by a two-to-one gear for the purpose of revolving the shaft at speeds of but one half of the speed of the engine.

HAND BRAKE: A term often applied to the emergency brake when it is designed to be operated by hand in the usual manner.

HAND HOLE: An opening provided in the crank case of larger engines for inspection and adjustment purposes. When not in use the opening is closed by a cover held in place by thumb nuts or other devices.

HANDLE: To operate a car.

HARDEN: To increase the hardness of a metal through heat treatment.

HARSH: The condition of a clutch when the surfaces are so roughened as to make smooth or easy engagement difficult.

HEAD: The top of a cylinder, whether cast integrally as a portion of that cylinder or not. Many present-day engines are provided with a detachable cylinder head.

HEADER: A main pipe into which other branching pipes terminate. The main portion of the manifold.

HEAD LIGHT: The lights at the front end of the car used to illumine the road and to announce the approach of the car.

HEAT (TREAT): A method of heat application, temper-

ing, and cooling applied to gears and many other metal parts subjected to severe service. HEAT TREATING serves to increase the strength, toughness, elasticity, or hardness of the parts so treated.

HEATER: A device employing the heat of the exhaust gases for the purpose of raising the temperature of the gasoline or air used in the mixture. Also an electric device employed for the same purpose. Also a radiator or register serving to convey heat from the exhaust gases to the floor of the tonneau or driving compartment.

HEAT UNIT: The unit by which the heating value of any fuel is determined. Custom in this country employs the British Thermal Unit or B. T. U. (*q.v.*).

HELICAL: Pertaining in shape to the form of a helix. HELICAL GEAR: A gear having its teeth generated with a helix as the basis.

HERRINGBONE: A combination of gear teeth shaped in a V form.

HIGH: The term applied to the third or direct speed of three speed transmissions. Some cars having four speed transmissions are "geared up" on high or fourth speed, so that the driving shaft turns at a greater number of revolutions than does the engine.

HIGH TENSION: The secondary current of the ordinary ignition system as it is supplied to the spark plugs. The voltage of this system will be from twelve to twenty thousand volts and determines the ability of the spark to jump across the air gap under the resistance offered by the compression in the engine cylinder.

HIT AND MISS: The method of governing the speed of an internal-combustion engine by totally eliminating explosions when the engine is exceeding its regulated speed.

HOBBER: A machine for cutting gears by means of the reciprocating motion of a special tool.

HOMOGENEOUS: A term applied to a gas or vapor which is thoroughly mixed and contains no layers of varying densities.

HOOD: The sheet-metal covering of the engine extending from the radiator to dash or cowl. Often termed the bonnet.

HOOK-UP: The retention of the reverse and cut-off linkage in a steam automobile in such a manner that the cut-off is changed from the full-stroke admission of steam.

HORSE POWER: The unit of work measurement. It is somewhat less than the actual working ability of the average horse for a limited period. It is known as the ability to perform 33,000 foot pounds of work, which means that an engine developing one horse power can raise 33,000 pounds one foot in one minute; 1,000 pounds 33 feet in one minute; one pound 33,000 feet in one minute; or any other combination for these factors of weight, time, and distance.

HOSE: A flexible tube of rubber or canvas used to carry gases or liquids. A standard part of the equipment of practically all cars, used to convey the cooling water between the engine and radiator.

HOT SPOT: The portion of an intake manifold heated by an exterior source, such as exhaust gases, for the purpose of more thoroughly vaporizing and mixing the incoming charge.

HOUSING: The container in which the differential gear or other assemblage of parts are mounted.

HUB: The center of a wheel from which the spokes radiate and in which the bearings on which it revolves are mounted.

HYDRAULIC: A term pertaining to water.

HYDROCARBON: The family to which all our fuels and lubricants belong, and including all of the petroleum, coal, and coal-tar products which are composed of various proportions of hydrogen and carbon.

HYDROGEN: One of the chemical elements; a gas highly inflammable which constitutes a portion of our atmospheric air. Also one of the essential parts of all fuels and lubricants.

HYDROMETER: A device consisting of a syringe employed for determining the specific gravity of gasoline, antifreezing mixtures, or battery solution.

I

I-BEAM: A piece of iron or steel having a cross section shaped similar to the capital letter "I"; used extensively for front axles, and for rear axles on the chain or internal-gear-driven type of trucks. Also as members of the "subframe" in which motors or transmissions may be mounted.

IDLER: The gear, pulley, or other rotating piece which does not perform any work in the actual transmission of power. Frequently used to keep a belt or chain of the proper tightness or within the proper confines. Also applied to a low or intermediate gear which is in mesh without performing any work when the mechanism is engaged in high or direct speed.

IGNITE: To set fire to. IGNITER: A portion of the ignition system; usually applied to the old type of "make and break" system. IGNITION: Specifically, the act of exploding the charge in the internal-combustion-engine cylinder by means of an electric spark. IGNITION SYSTEM: The entire electrical system having to do with the explosion of the charge in each cylinder.

IMPELLER: The vanes or paddles of a rotary water pump.

IMPREGNATE: To thoroughly saturate so that the impregnated material becomes a part of the fabric or other material so treated.

IMPULSE: Energy applied to cause motion. Usually the energy applied by a flexible medium, such as gas or water specifically the impulse of the explosion stroke.

INCRUSTATION: The slow-forming deposit of foreign matter on iron or other material. Usually applied to the combination of rust and other deposits on the interior of pipes and tanks carrying or containing water.

INDEMNITY: The claim paid by an insurance company to indemnify the owner for loss by fire, theft, collision, or damage suit.

INDICATOR: An instrument provided with a movable pointer and dial, or other means of determining pressure, flow of electric current, or temperature, or level to which a gasoline, oil, or water tank may be filled.

INDIVIDUAL: Separate from. Individual cast cylinders are those in which each cylinder is made and finished separately. Each is only connected to its neighbor when installed in the engine

INDUCTION: An electrical term applied to the change in character of current when subjected to certain conditions. INDUCTION COIL: The coil used in the ignition system of the gasoline engine for the purpose of raising the low voltage of the battery to the high voltage required to operate in the higher compressed gases in which the spark plugs are placed.

INERTIA: The property possessed by all bodies having weight which requires power to set them in motion, and, once in motion, to bring them to rest. Momentum is the inertia of a body in motion.

INFLATE: To add pressure to an air or gas-containing body; specifically applied to the act of pumping tires.

INJECT: To force a liquid or gas into a tube, tank, or other container.

INLET: A pipe or passage through which an incoming gas or fluid passes; applied to the intake pipe and also to the cooling water passages leading to the radiator or jackets.

INNER TUBE: A flexible rubber air container carried inside of the tire shoe and constituting the air-tight compartment.

INPUT: The amount of electric current, heat, or other form of energy passing to a storage reservoir, such as an electric battery.

INSERT: The use of a fabric or metal part of a material different from that constituting the main body. Cork inserts are pieces of cork introduced into brake or clutch linings to carry a portion of the friction and change the operation of the brake or clutch.

INSIDE (VALVE): A small plunger placed in a tire valve which serves to prevent the escape of air and yet permits the tire to be pumped to the desired pressure.

INSOLUBLE: Undissolvable. A chemical term applied to those materials or chemicals which will not dissolve in the liquid under consideration.

INSPECTION HOLE: An opening in a cylinder head, crank case, or gear case provided for the inspection of the interior mechanism.

INSPECTOR: The employee in a factory whose duty it is to test and inspect all manufactured parts for the purpose of determining their accuracy and availability.

INSULATOR: The material surrounding a wire or other electric conductor for the purpose of preventing the escape of current; any material which is a non-conductor of electricity and is used to hold the current within its proper confines; also, the heat-resisting material placed around exhaust pipes, steam boilers, and the like, to retain heat.

INSURANCE: A form of protection against fire, theft, collision, or liability to damage claims, in which the risk is taken by the insurance company in return for a stated sum per year.

INTAKE: The pipe passage or valve through which the explosive charge is sucked or forced into the cylinder previous to compression and ignition. Also the suction stroke of the piston which creates the force drawing the incoming charge into the cylinder

INTEGRAL: A part of. Applied to cylinders which, instead of being produced separately, are formed in one piece. INTEGRAL HEAD: A non-detachable cylinder head in which the heads are an actual part of the cylinders themselves.

INTENSIFY: To increase in strength at the expense of volume; usually applied to the electric-ignition current when its quantity is reduced in order to build up its voltage.

INTERCHANGEABILITY: The method of design and accuracy of manufacture whereby two or more pieces can be made to fit in the same place.

INTERLOCK: An arrangement of parts or surfaces, so that projections fit into corresponding depressions and the entire assembly becomes a unit.

INTERMEDIATE: The term generally applied to the middle or second gear or speed ratio of a three-speed transmission.

INTERNAL-COMBUSTION MOTOR: A general term for any engine obtaining its power from the combustion of fuel directly within its cylinders. Distinctly opposed to the steam engine and electric motor, which obtain their power from special sources, such as the boiler, and battery or dynamo, respectively.

INTERNAL GEAR: A system of rear-axle drive used in a large numbers of trucks whereby the power is transmitted to a small gear or pinion which meshes with a large annular or ringed gear, having the teeth cut on the inside and mounted on the rear wheels of the truck. This enables a solid rear axle to be used, the power being transmitted independently by means of a shaft on which the above-mentioned pinions are mounted.

INTERRUPTER: A circuit breaker or other mechanism designed for stopping the flow of ignition current, so that it may be "built up" in intensity and thus jump the gap in the spark plug.

INVOLUTE: A form of gear tooth having a certain shape based on a mathematical calculation.

IRON: Generally considered the most useful metal in the world. The basic constituent of all forms of steel.

IRREVERSIBLE: Capable of movement in but one direction. Specifically applied to mechanisms in which movement can be obtained by the application of power only at one end. For example, in the irreversible steering gear the wheels may be moved only by turning the steering wheel—

the steering wheel cannot be moved by power applied to the wheels.

J

JACK: A mechanical device for lifting the wheels of a vehicle from the road. JACK SHAFT: A shaft to which the power from the engine is transmitted prior to its application to the rear axle.

JACKET: The outer lining of the space provided for the water which surrounds an automobile engine for the purpose of maintaining temperatures below a given degree.

JAR: A rubber or glass container in which the solution and plates of each cell of a storage battery are carried.

JAW: A heavy piece of metal used in a clutch or a clamp to hold another piece firmly in place. JAW CLUTCH: A form of clutch in which the two members interlock when engaged, so that slipping cannot take place.

JIGG: A tool used in the production of identical parts. For example, the jigg used in the production of the cylinder head in a certain make of motor insures that every bolt hole on each piece will be drilled at exactly the proper place, so that the head will fit directly on any other engine of that same model.

JOINT: A piece or mechanism connecting two separate bodies. UNIVERSAL JOINT: A mechanism connecting two rotating members which allows the one to rotate at an angle with the line of the other.

JOURNAL: An entire bearing, including the bearing material and the "boxes."

JUICE: A term applied to electric current used for electrically-propelled vehicles, electric starters, or ignition purposes.

JUMP SPARK: The form of ignition used on practically all modern internal-combustion motors. The heat for ignition is caused by a high-tension current which is forced to jump across a gap provided by the spark plug, and in so doing produces an arc of intense heat.

JUNCTION BOX: A small box in which electric wires

leading to various parts of the ignition, lighting, and signaling system terminate or connect with other wires. Usually the box in which the fuses are placed.

JUNK: An article which, through excessive wear or abuse, has been rendered unfit for use.

JUNK RING: A large packing ring used to prevent the escape of gas between the sleeves of the sleeve-valve type of motor.

K

KEROSENE: A product of refined petroleum; it is water-white or slightly yellowish in appearance and can be used as a fuel either in a steam or internal-combustion engine. Its boiling point is higher than that of water, but before this temperature is reached an inflammable gas is given off which makes the use of kerosene highly dangerous in the neighborhood of an exposed flame. Kerosene does not evaporate as easily as does gasoline, and, therefore, is not as well suited as a substitute fuel in a gasoline engine. It retails at slightly more than half the price of gasoline, however, and may be used satisfactorily for removing grease, rust, and dirt.

KEY: In machine construction a piece of metal used to retain another piece in place. Usually in the form of a slim, square-shouldered bar, setting in a groove on an axle and projecting above the surface to set in a similar groove cut on the inside of the hub of the wheel, gear, or pinion to be held in place.

KHAKI: Originally a brownish material from which soldiers' uniforms are made, but now a term employed to describe the distinctive army color. Cars and trucks used in government service are painted a khaki color.

KICK: A premature explosion in one or more cylinders causing a reversal in the direction of the rotation of the crank shaft. Oftentimes termed a "back" kick and frequently the cause of a broken arm or wrist when the car is cranked by hand.

KICK SWITCH: An ignition switch mounted on the

dash of the car which may be thrown to the on or off position by a movement of the foot.

KILL: To stall the motor through the application of an excessive or sudden load.

KILN: A receptacle or oven in which wood is dried; all lumber entering into the construction of automobile bodies should be properly kiln-dried.

KILO: A Greek suffix meaning thousand, and used before a unit of the metric system.

KILOGRAM: 1,000 grams, the metric unit of weight; a kilogram is equal to 2.2 pounds. KILOLITER: 1,000 liters, the metric unit of liquid measure; a kiloliter equals 220 imperial gallons. KILOMETER: 1,000 meters, the metric unit of linear measurement; a kilometer is approximately 6–10 of a mile, or 3,280.8 feet. KILOWATT: 1,000 times the universal unit of electrical energy; a kilowatt equals approximately 1.34 h. p.

KINEMATICS: The science or the study of kinetic energy.

KINETIC: Relating to the stored-up energy of mass at rest, as opposed to active, dynamic energy.

KNOCK: A sharp, pronounced sound occurring at regular intervals in a moving part, generally caused by a loose bearing or premature ignition due to an unduly advanced spark or excessive carbon formation.

KNUCKLE: A peculiarly shaped piece of metal used to transfer the direction of motion. STEERING KNUCKLE: The portion of the steering gear attached to each front wheel which enables such wheel to change its plane of rotation independently of the axle.

KNURLE: To roughen a piece of metal or wood by means of parallel or angular lines; used extensively on nuts, bolts, and screw-heads which are to be tightened or loosened by the fingers.

L

LABOR: To give evidence of an overload, as when an automobile is driven up a steep hill on too high a gear.

LADLE: A long-handled metal scoop used for pouring metals previous to casting.

LAG: A small interval of time elapsing between mechanical, chemical, or electrical cause and effect. Applied in high-speed engines to the seeming slowness of the spark or mixture after electrical contact has been made or after the intake valve has been opened for the admission of the gases.

LAMP: Now almost universally applied to the electric bulb used in the head lights and tail lights. Electric lamps are specified by their size, their c. p., the voltage of the circuit on which they are intended to be used, and the nature of the wiring—*i.e.*, whether single or double contact.

LAND: A circular ridge on the surface of a piston, cut between the piston-ring grooves.

LANDAULET: A type of motor-car body, the tonneau portion of which may be open or closed. The top is flexible so that it may be folded down, while the glass sides generally pull down into the panels of the doors. That portion of the roof over the driver's head is permanent.

LAP: One circuit of a race course; a term used in automobile or horse racing. Also a technical term applied to the operation of "running in" pistons under separate power. A cutting or grinding compound is used so that the pistons and cylinders in which they operate will be furnished with a smooth surface, thus eliminating friction and producing a gas-tight joint.

LASH: Generally known as "back" lash, and representing the accumulated lost motion between the first and last of a chain of gears or series of linkages.

LATCH: A mechanism devised to hold a movable part in place and which acts automatically as soon as the movable part reaches the proper position. Latch is applied to a mechanism which will release either at the will of the driver or automatically by the machine itself.

LATE: Applied to an ignition spark or valve timing which occurs later than should be the case. A late or a retarded spark is a frequent cause of overheating. Late valve

timing will cause loss of power and an otherwise poor performance of the motor.

LATENT: Concealed or temporarily inactive. LATENT HEAT: The amount of heat, generally expressed in B. T. U.'s required to transform the physical state of a liquid or solid without changing the temperature. For example, heat is required to melt ice, and yet the temperature of the water will be the same as that of the solid ice.

LATHE: An instrument or machine used for revolving wood or metals to be turned to some specific shape.

LEAD: One of the mineral elements; a soft metal used largely in the construction of storage batteries; an excellent conductor of electricity; also, to cover with lead.

LEAD: (Leed) The amount of advance before its normal operation given to the action of a mechanism. For example, an intake valve may have a lead of 5 degrees if it opens by that amount of the revolution of the flywheel in advance of the beginning of the suction stroke.

LEAF: A portion or "plate" of the usual type of spring used to support automobile bodies; from three to a dozen leaves may be used in each automobile spring; opposed to the spiral type of spring.

LEAK: An unintentional escape of fluid or gas from a container; also specifically applied to the loss of electric current from a wire, spark plug, or the like.

LEAN: A term applied to a mixture of combustible vapor and air which contains too high a proportion of air to be readily ignited. Such a mixture is relatively slow-burning, and is the cause of back-firing through the carburetor.

LEATHER: A portion of animal's hide used in automobile upholstery.

LENS: A piece of glass through which the head-lamp rays are projected; formerly of the plain type, but now, since the almost universal enactment of non-glaring laws, of some optical shape in order to deflect or diffuse the strong head-lamp rays.

LEVER: An unbending rod or handle used to transform the point of application or the amount of power applied

on the "load" end. LEVERAGE: The ability to increase power by means of introducing a lever.

LIABILITY: A form of insurance intended to protect the owner of an automobile against suit for damages brought by a supposedly injured party. The amount of damages for which the owner of a car is responsible for damages caused to other persons or property.

LIBERATE: To free; applied to a storage battery when under electrical action; it gives off hydrogen gas.

LICENSE: The permit issued to operate automobiles by the Secretary of State or other official of state, county, or municipality.

LIEN: A mortgage granted by court on a piece of property for debts contracted. Specifically, the right of a garage to hold a car, on which labor has been expended or parts supplied, until satisfactory payment has been made.

LIFE: The length of service rightfully expected from a car, tire, battery, or other replaceable part.

LIFT: Specifically, the space between the valve seat and valve edge when the valve is open to its full amount. The amount of lift is determined by the size and shape of the valve cam. LIFTER: The intermediary mechanism between the valve stem and the cam.

LIMIT GAUGE: A device used in parts inspection tests for determining the accuracy of manufacture of a piece. LIMITS: The allowable variation in manufacturing accuracy.

LIMOUSINE: A type of permanently closed automobile in which the driver's seat is separated from the rear or tonneau.

LINE: The circuit or collection of wires and electrical instruments forming one continuous route of an electrical current. LINER: A thin piece of metal placed between two separate parts to take up space between bearings or otherwise tighten a joint or connection.

LINK: A portion of a chain. CROSS LINK: The portion of a non-skidding chain passing across the tread of a tire. DRAG LINK: A portion of the steering gear of an

automobile connecting the steering arm with the steering knuckle on the front wheel nearest the steering wheel.

LINOLEUM: A type of floor covering used on the running boards and front-seat compartments of automobiles.

LIP: A small projection of a piece of metal serving as a stop, lock, or deflector in a mechanical action.

LITER: The metric unit of liquid measure, approximately equal to our quart.

LOAD: The weight carried by a moving or stationary object. In mechanics, any resistance to the performance of work.

LOCK: Any mechanism for holding moving parts in a desired position until released.

LOCK NUT: An additional nut screwed on a bolt (usually a spring clip) to hold the original binding nut in place.

LONG-STROKE: A type of engine in which the stroke is greater than the bore by a certain arbitrary ratio.

LOST MOTION: The "play" existing in bearings or gears through wear or design which allows one member of a mechanism to be moved slightly, independently of its neighbors.

LOUVRE: The slits or openings in the side of a motor hood or bonnet intended for the escape of the hot air from the fan and radiator.

LOW: The first speed of a gasoline automobile. Through the introduction of a small gear which carries the power from the engine to a large gear which connects with the rear axle, a low-gear ratio is obtained, and, although producing slow speed, gives maximum power at the rear wheels for hill climbing, starting, and other heavy work.

LOW TENSION: The electric current coming from the battery in its low-voltage state before it is "stepped up" to the higher voltage required for forming a spark.

LUBRICATE: To interpose a filament of friction-reducing material between two moving surfaces. LUBRICATOR: The mechanical device for feeding at regular intervals the proper amount of oil to bearings or other

friction points. LUBRICANT: An oil or grease used to reduce friction.

LUG: A small arm or other projection cast on a piece of metal to serve as a support for itself or another part.

M

MACHINE: The operation of finishing or planing metal surfaces by means of power-operated tools. MACHINE SCREW: An iron or other metal screw having threads cut to United States standard gauge.

MAGNET: A piece of iron or steel possessing the properties of attracting other bodies of iron or steel.

MAGNETISM: The property of attracting other bodies of the same nature. The basis of all electric-power machines.

MAGNETIZE: To impart the property of magnetism, usually by passing an electric current through coils of wire surrounding the piece of steel to be so treated.

MAGNETO: A mechanically driven electric generator especially designed to furnish ignition current for an internal-combustion engine.

MAIN BEARING: The bearing in which the crank shaft revolves in the motor. To be differentiated from the bearings of the crank shaft to which the connecting rods are attached, and which are termed connecting-rod bearings.

MAKE-AND-BREAK: A form of ignition formerly widely used in the internal-combustion engine before the high-tension or jump-spark system was perfected.

MALLEABLE: Capable of being worked; opposed to cast iron, for example, which cannot be heated, hammered, or worked into shape.

MANDRIL: A steel part or shaft on which work to be handled in a lathe is securely mounted.

MANGANESE: One of the metallic elements used largely as an alloy in the production of special metals used for bearings and other purposes requiring special properties, ıch as wear-resisting abilities.

MANOGRAPH: A device used for determining the various pressures occurring during the explosion, expansion, intake, and compression of the cylinder of a steam or gasoline engine.

MANUAL CONTROL: A system of spark timing which permits the driver to set the time at which a spark should occur.

MASTER GEAR: The large beveled gear at the rear axle of the car which transmits the power from the driving shaft to the differential and the rear wheels. MASTER VIRBATOR: A single coil and vibrator used to increase the voltage in the spark plugs in any number of cylinders, to each of which the current is properly distributed from the common (or master) coil by means of the distributor.

MAT: The heavy covering of the floor or running boards of an automobile.

MEAN EFFECTIVE PRESSURE: The average pressure exercised on the piston through its entire stroke. Commonly abbreviated, M. E. P.

MERCURY ARC: A form of light of a peculiar greenish color formed by an electric arc in the vacuum between mercury electrodes. MERCURY ARC RECTIFIER: A device employing the mercury arc principles for transforming the alternating current to the direct type, and employed for charging storage batteries.

MESH: To engage the teeth of one gear with those of another gear.

METER: An instrument or gauge for measuring or recording speeds, pressures, quantities, and the like.

METER: A linear unit of measurement of the metric system. It is equal to 39.37″.

MICA: A semi-transparent mineral used principally for its heat and electrical resisting quality. Formerly used largely in the construction of spark plugs as an insulator.

MICROMETER: A device for measuring sizes to an accuracy within 1-1000″ or less.

MICROPHONE: A device for magnifying and locating sounds.

MILEAGE: (Fuel) The distance in miles covered, with the attendant consumption of one gallon of fuel.
MILLIMETER: A 1-1000 part of a meter.
M. P. H.: A frequently used abbreviation for "miles per hour."
MIRROR: (Rear view) A reflecting mirror placed on the mud guard or wind shield, thus announcing the presence of oncoming vehicles.
MISALIGNMENT: A distortion throwing out of line one or more of a series of bearings; also a bend in the rim of the wheel.
MISFIRE: A skip in the regular rounds of explosions in one or more cylinders caused by imperfect mixture, poor spark, incorrect timing, or leaky valves or piston rings.
MIXING TUBE: A tube in which the sprayed fuel of the steam car is mixed with the proper quantity of air to produce combustion in the engine cylinders.
MONOBLOC: A French term applied to cylinders cast in a single piece.
MOTOR: A mechanical device for transferring energy into work, or rather, into means of doing work. Can be applied with equal correctness to the power plant of the automobile, or to the electric device which furnishes the power for turning the engine, known as the starter.
MUD GUARD: A fender attached to the automobile body and placed over each wheel to prevent the splashing of mud. MUD HOOK: A series of cleats or projections chained to the tires of the car to afford traction through deep snow, mud, or sand.
MUFFLER: A sheet-iron cylinder or chamber into which the exhaust gases are delivered and allowed to expand in order to diminish the sound of the explosion. Some mufflers are provided with various shapes of plates which deflect the gases. A well-designed muffler should not produce material back pressure and consequently the muffler cut-out should not be necessary as a power saver.
MULTIPLE: More than one. MULTIPLE CYLINDERS: A term applied to engines having six, eight, or

twelve cylinders. MULTIPLE WIRING: Electrical connection in which all of the current available does not pass through each instrument or lamp. Opposed to the series system of wiring in which all of the current created passes through such lamp or instrument in succession.

N

NAPHTHA: One of the lighter constituents obtained in the distillation of crude oil, and practically identical with some of the lower grades of gasoline.

NEEDLE VALVES: A small opening in the carburetor or other fuel or air line which is controlled by the tapered point of a small pin or needle. As the needle is screwed into the opening, the orifice becomes smaller, and the amount of fuel or air passing by is reduced. The needle-valve adjustment on a carburetor usually controls the amount of gasoline fed into a fixed quantity of air.

NEGATIVE: The collection of plates of a battery to which the current flows from the positive terminal. Also applied to the direction of current in a circuit.

NEUTRAL: The position of the gear-shifting lever when none of the speed-reduction gears are in mesh, thus allowing the engine to operate without transmitting its power to the rear wheels.

NEUTRALIZE: To offset the effect. Specifically applied to the action of chemicals such as acids, which may be counteracted by the action of another chemical, such as alkali. For example, ammonia is the best agent to neutralize the burns or corrosion caused by battery acids.

NICKEL: One of the mineral elements. Used largely in the form of a thin coating or plating on surfaces to protect them from rust and to present a bright appearance. Also used as an alloy in steel to produce certain qualities of hardness.

NIGGERHEAD: A drum or pulley-shaped casting attached to the end of a revolving shaft or wheel, around

which a rope may be wound in order to employ the power of the engine or motor, to which such a niggerhead may be connected for hoisting or pulling purposes. A niggerhead attached to the hub of a truck wheel may convert the latter into a hoisting engine which will pull the truck out of mud when traction fails.

NIPPLE: A double-threaded pipe connection or other device intended to connect two parts of an air- or liquid-tight system.

NITROGEN: An inert gas, occurring in various amounts in atmospheric air. NITROGEN LAMP: A newer type of electric illuminating bulb in which the filament is placed in nitrogen gas, instead of in a vacuum, thus adding to the capacity of illumination.

NON-CONDUCTOR: A material which offers so high a resistance to the passage of electric current that normal voltages cannot be forced through it.

NUT: A threaded piece of metal screwed down over corresponding threads on a bolt or screw to hold, through its clamping effect, another piece in its place. SQUARE NUT: One on which there are four surfaces to which the wrench may be applied. HEX NUT: A nut on which there are six surfaces to which a wrench may be applied. THUMB NUT: A nut having knurled surfaces or extensions so that it may be tightened or loosened by the fingers.

O

OCTAGONAL: Having eight sides.

ODOMETER: An instrument which records distances traveled by a car, truck, or other vehicle. HUBODOMETER: An odometer, forming part of the front-wheel hub, so placed in order that the driver cannot readjust the reading, or otherwise affect the operation of the instrument.

OFFSET: Placed out of line. OFFSET CYLINDERS: Cylinders placed somewhat outside of the line drawn directly down from the crank-shaft bearings. This is a

design intended to produce the most direct thrust on the connecting rod at a time when the crank is in a position to transmit the maximum power.

OHM: The unit of electrical resistance representing the resistance encountered by a given quantity of current in passing through a column of mercury, one square millimeter in cross section, and 106.3 centimeters long.

OIL: A hydrocarbon product of petroleum, or other animal or vegetable substances, having a greater or less degree of lubricating property. An oil is usually fluid at normal temperatures, and is opposed to grease, which possesses greater consistency.

OLDHAM COUPLING: A form of universal joint by means of which rotary power may be transmitted in directions at an angle with its source.

"OPEN UP": To move the throttle and spark to their limits, so that maximum power may be obtained.

ORDER (FIRING): The order in which ignition takes place in the various cylinders of a multi-cylinder engine.

OSCILLATE: A swinging motion.

OTTO CYCLE: The internal-combustion-engine principle used on practically all passenger cars, trucks, and small stationary power plants. This consists of the use of an entire stroke of the piston for each of the following succession of events: Ignition and expansion (known as the power stroke); discharge of the exhaust gas (known as scavenging); suction of the fresh charge; and compression preliminary to ignition; and repetition of the above-mentioned cycle.

OUTPUT: The amount of energy obtained from a source of power. This may be horse power obtained from a gasoline engine, or it may be ampere hours obtained from a storage battery.

OVERCHARGE: Often applied to a garage bill. Technically, however, a term referring to a greater amount of current supplied through a storage battery than its capacity demands.

OVERHEAD VALVE: A design of gasoline engine where-

by the valve is placed over the cylinders and operates downward.

OVERLOAD: A load or resistance in excess of the rated capacity or power of a truck or engine.

P

PACKING: The material used around a sliding or revolving shaft to prevent the leakage of liquid or gas.

PADDLE: The vanes of a rotary or centrifugal pump.

PASSAGE: The opening in a casting or other piece of metal to permit the transfer of liquids or gases.

PASTE: The filling of the battery plate designed to intensify and control the chemical action which produces the stored power of a storage battery.

PATCH: A small piece of rubber which, when cemented or vulcanized over a hole in a tire, again renders the container air-tight.

PATCH: (Blow-out) A heavy piece of rubber and fabric intended to reinforce a tire tube at the point where the shoe is blown through. These patches are of the "inside" or "outside" type, depending upon whether they are to be placed inside the shoe or to be laced around the outside of the casing.

PATTERN: A wooden or metal duplicate of a metal piece which is to be cast. A pattern is used to form the mold into which the molten metal is poured.

PEDAL: A lever operated by the foot.

PEEN: To tap lightly with the small rounded end of a machinist's hammer or a special tool, in order to make a more perfect joint with an overlapping piece of metal.

PERIPHERY: The outside, or the circumference, of a wheel or a disk.

PETCOCK: A small, hand-operated drain valve or relief cock.

PETROL: An English term for gasoline.

PHOSPHOR BRONZE: A copper alloy possessing qualities making it especially suitable as a bearing metal, for

parts requiring strength, and for those which are subjected to the action of salt water.

PICKUP: The acceleration or the ability to increase speed rapidly.

PICRIC ACID: An acid sometimes used to increase the volatility of gasoline.

PILOT LIGHT: A small light which burns continuously and is used to vaporize and ignite the main burner of a steam car.

PIN: A cylindrical piece of metal used to hold two or more parts together. COTTER PIN: A pin split throughout its entire length which passes through a hole in a shaft or other pin, and which holds the nut or washer in place. A cotter pin is split so that the ends may be bent back to prevent its accidental removal. WRIST PIN: The shaft or bearing which passes through the upper end of the connecting rod and attaches it to the inside of the piston.

PINCH: A term applied to an inner tube which has been incorrectly installed, so that a portion of it is placed between the rim and the shoe.

PINION: A small gear on the end of a shaft meshing with the larger gear to which the power is to be transmitted.

PINT: One half of a quart, which serves as the American standard of liquid measure.

PIPE: A tube for the transfer of liquids or gases.

PISTON: A cylindrical piece attached to the upper end of the connecting rod, which moves up and down in the cylinder, following the action and the pressure of the exploded gas or steam, and thus produces the power.

PISTON PIN: (See Wrist Pin.)

PIT: The sunken portion of a garage floor which offers room for the repair man to work on the under side of the car. Also a term applied to the small holes or marks burned in the valve or its seat, due to the action of the exhaust gases.

PITCH: The number of threads on a screw, bolt, or nut in one inch of lengthwise measurement. Also a mathematical term applied to the shape of gear teeth.

PLANETARY: A system of speed changing or gear reduction in which all gears are constantly in mesh. Applicable generally to cars or tractors having only two-speed transmissions.

PLANIMETER: A mechanical device used for determining the area of an irregularly shaped outline. Especially useful for measuring the size of a steam engine or gas engine indicator card to determine the indicated horse power without the employment of an involved mathematical formula.

PLATE: A heavy piece of steel or other metal usually rolled to the proper thickness. Differentiated from a sheet of the same metal because of its inability to bend. Also, to cover one metal with a thin deposit of another through an electric process. One of the elements of the storage battery suspended in liquid and on which the action of the battery is dependent.

PLUG: A wooden or metal piece, either smooth or threaded, which, when fitted into a hole, prevents the escape of liquid or gas. A term also applied to the spark plugs used in ignition of the charge in the cylinder of a gasoline engine.

PLUNGER: The piston of an oil, water, or air pump.

PLY: One of the layers of fabric used in the construction of tire casings. Such a casing may consist of four, five, six or even more layers, and in such a case are termed a four-, five-, or six-ply shoe, as the case may be.

POINTS: The terminals between which the electric current jumps in the spark plug; also the contact points of the circuit breaker or interrupter in the ignition system.

POLARITY: The condition of the battery or generator terminal which determines whether the current flowing in it is of the positive or negative type.

POLARIZE: A chemical condition of the storage battery due to overwork, which reduces its efficiency through the collection of mineral deposits on the active plates.

POLE: The terminal of the battery, magnet, or other electric generator, or storage battery.

POPPET: A type of valve composed of a stem on which is mounted a "mushroom"-shaped head, which is alternately lifted and returned to its seat by means of mechanical, spring, or air-pressure action.

POPPING: A sound in the carburetor or muffler, occasioned by continued burning of the charge after the inlet or exhaust valve is opened.

PORT: An opening in an engine cylinder through which gases pass, following the uncovering of this opening by the movement of the piston or other controlling device.

POSITIVE: A section of a battery, or terminal of a generator, from which electric current flows.

POTENTIAL: Electric pressure or voltage.

POUND: An English unit of weight equal to 16 oz. avoirdupois; also an intermittent sound. A knock occasioned by a loose bearing or a broken gear tooth.

PREIGNITION: A premature ignition of the gasoline charge due to a weak mixture, high compression, a hot engine, or carbon formation which becomes incandescent.

PREMIUM: The annual amount paid in return for insurance protection; also occasionally the amount paid in excess of the price of a car to insure prompt delivery.

PRESS: A machine for compressing parts or materials.

PRESSFIT: The machining of parts so closely that pressure is required to separate them. Distinguished from running fit, in which limits are not so close and a motion between the two parts is possible.

PRESSED STEEL: Steel fabricated by pressure of a machine instead of forging, casting, or rolling. Usually applied to thin sheets of steel.

PRIMARY: The electric circuit and wiring of the ignition system through which the battery current passes directly, and opposed to the supplementary system (known as the secondary system), which carries a high-voltage current to the spark plug.

PRIME: To introduce raw gasoline into the cylinders or intake manifold, to facilitate starting in cold weather.

PROGRESSIVE: A type of sliding gear in which the

higher speeds are thrust in after passing through the lower gears.

PRONY BRAKE: An apparatus designed to test the power output of an engine or motor by means of application of friction.

PROPELLER SHAFT: The shaft extending from the clutch or transmission to the rear axle, and which furnishes the driving between the engine and the wheels.

PUMP: A mechanical device for moving liquids or gases.

PUNCH: A steel, pointed instrument used for making a mark on a metal piece to distinguish its location, or for locating drill holes. PUNCH PRESS: A power-operated machine used to force closely fitting parts into place.

PUNCTURE: A cut which penetrates both the shoe and the inner tube of a tire, thus making it impossible to retain air.

PUNISHMENT: Overload or other abuse to which a car or an engine may be subjected through lack of care or reckless driving.

PUTTY: A pliable, mudlike material used as an emergency plug for gasoline leaks.

R

RACE: A speed contest. Also the groove in which ball bearings roll, and the sides of which form the container.

RACK: To shake loose or strain by means of undue jolting and vibration; also a toothed rod over which a toothed gear, called a pinion, operates to produce motion without slipping.

RADIATOR: An appliance having a large air surface over or through which air is sucked or blown to carry off the heat of the water contained within. A necessary part of all water-cooled internal-combustion engines having a limited supply of water available for cooling purposes. Stationary engines having a city water supply, and motor-boat engines able to draw cold water continuously, require no radiator.

RADIUS: A dimension of a circle measured from the center to the circumference, equal to one half of the

diameter. RADIUS ROD: A structural piece used on some chassis to connect the rear axle with the frame and holding the two in the same relation to one another.

RAIL: A piece of wood or metal used for a support, as a foot rail, robe rail, and the like.

RAKE: To set at an angle, as a steering post. RAKISH: Of long, low, and speedy appearance.

RAMP: An inclined runway used in many garages to move cars from one floor to another without the use of an elevator.

RAT TAIL: A small round file.

REAMER: A tool having several parallel cutting edges used to enlarge a slightly smaller hole to exactly the proper size without depending upon grinding or boring instruments.

RECIPROCATE: To move back and forth, as the motion of the piston within the cylinder.

RECOIL: The bounce of springs after they have been compressed, due to depressions or obstructions in the road.

RECTIFIER: An apparatus, chemical or electrical, used to change the alternating current to direct current for charging storage batteries.

RELIABILITY RUN: A form of test in which the absence of breakdowns and necessity for adjustments is the determining factor, rather than speed.

RELIEF: A reduction of compression or other form of pressure.

RESISTANCE: Obstruction to movement. Specifically, an element or material introduced in an electric circuit to prevent the flow of an excessive amount of current. The unit of electrical resistance is an ohm.

RETARD: To set back. Specifically applied to the position of the spark lever when the ignition does not occur until after the piston has started on its downward stroke.

REVERSE GEAR: The position of the gear-shifting lever when the supplementary gear is thrown into mesh so that the engine will move the car backward.

REVOLUTION: One complete turn of a wheel throughout the 360-degree angle.

R. P. M.: A frequently used abbreviation for "revolutions per minute."

RHEOSTAT: A device furnishing varying resistance to an electric circuit, used for large motors carrying heavy loads. Were a full current led to a heavy electric motor in a state of rest, some of the wiring would be burned out.

RIB: A raised piece of metal thicker than the main body with which it forms a part; used in castings to reinforce an unsupported portion or place where excessive strain will occur.

RICH: A term applied to a mixture of gasoline vapor and air in which an excess of the former prevents perfect and clean combustion.

RIDE: Applied to a chain which has become so stretched that it will not fit in the teeth of the sprocket, but rests on the top of them.

RIGID: Structurally so heavily built or so well braced as to be unyielding.

RIM: The outside, or the periphery, of a wheel. Specifically, the removable ring to which the tire is attached to facilitate application to an automobile wheel.

RING: A circular piece of metal or other material. OIL RING: A ring loosely slipped over the rear axle to prevent the transmission lubricant from reaching the brakes. RING GEAR: A gear of the shape of a ring having teeth cut in its side.

ROADABILITY: The property of negotiating ordinary roads at high speeds with comfort and no tendency to skid or bounce over small depressions.

ROADSTER: A two-, three-, or four-passenger vehicle, differentiated from a touring car or a closed vehicle.

ROCKER ARM: A lever operated by a push rod used to change the direction of motion. Employed in all overhead-valve mechanisms to transform the upward motion of the push rod into the downward motion of the valve stem.

ROD: A solid bar of steel or other metal used to unite two parts. REACH ROD: A rod used on some forms of chassis construction connecting the front and rear axles independently of the frame.

ROLLER BEARING: A friction-reducing bearing composed of small rollers laid parallel to the axis to the shaft.

ROTARY: Having a circular motion.

ROTOR: The revolving part of a machine, usually an electrical appliance.

RUBBER: The gum of a tree which, when properly manipulated and treated, becomes the basis of construction of all good tires and tubes.

RUMBLE SEAT: A small additional seat placed in the rear, formerly used on many cars of the runabout type.

RUNABOUT: A two- or three-passenger car or roadster smaller than the touring-car type.

RUN IN: The process of fitting bearings and other moving parts to the proper size by wear or actual use.

RUNNING BOARD: The long steps on either side of the car connecting the front and rear fenders and used to facilitate entrance to and exit from the front and rear seats.

RUNNING FIT: The fit of one part over another so loose as to permit the two to slide or turn independently of each other.

RUNNING GEAR: A term applied to the wheels, shafts, universals, and other moving parts of a stripped chassis.

S

SAFETY GAP: A space provided in the high-tension circuit of the ignition system to prevent damage which might be occasioned if a short circuit occurred, or if the points of the spark plug were brought too close together. Such a gap also serves to increase the voltage of the current.

SAFETY VALVE: A valve used in steam boilers or tanks to prevent an accumulation of excessive or dangerous pressure. It is set to relieve excess pressure automatically.

SAG: To drop below the normal position, due to wear or strain of the supporting member.

SALT: A chemical term applied to an alkaline base. When in solid form, salt is generally of granulated appearance.

SAND BLISTER: The separation of the tread from the fabric of the tire caused by a slight cut, into which water, sand, and dust may enter and cause a blister which will eventually work its way over a greater area and result in the destruction of the center tread, if not given proper attention.

SAPONIFY: To possess an action similar to soap when it creates foam or suds, and applied to actions resulting from the use of certain ingredients in greases and other gear lubricants.

SATURATE: To fill an absorbent gas or other substance completely with moisture.

SCALE: The marks on a measuring or registering instrument.

SCOOP: A dipper-shaped attachment on the under side of the connecting-rod bearing which dips into the oil at each revolution and collects enough for bearing lubrication.

SCORE: To wear the piston and cylinder unevenly, due to lack of lubrication or to overheating.

SCOUR: To remove impurities from gas or air.

SCRAPE: To remove carbon from cylinder heads, pistons, and valves by means of a sharp tool introduced through the spark plug or valve opening.

SCREEN: A fine-wire mesh used as a filter to prevent the entrance of dust or dirt with air or liquid.

SCROLL: A sharply curved portion of the leaf spring of a certain type, in which the end forming the point of support turns back on itself.

SEARCHLIGHT: (See Spot Light.)

SEAT: A smooth surface cut in a cylinder or other casting on which a valve rests when it is in its closed position.

SECONDARY: The winding of an induction coil in which the secondary or high-tension current is collected by in-

duction from the primary winding which carries the current directly from the battery or the generator.

SEIZE: The expansion of a portion of a bearing or piston to the point where it becomes immovable. Usually caused by the excessive speed of the bearing which is set too tight, or through lack of lubrication.

SELECTIVE: The system of gear changing by which any speed may be reached from neutral without going through the progressively lower or higher speeds.

SELF-CONTAINED: Applied to a mechanical action in which the transmission or generation of power and the result of such action are not separate.

SELF-STARTER: A popular name applied to an electric motor which gives the gasoline engine its initial revolution in lieu of the hand crank.

SEMI-ELLIPTIC: A method of spring suspension in which the leaf springs are used only on the lower half of the suspension.

SEPARATOR: A thin insulator used between the positive and negative plates of a storage battery.

SERIES: A system of wiring cells or electric instruments in which the current passes through each in succession.

SERVICE BRAKE: A brake usually operated by the right foot, which is used for retarding the speed of the car. Differentiated from the emergency brake which, on the majority of cars, is operated by hand and is provided with a rack to hold the brake in a locked position when the car is at rest. Some cars are provided with a service brake connected to the clutch and an emergency brake operated by the right foot.

SET SCREW: A small screw placed in a movable piece and so arranged as to rest with its lower end on the stationary piece and intended to prevent motion or rotation of one within the other when the movable piece has been set in the proper position which it should maintain.

SETTLE: To assume a lower position, due to the continued action of undue weight on the part in question.

SHAFT: A revolving part used to transmit power.
SHAPER: Amachine used in automobile manufacture and repair to cut or plane flat surfaces to the proper size and shape.
SHELL: A hollow piece of metal or other material providing the main structural strength of a part. Also applied to that portion of the spark plug on which other parts are mounted.
SHELLAC: A resinous fluid used as a covering for wood and also employed on pipe joints and gaskets to render them air-tight.
SHIELD: A protection against flying water, dust, or wind. Used to protect the occupants of the driver's compartment, and also, when in form of a pan, to prevent the entrance of mud and dust into parts of the engine or other mechanism.
SHIM: A thin, flat piece of metal, fiber, or other material used to hold the two halves of a bearing the proper distance apart so that they may be tightly screwed together without any undue pressure on the revolving shaft. In other words, the shim receives the pressure necessary to hold a bearing tightly in place. They are made thin so that one or more may be removed to compensate for wear.
SHORT CIRCUIT: A leak in the insulation on an electric conductor which permits the current to flow back to the battery or generator without having accomplished its purpose by passing through the light, spark plug, or other apparatus for which it was to be used.
SHOULDER: An enlarged portion of a shaft used to mark the limit to which another part may be moved. In other words, a "stop" on a shaft.
SHRINK: To contract or decrease in size, due to moisture, dry air, cold or other physical condition.
SHUTTER: A movable disk, or other surface used to restrict the flow of air or liquid through a pipe or radiator. Applied specifically to the apparatus used to restrict or throttle the gasoline or air flowing from the intake into the carburetor and to the series of plates or other de-

vices employed to restrict the cooling effect of air passing through a radiator.

SIDE LIGHT: A small light of low candle power mounted on the side of the car and used in city driving when bright head lights are either not allowable or are unnecessary.

SIGHT FEED: A portion of some lubrication systems through which oil passes through a glass tube in sight of the driver, so that the main supply may be under constant observation.

SIGNAL: A device used on cars to indicate the intention of the driver as to stopping or turning.

SILICON: A mineral used in steel alloy to increase the magnetic properties of certain portions of electrical instruments.

SIMPLE: An engine which does not re-expand its exhaust steam or gas in a large, low-pressure cylinder.

SINGLE CONTACT: A wiring system used in the electric lighting of a car which employs the metal of the car as the return.

SIPHON: A flow of water or other liquid caused by the difference in the atmospheric pressure between the intake and discharge ends of a pipe.

SIREN: A form of warning signal.

SKID: The action of a car when it moves sideways out of the desired direction, due to the sudden application of the brakes on a slippery surface, or rounding of a turn at high speed. Also applied to the small casterlike device placed under the wheels of the car to facilitate its movement in a garage.

SKIP: Interruption in the regular explosions of a gasoline engine.

SKIRT: The lower cylindrical portion of the usual type of hollow piston.

SLACK: Accumulation of "play" in a wire, rope, or series of mechanical connections.

SLAP: A pronounced thump or knock produced by oscillation of the piston on the wrist pin. The piston must be smaller than the cylinder and a violent downward thrust

occurring at the wrong time will cause the lower portion to strike against the cylinder.

SLIDE VALVE: A form of valve which slides on its side, thus exposing or covering the opening through which it controls the passage of the gases. Opposed to the poppet type of valve used on the majority of gasoline engines.

SLIP COVER: Covers of linen and other goods designed to fit the upholstery of the car.

SLIPPAGE: The amount in per cent of the lost motion between the wheels and the road.

SNAP: A form of curtain fastener similar to those used on gloves.

SNAP GAUGE: A type of gauge used for quickly determining the accuracy of a machined piece.

SOD PAN: A pan placed underneath the engine and transmission extending from one side of the frame to the other. Formerly used to protect the vital portion of the running gear from the effect of travel over highly crowned dirt roads.

SOLDER: A material of low melting point which can be used to hold in place or to repair pieces of iron, tin, lead, copper, and the like; used largely in electrical connections to provide an unresisting course for the current; also in liquid and air tanks to make leak-proof joints.

SOLUTION: The mixture of water and sulphuric acid used in the storage battery.

SOOT: A dry form of carbon which may be wiped off with a cloth.

SPACER: A metal ring or disk used to separate two or more ball bearings and hold them in the proper relation to one another.

SPANNER: A special type of wrench intended to fit holes arranged in a certain kind of nut on which the ordinary adjustable wrench cannot be used.

SPARK PLUG: The device used in the cylinders of a gasoline engine to form an air gap over which the ignition current will jump and produce the spark which explodes the mixture.

SPECTRUM: The division of rays of light into groups according to their relative length by means of a special lens. Scientists use the spectrum in analyzing metals and gases.
SPEEDOMETER: An instrument for determining the speed in miles per hour at which a car travels, usually mounted on the dashboard and employed in connection with a set of odometer figures (*q. v.*) which indicate the distance traveled.
SPIDER: The arms radiating from a common center and used to support a rim or gear. STEERING SPIDER: The arms or "spokes" of the steering gear. DIFFERENTIAL SPIDER: The radial spokes on which the small differential bevel gears are mounted.
SPIN: To turn rapidly without resistance, as to crank the engine rapidly by hand or with the starter, or, to slip the wheels at high speed in a mudhole or on a slippery pavement.
SPINDLE: A projecting step or shaft on which a bearing carrying a wheel or other revolving member is mounted.
SPIRAL: A form of line which surrounds a cylindrical surface and which becomes higher with each turn. All screw threads are in the form of a spiral. SPIRAL GEAR: A form of bevel gear in which the teeth are a portion of a spiral instead of the straight type formerly used.
SPIT: The sputter or pop back through the carburetor, due to the imperfect action of the valve or the use of too lean mixture.
SPLASH BOARD: A sheet of metal filling the space between the running board and the frame of the car.
SPLINE: A projection machined in the shaft parallel to the axis. Used to prevent the gears mounted thereon from turning independently of the shaft and yet allowing them to slide laterally. Used largely in transmissions.
SPLIT PIN: A cotter pin used to hold nuts in place.
SPOKE: One of the radial supports of the rim of a wheel.
SPOT LIGHT: A movable light of considerable brilliancy generally mounted at the side of the wind shield of the car to aid in night driving.

SPRAG: A pointed rod which may be let down to drag behind the car and serve as a brake to check a dangerous backward coast when climbing an exceptionally steep hill. Used largely in the Alpine countries.

SPRAY: To divide into a fine mist.

SPRING: A metal piece possessing elasticity which is employed to hold other parts in a certain normal position. SPIRAL SPRINGS are similar to a coil of wire. FLAT SPRINGS are, as the name implies, made of a flat piece of steel. LEAF SPRINGS are an assembly of long, flat steel bars of steel used in building up the supporting springs of an automobile.

STALL: To kill the engine through the application of excessive load or lack of sufficient throttle opening.

STANDARDIZE: To adopt a uniform shape, system, or size, so that parts for one car can be used on other cars of different makes without refitting.

STAND PIPE: A vertical pipe introduced in a water, fluid or air line to equalize pressures and serve as a pressure, or storage reservoir.

STARVE: To so reduce the amount of gasoline in the mixture that the engine fails to operate properly.

STEEL: The alloy of iron containing varying proportions of carbon.

STEERING GEAR: The steering wheel and all other mechanism by which the direction of motion of the car is controlled.

STEERING POST: The shaft on which the steering wheel is mounted and which transmits the twisting motion to a mechanism connected with the front wheel.

STEP-UP: To increase the voltage of an electric current for transmission purposes.

STETHOSCOPE: A sound-magnifying device intended to locate knocks and other danger signals in an engine.

STIFF: A term applied to an engine having unusually tight bearings, or to any portion of a mechanism which has insufficient freedom between moving parts to enable it to operate easily.

STILLSON: A special type of adjustable wrench which will grip pipes, rods, and other round metal.

STOCK: A term applied to a car manufactured in commercial quantities. Differentiated from a special car built to the requirements of one customer or group of customers.

STONE BRUISE: A rupture in the fabric of the tire caused by a sudden impact with a sharp corner. Such a condition may not always be evidenced from the tread of the tire, and for this reason it is a frequent cause for blowouts because the damage to the fabric cannot be observed by a casual inspection.

STORAGE BATTERY: An assembly of plates and chemicals used to receive charges of electric current and deliver them to the starting, lighting, and signal system at the will of the driver.

STORAGE (DEAD): A term applied to garage storage when a car is not to be used for a considerable length of time, and may, therefore, be kept in a less accessible portion of the building than would be the case were it to be operated every day.

STRADDLE: To rest with two supporting points on either side of an opening of another part.

STRAIGHT SIDE: A type of tire having a straight bead to fit the sides of the rim and used in the majority of large tires. Opposed to the clincher type, the bead of which is constructed with a circumferential hook-shaped projection.

STRAIN: An unusual load or treatment to which a part is subjected to an extent which compels abnormal action beyond its line of duty.

STRAINER: A cloth or wire-mesh device for preventing the passage of impurities with gas, air, or liquid.

STRANGLE: To check or reduce the supply of air furnished to the carburetor.

STRAP: A fabric or metal piece or band so shaped as to partly surround a member which it supports in suspension.

STRAP IRON: A length of thin, fairly flexible iron which can be bent to the desired shape without heating.
STRESS: A load or strain to which a part is subjected in the normal performance of its duty.
STRIP: To dissemble a car of all the parts not essential to its actual operation. Largely employed in racing to eliminate all unnecessary weight. Also a term applied to the damaging effect on the gear teeth occasioned when they are improperly meshed or when a load is applied too suddenly.
STRUT ROD: A rod occasionally employed on the rear axle to support the center section by means of the tension which it carries.
STUB: A short protruding end.
STUD: A small projection on which a separate part may be rigidly mounted.
STUFFING BOX: A nut-shaped cap fitting over the opening through which a piston or shaft projects, and provided with an adjustment whereby packing may be held in place with various degrees of tension to prevent the escape of liquid or gas beyond the moving part.
SUCTION: That stroke of the gasoline engine which is devoted to creating a partial vacuum which fills the cylinder with the explosive charge.
SULPHATE: A chemical action occurring in storage batteries due to rapid discharging or overcharging which eventually ruins the plates.
SULPHURIC ACID: A powerful and highly dangerous acid used as the active chemical agent in storage batteries.
SUMP: The portion of the engine lubricating system to which the oil is returned, in the bottom of the crank case, after its circulation.
SUN AND PLANET: An arrangement of gears employed to convert reciprocating into rotary motion, or vice versa.
SUPERHEAT: To reheat the gas beyond the boiling point of the liquid from which it was formed, or to raise its temperature by successive applications of heat. The

result is a dry gas from which every atom of moisture has been removed.

SUPPLEMENTARY SPRING: A spring employed to increase the "period of oscillation" of the automobile spring and thereby improve its riding qualities through the same effect as though the spring were made longer.

SUPPLY PIPE: The main feed pipe carrying the fuel from the tank to the carburetor or vacuum feed tank.

SURREY: A name applied to certain types of touring cars.

SUSPENSION: The act of holding up.

SWAY: A dangerous pendulumlike side motion communicated to a car when driven at excessive speeds.

SWITCH: A device for opening or closing an electric circuit.

SYNCHRONIZE: To so time a series of separate operations that their action becomes related, and all unite to the attainment of a common result.

SYNTHETIC: A chemical duplication of a mineral product. Synthetic rubber has proved one of the delusions of the times. Many men have endeavored to create a substance similar to rubber by combining several chemicals, but as yet nothing has been found to possess the qualities of the pure rubber as obtained from the rubber trees.

SYSTEM: The entire grouping of the various units of an assembly performing a certain office, such as the lighting system, ignition system, and the like.

T

TACHOMETER: An instrument similar to a speedometer which indicates the number of revolutions per minute at which the shaft or the wheel to which it is attached may be turning.

TAIL LIGHT: A red light displayed at the rear of a car or other moving vehicle, which is also used to illuminate the numbers of the rear license plate.

TALC: A fine white powder used in tires to prevent

chafing and heating between the tube and the inside of the shoe.

TAMP: To pack down gently but firmly; used in foundries to obtain a perfect mold from the casting sand.

TAN: The chemical treatment of leather which makes it suitable for commercial use; also a brown color.

TANK: A metal receptacle for containing gases or liquids; usually the main storage reservoir of an automobile. Also a name popularly applied to the heavily armored, crawler type of army tractor.

TAP: A tool used to cut threads on the inside of a hole drilled in metal; also the verb used to denote such an action.

TAPE: A sticky piece of thin canvas cut in a ribbon shape intended to be wound around exposed wiring to supplement the insulation or to repair breaks in such insulation.

TAPER: To make a tube or a bar of a constantly decreasing diameter.

TAPPET: The adjustment provided on a valve stem at the point at which it is lifted by the cam so that wear and valve grinding may be provided for.

TAR: A gummy oil material used to waterproof roads.

TARNISH: The effect produced on brass, nickel, and other polished parts by the action of water, gases, or dirt.

TAXI: A passenger-carrying vehicle in which rates and charges are based on the distance covered, which is recorded on the meter.

TEE: A T-shaped pipe having three openings which enables a junction to be made with the supply line.

TELESCOPE: So to fit parts that they will slide one within the other when collapsed.

TELLTALE: A signal or other device to indicate the height to which a tank is filled, or to give warning of other conditions. TELLTALE LIGHT: A dash lamp so wired that it is in series with the tail light, and will refuse to burn if the tail light is out of commission.

TENSION: A force tending to pull away from, as opposed to compression.

TERMINAL: The end of a wire or pipe. Specifically applied to the method of connecting electric wires to spark plugs, coils, batteries, lamp sockets, and the like.

TEST: To try out a part or a machine with a view of determining its correct condition or the discovery of faults.

TESTER: The employee of an automobile factory, service station or an agency, whose business it is to test completed cars after manufacture or repair. Also a device used to determine the condition of a battery, electrical system, or other portion of a car, as the case may be.

THERMAL: Relating to heat. THERMAL EFFICIENCY: The relation of the total power produced to the value of heat units of the fuel on which it operates.

THERMO-SIPHON: A system of water cooling which employs no pump for circulation and which relies on the physical law which causes the heated water to rise and cooled water to settle. The cooling effect of the radiator thus induces automatic circulation.

THERMOSTAT: An automatic device installed in the water-cooling system and designed to keep the temperature of the cooling water at sufficient heat to permit of the most economical operation of the car. The thermostat automatically closes the passage of the water leading to the radiator until the temperature has reached the desired point, at which time it opens and full cooling takes place.

THIRD: The third forward speed of a gasoline car; generally the direct speed, although, in the case of some cars provided with four speeds, it is the fourth which is connected directly with the drive shaft.

THREAD: The V-shaped projections placed in spiral arrangement on a rod to accommodate similar projections and indentations on a nut; when one piece is turned in relation to the other the spiral arrangement of the threads causes a forward or backward movement, depending upon the direction of rotation.

THREE-POINT: A type of engine or frame suspension

in which connection with the springs is made at only three points; this gives flexibility without distortion.

THROTTLE: The valve placed in the pipe between the carburetor and the intake manifold which regulates the amount of mixture fed to the cylinders, and which, therefore, controls the speed of the engine; also a verb indicating the use of the throttle.

THRUST: A weight or load applied longitudinally or parallel with the piece carrying such a load. For example, the axle normally carries a rotary load and a transverse load. A thrust is induced, however, whenever a car rounds a turn and creates a resistance to the sidewise motion of the car.

TICKLER: A small lever protruding from the valve chamber of the carburetor and used to operate the float valve to obtain additional supplies of fuel when starting.

TIE ROD: A rod extending parallel with the front axle which connects the steering knuckles of the two front wheels so that one will turn in conformity with the other.

TILT: To move out of the vertical or perpendicular.

TILTING WIND SHIELD: The form of wind shield in which the supports or the stanchions lean backward toward the rear of the car.

TIMER: That portion of the ignition system which controls the time at which the spark shall occur in each cylinder in relation to the position of the piston.

TIMING: The act of setting the valve or spark mechanism so that the various movements shall occur in proper relation to the position of the piston.

TIN: One of the mineral elements. Largely used in tank construction and for other purposes requiring flexible and easily manipulated sheet metal. Also the verb referring to the process of treating a soldering iron which enables it to hold melted solder on its point.

TIRE: The removable covering of a wheel which rolls in contact with the road.

TISSUE: The cellular matter of which fibrous bodies are

composed. Also paper or metal worked out into a very thin sheet.

TOE-IN: The construction of the front wheels which causes them to stay closer together at the front than at the rear to keep the natural tendency of the car in the forward direction.

TOGGLE: The arrangement of levers and joints to produce a tremendous pressure which can be obtained by its proper operation. The arrangement usually consists of two or more rods and joints which, when extended to form a straight line, move the parts to which they are connected farther apart and lock them in this position.

TOLERANCE: The limits given by the designer to a workman, representing the accuracy to which the finished product must be kept. In many of the automobile parts a tolerance in each direction of about one or two 10,000ths of an inch is permitted.

TON: The weight represented by 2,000 pounds. The long ton is a unit of wholesale measure and represents 2,200 pounds.

TONNEAU: The rear portion of a touring car in which the passengers are seated.

TOOTH: One of the series of projections on a gear wheel, which, during the course of its revolution, meshes between the corresponding teeth on the adjoining gear wheel.

TOP: The permanent or folding protection over the body of a motor car or truck.

TORCH: A pipelike arrangement through which gas or other kinds of fuel is injected to form light or heat. The plumber's torch employs gasoline vapor as fuel and is used to heat soldering irons and the like.

TORPEDO: The shape of automobile body in which the rear tapers to a point similar to the nose of the marine torpedo.

TORQUE: A term applied to the force developed by a turning part.

TORSION: The strain induced through the twisting or rotating force of a shaft or wheel.

TOUGHEN: To increase the resistance to cutting or breaking of a metal through heat treatment or chemical process.

TOURING CAR: The type of motor car having accommodation of from four to seven passengers, and provided with a folding top.

TOWN CAR: The type of motor car with an inclosed cab-like body having no protection for the driver, who sits forward of the inclosure.

TRACK: Rails of metal or wooden pieces laid at a given distance apart on which another body may be made to slide or revolve. Also the effect obtained when a series of wheels in a train of trucks or trailers follows in the track of each preceding wheel.

TRACTION: The grip obtained between the power-wheels of the vehicle and the road, which causes the vehicle to be moved forward.

TRACTOR: A heavy type of automotive machinery used to haul trailers or other vehicles. Also the mechanical device used for plowing, harvesting, and the like, which takes the place of horses on the farm.

TUBE: A long cylindrical piece of hollow metal or other material. Also a pure rubber air container which is placed inside of the shoe or the tire.

TUBULAR: Pertaining to a tube in shape or construction. Tubular shafts which transmit power through rotation are found to be as strong as those which are solid.

TUNE-UP: To adjust the moving parts of a car so that its operation is as nearly perfect as possible.

TURNBUCKLE: A solid piece joining the threaded ends of two rods, one being a left-hand and the other a right-hand thread. The rods will thus be brought closer together or forced farther apart, depending upon the direction in which the turnbuckle is screwed.

TURNING RADIUS: The radius of the smallest circle within which a car may be completely turned around.

TURNTABLE: A mechanical device used in garages for

turning a car in any direction without necessitating movement of the wheels of that car.

U

UNDERCUT: To machine or cut with a tool so that a small cavity is formed under a projecting lip or edge.

UNDERSLUNG: A type of chassis construction, popular a few years ago, in which the frame is suspended under both the front and rear axles. In some modern designs the springs themselves are clamped to the under side of the axle, but the frame rests above in the usual position.

UNION: A pipe fitting threaded at each end, used to connect two other pieces of pipe in a fluid or pressure line. Differentiated from a nipple in that a union has the threads cut on the inside and fits over the pipes to be joined; whereas on a nipple the threads are cut on the outside and fit into the union.

UNIT: A part or a collection of parts serving a single purpose. More restricted in its character than a system. Generally applied to self-contained parts of a system, such as the distributor unit, generator unit, and the like.

UNIVERSAL: The joint in a power-transmission line which permits slight variations in the direction of rotary motion. This is a necessary attachment on any flexible or semi-rigid shaft which cannot transmit its power in an absolutely straight line.

UPSET: A blacksmithing and forging term applied to the process of hammering down a heated bar or rod to increase its diameter.

V

VALVE: A mechanical device used to control the flow of gas or liquids. These range in design from the mechanical, instantaneously operated exhaust and inlet valves of the gasoline engine to the infrequently used hand-operated drip valves and drain valves of the fuel and cooling systems.

VANADIUM: An alloy used in steel to give properties of great strength and elasticity.

VAPORIZE: To convert a liquid into a gas.

VAPORIZER: A term sometimes applied to the carburetor. The modern carburetor, however, serves more than this single purpose in that it also mixes the vaporized fuel with exactly the proper quantities of air to meet the various conditions of operation.

VARIABLE: A mathematical term applied to any group of figures which vary in amount by a regular or irregular degree.

VENTURI: A tube constricted in its diameter at a certain point in order to increase the rapidity of the flow of the gases or liquids passing through it. A venturi is a part of the construction of nearly all modern carburetors and is placed at the point at which the gasoline mixes with the air in order to increase the flow of the air and thus add to the suction.

VIBRATION: A rapidly recurring regular action occasioned by rhythmical motion of some rigid body. SYNCHRONOUS VIBRATION: A vibration of one piece which is timed to correspond exactly with that of another part, thus producing what might be called "sympathetic" vibration.

VIBRATOR: A springlike piece of metal used in some ignition systems to make and break a current rapidly so that it can build up in the coil and be emitted with added force at the spark-plug terminals.

VISCOSITY: The property affecting the rapidity of flow of a liquid; applied especially to oils in which viscosity is measured by the number of drops passing in a given time at a predetermined pressure through a standard size of opening. The viscosity of oils varies greatly with the temperature and increases as the oil thickens, due to the application of cold.

VISE: A device attached to a work bench or other substantial mounting which has movable jaws controlled by a handle. These jaws may be brought tightly together to hold a piece of work in place.

VISOR: A projecting lip of glass or metal. In the form

of glass it may be used to reduce the glare of head lights, and in metal it may be the end of the old type of mud guard or fender.

VOLT: The unit of electrical pressure. This corresponds to the number of pounds or feet "head" in a water-supply system. VOLTMETER: An instrument for registering the voltage supplied by the battery or other electrical producer or reservoir. VOLTAMMETER: A combination instrument registering both voltage and amount of current or amperes.

VOLUMETRIC EFFICIENCY: The relation between the actual capacity of the cylinders of a gasoline engine and the amount of combustible charge sucked in at each stroke. The power output of the engine is dependent upon this volumetric efficiency, hence the advantage of large valves which permit the cylinders to be completely filled with the explosive mixture.

VULCANIZE: A method of treating rubber by the application of heat to render it more serviceable for commercial purposes. The process of vulcanizing also tends to fuse or weld parts together so that the repaired section may be as strong as the original section.

W

WALKING BEAM: A mechanical action composed of a lever with the fulcrum placed between the points of application of the power and load. A term sometimes applied to the rocker arm of the overhead type of valve mechanism.

WARP: To change in shape due to the action of moisture in the atmosphere or great differences in temperature. Applied specifically to the continual heating and cooling of the exhaust valve which may eventually cause a change in the shape of the head, thus preventing perfect seating.

WASTE: Threads and other remnants of cotton or linen manufacturing used largely for wiping and cleaning oily and greasy parts of machines.

WATER COOLING: A system of circulating water

around cylinders of the gasoline automobile engine for the purpose of transferring the heat from the explosion chambers to the radiator, where this heat is dissipated into the air.

WATT: An electrical unit of energy obtained from multiplying the voltage by the number of amperes consumed.

WEAK: A term applied to a mixture when it does not contain a sufficient amount of gasoline vapor to permit proper combustion. Also applied to the ignition spark when the current is not of sufficient intensity to furnish adequate or regular explosions.

WEAVE: An intermittently occurring misalignment of the parts of a large structural piece such as the frame of an automobile. This will occur when the car is driven over deep depressions if the frame is not of sufficient stiffness.

WEB: A thinner piece of structural metal used between other portions for the purpose of support. The web of the frame is the vertical section connecting the two flanges, or the horizontal projections.

WEDGE: A tapered piece of metal or wood used to hold two parts firmly in position. Applied specifically to the pieces of iron forced into the space between the felloe around the automobile wheel and the tire rim to hold the latter in place and yet permit of its quick removal.

WEEP: The appearance of moisture or liquid in vapor form at a joint or union, indicating a slight leakage.

WESTCOTT WRENCH: A type of adjustable wrench with the jaws placed at the end of a curved handle or set at a slight angle so that nuts inaccessible to the ordinary type of adjustable wrench may be reached.

WHEEL: A circular mass of wood or metal which may be revolved upon its own axis.

WHEEL BASE: The distance, usually expressed in inches, between the center of the front and rear axles of an automobile. This point is generally measured between the center of the front and rear wheels when the former are in their straight-ahead position.

WHEEL PULLER: A mechanical device used for removing automobile wheels from the shafts on which they revolve.

WHETSTONE: A stone or other composition of uniform construction used for securing a fine edge on cutting instruments.

WICK: A cotton fabric used in kerosene lamps to convey the fuel by means of the capillary attraction to the source of light. Also used in certain types of oiling systems to carry the liquid lubricant to the proper point in the bearing.

WINDAGE: The amount of energy required to overcome air friction by a revolving part.

WINDING: An assembly of wires placed around the armature of an electrical instrument or the core of a coil or a magnet.

WIND RESISTANCE: The power required to overcome the propulsion of a vehicle through the air at a given speed. This increases above all proportion to the increase in speed and may call for 100 H. P. or more in case of speeds in excess of 60 or 75 miles per hour.

WIND SHIELD: A glass protection placed on the dash in front of the driver to prevent the annoying rush of air when driving at high speeds, and to protect the occupants from rain.

WINE COLOR: A reddish purple or lavender tone once popular as a color for passenger cars.

WIPER: A mechanical device provided with a rubber strip, which, when moved across a wind shield, frees the surface of rain, snow, and vapor. Also a device operated mechanically to apply lubricant to certain portions of a machine.

WIRE DRAWING: A term applied to the effect obtained when air or gas under pressure is forced at too high a velocity through an opening of a restricted size.

WIRE WHEEL: A type of automobile wheel in which the spokes are composed of steel rods or wires, the tension of which may be changed. In such a wheel the weight of the

car is suspended from the upper spokes, the lower thus being carried in compression. In the case of wood or disk wheels, however, the weight of the car rests on the lower section of the wheel, thus relying on the compression of the parts for carrying the load.

WIRING DIAGRAM: A diagram furnished by the car manufacturer or the manufacturer of the electrical system, designed to show the location of the various wires used in the system in question.

WOOD ALCOHOL: A poisonous alcohol distilled from sawdust, which may be used in connection with painting or varnishing a car, and for cleaning. It also prevents the freezing of the cooling water in the engine.

WOOD WHEEL: A type of automobile wheel in which the spokes and the inner rim are of wood; frequently called "artillery wheel."

WORKING STROKE: The one effective stroke of the gasoline engine which follows the ignition of the charge. The remaining three strokes of the ordinary four-cylinder engine are not work-producing, but rather work-consuming, inasmuch as no power is derived from them and the energy of the flywheel or the other cylinders is required to move the piston until it reaches its position ready for the following working stroke.

WORM: A coarse cut thread on a shaft used for conveying power at a greatly reduced speed to a wheel revolving with its axis at right angles to the shaft on which the work is mounted.

WRAPPED TREAD: A method of building tire treads by a hand-wrapping process instead of by the use of molds.

WRENCH: A tool with a fixed or adjustable opening used to obtain leverage for loosening and tightening a nut.

WRINKLE: Any quick, simple, and effective method of performing a repair or obtaining a special result in connection with automobile operation.

WRIST PIN: Sometimes called piston pin; a shaft or

stud which forms the bearing between the upper end of the connecting rod and the piston.

Y

YOKE: A forked piece of metal used as a means of attachment for mechanical operations. Applied specifically to the means by which the members of a clutch are disengaged when pressure is applied at the pedal. Also the usual termination of a brake rod at its point of connection with the operating linkage.

THE END

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